



Waveform Generator 175 (Model ER175)



- Interactive operation
- Output pulses, ramps, triangles, and sine waves
- Define initial conditions
- Ideal for cyclic voltammetry
- Works with many types of potentiostat
- Serial interface protocol with USB connection

Description

The eDAQ Waveform Generator 175 is designed to produce relatively slow waveforms where the user can manually interact with the experiment to pause or reverse the applied waveform.

Pulses, ramps, triangles and sinusoidal waveform can be defined with amplitudes up to ± 10 V. In addition the triangle function can be started at any arbitrary value.

Waveforms are generated by an internal DAC at clock speed of 10 kHz with 22 bit resolution.

TTL (or contact closure) signals are provided to synchronize the waveform with other laboratory devices (eg dropping mercury electrodes, third party potentiostats, light sources, stirrers, etc).

Applications

The Waveform Generator is ideal for cyclic and linear sweep voltammetry where the user may wish to reverse, or pause, the sweep during the experiment. It can also be used to set up a series of voltage levels, each over a different duration, and to repeat this sequence if required. Other applications include vibration and servo-control loop testing.

Computer Requirements

The computer should have a spare USB port for direct connection of the Waveform Generator, or for connection to an e-corder with which the Waveform Generator is being used. Windows XP or later is required for use with an e-corder system.

Software

The Waveform Generator can be used with an e-corder unit (via the I²C connection) and eDAQ Chart software. Alternatively it can be used with its AC mains adaptor, and serial compatible software (RS232), via the computer USB port (a virtual serial port is created) — such as:

- LabVIEW™, www.ni.com
- Connect™, www.labtronics.com/DI/RS232_Software.htm
- WinWedge®, www.taltech.com/products/winwedge.html
- Tera Term, <http://logmett.com/>

or with your own software written in Visual Basic or C++ etc.

Ordering

The eDAQ Waveform Generator (model ER175) includes hardware unit, cables and 12 V DC mains adaptor.

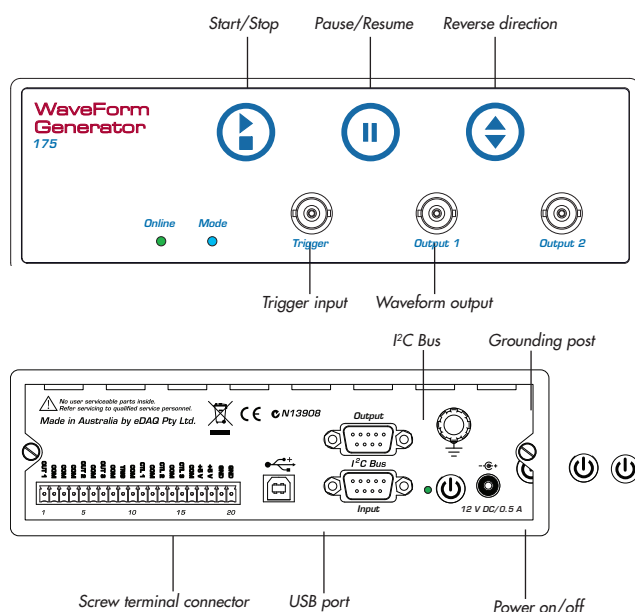


Figure 1. Front and back panels of the Waveform Generator.

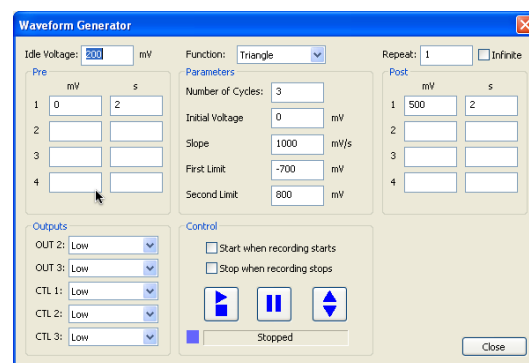


Figure 2. Control panel provided by Chart software.

