QUALITY INSPECTION SUMMARY

We have made every effort to manufacture this instrument to the highest quality standards. All assemblies have been thoroughly tested and inspected at the factory as follows:

Initial Assembly Inspection ________☐
Initial QC Inspection/Calibration ________☐
Burn-In Cycle ________☐
Final Performance Inspection ________☐

Packaging Inspection Initials: __________ Date: __________

Items included with any catalog number may be labeled and packaged separately in shipping carton.

Description	**Quantity**	**Checked**
Cat.#55-60-0 PGM Pulse Generator Module		
Containing:		
PGM	________	☐
PGM Accessory Kit	________	☐
Cat.#55-65-0 ESG Electrical Stimulus Generator		
Containing:		
ESG	________	☐
ESG Accessory Kit	________	☐

FHC, Inc. maintains a system of traceability to allow for product notifications in the event that issues arise pertaining to the recall or failure of critical components contained in this instrument. In order that we may properly notify you, we ask you to complete the following information and return to:

Quality Assurance Department
FHC, Inc.
9 Main Street
Bowdoinham ME 04008 USA
Serial Number(s) _________ _________ _________
Installation and Functional Checkout Complete per section 2.2 and 2.4 of this manual:

Accepted by: ____________________

Institution: ______________________

Date: __________________________

0.1 EC Declaration of Conformity

We: **FHC Europe (TERMOBIT PROD srl)**

of:

129 Barbu Vacarescu Str, Sector 2
Bucharest 020272
Romania
declare that:

Equipment: **StimPulse Electrical Stimulation System**

Model: **Catalog No.s *55-60-0, 55-65-0***

Serial Number: ___________

Serial Number: ___________

Serial Number: ___________

has been designed and manufactured to the following specifications:

IEC61326 Electrical Equipment for Measurement, Control, and Laboratory Uses

I hereby declare that the equipment named above has been designed to comply with the relevant sections of the above referenced specifications. The unit complies with all essential requirements of the Directives.

Signed by: Keri S Seitz Date: 11/19/10

Name: Keri Seitz

Position: President , FHC

Done at: *FHC Inc., 1201 Main Street, Bowdoin, ME 04287 USA*

Phone: 1207-666-8190, Fax: 207-666-8292

E-mail: *fhcinc@fh-co.com*, Website: http://www.fh-co.com

"Innovation through collaboration"

Providing Instrumentation and Apparatus for Cellular Research, Intraoperative Recording; and Microneurography; Microelectrodes, Micropipettes, and Needles to the Neuroscience Community for 38 years.

StimPulse Electrical Stimulation System

55-60-0 PGM Pulse Generator Module
55-65-0 ESG Electrical Stimulus Generator

A1005 (REV. A0, OCTOBER 2010)

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Sector 2
Bucharest 020272
Romania

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Manual A1005: StimPulse

0.2 *CONDITIONS FOR USE*

Intended Use
The ESG is used to provide an electrical stimulus to activate cells as part of in vivo, in vitro, or in situ experiment setups. The PGM is used to provide timing pulses and triggers to stimulus generators or other devices. These devices are not intended for human use.

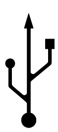
Warnings
The StimPulse should not be disassembled beyond its major assemblies. Any disassembly beyond this may affect function and calibration. If repair is required please contact FHC at (207) 666-8190 for evaluation and to secure a return authorization number if necessary. Take care to keep the vent holes designed into the packaging of the PGM and ESG free of any obstruction. Additionally, keep any devices that would be affected by heat away from these vents.

Storage Precautions
Store at normal room temperatures between -34°C (-29°F) and 57°C (135°F). Do not expose to temperatures below -39°C (-29°F) or greater than 70°C (158°F), or a relative humidity of less than 10% or more than 100%, including condensation, or an atmospheric pressure less than 500hPa or greater than 1060hPa for long-term storage.

Sterilization
The StimPulse and accessories are not designed for sterilization.

Handling
While a high degree of durability has been designed into the StimPulse, care should be taken not to drop them. Place all cables and leads where they will not be inadvertently pulled or tangled.

0.3 *SYMBOLS USED*



USB: This symbol is used to designate a standard USB connection.

1 *OPERATIONAL MANUAL*

1.1 *FEATURES*

- Simple or complex timing trains of 1µsec resolution in a single channel device.
- Medically isolated constant current or voltage with a compliance range of +/-125V
- Monophasic or biphasic, charge-balanced, and multilevel rectangular pulse output with additional ramp, sine, zeta, and arbitrary waveform support.
- Built-in viewing function displays ideal or actual stimulus delivered during output.
- Custom waveforms and trains can be imported from Matlab or similar general-purpose waveform editors via USB port.
- Onboard Digital Signal Processor (DSP) performs real-time control of the operation. Flexible firmware and USB ports allow updates and customization through downloaded flash upgrade.
- Digital inputs/outputs for interaction with recording and behavioral systems, or to provide timing for other lab devices
- Safety output shutoff if actual voltage/current exceeds set parameters.
- User-configurable AC/DC coupling of the output and multiple chassis grounding options.
- Preset functionality allows storing of specific parameter settings for later recall.
- Factory loaded presets provide convenient templates for startup programming.
- Growing downloadable library of user-contributed presets located at www.neurocraft.com. Custom preset programming available on request.
- Fully customizable for specific application needs through downloadable firmware upgrade
- Desktop or rack mountable

1.2 *DESCRIPTION*

The neuro/Craft™ StimPulse Electrical Stimulation System is comprised of two devices, the PGM Pulse Generator Module and the ESG Electrical Stimulus Generator, that deliver isolated electrical stimulation in a wide range of user-defined timing and pulse parameters.

Flexibility

The Pulse Generator Module (PGM) provides a broad spectrum of timing control parameters, from simple to complex, without the need for additional channels or devices. A wide range of waveforms are supported including monophasic or biphasic square, charge-balanced biphasic, ramp, sine, zeta, and multi-level rectangular. Arbitrary waveforms are easily imported or exported from Matlab, or similar general-purpose waveform editors, through USB port connections. Simple or complex pulse timing trains of 1 microsecond resolution are created through an intuitive, graphical interface, or imported through the USB.

An onboard digital signal processor (DSP) performs real-time control of the operation. The PGM is fully customizable through simple firmware updates using provided USB ports. Additional USB interfaces to a PC, external storage device, keyboard and mouse are also provided.

The PGM's intuitive user interface supports straightforward creation and storage of multiple user presets. Easy import/export functionality allows sharing of these presets between devices, as well as convenient storage. FHC maintains a growing library of downloadable preset files. Custom preset programming is available by request from FHC Technical support.

Performance

The ESG Electrical Stimulus Generator delivers a galvanically isolated constant current or voltage with a compliance range of +/-125V. User-configurable features include AC/DC output coupling and mulitiple chassis shielding options. The ESG additionally includes ground shunts during low use periods to prevent leakage and noise artifacts.

Safety

To protect subjects, the ESG and PGM automatically shut off if output exceeds set voltage/current parameters. The mini transformers provide high output isolation characteristics. The microelectrode cabling is designed with "No Touch" connections.

Feature Rich

The compact PGM may be rack mounted or set on a desktop. The ESG is linked to the PGM by a 3m data cable, allowing placement close to the preparation. Digital inputs include programmable triggering options and outputs conveniently link to recording and behavioral systems. The PGM may also provide timing for other lab devices. The touch screen interface doubles as a graphic display of the ideal or actual output during the experiment. A secondary analog output of the ideal or actual stimulus output is provided for viewing or recording.

1.3 *OPERATING ENVIRONMENT*

The StimPulse has been designed to operate in a typical laboratory setup. The devices should be placed on a flat surface that is level and free from contaminants and vibration.

1.4 *INVENTORY*

1.4.1 *ITEMS DESCRIBED IN THIS MANUAL*

The following Items are included under the following catalog numbers:

1 ea. 55-60-0 PGM Pulse Generator Module

Includes: PGM Module
A1005 Manual (not shown)
Accessory Kit
Includes:
Probe Communication Cable (10')
USB 2.0 Cable (5')
Digital Input/Output BNC Adapter Cables (6ea.)
Male Phono Patch Cable (6ea.)

Rubber Feet (4 ea. Use Optional)

1 ea. 55-65-0 ESG Electrical Stimulus Generator

Includes: ESG Unit
Accessory Kit
Includes:
1 ea. Stimulus Output Cables (2')
Rubber Feet (4 ea. Use Optional)

1.4.2 *ADDITIONAL ITEMS REQUIRED FOR OPERATION*

The following additional items are ORDERED SEPERATELY:

1 ea. 55-XXX Line Cord (Country specific see sec 2.1.4 of this manual for catalog number)

1.4.3 *REPLACEMENT ITEMS*

Cat. #55-65-0-01 ESG Output Cable Pair (2')

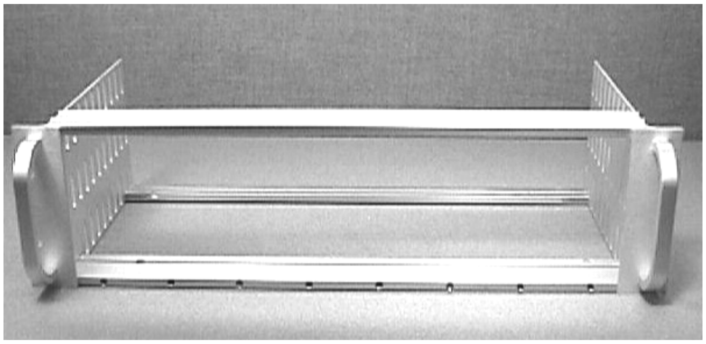
Cat. #55-65-0-02 ESG Output Cable Pair for FHC Microelectrodes (2')

Cat. #55-65-0-04 Probe Communication Cable (10')

Cat. #55-00-4 BNC Adapter Cable

Cat. #55-00-9 Male Phono Patch Cable

1.4.4 ***OPTIONAL ACCESSORIES***



The following accessories are available:

Cat. #55-11-0   SAF Rack Frame for Stand-Alone Modules

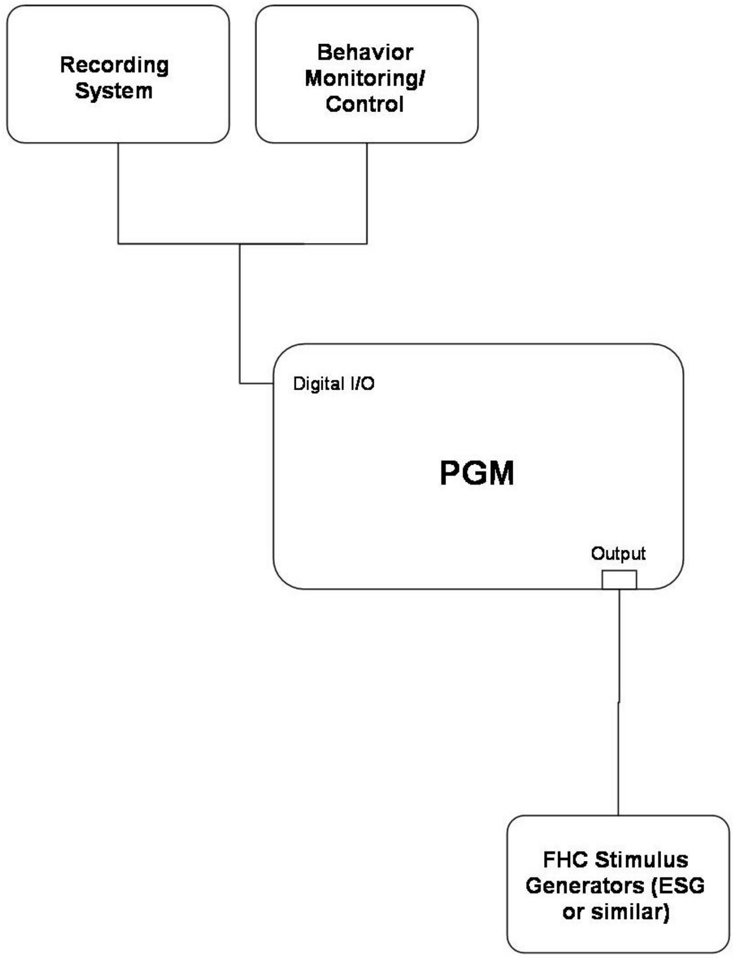
Cat. #55-00-10 USB Mouse

Cat. #55-00-11 USB Keyboard

Cat. #55-00-12 Stylus

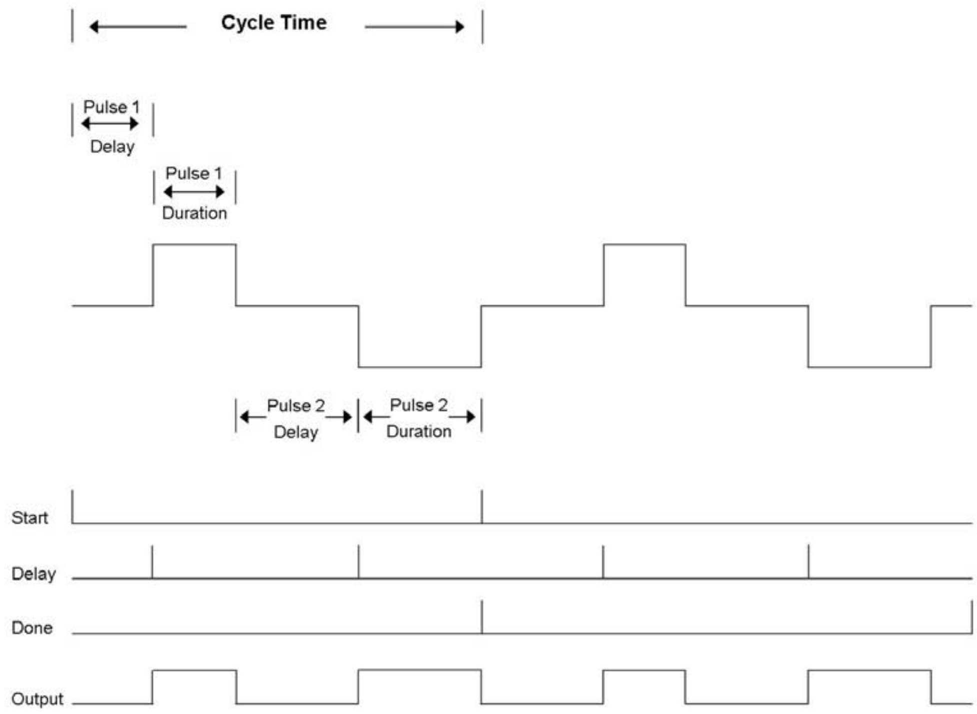
Cat. #55-65-0-05 ESG Output Extension Cable Pair (2’)

1.4.5 *SYSTEM CONFIGURATIONS*



1.5 *CONCEPTS*

1.5.1 *TERMINOLOGY*



Cycle Time: The total time of one run of the output pulse sequence.

Pulse 1 Delay: The time between the cycle start and the first pulse.

Pulse 2 Delay: The inter-pulse interval.

Pulse Duration: The time that the output pulse is a value not equal to 0.

Train Cycles: Number of cycles composing a train.

Train Time: The total time of the train output.

1.5.2 *Stimulation Primer*

Stimulation in any type of experiment is defined as an energy applied to tissue in order to elicit a response. The response could be either an observable cellular response (ex. neuron firing, neurotransmitter discharge, or electrical current travel in a nerve fiber) or a behavioral response (ex. eye blink, whisker twitch, or leg jerk). The energy can come in one form, or a combination: electrical, mechanical, thermal, or chemical.

- **Electrical Stimulation** refers to the application of an electric energy (voltage and current) to a specific site in tissue.
- **Mechanical Stimulation** refers to manipulation of a limb or section of skin.
- **Thermal Stimulation** refers to applying a heat source or cold source to a section of skin
- **Chemical Stimulation** refers to injection of a chemical solution into the bloodstream of a subject, or directly into a specific site in tissue.

