SIGNAL FORGE™

SIGNAL FORGE 2000™
HIGH VOLTAGE PULSE AND PATTERN GENERATOR

User Manual

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Table of Contents

INTRODUCTION 7
Applications 7
SF2000 Features 7
PulseWave Software Features 8

SPECIFICATIONS 9

FRONT AND REAR PANELS 11
Front Panel Diagram 11
Front Panel Connectors 11
Indicator Lights 11
Buttons 12
Arm Button 12
Trigger Button 12
Stop 12
Operation Using the Front Panel 12
Menu Mode 12
Edit Mode 13
Rear Panel Diagram 13
Rear Panel Connectors 13

PULSEWAVE SOFTWARE 14
Installation 14
AC Adapter 14
USB Driver Installation 14
Com Port Identification 14
PulseWave Software Installation 15
System Requirements: Microsoft Windows 7, Vista, XP, 2000. 15
Using PulseWave Software 15
Custom Programming 15

OPERATING THE SF2000 16
First: Set The Output Voltage Level 16
Power Up and Reset 16
Stopping and Starting a Channel 16
Operation 17
Programmable Parameters 17
Channel Status 19
Pattern Mode 19
Pulse Mode 19
Single-step Mode 19
Trigger Delay and Skew 19
Gate 20
PulseWave Pattern File Format 20
Programming Examples 20
Example: Basic Pattern and Pulse Operation 20
Theory of Operation 22
Programming Interface 22
SCPI Conformance Information 22
User-developed Programming 22

CALIBRATION AND ACCURACY 24
Calibration Interval 24
Procedure 24

GENERAL SAFETY AND WARRANTY INFORMATION 25

To Avoid Fire or Personal Injury 25
Warranty 25

SOFTWARE UPDATE PROCEDURE 26

PRODUCT LINE 27
How to Buy 27
Buy Online 27
Purchase Orders 28
Quotes 28

Table of Figures

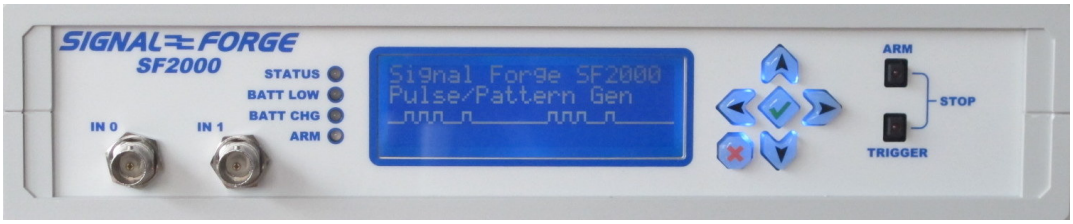
FIGURE 1. FRONT PANEL 11
FIGURE 2 REAR PANEL 13

Table of Tables

TABLE 1 SPECIFICATIONS 9
TABLE 2 - GLOBAL PARAMETERS 17
TABLE 3 - PER-CHANNEL PARAMETERS 18
TABLE 4 SIGNAL FORGE PRODUCT LINE 27

Chapter 1

Introduction



The Signal Forge 2000 Pattern and Pulse Generator is a high voltage signal source with optional battery operation for field use. The pattern-based pulse mode featured on the SF2000 is much more capable than common pulse generators which only generate simple pulse bursts.

The SF2000 may be controlled from the front panel, or from a PC with the PulseWave software supplied with the unit (a USB cable connects the SF2000 to the PC). SCPI (Standard Commands for Programmable Instruments) command support allows for easy integration into most test environments. PulseWave runs on Windows 7, Vista, XP and 2000.

USB drivers are available for Windows 7, XP, CE, 2000, Vista, 98 and Mac OS X™. PulseWave is not available for OSX.

Applications

The SF2000's high voltage and high power capability make it ideal for numerous applications such as:

- Sensor testing and sensor simulation
- Low data-rate communications
- Digital stimulus testing
- Portable, bench top and ATE system applications

SF2000 Features

The SF2000 provides the following features:

- Voltage range 3.3V to 20 V into high impedance (100mA per channel)
- Outputs balanced to drive 50 ohm
- Pattern and pulse modes
- Pattern bit period 20ns to 42s with 10ns resolution, 16k deep per channel
- Pattern-based pulse generation (pulse location determined by pattern memory)
- Pulse width 10ns to 42s with 10ns resolution
- 3 channels in base model, expandable to 9
- Front panel controls and LCD for stand-alone operation
- PC-control using PulseWave software (provided) or your test program
- Independent channel operation (e.g. pulse period & width, trigger source, etc.)