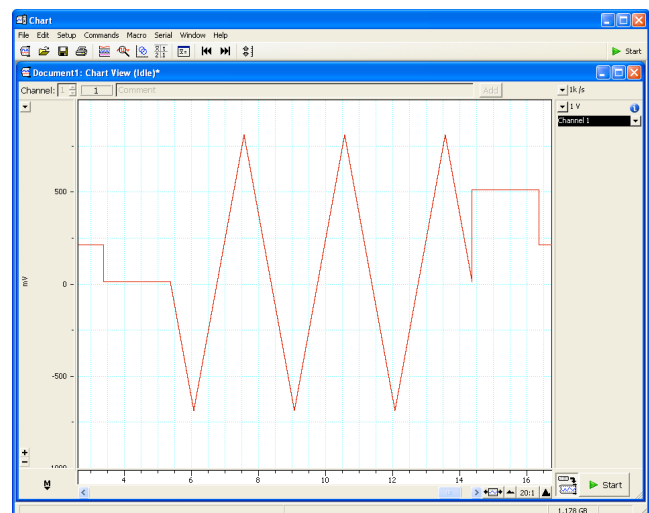


Figure 3. Triangular waveform with pre- and post-function voltage levels.

Serial Communications

The Waveform Generator is fitted with a USB port. This can then be used as a virtual serial port with Windows, Mac OSX, and Linux computers. A Windows USB driver for most Windows computers is located on the eDAQ Software Installer disk supplied with the Waveform generator. Otherwise you can download a suitable driver from

<http://www.ftdichip.com/Drivers/VCP.htm>

Software can then be written to communicate with the Waveform Generator as a serial (RS232) device, for example using LabView, Visual Basic, or C++.

The serial port number must first be established. Serial Ports 1 and 2 on Windows computers are reserved for the mother board. Thus it is common to find that the Waveform Generator is located on serial port 3 (COM3) or greater.

The virtual serial port should be configured as 115200 baud, 8 bits, 1 stopbit, no parity. Set the flow control to NONE.

When correctly configured the unit will send the command prompt **WF>** to indicate that a new command can be sent. This is abbreviated to **>** in the description below.

Interactive Communication

You can use terminal emulation software (eg Tera Term) to manually interact with the Waveform Generator:

1. Download the Tera Term installer from <http://logmett.com>
2. Install Tera Term choosing the 'Compact Installation' option to reduce unnecessary extras.
3. Connect the Waveform Generator, and provide the computer with the eDAQ Software Installer CD if a USB driver is requested.
4. Open the Windows device manager and find the Waveform Generator and its corresponding COM port listed under 'Ports (COM & LPT)'. On first use there is no way to know in advance what COM port will be assigned to the isoPod, except that it will be COM3 or greater.

Once interactive communication is established you can be confident that the serial communications are working and can proceed to write your own software.

Serial Protocol

The Waveform Generator will accept certain commands, as listed below. Durations can be entered in units of seconds (the default), milliseconds, or microseconds. For example durations of 5, 5s, 5 ms, and 5µs, would all be accepted as legal durations. Voltage levels are entered in millivolts within the range ±10000 mV.

Help command

> help
> ?

Returns a list of legal commands

Waveform definitions

> pre <level> <duration> [<level> <duration> ...]

Up to twenty voltage levels and durations can be defined. These are applied immediately before the main function. Example **> pre -800 15s** will apply -800 mV for 15 s before the function is started. This command can be used to set a deposition and resting potential prior to a ramp for anodic stripping voltammetry.

> triangle <N> <slope> <start level> <first limit> <second limit>

Defines a triangle function of **<N>** cycles that will begin at the **<start level>** and proceed to the **<first limit>**, then to the **<second limit>**, and back to the **<start level>** at a rate of **<slope>** mV/s. Example **> triangle 5 100 200 800 -500** defines a cyclic voltammogram repeated 5 times of rate 100 mV/s starting at 200 mV and proceeding to 800 mV, then to -500 mV and back to 200 mV.

> ramp <N> <slope> <first limit> <second limit>

Defines a ramp function of **<N>** cycles that will begin at the **<first limit>** and then go to the **<second limit>** at a rate of **<slope>** mV/s. Example **> ramp 1 100 -200 700** defines a single linear sweep voltammogram of rate 100 mV/s, starting at -200 mV and proceeding to 700 mV.

> pulse <N> <first level> <first duration> <second level> <second duration>

Defines **<N>** pulse sequences of **<first level>** mV that will be applied for period of **<first duration>** followed by **<second level>** mV that will be applied for period of **<second duration>**. In many cases **<second level>** will be equal to the idle voltage. Example **> pulse 999 450 200ms -50 800ms** defines

a pulse sequence comprising a pulse of 450 mV for 200 ms followed by -50 mV for 800 ms, which is repeated 999 times.

> sine <N> <frequency> <baseline> <amplitude>

Defines **<N>** cycles of a sine wave function of **<frequency>** Hz and **<amplitude>** mV about a centre of **<baseline>** mV. Example **> sine 99999 25 0 50** defines a sine wave of 25 Hz and amplitude 50 mV (100 mV peak-to-peak) centred at zero volts.