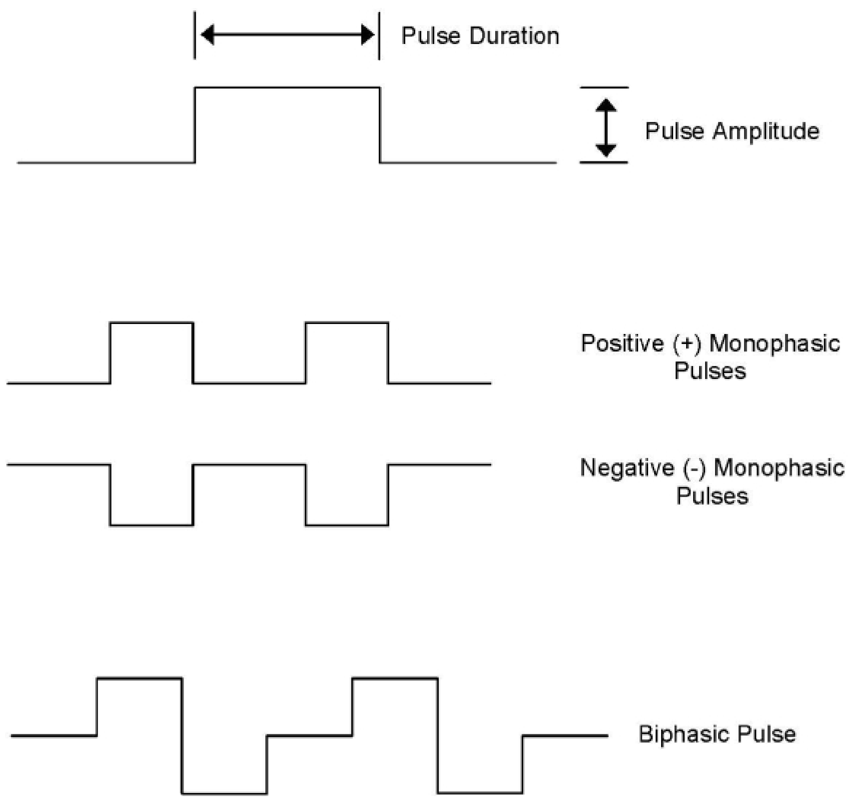
Electrical Stimulation Overview

An electrical stimulation system is comprised of a device used for generating the voltage and current in a timed manner and a microelectrode or set of microelectrodes for delivering the stimulus to the tissue. The stimulus generation and timing can either be combined in one device, or split into two: a timing generator and a stimulus generator.

Timing Generator

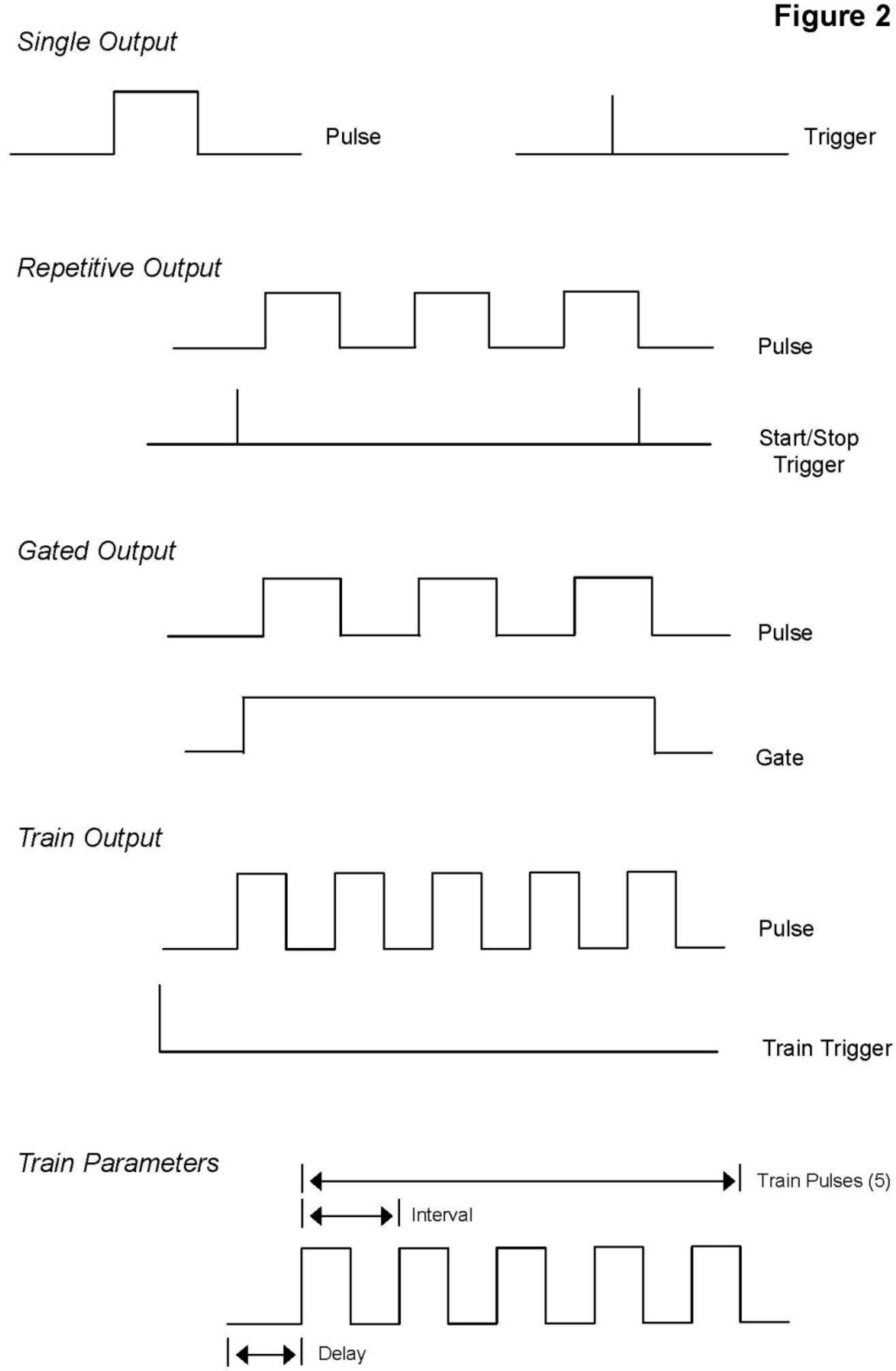
The timing, or pulse, generator establishes how long and how many times the stimulus is applied to the tissue. How long a stimulus is applied at a single time is often called the pulse. The pulse is defined by a specific amplitude of voltage applied over a specific period of time (called the pulse duration or width). The pulse can be either all positive or all negative (called monophasic) in relation to a 0 reference (called positive or negative polarity), or a combination of the two (called biphasic). See Fig 1

Figure 1



There are different ways that a timing generator can be set up for the number of times a stimulus pulse is applied, and the timing of those pulses. Single output refers to applying one pulse for every trigger (either from the press of a button, or an electrical cue from another device). “Free Run” output refers to pulses that repeat from a triggered start until another triggered stop. Gated output refers to applying a repeated output based upon a continuous trigger input over a period of time; the stimulus repeats while the trigger is applied. A Train output is a repeated output that has a defined start stop time, as well as possibly varied spacing between pulses. See Fig 2

Figure 2



Stimulus Generator

The stimulus generator produces the electric energy that is delivered by the pulse. The two quantities are related by Ohm's Law: ***V = I x R***, where ***V*** is the applied voltage, ***I*** is the current, and ***R*** is the resistance of the tissue and/or the stimulating microelectrodes. In this equation, if ***V*** (voltage) is constant, the amount of ***I*** (current) will diminish if the ***R*** (resistance) of the tissue/microelectrodes goes up, or will increase if the resistance decreases. Alternately, the voltage will increase or decrease if the current is kept constant. In an experiment application, the varying factor is the resistance. Microelectrode resistance (or impedance) generally decreases over time due to the application of current, and tissue resistance (which varies from sample to sample to begin with) changes over time due to a process called polarization at the interface of the microelectrode metal and tissue.

Types of Stimulators

Stimulators generally come in two types. A device that holds a voltage to a constant value set by the user in order to allow the current to be determined by Ohm's law is called a Constant Voltage Stimulator. Conversely, a Constant Current Stimulator holds the current to a value set by the user by varying the voltage in accordance with Ohm's law.

Constant Current Stimulators

Constant current stimulation is preferred in most applications for two reasons. Current is the quantity that stimulates most types of excitable tissue, and since most microelectrodes and tissue increase their resistance as stimulation progresses, constant current stimulators most efficiently "sense" the change and provide the necessary voltage to maintain the useful amount of current. There is a limit to the amount of voltage that can be applied to maintain the set current, this is called the Compliance Voltage of the device. Once this voltage is reached, the delivered current will drop.

Constant Voltage Stimulators

Constant voltage stimulation is less widely used than constant current. An exception to this is in some areas of nerve study that require considerations for low current until the microelectrode contacts the nerve fiber, in which case the lowered resistance would increase the current. Constant voltage stimulators are also less complex and cheaper to produce than constant current stimulators.

Stimulus Isolation

An Isolated Stimulus is an electrical energy that is isolated from a common ground point (most often earth ground). There are two reasons for isolating the electrical stimulus, artifacts and safety. Artifacts are additional voltages that are introduced into the stimulus circuit which can skew (add to) the stimulus, or create an unwanted stimulus. (see following sections)

Artifacts

In a setup where an isolated stimulus generator is used, current travels from the positive terminal of the stimulator, through the tissue, and returns to the negative stimulator terminal. When a voltage meter is in place, in the form of a recording microelectrode system, the voltages produced by the tissue are measured in respect to the recording system's ground (earth ground), while 100% of the stimulator current returns to the negative stimulator terminal. If the stimulator shares a common ground with the recording system, a significant portion of the stimulus current returns to the ground through the recording system ground which will add to the recorded voltage from the tissue. This is called a DC Artifact on the recorded tissue data.

In this same common ground setup, a capacitive coupling takes place between the recording circuit and the stimulator circuit. This coupling can cause current to flow into the recording circuit ground, which will produce a transient (unwanted) tissue voltage in front of and behind the stimulus current. This is called an AC Artifact on the recorded tissue data.

Safety

It is nearly impossible in an experiment setup to completely isolate the subject (human or animal) from ground. If the subject is in a stereotaxic, or on a table, there are many points along the body of the subject that are in contact with earth ground. In an isolated stimulus setup, 100% of the stimulus current travels from the positive terminal to the negative terminal of the stimulator. If the stimulator shares an earth ground with the subject, then the stimulus current will flow from the positive microelectrode to the commonly shared ground points, which could cause tissue burning or death.

Types of Isolation

The first type of isolation employed in stimulators was the use of battery operated devices. While these worked well in some instances, the amount of batteries needed, and the life of the batteries restricted use.

The next improvement was the use of transformer isolation. Pulses were applied to the primary winding of a transformer and the stimulus energy was produced by the secondary winding through induction (A current applied across a fixed winding of wires around a magnet core produced a current on another set of windings around an ajacent magnet core). This method contained two inherent issues. Due to its nature, no constant voltage stimulations could be produced, and it contained an intrinsically higher capacitance, causing an unacceptably large AC artifact.

Optical Isolation has become the industry standard for stimulus generation. Basically, the input pulse powers a light that shines across a barrier to a photocell that generates the stimulus in a direct ratio.

1.5.3 *DESIGN DESCRIPTION*

The StimPulse design features two subsystems, the PGM (Pulse Generating Module) and the ESG (Electrical Stimulus Generator). The PGM provides the user interface as well as a 32bit Digital Signal Processor for DDS waveform generation (Direct Digital Synthesis). The ESG provides electrical isolation, high voltage step-up, and the precision analog stimulus output.

Operation consists of the PGM sending a digital representation of the waveform selected by the user to the ESG via the power-data cable that connects the two subsystems. The ESG, in turn, performs a digital to analog conversion and finally a constant current amplification using a circuit based on the Howland Current Pump. Additional circuitry in both subsystems as well as software, monitor the resultant output stimulus waveform to ensure accuracy and safety.

Note on viewing
The PGM does not have a built in oscilloscope. The sampling buffer is limited to 2mS. Pulse trains with **Cycle Times** longer than 2mS will not be triggered; rather the display will show buffered views that will synch with various parts of the train when **Output Current** or **Output Voltage** is selected. For pulse trains longer than 2mS, we recommend using the **Ideal** view and using an oscilloscope on the **Analog Output** to verify actual output.

1.6 *TECHNICAL SUMMARY*

1.6.1 *SPECIFICATIONS*

PGM:

Timing Range: Accurate timing specifications for the PGM are depedent on the load, and are given under the stimulus generator device (ESG etc.)

Train Cycles: 1 - $2.1*10^9$

Pulse Type: Square, ramp, sine, zeta, or custom

Pulse Phase: Monophasic, biphasic, or charge-balanced

Pulse Polarity: Positive (+) or Negative (-)

Cycle Latency: <1µsec between cycles

Timing Resolution: 1µsec, better than 100ppm

Digital Trigger In Latency: <10µsec

Touchscreen Area: 11.5cm X 8.2cm (4.5” x 3.2”) +/-0.25"

Touchscreen Resolution: 640X480 Color (256) min.

PC Interface: USB 2.0 Type B port

Data Port: 2ea. USB 2.0 Type A ports

Power Requirements: 100-240 VAC, 50-60Hz

Dimensions:

Height: 13cm (5.22") Width: 23cm (9") Length: 24cm (9.6")

Weight: TBD

Mounting Options:

Tabletop, 4 rubber feet prevent sliding

Rack mountable with SAF Rack Frame (Cat. #55-11-0 Available separately)

ESG:

Note: *All timing measurements made from 10% - 90% amplitude of leading edge under 100k load*

Isolation Method: Digital, using micro-transformers

Isolation Impedance: >10^{11} Ohms @ 60Hz

Isolation Barrier Capacitance: <25 pF

Isolation Voltage: 4000VAC

Train Time: 1ms – 596.5hrs(24days) at 1ms resolution(continuously adjustable)

Cycle Time: ***Constant Current Mode:*** 15µs - 59.6hrs ***Constant Voltage Mode:*** 4µs - 59.6hrs in 0V-10V range; 60µs - 59.6hrs in 10V-125V range (continuously adjustable, on-the-fly adjustable)

Pulse Delay: 5us – 35min at 1us resolution(on-the-fly adjustable, continuously adjustable)

Pulse Duration: ***Constant Current Mode:*** 15µs - 5.9hr ***Constant Voltage Mode:*** 4µs - 5.9hr in 0V - 10V range; 60µs - 5.9hr in 10V – 125V range. (continuously adjustable, on-the-fly adjustable)

Constant Voltage Ouput: 0 - 125V at 1µA (1Meg load); (continuously adjustable, on-the-fly adjustable)

Constant Current Ouput: Four ranges, 0 – 10 uA, 0 – 100 uA, 0 – 1mA, 0 – 10 mA, (continuously adjustable, on-the-fly adjustable)

Compliance Voltage: +/-125V (10uA and 100uA range) +/-100V (1mA and 10mA ranges)

Ouput Impedance: <1k

Leakage Current: <10 nA

Noise: <1% of range (current or voltage)

Dimensions:

Height: 4.5cm (1.77") Width: 8cm (3.15") Length:16.5cm (6.5")

Weight: 2lbs

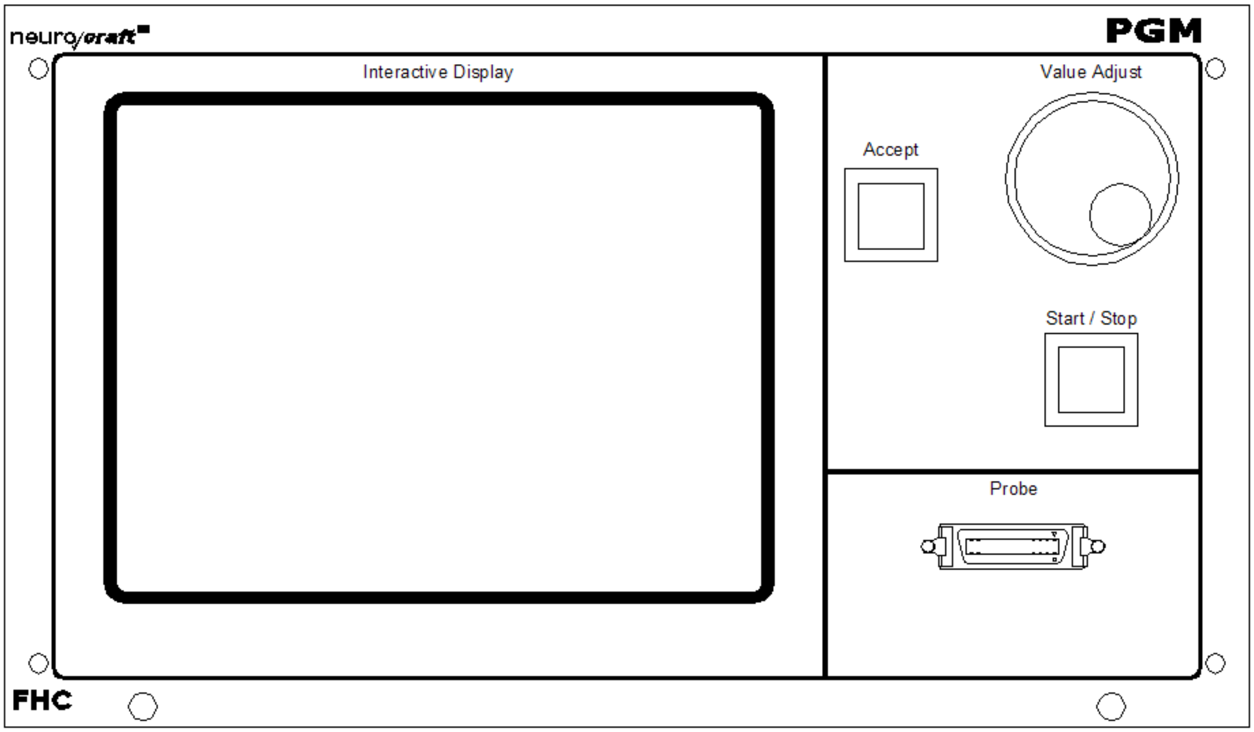
Mounting Options:

Tabletop, 4 rubber feet prevent sliding.