- Adjustable channel skew up to 16.77ms in 250ps steps
- IN0 and IN1 usable for trigger, IN1 can be gate or master clock input
- Trigger on edge or level (any polarity), internal interval, software, or manually using button on front panel
- Trigger runs pattern once or looped
- Single-step mode triggers per pattern bit (including pulse mode)
- Gate signal can mask trigger and/or output
- Save / load nine user-defined settings
- Auto Start loads any one of nine user-defined settings at power up
- SCPI programming interface for integration with LabView™ or other test environments
- Battery-powered models are available
- Optional TCXO for high master clock accuracy and stability
- Small, portable package (8.83in x 7.83in x 2.85in)

Note

Future models will provide 1ns pulse width resolution and up to 9 channels.

PulseWave Software Features

PulseWave is a Microsoft® Windows® compatible program supplied with the SF2000. It provides simple intuitive control of the SF2000. PulseWave features include:

- Support for all SF2000 operations
- Save or restore patterns to/from files
- Save and restore settings from SF2000 flash
- Edit patterns in many modes (binary, hex, ON/OFF count)
- Update firmware
- Force an output high/low
- Arm and trigger channel(s) simultaneously from your PC
- View channel status (armed, triggered, running, done)
- Multiple-channel parameter editing and viewing
- Saves SCPI command history which may be copied to a text file for review or use in a user developed test program

Chapter 2

Specifications

All parameters are programmable in 10ns increments using the internal master clock MCLK (100 MHz), unless otherwise specified.

Table 1 Specifications

Parameter	Description
Ambient Temperature	0C to 40C (32 to 104F)
Pulse width range	10ns to 42.9 seconds (32-bit MCLK counter @100mhz)
Pulse width resolution	10ns
Amplitude Range	3.3V to 20V into high impedance 1.65 to 10V into 50 Ohms
Amplitude Accuracy	0.2V
Amplitude Resolution	0.05V
Output power maximum [1]	150mA per channel
Rise/fall times	3ns (5V 1 MHz into 50 ohms) 7ns (20V 1µs pulse into 50 ohms)
Pulse period (pattern bit period)	20ns to 42.9 seconds (32-bit MCLK counter @100mhz)
Pattern depth (per channel)	16k bits
Channel skew [2]	Added delay 0 to 50ns in 250ps increments. Must be disabled when output high or low time is less than 40ns.
Fixed trigger delay [3]	50-80ns. Delay is 20-30ns less if skew is disabled
Trigger jitter (from IN0 or IN1)	10ns
Programmable trigger delay	0ns – 167.7ms (16-bit MCLK counter @100 MHz). This delay is in addition to the fixed trigger delay.
Internal trigger interval	Min 8 MCLK cycles (80ns) to 42.9s (10ns resolution)
Skew accuracy skew = 0, 50ns	+/- 1.0ns @25C, +/- 2.5ns over 0C – 40C
Skew integral non-linearity	+/- 2.5ns @25C
Skew step size	-0.75 to 1ns (typ 0.25ns) @25C
Inputs IN0 and IN1	3.3V (5V Tolerant) diode protected
IN0 / IN1 trigger high/low time	Min 3 times MCLK plus 5ns (typically 35ns)
IN1 used as gate signal	No minimum high / low time

User-driven clock (IN1) rate	Multiplied by 10 to become MCLK. IN1 must be 500khz – 10mhz.
Standard oscillator [4]	Frequency tolerance 70ppm Frequency stability 15ppm over 0-35 ºC ambient
Wall outlet power supply	Input 100/ 240VAC, 50/60 Hz Output of 24 VDC and 1.5A.
USB power used	none

Note 1: The output capability of 150 mA (per channel) must be taken into account when driving higher voltages into a 50 Ohm load.