> none

No Function will be applied (which is the default state). This can be used when you want to apply a constant potential, or a series of voltage levels with the **pre** and **post** commands.

> post <level> <duration> [<level> <duration> ...]

Up to twenty voltage levels and durations can be defined. These are applied immediately after the main function. Example **> post 300 5s -500 2s** will apply 300 mV for 5 s and then -500 mV for 2 s after the main function is complete. After the last post level the idle voltage will be reinstated. This command can be used to set a cleaning potential after completion of an anodic stripping voltammetry experiment.

> repeat <N>

Configures a waveform, defined by the pre, function, and post definitions, so it is repeated **<N>** times and then goes to the idle voltage. The default value is **<N> = 1**. If **<N> = INF** then the sequence is repeated until a stop or pause command is sent.

Actions

> idle <level>

Sets an idle voltage level which is immediately applied or, if a waveform is running, after the waveform has ended. The idle level is output whenever the waveform is stopped.

> run or **> go**

Begins the waveform defined by the pre, function, and post definitions, and then sets the idle voltage. This command is also initiated on receipt of a suitable signal at the front panel Trigger connector. Equivalent to the front panel start button.

> stop

Stop, and return to the idle voltage. Equivalent to the front panel stop button.

> reverse

Reverse the waveform being output. The idle voltage value is unaffected. Equivalent to the front panel reverse direction button.

> pause

The waveform being output is halted at its current value. Equivalent to the front panel pause/resume button.

> resume

The waveform is continued after being paused. Equivalent to the front panel pause/resume button.

> prompt off or **prompt on**

Disable or re-enable the command prompt.

Synchronization signals

Output 2 is located both on the front panel and on the back panel screw terminal connector. Output 3 and the Control lines (CTL1, CTL2, and CTL3) are located on the back panel screw terminal. They serve to synchronize the operation of other equipment with the generated waveform.

By default the Control lines are configured as open contact closures (CC). Outputs 2 and 3 are set at 0 or +2.5 V, whereas the Control lines are set at 0 (Low) or 4 V (High) when configured with the **TTL on** command. **PulseAt...** or **PulsePer...** commands (cause a 10 ms inversion of the state (eg low to high, or open to closed).

> TTL off

Configures CTL1, CTL2, and CTL3, to operate as contact closures. This is the default state, with the contacts open.

> TTL on

Configures CTL1, CTL2, and CTL3, to operate as TTL (which is low as the default).

> output <outputname> <outputfunc>

where **<outputname>** = OUT2, OUT3, CTL1, CTL2, or CTL3, and **<outputfunc>** = Low, High, PulseAtRun, PulseAtFunction, EntireRun, FunctionSync, SlopePos, SlopeNeg, PulseAtLimit, or PulsePerCycle. The synchronisation output functions cause the conditions defined in Table 1.

Table 1. Output functions available for synchronization with an external device.

Low	TTL low, CC open
High	TTL high, CC closed
PulseAtRun	TTL pulse, or brief CC closed, at start of pre period
PulseAtFunction	TTL pulse, or brief CC closed, at start of function
EntireRun	TTL high, CC closed, from start of pre period to end of the post period
FunctionSync	TTL high, CC closed, from end of pre period to start of the post period
SlopePos	TTL high, CC closed, when a triangle or sine function is increasing
SlopeNeg	TTL high, CC closed, when a triangle or sine function is decreasing
PulseAtLimit	TTL pulse, brief CC closed, at upper or lower limit of triangle function
PulsePerCycle	TTL pulse, brief CC closed, at end of each main function cycle

Use with e-corder and Chart Software

The Waveform Generator can also be used in conjunction with Chart software (version 5.5.9 or later) and an eDAQ e-corder unit. In this case the I²C ports of the e-corder and Waveform Generator are connected with the cable provided. This provides communication to the Waveform Generator (the USB cable is not required). Power up the Waveform Generator with the 12 V DC plug pack before starting the e-corder and Chart software. The software control panel (Figure 2) is accessed using the Waveform Generator command in the Chart Setup menu. No programming with the serial protocol is required!

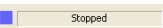
The various settings: pre, post, function, idle, repeat, output etc. are equivalent to the serial protocols of the same name, discussed in the previous section. In addition the controls:

- Start when recording starts
- Stop when recording stops

enable the waveform to be started and stopped in synchronization with the Chart software Start and Stop recording commands. The virtual buttons:



emulate the actions (stop/start, pause/resume, and reverse) of the equivalent front panel buttons, Figure 1, and the slider bar:



indicates the condition of the unit and the degree to which a waveform has been completed.