1.6.2 ***CONTROLS/CONNECTORS***

PGM

Front Panel



Controls:

Value Adjust - Continuously adjustable turn-knob for scrolling parameter values.
Accept - Push button for accepting changes to selected parameter fields or input (Use may be disabled in the **Preferences** screen of the user interface.)
Start/Stop - Push button for starting and stopping the output cycle.

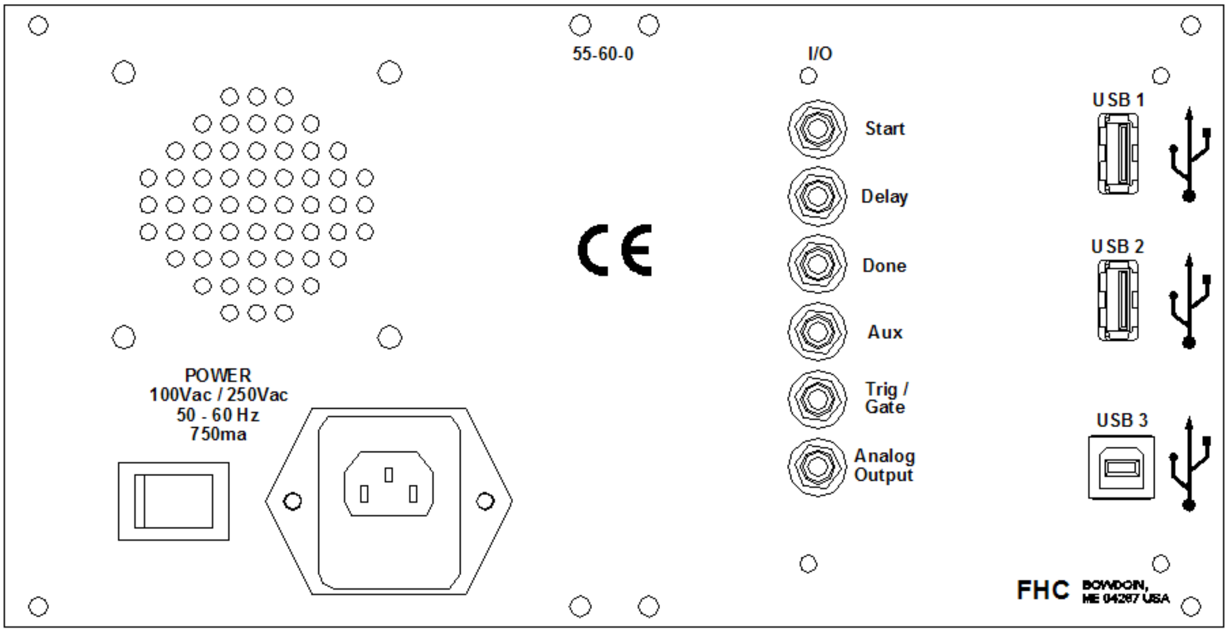
Connections:

Probe - 26 position MDR Female connector for data communication and power to ESG or similar.

Display:

Start/Stop - Pushbutton lights to indicate output cycle is active
Interactive Display - 11.5cm X 8.2cm QVGA touch screen for selecting and changing parameters, displaying waveform data and user selectable functionality.

Back Panel



Controls:

0|I: Rocker switch used to activate power

Connections:

USB 1: USB 1.1 Type A port for interfacing with outboard memory device, USB mouse or USB Keyboard

USB 2: USB 1.1 Type A port for interfacing with outboard memory device, USB mouse or USB Keyboard

USB 3: USB 1.1 Type B port for interfacing with PC

Digital Input:

Trig/Gate - 3.5mm mono jack for TTL level external trigger or gate input

Digital Output:

Start - 3.5mm mono jack for TTL output at cycle start
Delay - 3.5mm mono jack for TTL output at the end of any pulse delay
Done - 3.5mm mono jack for TTL ouput at cycle end
Aux - 3.5mm mono jack for user-configurable TTL output.

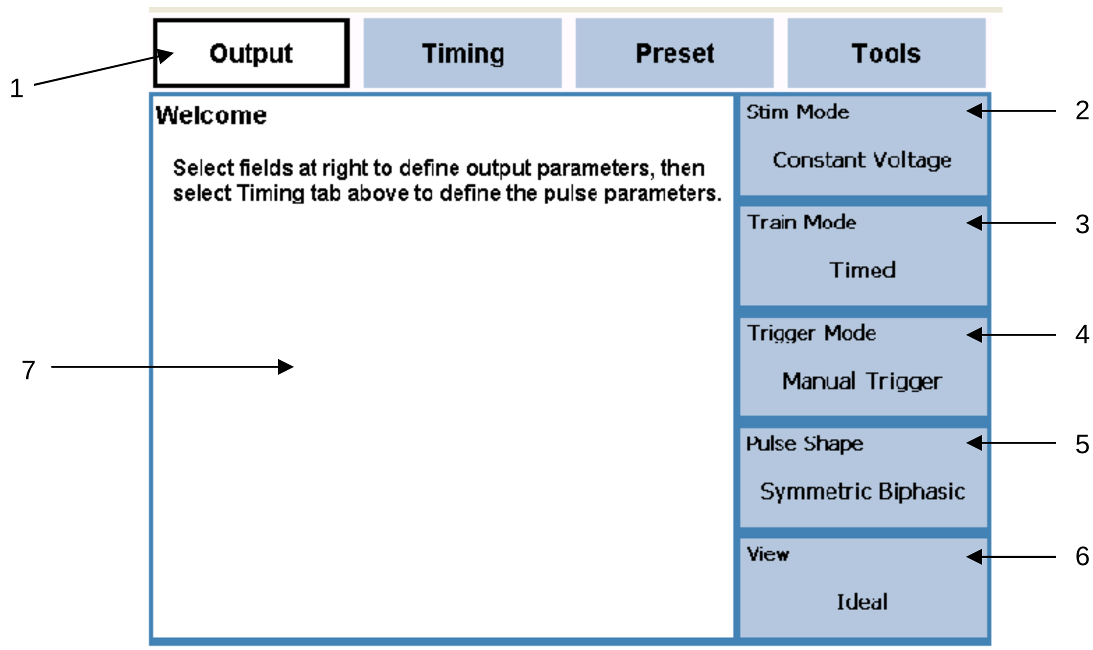
Analog Output:.

Ideal -
Actual –
Pulse Marker -

User Interface

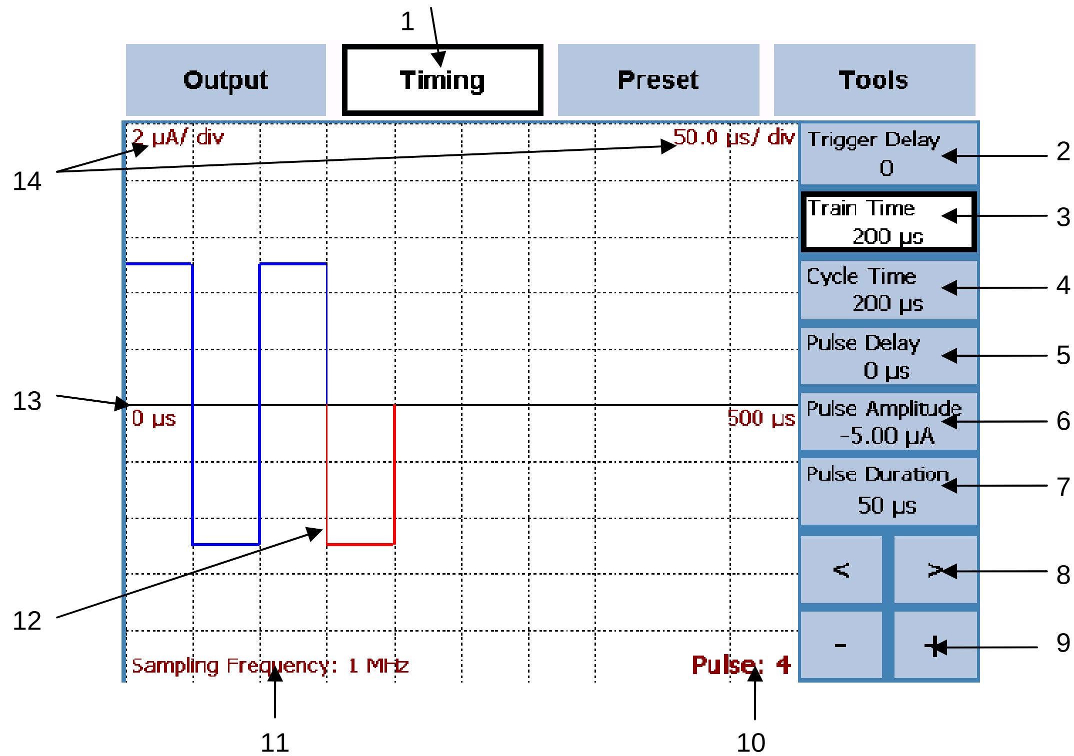
Main Tabs

Output



1. **Output Tab** - Highlighting this brings up the parameters that define the output of the device.
2. **Stim Mode** - This field sets the type of stimulation output
3. **Train Mode** - This field sets the mode of output following a trigger event
4. **Trigger Mode** - This field defines the type of triggering event to start output
5. **Pulse Shape** - This field defines the shape of the output pulse.
6. **View -** This field sets the format for viewing the output during stimulation. (See "Note on Viewing" in section 1.5.3)
7. **Viewing Window** - This window shows descriptions of the various parameter selections. Under the Timing tab and during output, it shows the ideal form of the output parameters, or the actual current/voltage output to the electrode.

Timing



1. **Timing Tab** - Highlighting this brings up the parameters that define the timing and amplitude of the output pulses.
2. **Trigger Delay** - This field sets the length of time between the start trigger (press of the **Start/Stop** button or TTL on the **Trig/Gate**) and the defined pulse train start.
3. **Train Time** - This field sets an overall time that the current cycle will be repeated for. This field is active ONLY when "Timed" is selected as the **Train Mode** of the **Output** tab.
4. **Cycle Time** - This field sets the overall time from the start to the end of the programmed train cycle. Cycle Time will automatically adjust as pulses and delays are programmed into the cycle, however it will not recalculate if pulses are removed. To adjust to actual cycle time set the value to "0" using the keypad. The PGM will automatically readjust. If additional time is added to this value after all pulses have been programmed, it will be added as a delay after the last programmed pulse.
5. **Pulse Delay** - This field defines the amount of time between the last programmed pulse and the currently selected pulse. If pulse 1 is the currently selected pulse, it defines a delay from the origin and the first pulse. (Not to be confused with the **Trigger Delay** above)
6. **Pulse Amplitude -** This defines the amplitude and polarity setting of the currently selected pulse.
7. **Pulse Duration** – This defines the time duration of the currently selected pulse.
8. **<** or **>** - These are used to toggle between pulses, change is indicated by the red section of the trace, and pulse number display.
9. **–** or **+** - These buttons are used to delete the currently selected pulse, or add a new pulse after the last pulse in the cylcle.
10. **Pulse Number Display** – This indicates the currently selected pulse in the cycle independently to what is shown in the viewing window. Double clicking on this changes the display to **Pulse: All**, which allows a parameter change to affect all pulses in the cycle.
11. **Sampling Frequency Display** – This indicates the current sampling frequency of the microprocessor.
12. **Trace** – Graphical display of programmed pulses and delays. Current pulse indicated in Red.

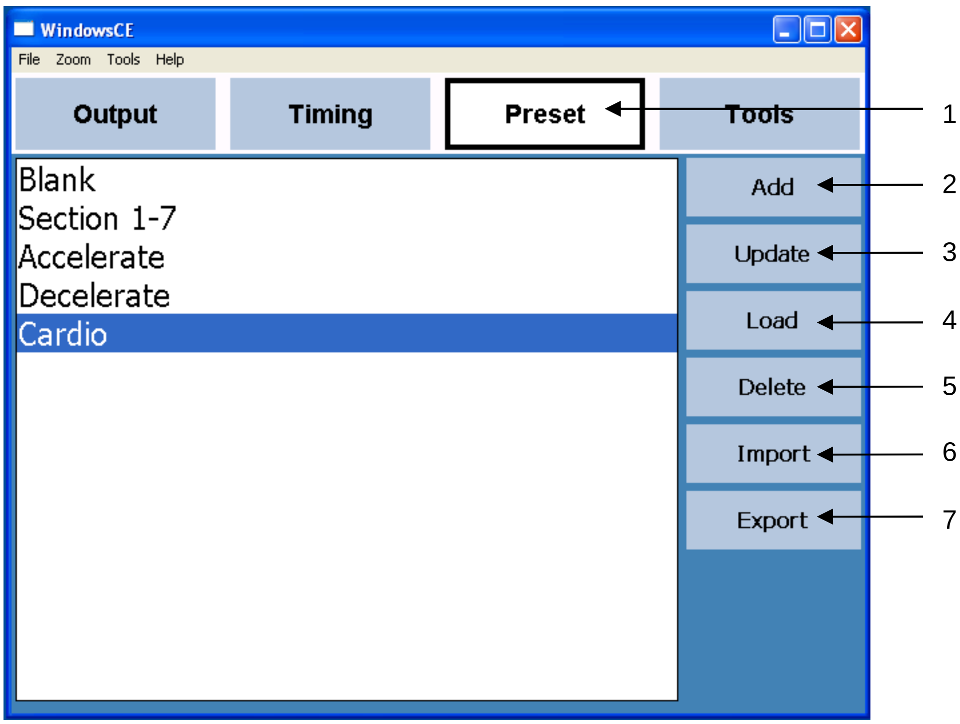
13. **Zero Line** – Graphical representation of zero amplitude with indicators for current time range displayed in the viewing window. Values of the trace shown above this line are positive polarity, those below are negative polarity.

14. **Scale Display** – These indicate the unit measurement scale of the displayed graph.