Note 2: Chanel skew is implemented using a programmable delay line with 250ps steps. Total output delay adds the digital trigger delay parameter in combination with the channel skew parameter. The skew delay is most accurate near 0ns, 32ns, and 64ns.

Integral non-linearity is the deviation from a straight line response drawn between the measured step zero delay (tD0) and the measured step 255 delay (tD255) with respect to the step 0 delay.

Note 3: The fixed trigger delay is composed of two parts: the digitally sampled trigger and an analog delay line (may be removed from the path). The digital portion runs from MCLK (usually 100 MHz) so it has a range of 10ns (e.g. 50-60ns). The delay line inserts a 17-23ns delay that depends on the calibrated value for that delay line.

Note 4: Frequency tolerance is the deviation from the specified nominal frequency at ambient room temperature. Frequency stability is the deviation over a temperature range.

Chapter 3

Front and Rear Panels

Front Panel

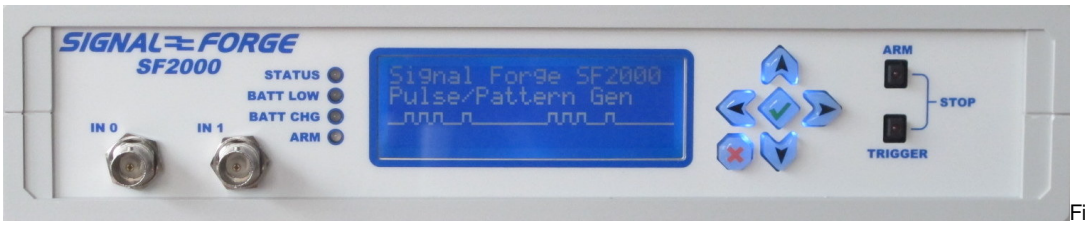


Figure 1. Front Panel

Front Panel Connectors

BNC input IN0 can be used as a trigger signal.

BNC input IN1 can be used as a trigger or gate signal, and it may be used to drive the master clock MCLK. When used to drive MCLK the signal is multiplied by 10 and has speed requirements defined in the specifications section.

Indicator Lights

There are 4 LEDs to the left of the LCD screen:

- "Status" – OFF means no "fatal" or "questionable" conditions. Orange means there may be minor problems with the output (the output is usable but not fully accurate - usually due to a calibration error). Red means a fatal condition exists (probably hardware failure) and the output is not usable. The cause can be found using the front panel menu or by running PulseWave
- "Battery low" – only ON (red) during a low battery condition
- "Charging" – only ON (green) when the battery is charging
- "ARM" – momentary ON (green) when any of the outputs toggle

Note that the battery-related LEDs are only operational on battery-powered models

Programmers note: The "Status" LED is directly related to SCPI status. Orange means only "questionable" conditions as reported by the Questionable Condition register are present (the output is usable but not fully accurate). Red means one or more "fatal" conditions (output is unusable). Only "fatal" conditions are reported in response to SCPI commands used to program channel operation.

Buttons

The LCD buttons are used for menu operation.

The two panel buttons, “Arm” and “Trigger”, perform three operations: Arm, Trigger, and Channel Stop. These actions occur upon button release.

For the "channel stop" action the buttons can be pressed and released with any timing so long as the second button is pressed before releasing the first. A "channel stop" message is momentarily displayed when the action is performed

Any combination of channels may be armed, triggered, or stopped using these buttons but all channels are enabled by default.

Arm Button

This button reprograms then arms channels making them ready to trigger. If a channel is still running from a previous trigger it is immediately stopped when reprogramming begins. By default all channels are enabled to respond to the button arm operation.

Arming occurs simultaneously on the same MCLK edge for all channels.

The Arm LED indicates arming status as follows:

- LED is ON – Any channel armed by the button is armed

The LED will go OFF when all of the channels armed by the button have been triggered.

Trigger Button

This button triggers armed channels. By default all channels are enabled to respond to the button trigger (even if another trigger source is enabled).

The Trigger LED goes ON when any channel triggers, and goes OFF when no channels have triggered in the last half second.

Stop

Pressing the arm and trigger buttons together re-programs enabled channels. The channels are then ready to be armed. By default all channels are enabled to respond to the stop operation.