When using an e-corder and Chart software typically the Waveform Generator Output 1 is connected to the potentiostat external input (often labelled 'E in', or 'Ext In'), while the potentiostat potential and current signal outputs are connected to the various e-corder input channels.

For testing purposes, the Waveform Generator Output 1 can be attached to the e-corder front panel Input 1 connector. This will enable the Chart software to directly record the Waveform Generator signal.

Hardware Features

The Waveform Generator front and back panels are shown in Figure 1. The front panel indicator lights are:

- Status. Green when on, blinks during serial or I²C communication.
- Mode. Blue when not running (idle voltage being applied). Green when a waveform is running. Orange when the waveform is paused.

There are three control buttons on the front panel:

- Starts and stops the waveform running. The waveform comprises a series of preconditioning voltage levels (pre), the main function (triangle, ramp, pulse, or none), followed by postfunction (post) voltage levels as defined by the Chart control panel, Figure 2, or by a set of instructions sent over the virtual serial port.
- Pauses the waveform at the instantaneous voltage level. Pressing again will resume the waveform from the point at which it was paused.
- Reverses the direction of a function. The values of the idle voltage and pre and post levels are unaffected.

Three connectors are also located on the front panel:

- Trigger. A TTL pulse or contact closure received at this input will cause the waveform to start running.
- Output 1. This is the main waveform signal which is normally connected to the input of a potentiostat, oscilloscope, or e-corder.
- Output 2. This analog output is controlled by the serial protocol commands (see above).

The back panel features a:

- USB Port. Required for a virtual serial port connection to a computer. This enable use of the serial protocols (above).
- I²C Port. Required for connection to an e-corder unit and use with Chart software.
- 12 V DC input. Required when not being used with an e-corder. Depress the On/Off switch for a couple of seconds to actuate.
- Grounding post. This chassis grounding point may be useful if you are experiencing high noise levels. In most situations it is not required.
- Screw terminal connector. This terminal block provides alternative connections to the front panel functionality. It also provides various synchronization functions which are described in Table 1 and which are controlled by the **output** serial command (above) or the Outputs section of the Chart software control panel, Figure 2.

Specifications

Waveform signal	
Output signal:	±10 V maximum
Output accuracy:	±1 mV + 0.02% of full scale
Output current:	±50 mA continuous (200 ohm load)
Waveforms:	Pulse, ramp, triangular, sine
Ramp and triangle sweep rates:	< 1 mV/h to 1 V/s (with 0.1 mV steps) 10 V/s (with 1 mV steps)
Waveform steps:	Minimum step width 100 µs Minimum step height 5 µV
Noise (p-p):	<15 µV typical
Linearity:	<0.02% typical
Slew rate:	0.2 V/µs
Controls	
Front panel buttons:	Stop/start Pause/resume Reverse sweep direction
Trigger input:	TTL or contact closure
Logic outputs :	CTL 1, CTL 2, CTL 3
Logic TTL levels:	4 V high @ 1 mA maximum each 0.5 V low at 15 mA maximum each
Analog outputs:	OUT 1 (main output), OUT2, OUT3
OUT2, OUT3 logic levels:	2.5 V high 0.0 V low

Available logic signals:	Low, High, Pulse at Run, Pulse at Function, Entire Run, Function Synch, Slope is Positive, Slope is Negative, Pulse per Cycle
Auxiliary power:	Two +5 V outputs @ 100 mA maximum each
Preconditioning levels:	4 (Chart software) 20 (serial protocol commands)
Postfunction levels:	4 (Chart software) 20 (serial protocol commands)
Function cycles:	1 to continuous
Repeat loops:	1 to continuous
Instrument Connection Port	
Type:	20 pin male connector, 3.5 mm spacing. Screw terminal adaptor supplied.
Data Communication	
USB:	USB 2.0 or 1.1 compliant
I ² C expansion port:	Power and control bus when used with e-corder. DB-9 connector.
Physical Configuration	
Dimensions (w x h x d):	200 x 65 x 250 mm (7.9 x 2.6 x 9.8")
Weight:	1.4 kg (3 lb 1 oz)
Power Requirements:	12 V DC, 2 A
Operating conditions:	0 to 35 °C 0 to 90% humidity (non-condensing)

eDAQ Pty Ltd reserves the right to alter these specifications at any time.