15. **Scroll (Not Shown)** – Drawing a horizontal line with finger or stylus within the viewing window allows scrolling through time along the Zero Line. Indicators display change in time range. Drawing from left to right moves back through time scale, right to left moves forward through time scale. **Note:** Scroll is unavailable whenever the output is active.

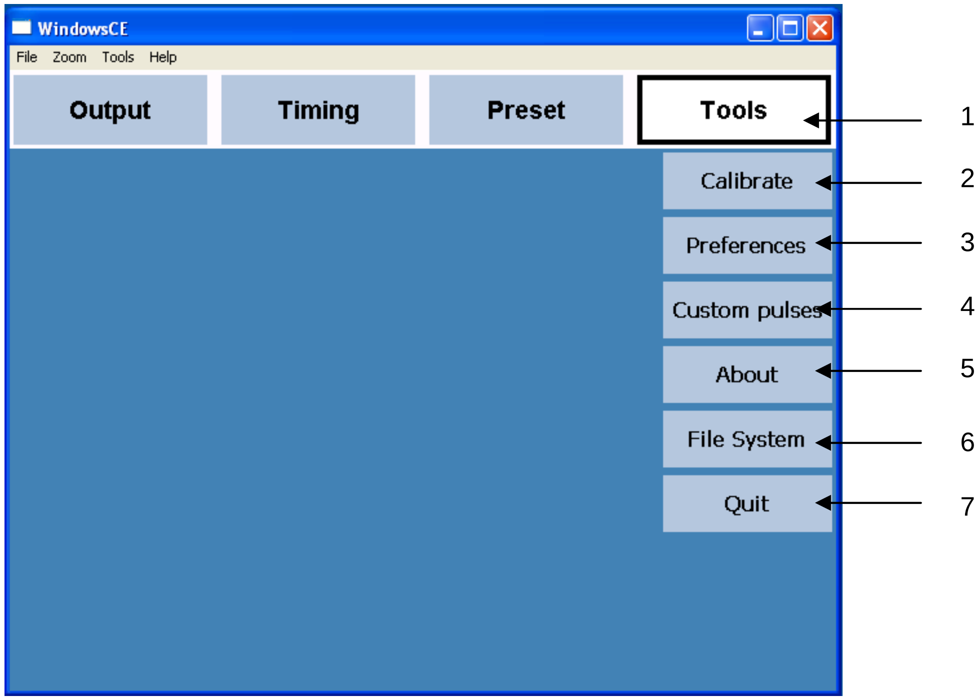
16. **Zoom (Not Shown)** - Drawing a vertical line with finger or stylus within the viewing window zooms in or out on the graph. Indicators display change in scale. Drawing from bottom to top zooms in on the graph, top to bottom zooms out. **Note:** Zoom is unavailable whenever the output is active.

Preset



1. **Preset Tab** - Highlighting this brings up the options for working with user-defined settings profiles.
2. **Add** - This brings up options for saving the current settings as a new user-defined preset profile. Once added, the preset name is listed in the viewing window (Not Shown)
3. **Update** – This button is used to save any recent changes to the currently in use preset.
4. **Load –** This button is used to load a selected (from the list in the viewing window) preset.
5. **Delete –** This button deletes the selected preset from the list, and the PGM's memory (confirmation required)
6. **Import** – This button is used to import presets from an external memory device
7. **Export –** This button is used to export presets to an external memory device

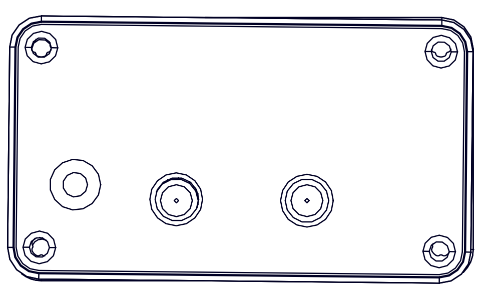
Tools



1. **Tools Tab** - Highlighting this brings up options for setting custom global preferences, and advanced user options.
2. **Calibrate** - This button brings up dialog boxes for calibrating the output of the PGM and ESG.
3. **Preferences** – This button brings up a set of global preferences to be set by the user.
4. **Custom Pulses –** This button brings up a dialog box for adding a custom pulse as an option in the **Pulse Shape** field of the **Output** tab.
5. **About –** This button displays a popup showing the information of the PGM (FHC contact information, current software revision etc.)
6. **File System** – This button brings up a dialog box for accessing the devices operational system and file structures
7. **Quit –** This button is used to safely exit the PGM application and power down the device. On next startup, the PGM will automatically load the parameters saved via this exit procedure.

ESG

Front Panel



Connections:

"+" "-" : 1mm concentric "no touch" jack for connecting the stimulus output to a microelectrode.
"Gnd": Jack for grounding the ESG packaging

1.6.3 *COMPATIBILITIES*

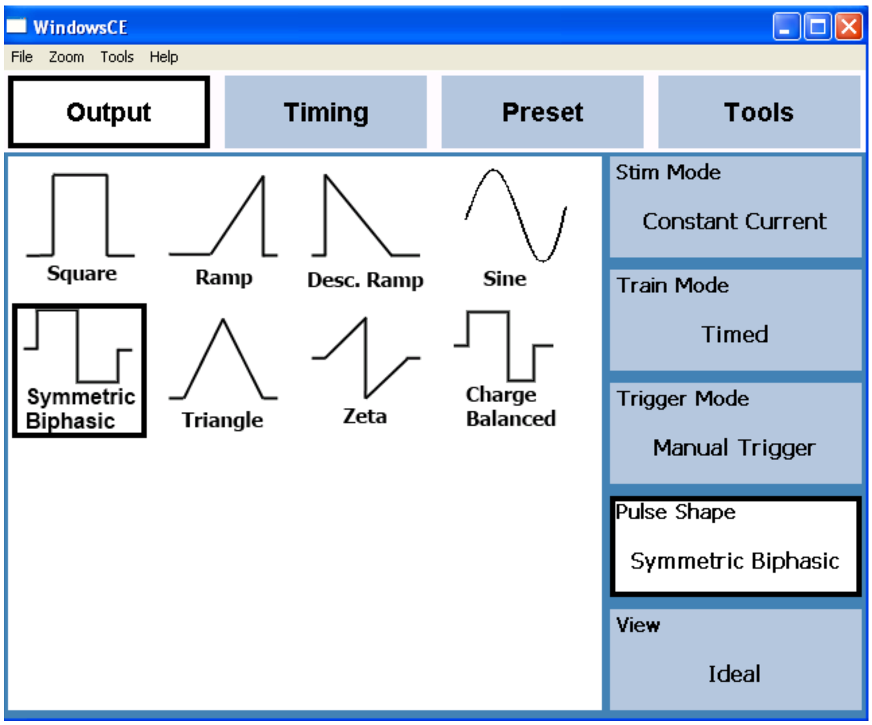
The devices that comprise the neuro/Craft™ StimPulse are not designed to work individually with other available timing units or stimulus isolators. They can be used to provide TTL timing pulses to other devices or output to voltage driven devices with correct input ranges.

1.7 *ILLUSTRATIVE PROCEDURE*

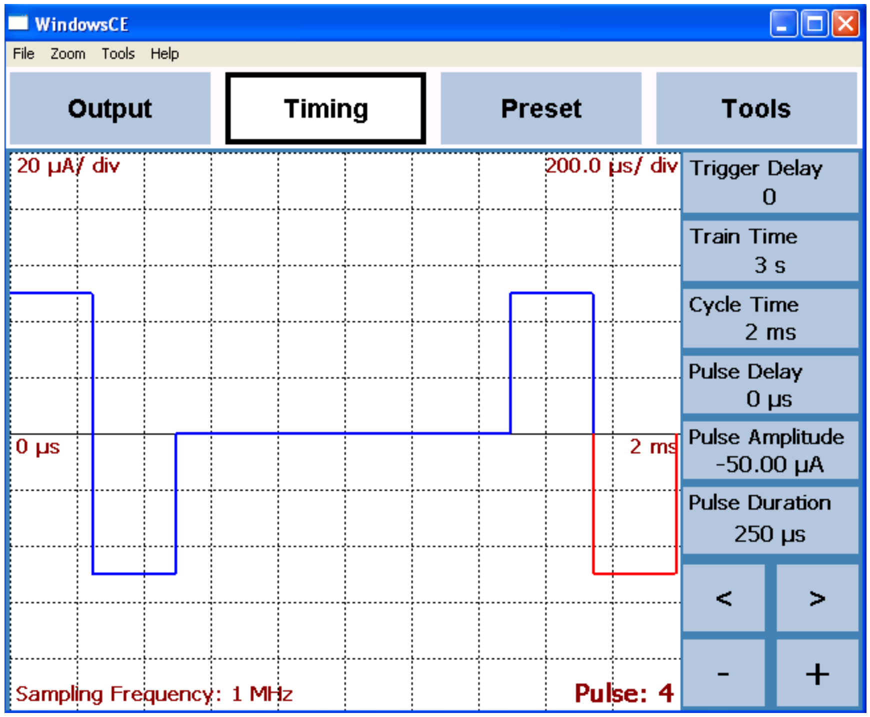
Programming a Simple Pulse Train

Note: This example is a factory default **Preset** named "Section 1-7"

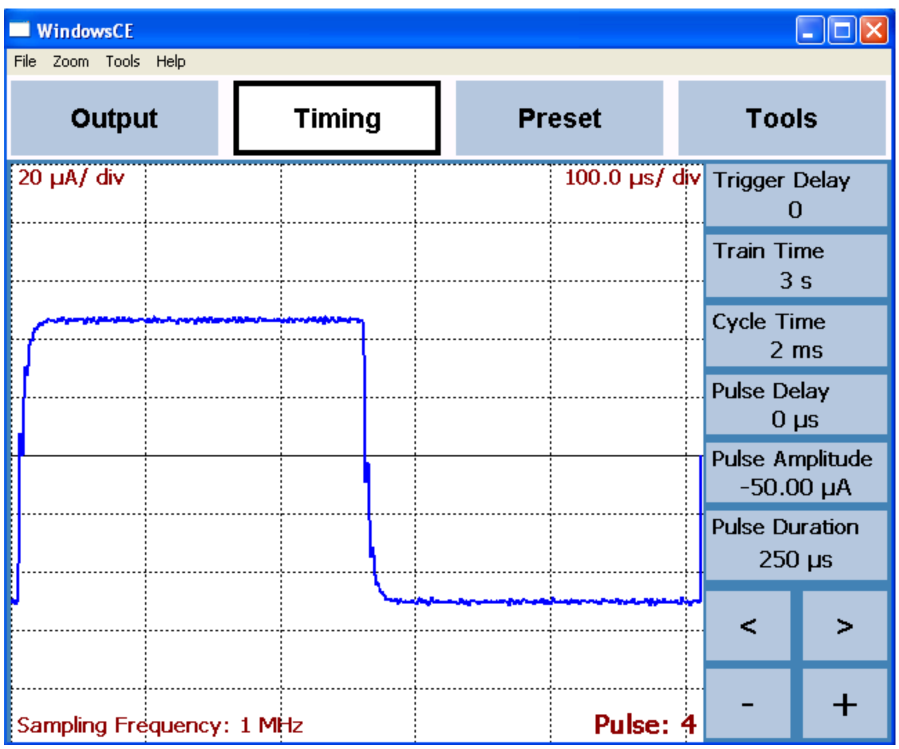
Ex. 3 second 500Hz constant current train of 50uA biphasic pulses (.25mS duration each phase; 1mS inter-pulse interval)



Set the **Output** Parameters to reflect a timed train of constant current symmetric biphasic pulses with a manual trigger (**Start/Stop** button).



Set the **Timing/Amplitude** Parameters of the first pulse, then highlight the Add ("+") button to add an identical pulse 2 (note that each biphasic pulse is made up of two numbered pulses). Adjust the inter-pulse interval to 1ms. Set the overall **Train Time** to 3s.



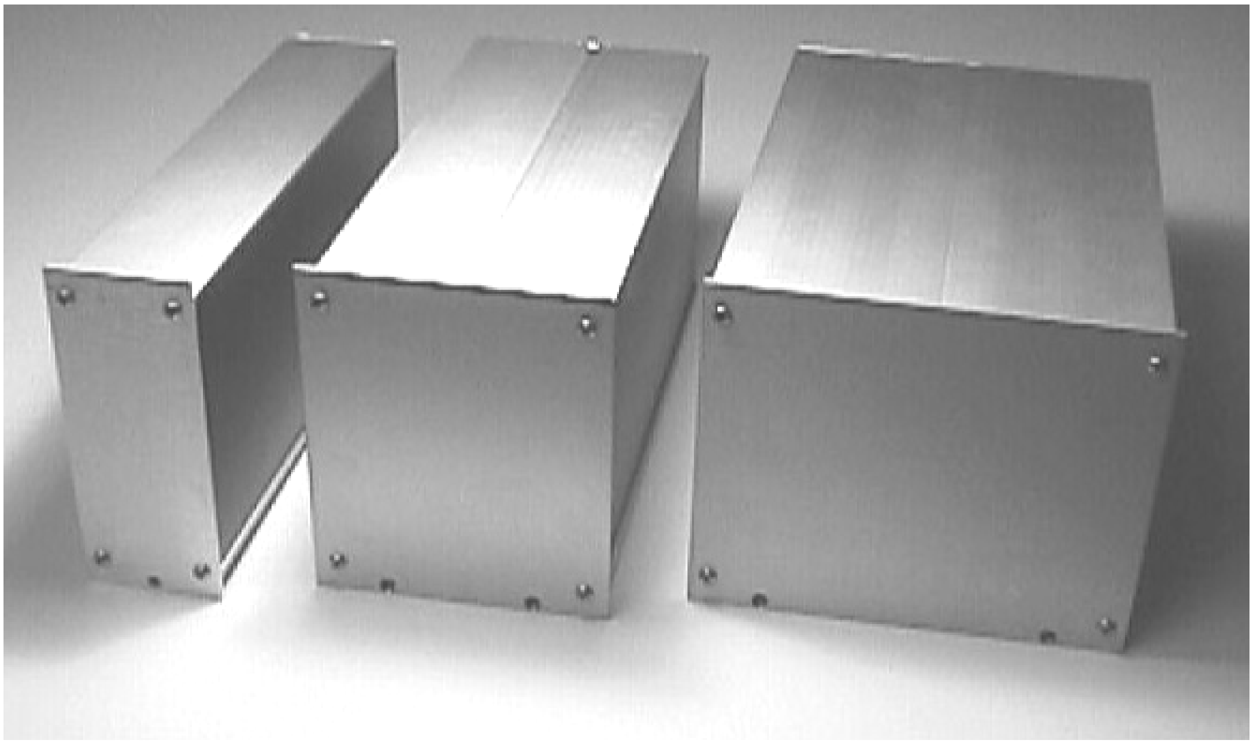
Set the **View** to **Output Current** in the **Output** tab to view the monitored stimulus as it is delivered. When the stimulus is active, the screen displays the output to the microelectrode

Note: *See section 2.6 for more programming examples.*

2 ***REFERENCE MANUAL***

2.1 ***REFERENCE INFORMATION***

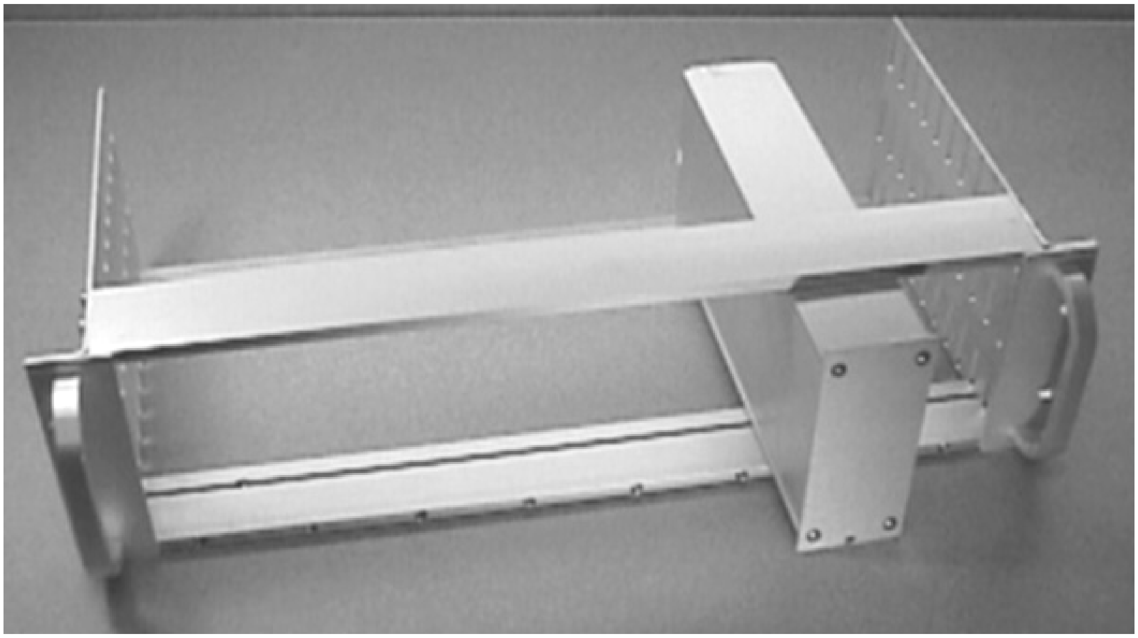
The stand-alone modules of the neuroCraft series instruments are packaged in metal cases, which consist of standard 5.25" high front panels. Front panel widths are specified as Type 2 modules (2.05" actual), Type 4 modules (4.15" actual), Type 6 modules (6.25" actual), and Type 9 modules (9" actual, Not Shown). Front panels are mounted on extruded top and bottom panels. Flat side panels slide into slots in the extrusions, and are held in place when the back panel is secured into the extrusion. All modules are 9.75" in depth.