Operation Using the Front Panel

1. Plug in AC adapter
2. Turn on the SF2000
3. Press any key to bring up the menu
    a. The “X” key is used to go up one level in the menu or to abort editing.
    b. The “√” key is used like OK or ENTER or SELECT. When the panel LCD says something like “press OK” it means press the ”√” key

The front panel supports all SF2000 functions. However, pattern editing is limited due to the available character space.

There are two modes: menu and edit. When you are not editing a value, you are in menu mode.

Menu Mode

In menu mode the upper right of the screen shows “CHx” where x is the current channel number. When a channel-specific parameter is displayed or edited it belongs to channel x.

- **Up/down arrows** are used to scroll the current menu level
- **Right/left arrows** change the current channel number. This is handy for quickly scrolling through the channels when you have a parameter selected
- **"X"** backs up one menu level
- **"+"** at the beginning of a line indicates that there is a submenu below the current selection: press **<check>** to go to the next level
- **"#"**at the beginning of a line indicates that a parameter is being viewed. The last line displays the current parameter value
- **<check>** to modify the value (on/off values may be changed entering edit mode)

Edit Mode

There are several edit windows.

- **Left/right** arrows move from digit to digit
- **Up/down** changes the value of the digit
- ✓ accepts the value
- **"X"** aborts the edit with no changes made

Note

If you change parameters using the front panel while the PulseWave software is running, you must refresh the application window in order for those changes to appear on your computer display.

Rear Panel Diagram

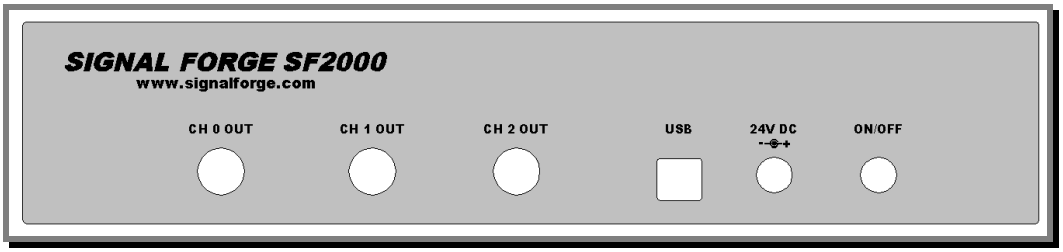


Figure 2 Rear Panel

Rear Panel Connectors

BNC connectors for output channels: CH0, CH1 and CH2

USB: Type B USB connector

Power: Accepts the power plug from the wall power module

On / Off: Power switch

Chapter 4

PulseWave Software

Installation

PulseWave is a Windows-based application which provides easy control of the SF2000 without the need for custom programming. It is compatible with Windows 7, Vista, XP, 2000, and Server 2003 (Windows 95 and NT are not supported).

The installation and setup procedure is as follows:

1. **Before you install the software and drivers:**
    a. Plug in AC adapter
    b. Connect the SF2000 to a USB port on your computer
    c. Turn on the SF2000 (allow 5 secs for the SF2000 to boot before starting PulseWave)
2. Install USB drivers
3. Install PulseWave software
4. Start PulseWave
    a. The first time….Configure COM port

AC Adapter

Use only the power adapter that came with your SF2000 because adapters have different voltage outputs and power capability.

USB Driver Installation

To install the USB drivers on your Microsoft Windows computer:

1. Connect the SF2000 to your computer and turn it on. Windows will find the new hardware and ask to install the driver. Two drivers will be installed, a USB driver and a VCP (virtual COM port) driver.

Installation is usually automatic if the PC is connected to the internet. Windows 7 uses the internet to connect to the Windows Update website and install any drivers not already on your computer.

If Windows does not recognize the SF2000, re-boot your PC while the SF2000 is connected and turned on.

Com Port Identification

When the UBS Virtual COM Port driver is installed, make a note of which COM port number is assigned to the USB port. You can find this information under Control Panel->Hardware and Sound->Devices and Printers and look for “FT232R USB UART”. Double-click to open the properties window then select the Hardware tab. You should see something like

"USB serial port (COM5)". In this case COM5 is the SF2000 and COM5 is the port you need to select when running PulseWave or your own program.

The SF2000 can communicate with any computer that supports a virtual COM port for the FTDI RT232R USB chip.

PulseWave Software Installation

The PulseWave program is installed by simply copying it to your desktop or any directory you choose.

If more than one SF2000 is connected to a computer, you need to install one instance of PulseWave for each unit. Each copy of PulseWave must reside in a separate directory.

System Requirements: Microsoft Windows 7, Vista, XP, 2000.

Using PulseWave Software

1. Turn on the SF2000 and allow 5 seconds for it to boot
2. Start PulseWave
3. The first time you run PulseWave you need to select the USB COM port. Navigate to the Misc->USB COM Port menu and select the SF2000 COM port. The COM port number will be saved so you do not have to select it the next time the program runs.

Note

If the SF2000 is not powered on when PulseWave starts you will receive a message that the COM port could not be found. Either exit and restart PulseWave or re-select the COM port.

Pressing the *Identify* button causes PulseWave to display SF2000 configuration information.

If PulseWave is started before the SF2000 finishes booting, you will get an error message when you press the *Identify* button.

Changes made using PulseWave are immediately programmed on the SF2000. If you modify a channel-related parameter the channel output is set low while the channel is programmed. The output will not go high until the channel is armed and triggered (if the output is programmed as active high it causes the output to be high the whole time instead of low).

The SCPI command history window displays the commands and responses to/from the SF2000. This is useful if you are developing your own control program.

Custom Programming

The SF2000 may be operated using a third-party application or user-developed software which supports the SCPI standard IEEE 488-1990.0 (with a few minor differences). For complete programming information refer to the SCPI Programmer's Manual for the SF2000 which may be downloaded from the Support page of Signal Forge web site.

Chapter 5

Operating the SF2000

First: Set The Output Voltage Level

When the SF2000 programs the output voltage it forces the output high for a short period of time (< 100ms) while the voltage is moved from the minimum setting to the target voltage. This is done even if the <output control> parameter is set as "disabled: low". Once the voltage level has been set the output is placed at the level determined by the <output control> parameter (usually 0V).

The voltage is programmed at these times:

- Power-up (max voltage output is 3.3V unless user setting is loaded)
- When an "instrument reset" is performed (max voltage output is 3.3V)
- The output voltage level parameter is changed

If you work with devices that can be damaged by high voltage we suggest you do the following:

- Unplug your cables before setting a new voltage level (in case you enter a damaging voltage value by mistake).
- Unplug your cables before loading a new setting.
- Save settings with the voltage set to the minimum. Modify the voltage after loading the setting.

Power Up and Reset

When the SF2000 powers up it either loads the default instrument settings or a user-defined setting.

System reset forces all parameters to their default value and reprograms the instrument: The output is set for minimum voltage level; Channel outputs are low until armed and triggered.

To reset the system:

- Use the front panel menu "Reset"…"Reset Instrument"
- Use PulseWave to issue a "Reset Instrument"

The default settings may be viewed using the front panel menu or the PulseWave program. They are also listed in the SCPI Programmers Manual.

Stopping and Starting a Channel

In order to run, a channel must be armed then triggered. The following methods are used to re-program and arm channels:

- Press the front panel "Arm" button
- In the PulseWave "Channel Control" window click the "Arm" button

A channel may be stopped and re-programmed (but not armed) in these ways:

- Press the front panel Arm and Trigger buttons at the same time to create the "Stop" condition
- Use the front panel menu "Reset"…"Stop channel".
- In the PulseWave "Channel Control" window click the "Stop" button.

When a channel is re-programmed the output will be low (unless you set the output to "active low") until the channel is armed and triggered.

Operation

This section describes how to use either the PulseWave software or the front panel to control the SF2000. Emphasis is placed on PulseWave. The front panel menu system supports the same functions. You may also write your own program to control the SF2000. Refer to the SCPI Programmer's Manual for a description of the programming interface.

Operating the SF2000 generally proceeds in the following order:

1. Set the global operating parameters
2. Set the per-channel output voltage
3. Set the per-channel operating parameters including pattern data
4. Arm
5. Trigger (must be armed first, then triggered)

Once this is done you normally just modify desired parameters (e.g. pattern data or pulse width) then arm and trigger.