Type 2 Module Type 4 Module Type 6 Module

2.1.2 ***MOUNTING***

All stand-alone modules are completely encased and can be used without further mounting or hardware. Provided rubber feet may be used to protect surfaces from scratching. However, it may be suitable to group modules, and we have made provision for several configurations. The SAF Rack Frame for Stand-Alone Modules (cat #55-11-0) will hold up to eight Type 2 modules, four Type 4 modules, or two Type 6 modules and 2 ea. Type 2 Dress Panels (cat #55-11-1 use optional), while occupying only 3 rack units (5.25") vertically on a standard 19" instrument rack. Several combinations are available for all of the neuroCraft series stand-alone modules. For example an SAF frame could accommodate 3-Type 2, 1-Type 4, and 1-Type 6 within its 16" of horizontal rack space.



SAF Rack Frame For Stand-Alone Modules
(Shown with a neuroCraft Type 2 Module)

Dress Panels for SAF (Ordered Separately):

- 55-11-1 Type 2 Dress Panel

2.1.3 *INSPECTION*

FHC Modules are factory checked and calibrated but should be carefully inspected upon receipt, before using, or activating power. If any exterior damage to the shipping carton is noted, the instrument(s) should be inspected for obvious physical damage. The contents of each package should be physically checked against the inventory list (sec. 1.3) to determine shortages or errors in inventory.

2.1.4 *POWER CONNECTIONS*

All of the stand-alone modules in the neuro/craft series are powered by an internal universal power supply that accepts inputs of 85-265VAC, 50-60Hz. An international pattern Line Cord (not shown) is ordered separately, and is specified by country per the catalog number. (See table below for catalog numbers.)

66-EL-LC-AUS	Australia
66-EL-LC -CH	China
66-EL-LC -DAN	Denmark
66-EL-LC -EURO	Europe
66-EL-LC 5-ISR	Israel
66-EL-LC 5-ITA	Italy
66-EL-LC -JA	Japan
66-EL-LC -SAF	South Africa
66-EL-LC -SWI	Switzerland
66-EL-LC -UK	United Kingdom
55-USA	North America

2.1.5 *WARRANTY*

All FHC products are unconditionally guaranteed against defects in workmanship for one year from date of shipment as long as they have been exposed to normal and proper use. Although the one- year warranty may have expired, please contact our Service Department before attempting any repairs or alterations. Many of these repairs will still be performed at the factory at no charge to the customer.

2.1.6 ***POLICIES***

1. TECHNICAL SUPPORT: It is our policy to provide our customers with the most comprehensive technical support in the industry. If any questions arise or problems occur, we encourage you to call or write and we promise to promptly and comprehensively respond to your requirements.

2. TRADE-UP POLICY: It is our policy to offer customers trade-up ability as new and/or expanded capabilities for their instruments are announced. In many cases, full credit will be given. In general, we will allow 100% credit for two years and depreciate 20% per year thereafter. Please contact our Marketing Department for information relating to your particular situation.

2.1.7 ***SERVICE***

Should service be required, please contact our Service Department for a return authorization number and instructions (207-666-8190). Please have the model and serial number on hand (Both are located on the back panel). Carefully pack the instrument before returning.

Please include a note indicating:

1. The model number and purchase date of the instrument
2. The person to contact if questions arise
3. The "symptoms" indicating that repair is necessary

If the instrument is not covered by the warranty, a quotation will be forwarded to the sender detailing the repairs necessary and charges, before repair is begun.

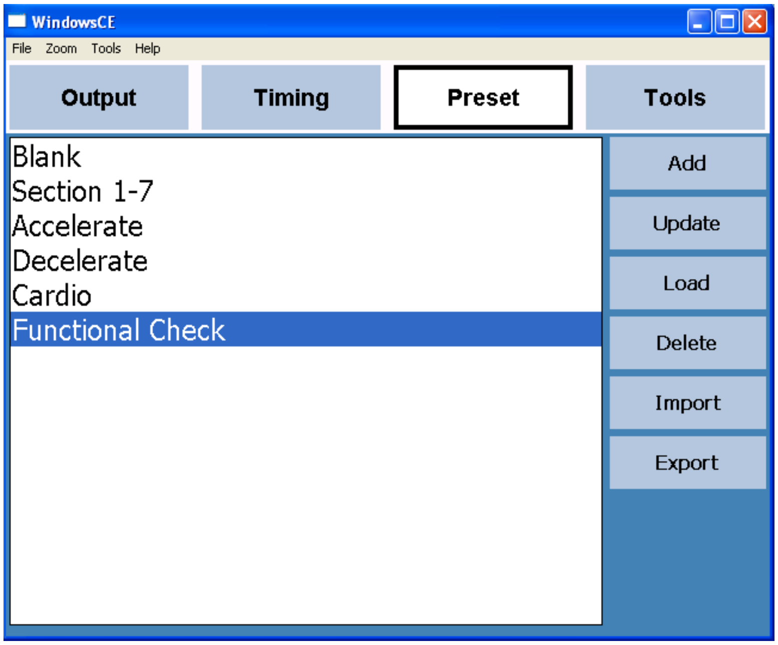
2.2 ***INSTALLATION***

1. Attach rubber feet to the bottom corners of the PGM if mounting on a desktop. If rack-mounting in the SAF Rack Frame, do not attach the rubber feet.
2. If rack mounting, install the thumbscrews thread-first in the holes at the bottom of the front panel. Slide the provided C-clips into the slot in the thumbscrew that is exposed on the back side of the front panel, locking the thumbscrew in place on the front panel
3. Install the device into the rack frame and tighten the front panel thumbscrew before plugging in any cabling.
4. Plug the line cord into the power outlet on the back panel.
5. Plug the data cable into the Probe jack on the front panel. Ensure that the clips "click" into place and that the cable can't be pulled out by a gentle pull. Repeat this process with the other end of the data cable with the corresponding jack on the outboard stimulus generator (ESG or similar).
6. Route the electrode cable from the stimulus generator to the stimulus delivery device (electrode or similar) so that it can't be inadvertently pulled or tangled.
7. Power up the unit. It will go through an initialization routine, and then will display a welcome screen under the Output tab. Unit is now ready for use.

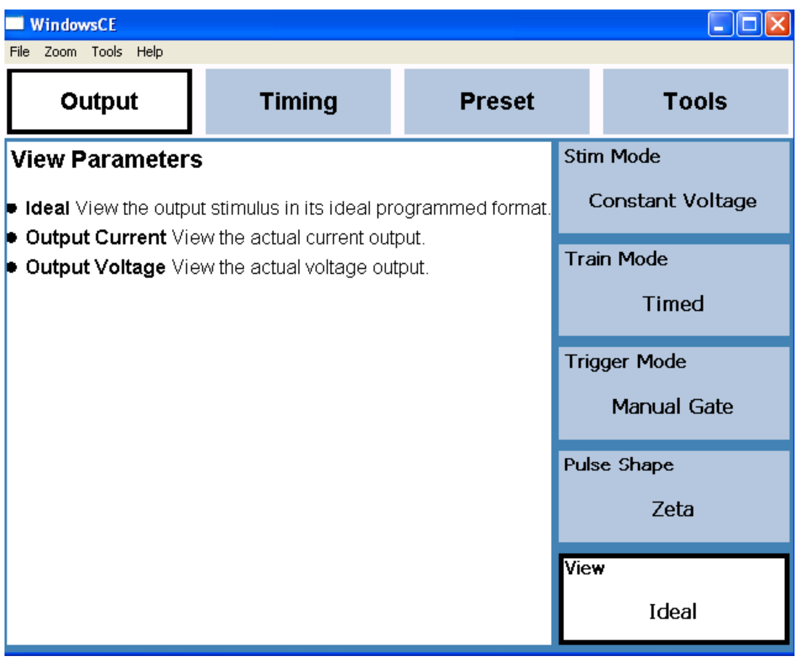
2.3 ***FUNCTIONAL CHECKOUT***

Note: Read the first three sections in 2.4 Operational Information below to familiarize with making changes to settings.

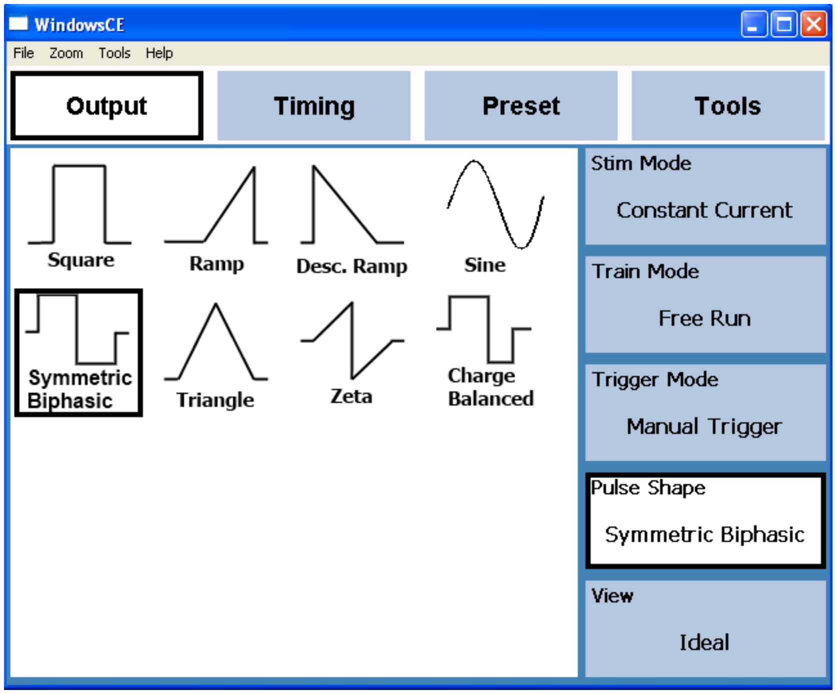
1. Ensure all cabling is connected per installation instructions in sec 2.2
2. Connect the 100k test load to the ESG output cables.
3. Power up the PGM and wait for the Output tab to display.
4. From the Output tab, highlight the Preset tab.



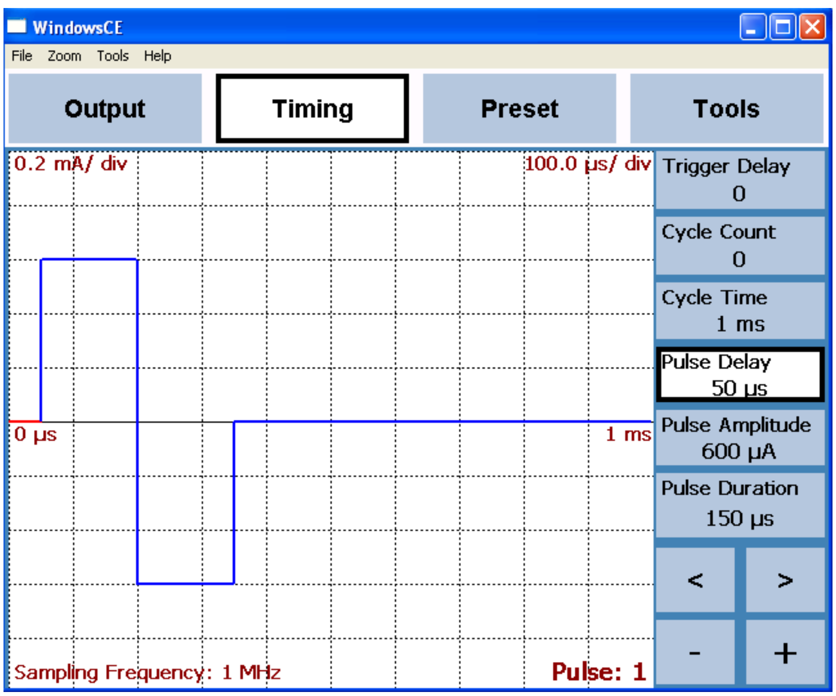
5. Highlight the factory preset named "Functional Check" and then highlight the Load button.



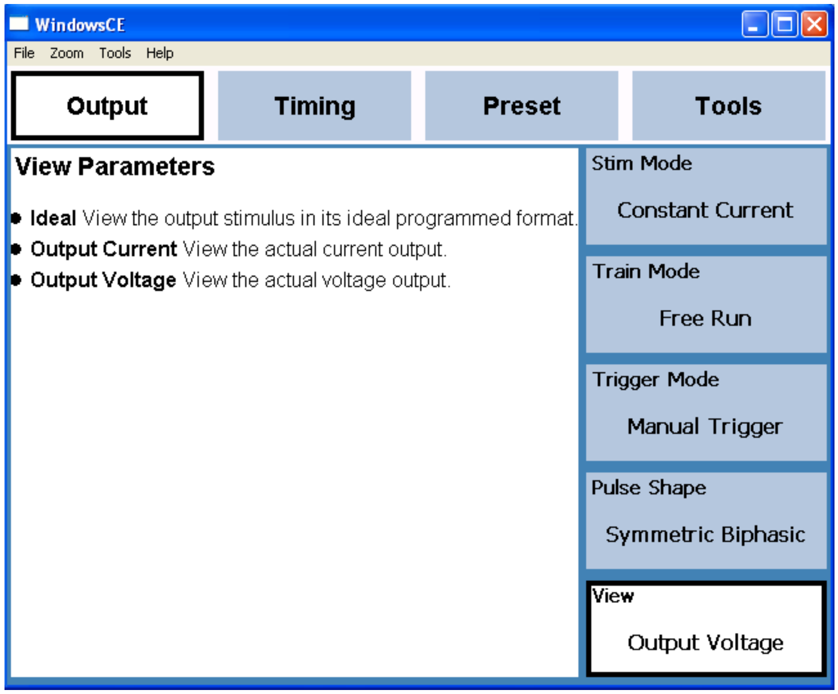
6. Highlight the Output Tab and ensure the settings match the above photo.



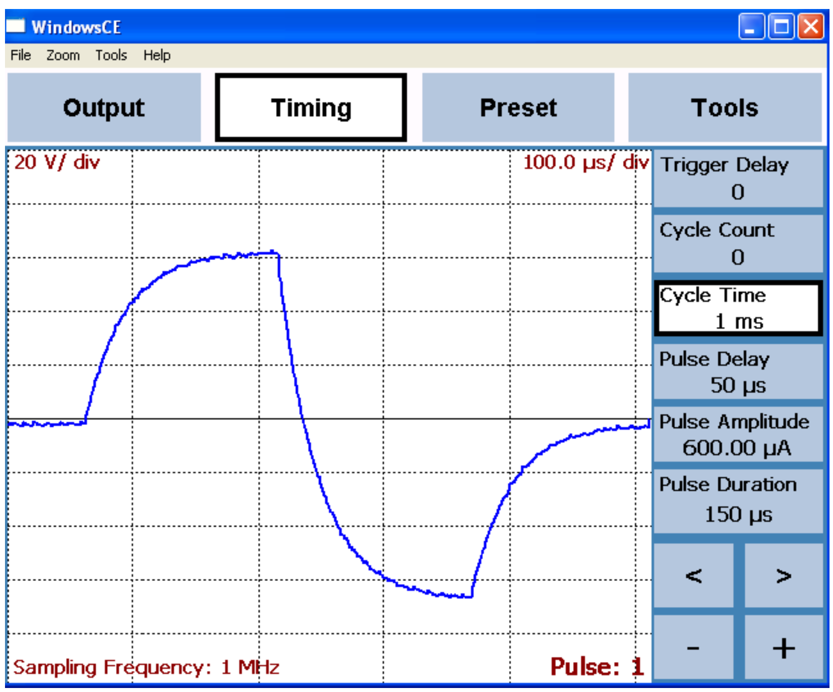
7. Change the Output settings to match the above photo.



8. Highlight the Timing tab and Add ("+") a pulse. Set the parameters as shown above. Note: Use the "<" arrow to set these changes to pulse 1



9. Highlight the Output tab and set the View to “Output Voltage”
10. Connect 100k test load to electrode output cables



11. Go back to the Timing tab and press the Start/Stop button to activate the stimulus through the 100k test load. Confirm that the Start/Stop button lights up and the display is similar to the photo above.

2.3.1 *CALIBRATION*

LCD Touch Screen Calibration

Note: Only perform the following steps if necessary. The touch screen calibration constants have been flashed to the unit. However, variations from one unit to the next may require a touch screen re-calibration. Having difficulty accessing buttons is a typical symptom of touch screen miss-alignment.

1. Under Tools tab, click on the File System button. Answer “Yes” to exit that application to the operating system.
2. Once in the WindowsCE operating system, click on the Start button and select Settings > Control Panel
3. Click on the Stylus icon. Select the Calibration tab and press the Recalibrate button
4. Using a stylus, or fingertip, follow the on-screen directions

2.4 *OPERATIONAL INFORMATION*

Note: *In this manual, "highlight" means to select a field or element by lightly touching once directly on the screen, or moving a cursor over and single clicking if using an optional USB mouse. “Double clicking” means lightly tapping twice on the screen or moving the cursor over and double clicking.*

Note: *The default setting for the PGM is to force a user confirmation of a setting change by pressing the* ***Accept*** *button. The PGM can be set to make changes “on the fly” (instantly, no confirmation required) under the* ***Preferences*** *settings in the* ***Tools*** *tab. See* ***Defining Preferences*** *in this section for instructions.*

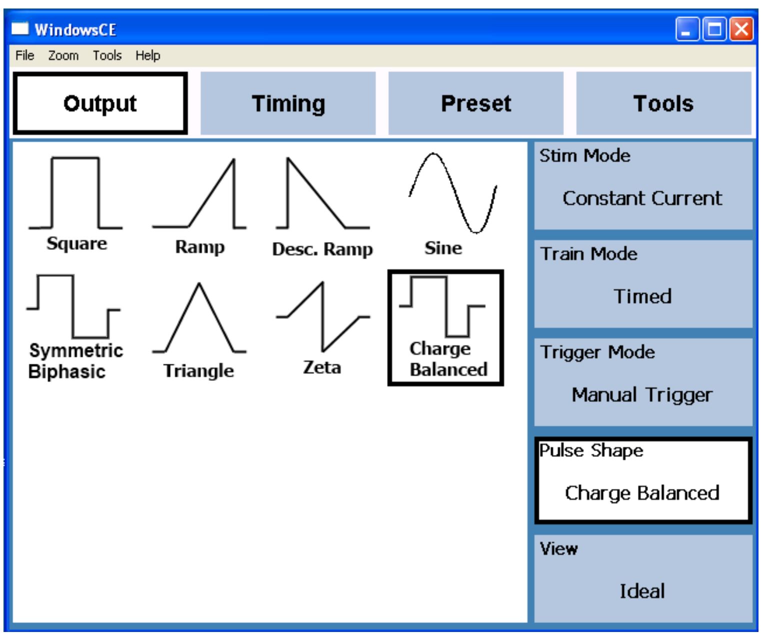
Setting Output Parameters

1. From the initial welcome screen (or from highlighting the **Output** tab at any point) highlight one of the parameter fields on the right side of the screen. (Options: **Stim Mode**, **Train Mode**, **Trigger Mode**, **Pulse Shape**, **View**)

2. Use the **Value Adjust** knob to scroll through the parameter selections for each field. See "User Interface" under section 1.6.2 Controls/Connections for a detailed description of each parameter selection. Definitions are also presented on screen in the viewing window when the parameter field is highlighted.

3. Press the **Accept** button to confirm and initiate the changed parameter selection.

4. Changes can be made at any time, including "on the fly" during stimulus output by highlighting the **Output** tab, and changing as above. Any changes will be implemented in the next cycle following confirmation by pressing the **Accept** button.

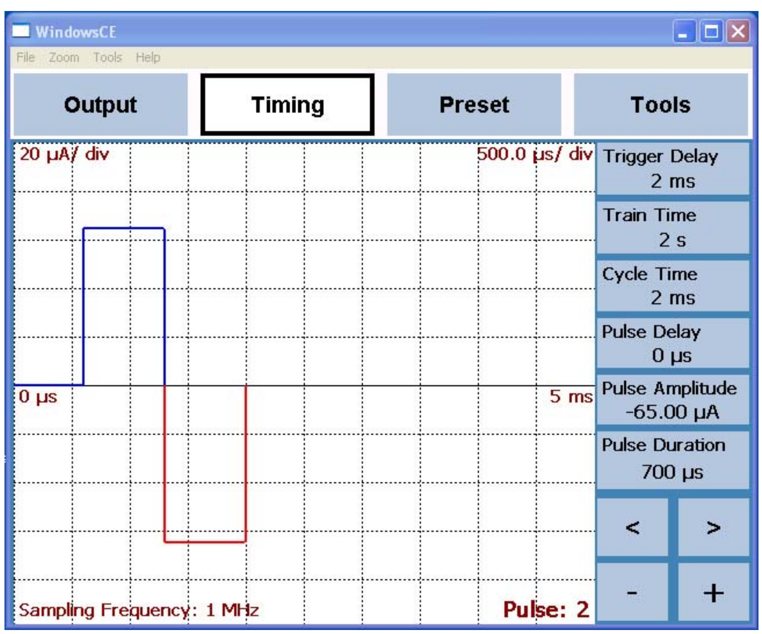


Example of an output screen set up for a train of constant current charge balanced pulses with a manual (Start/Stop Button) trigger that outputs for a user-defined period of time.

Setting Timing Parameters

Note: Values in the **Timing** fields can be input by either highlighting the field and using the **Value Adjust** knob, or “double-clicking” the field on the touch screen and using the pop up keypad to enter values.

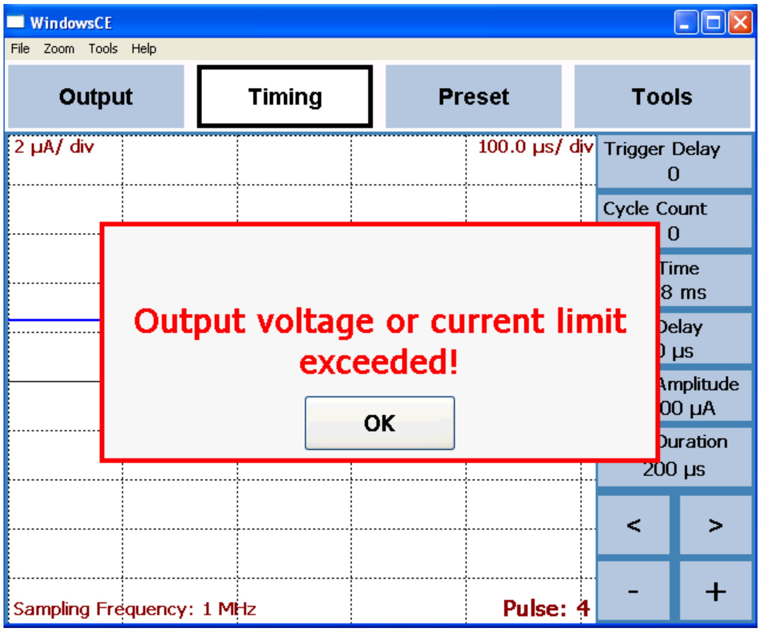
1. Highlighting the **Timing** tab brings up a basic default pulse (or the pulse train last used before powering off) in the viewing window, along with pulse parameter fields to the left of the screen.
2. If a delay between the trigger (either manual or digital) and the first pulse of a train is required, enter the time value in the **Trigger Delay** field.
3. If "**Count**" or "**Timed**" is selected as the output **Train Mode**, then the defining parameter for either of those can be set by highlighting, then setting, their respective parameter fields on the right ("**Cycle Count**" for a set number of cycles (**Count**); Total "**Train Time**" for a set time period of cycles (**Timed**). If neither of these modes are selected, changes to these fields will have no effect on the output programming.
4. Set the overall length of the programmed cycle in the **Cycle Time** field if known, alternately, **Cycle Time** will scale automatically as the pulses are programmed. When cycles are repeated (**Twin**, **Free Run**, **Timed**, and **Count** modes), **Cycle Time** can be used to create periods of time between the last pulse of the first cycle and the first pulse of the next cycle.
5. Highlight the pulse parameters to manipulate the timing and amplitude of the currently selected pulse (Options: **Pulse Delay**, **Pulse Amplitude**, **Pulse Duration**). The highlighted parameter will turn to red on the display.
6. Press **Accept** to confirm and implement the changes.
7. If "**Sine**", "**Biphasic**", "**Zeta**", or "**Charge Balanced**" is chosen as the output **Pulse Shape**, The default and subsequent pulses will be made up of a set of two individual pulses of opposite polarity (1&2, 3&4 and so on). This allows the user to define asymmetrical biphasic pulse shapes.
8. To add additional pulses, highlight the plus (**+)** box. This adds a duplicate of the last confirmed pulse or pulse set. This pulse or pulse set can be manipulated independently of any previous or subsequent pulses by highlighting and changing its individual pulse parameters as above. This allows complex timing trains to be built.
9. Use the **<** and **>** boxes to scroll through pulses in the train. The current pulse will turn red as you scroll.
10. To remove a pulse or pulse set, use the **<** and **>** fields to move between pulses until the pulse to be removed is reached. Highlight the minus (**-**) box. This removes the pulse or pulse set from the train.
11. Changes can be made at any time, including "on the fly" during stimulus output by highlighting the various parameters, and changing as above. Any changes will be implemented in the next cycle following confirmation by pressing the **Accept** button.



Example of a programmed 65uA biphasic pulse of 700us duration per phase with a 700us delay on the first pulse. Additionally, has a 2ms delay between the trigger and the start of the train.

Running the stimulus output

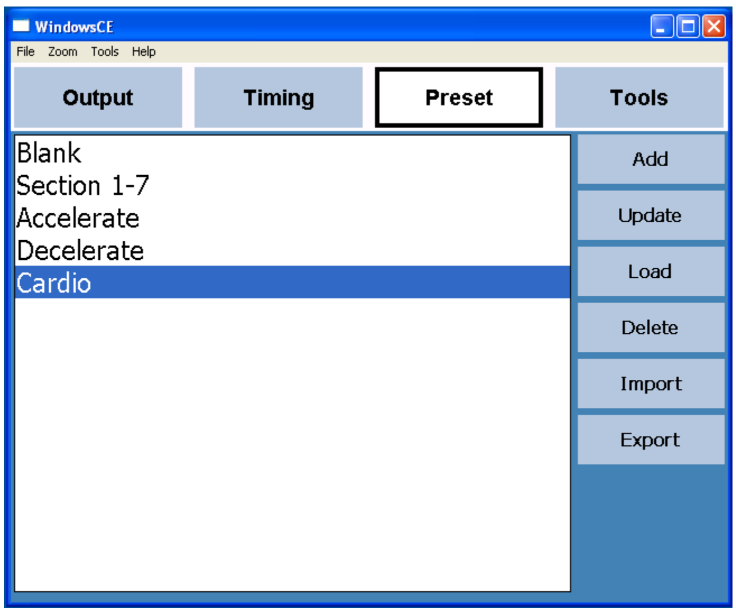
1. Once the **Output** and **Timing** values have been set, press the **Start/Stop** button to activate the stimulus output, or run the program/device to digitally trigger the PGM.
2. The viewing window will display the output as set through the **View** parameter setting on the **Output** tab. Additional indication of output is provided by the lit **Start/Stop** button.



3. If the device monitors a value that exceeds the **Compliance Voltage** or **Protection Current** set in the **Preferences** field of the **Tools** tab, the output will shut off and a warning will be displayed on the screen prompting the user to adjust parameters. (see figure above)

Working With Presets

1. Highlighting the **Preset** tab brings up a list of presets previously saved by users, in addition to the **Default** factory settings in the viewing window.
2. To implement a saved preset, highlight the preset name, and then highlight the **Load** button.
3. To save the current settings as a preset, highlight the **Add** field. A keypad will come up on the screen which can be used to enter a name for the current preset. Click the Enter key on the keypad or the OK button on the dialog box. Once the name is displayed in the list, highlight the **Update** button to confirm and save the new parameters to this profile.
4. To save changes to an existing loaded profile, highlight the **Update** button and confirm that you want to save the changes.
5. To remove a profile from the list and PGM memory, highlight the **Delete** button. A confirmation window will pop up requiring user acceptance of deletion.
6. To load a profile from an external storage device (ex. memory stick), highlight the **Import** button and select the file from the popup dialog box.
7. To send a profile to an external storage device, highlight the profile name and then **Load** to bring the profile into the firmware (If it's not the loaded profile), then highlight **Export** and save it using the popup dialog box.



Example of the default set of factory profiles listed on the Preset screen, and the available function buttons.

Defining Preferences

1. Highlight the **Tools** tab, and then highlight the **Preferences** tab.
2. The output coupling method can be set by selecting **DC** or **AC** from the **Coupling** drop down box
3. Checking the box next to “**Manually Accept Values**” forces a confirmation (by pressing the **Accept** button) of all changes to any parameters. When unchecked, changes can be made “on the fly”, i.e. instantly, and without confirmation.
4. The type of output at the Analog Output jack on the back panel can be selected. **Actual** and **Ideal** work the same as in the **View** parameter field on the **Output** tab. **TTL** provides a +2.5V output marker pulse.
5. **Compliance Voltage** and **Protection Current** set the upper limits for the safety shutoff feature of the PGM. Any time the device monitors an output above these values, the output shuts off and a warning popup is displayed on the screen.
6. Options for how the case of the ESG is grounded can be selected. Selecting **Banana** allows the case to be connected to a ground via the banana jack on the side of the case.
7. Alternately, the case can be directly grounded internally. To do so, select **Leave Connected To Selected Shield** and then select which shield, **Negative** or **Positive**.

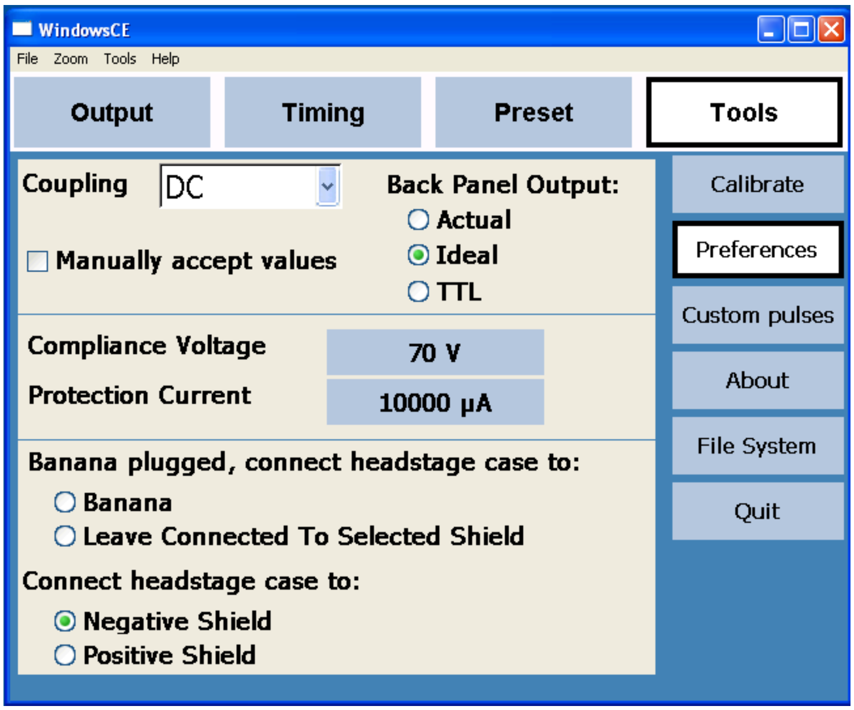
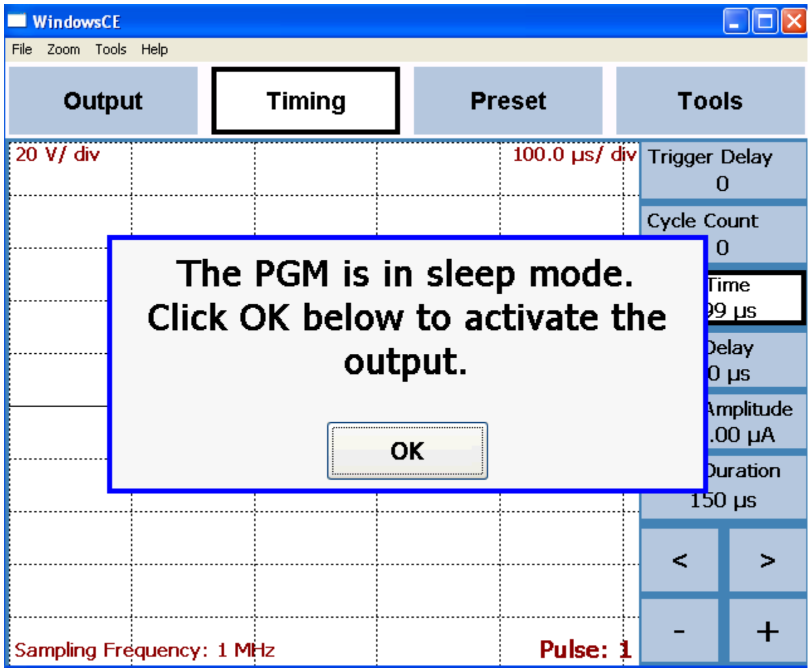


Figure shows the parameters and option fields for the global preferences.

Sleep Mode

After 10 minutes of inactivity the StimPulse enters a sleep mode where the output is grounded and the power is decreased. This prevents overheating of the ESG and circuit protection. The PGM displays the screen below (click "**OK**" to exit Sleep Mode):

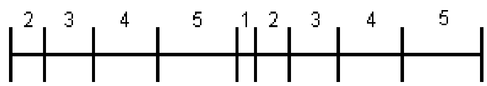


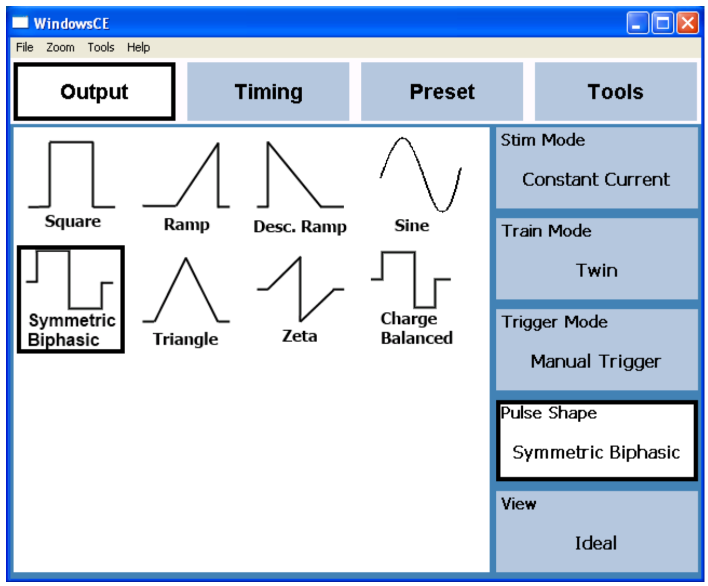
2.5 *PROGRAMMING EXAMPLES*

Programming a decelerating pulse train

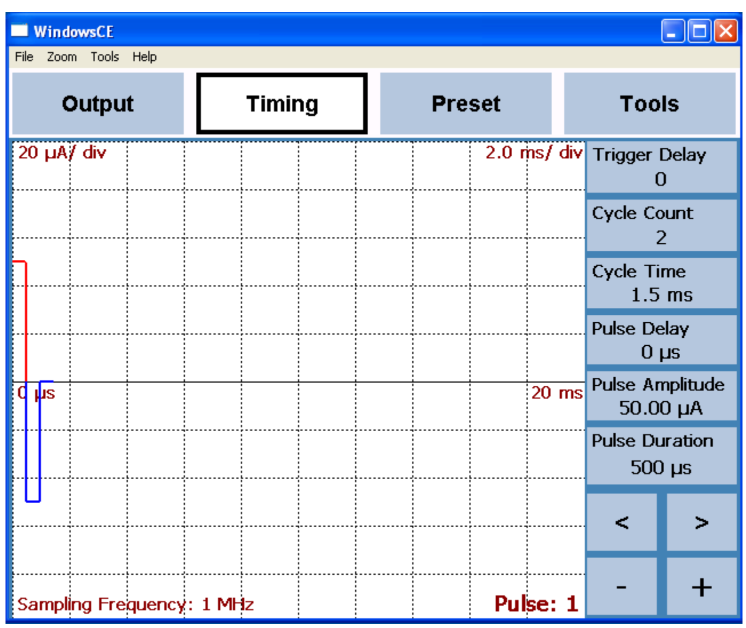
Note: *This example is a factory default **Preset** named "Decelerate" A mirrored version of this is saved as a **Preset** named "Accelerate"*

Ex. Two cycles of 5 bipolar pulses (50uA; 500uS each phase) with increasing inter-pulse intervals (1mS increase per pulse). Cycles separated by 1mS.

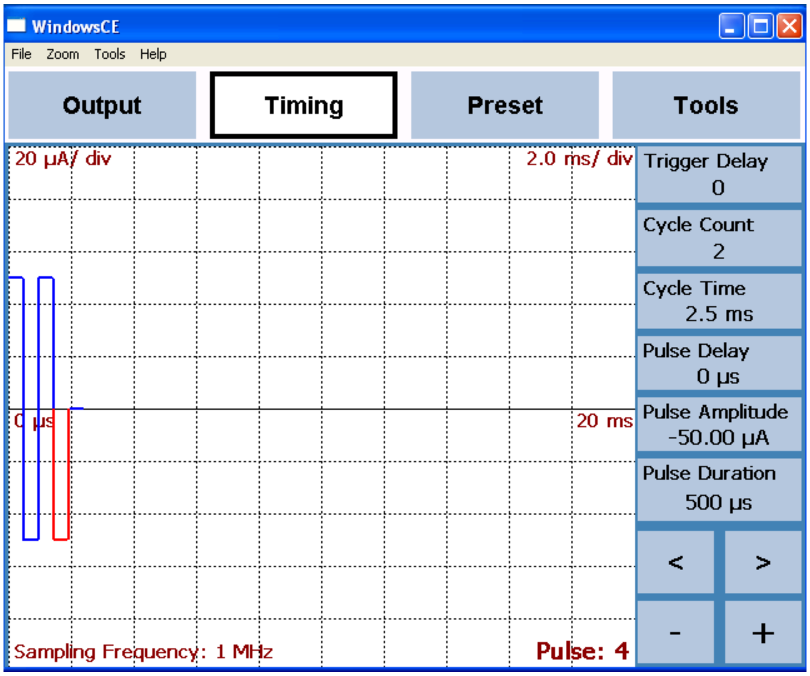




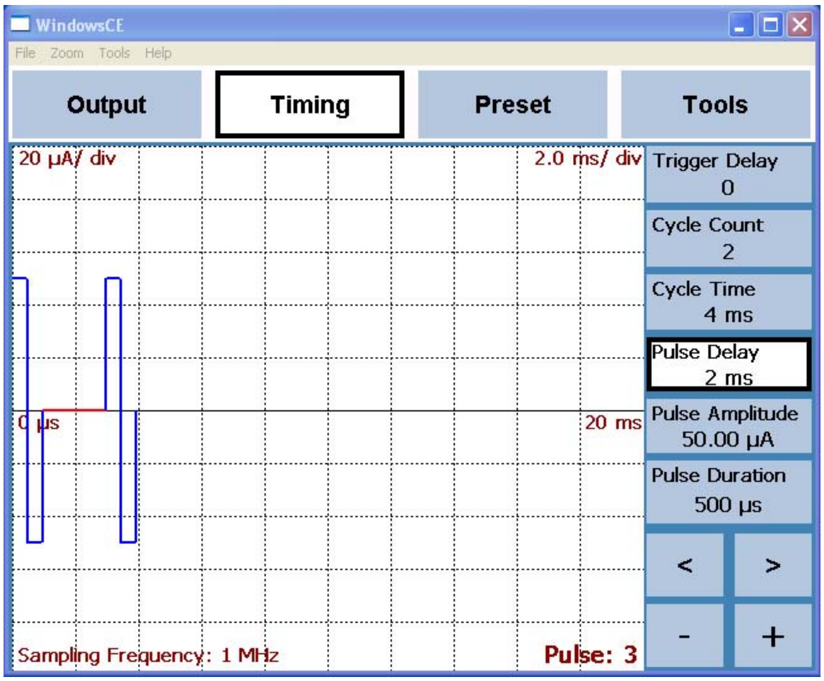
1. Set the **Output** parameters to reflect a twin train of symmetric biphasic, constant current pulses with a manual trigger (**Start/Stop** Button)



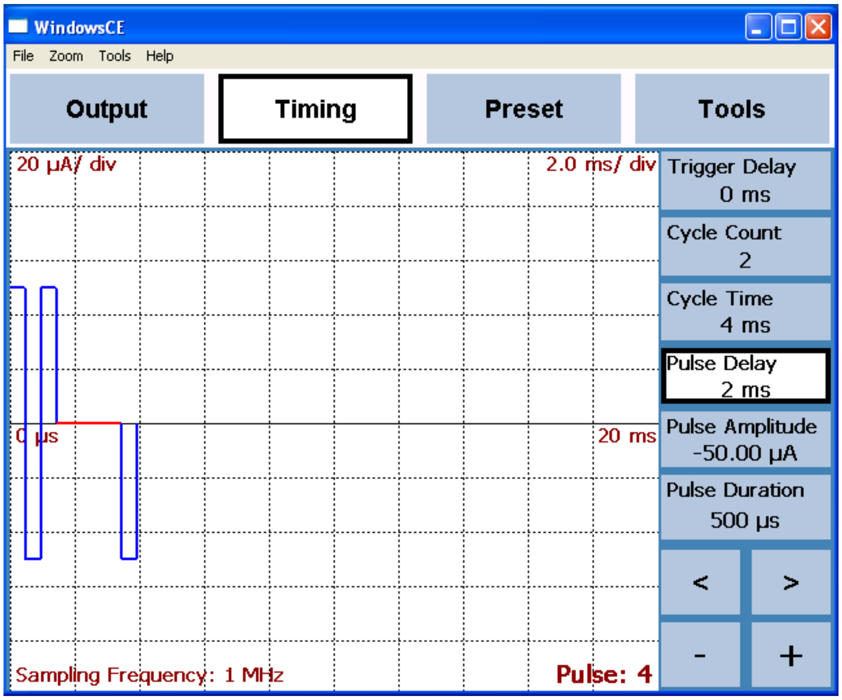
2. **Add** ("**+**") the first pulse and set its timing parameters. It may be necessary to use the Zoom functionality to best scale the viewing window.



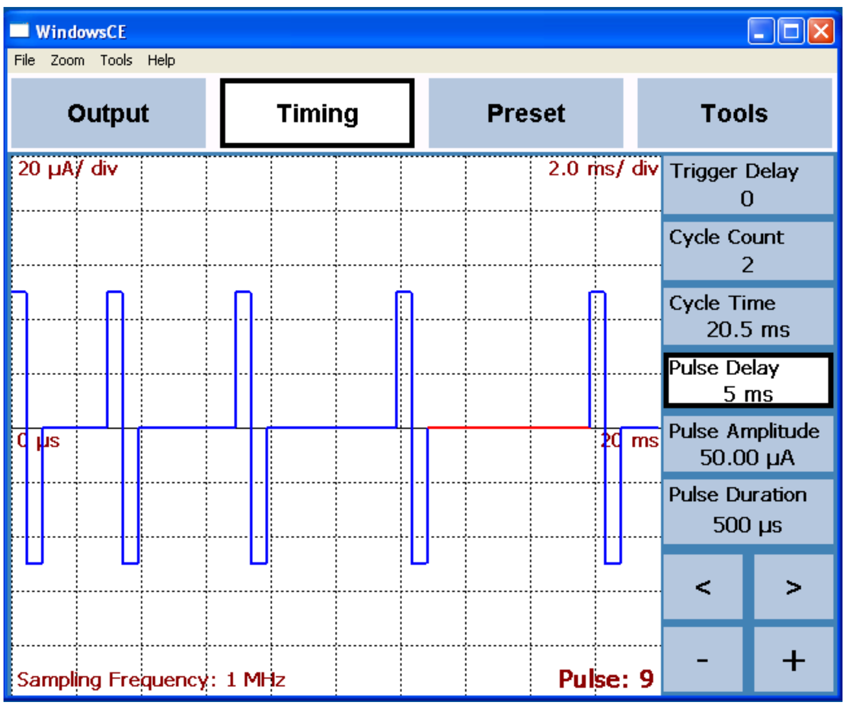
3. **Add** (“**+**”) the second pulse, which will be a duplicate of the first pulse



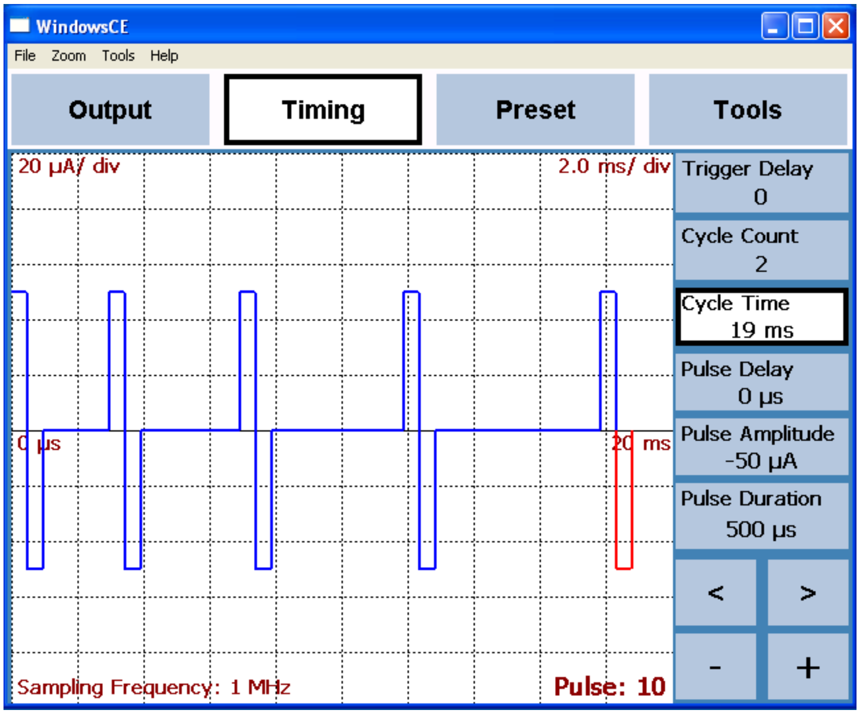
4. Use the “**<**” key to indicate the leading pulse (in this case it is “Pulse: 3”). Adjust the **Pulse Delay** to “2ms”



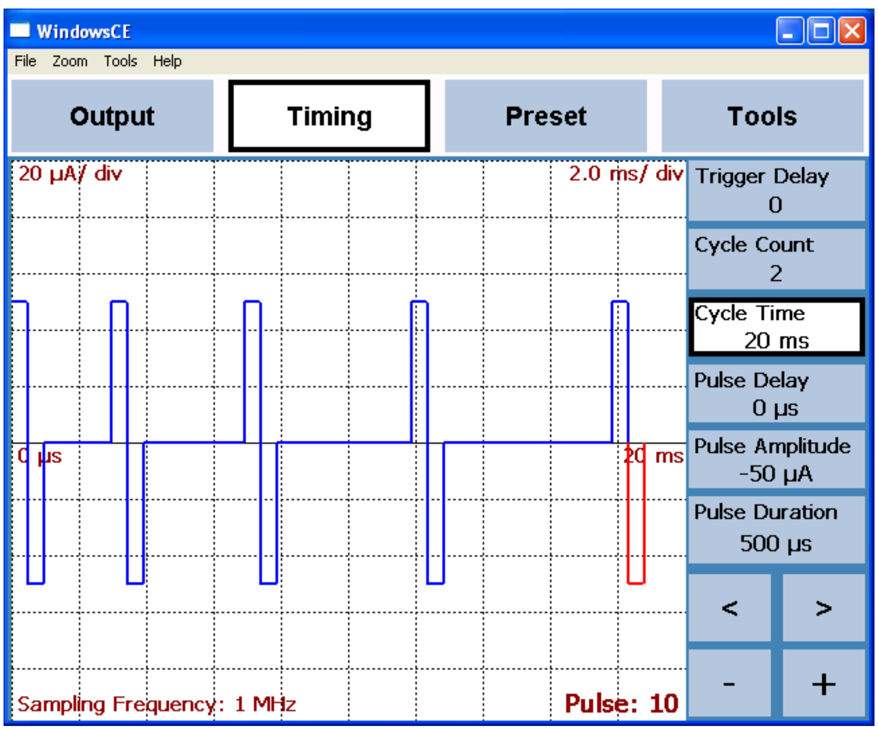
Note: If you do not move to the leading edge of the pulse (i.e. "Pulse: 3" above), before adding the delay, it will split the pulse as shown.



5. Repeat adding and adjusting variables for the remaining pulses



6. At this point the **Cycle Time** displays the correct total time of the programmed cycle. In order to add a 1ms delay between this cycle and the second cycle of the **Twin** output; adjust the **Cycle Time** for an additional 1ms.

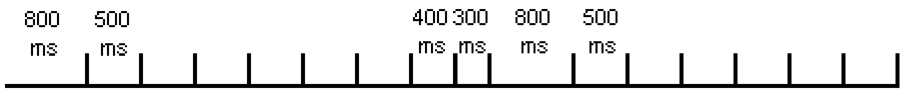


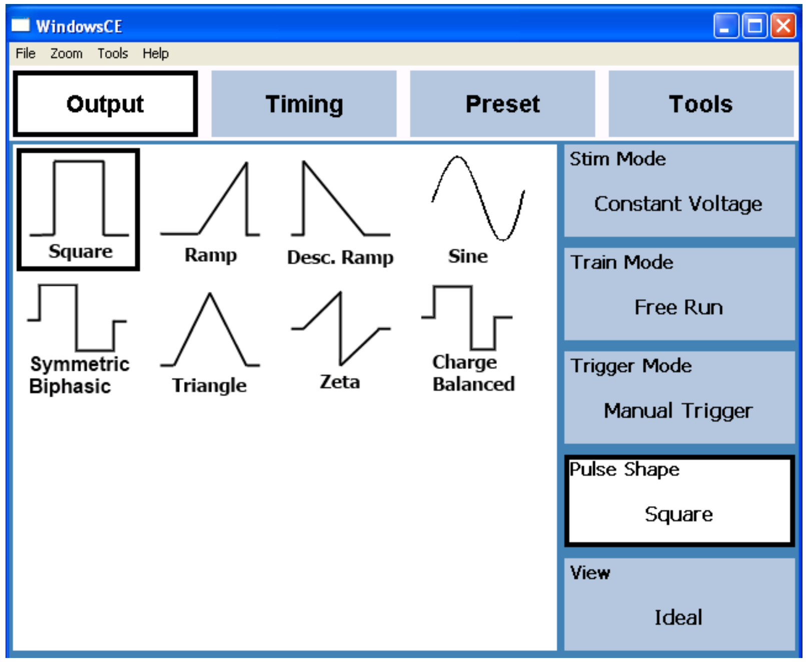
7. This shows the completed cycle programming to achieve the example output.

Programming a cardiac pacing train

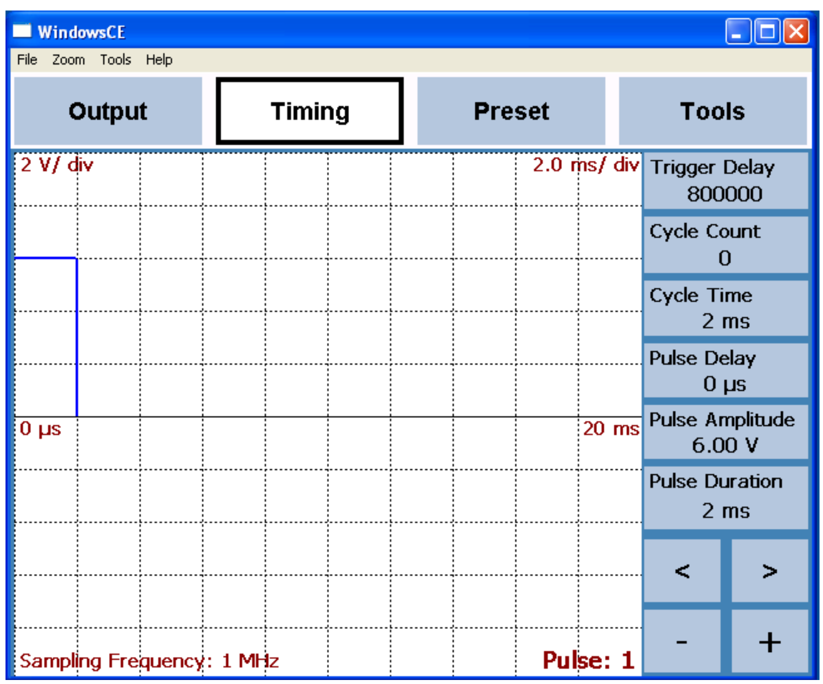
Note: This example is a factory default **Preset** named “Cardio”.

Ex. Free running train consisting of seven monopolar pulses of 6V constant voltage (2ms duration, 498ms inter-pulse interval) followed by two extrastimuli pulses of the same voltage with accelerated inter-pulse intervals (398ms and 298ms respectively). Each cycle is delayed from the previous by 800ms, including the first cycle following the trigger.

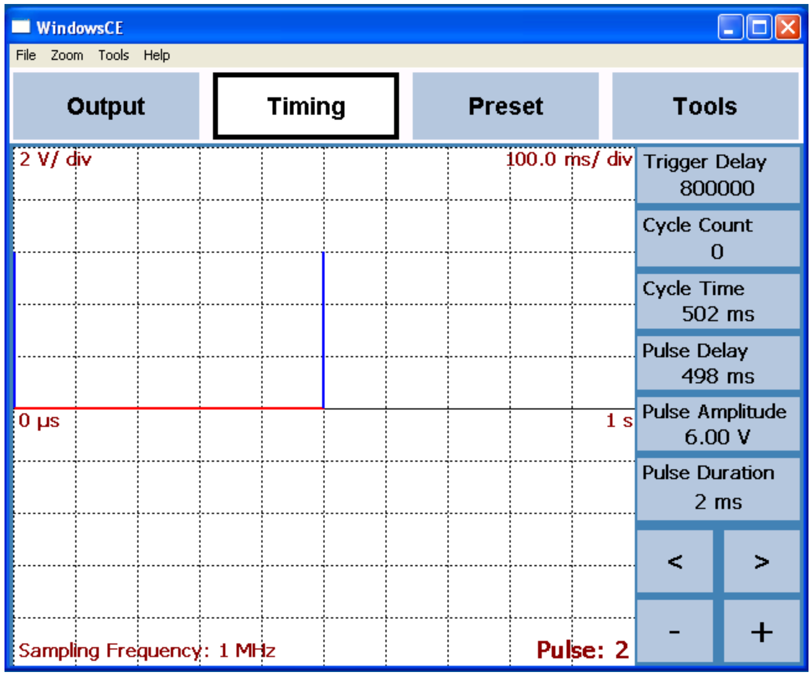




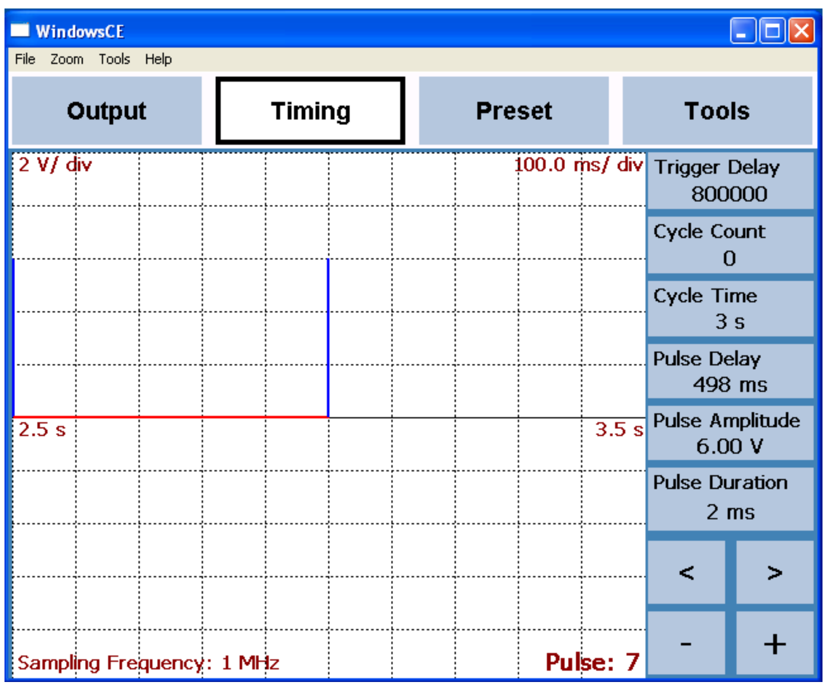
1. Set the **Output** parameters to reflect a free running train of constant voltage square (monophasic) pulses



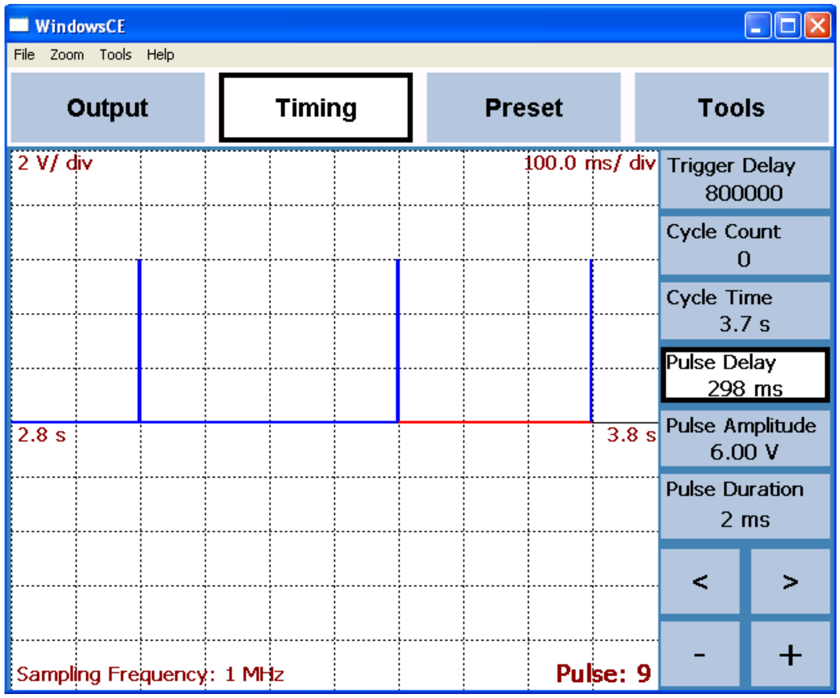
2. Create the first pulse of the train. Note that this train requires an 800ms delay between the trigger and the first pulse. This is programmed into the **Trigger Delay** field settings. The 800ms delay between subsequent cycles will be achieved at the end of the cycle as shown in step 6 below.



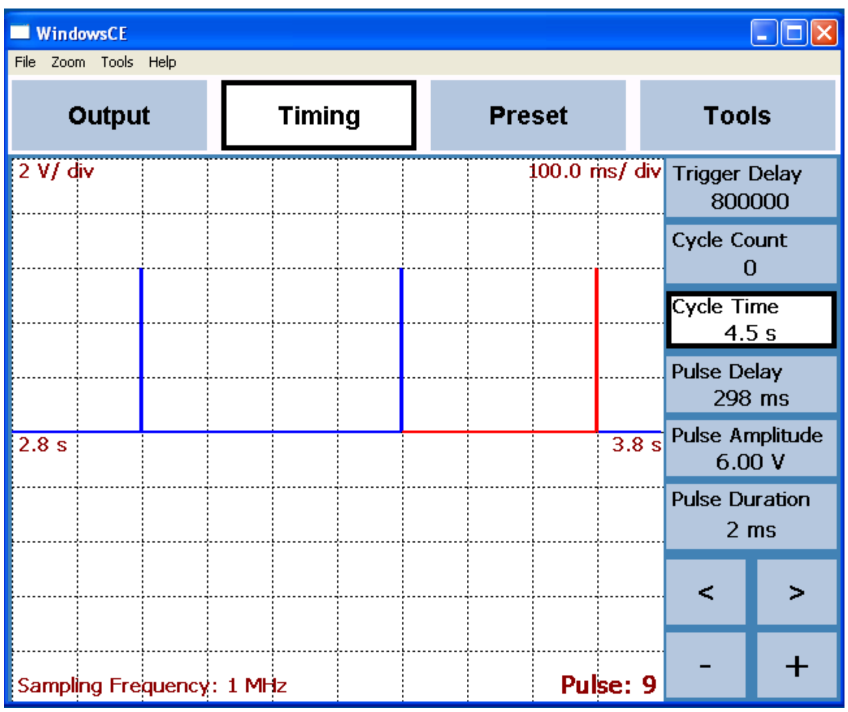
3. **Add** (“**+**”) the second pulse and adjust the **Pulse Delay**. Use the Zoom functionality to best scale the viewing window.



4. Use the **Add** (“**+**”) button to create pulses 3-7, which will be duplicates of pulse 2. Note the change in values of the time scale in the viewing window. Use the Zoom functionality to see back and forth in time along the scale.



5. Add the extrastimuli pulses (Pulse 8 and 9), and adjust their parameters. (In this example pulse 8 has a Pulse Delay of 398ms, and Pulse 9 has 298ms as shown)



6. To create the delay between cycles, adjust the **Cycle Time** to add an additional 800ms to the overall time of the cycle. (In this example 800ms was added to the 3.7s of the programmed pulses)

2.6 *SCHEDULED MAINTENANCE*

A yearly performance of the Functional Checkout in section 2.3 should be performed to ensure function and calibration. If the unit fails any part of this functional test, contact the FHC Repair Department at (207)666-8190