When most channel-related parameters are changed (e.g. pulse width) the channel is reprogrammed (channel must be armed). Some parameters do not require reprogramming the channel (e.g. enabling the gate feature) and do not change the current channel status (e.g. running).

To check the channel state after changing a parameter open the "Control Window" and do one of the following:

- Click "Arm" to re-program and arm the channel
- Click "Stop" to re-program the channel (requires arming)
- Click "Update Status" to display the current channel status

Programmable Parameters

The globally programmable parameters are listed in Table 2 - Global Parameters.

Table 2 - Global Parameters

Parameter	Description
IN0 trigger use	Rising / falling edge or level sensitive high / low.
IN1 trigger use	Rising / falling edge or level sensitive high / low.
Interval counter	#MCLK cycles (for use as trigger source).
IN1 drives MCLK	Enabled means MCLK is derived from the signal on user input IN1. The signal is multiplied by 10 to become MCLK and has frequency requirements as stated in the specifications.
Gate when low	Normally the gate function is active when IN1 is high. This enables gating when IN1 is low.

The per-channel parameters are listed in Table 3 - Per-Channel Parameters.

Table 3 - Per-Channel Parameters

Parameter	Description
Output voltage	The voltage on the output when high.
Output control	Active high, active low, force high, force low. Active high means the output follows the pattern bit ("1" means output is high). Active low inverts the output. "Force" sets the output to a specific value (ignores pattern).
Trigger delay	#MCLK cycles from trigger to start of pattern. This can be used to offset pattern bits / pulses from one channel to the next.
Pattern bit period	#MCLK cycles to output each pattern bit.
Pattern depth	How many pattern bits to output.
Pattern data	The bit values that define the pattern.
Pulse mode enable	When disabled the output follows the data pattern. When enabled a pulse is output for each "1" bit of the data pattern.
Pulse width	#MCLK cycles that every pulse is high (pulse mode).
Continuous mode enable	When ON the pattern will repeat forever after the first trigger.
Single-step mode enable	When ON a trigger is required for every bit of the pattern.
Hardware trigger source	IN0 signal, IN1 signal, rate generator, or none. Triggering can always use trigger button or software SCPI command.
Auto-arm enable	When enabled, the channel is automatically armed after it runs each sequence. Channel must be armed once.
Gate trigger enable	Enabled means IN1 signal gates (disables) the trigger.
Gate output enable	Enabled means IN1 signal gates the output (forces inactive). The <output control> parameter has priority (i.e. forcing a specific output value ignores gating).
Skew (ns)	Delay the output with 250ps resolution. Skew must be enabled (next parameter).
Skew disable (note 1)	When TRUE the skew delay chip normally in the output path is removed. Skew should be disabled whenever the output signal will be less than 40ns (i.e. shorter pulse, or bit period is less than 40ns).
Arm button enable	When enabled pressing the front panel "Arm" button reprograms and arms this channel. Default is enabled.
Trigger button enable	When enabled pressing the front panel "Trigger" button triggers this channel (if armed). Default is enabled.
Stop button enable	When enabled pressing the front panel "Arm" and "Trigger" buttons at the same time re-programs this channel. The output will be inactive and ready to be armed. Default is enabled.

Note 1: An analog delay line is normally used in the output data path (used to implement skew). This delay line cannot accurately pass pulses of less than 40ns. Therefore when the output will be programmed to create high or low signal times less than 40ns then skew should be disabled.

Channel Status

The PulseWave "Channel Control" window displays status for every channel:

- Armed - ready for trigger (output is at inactive level)
- Running - pattern is driving the output
- Done - pattern completed a run (output is at inactive level)
- Triggered - a trigger occurred since the last press of the "Update" button
- "Output is:" - live high / low level of output signal

The front panel menu can also be used to display status.

When a channel is initially programmed or reprogrammed, all the status will be false: not armed, not running, not done, and not triggered.

Once a channel is armed it will always be either armed, running, or done. Once set the "triggered" status is only cleared by a channel reprogramming or by querying the triggered status (e.g. the PulseWave status "Update" button).

Pattern Mode

Pattern mode is used to drive the output directly from pattern memory. Each pattern bit is output for a time specified by the <bit period> parameter.

Pulse Mode

Pulse mode works like pattern mode except that a pulse is output for each "1" bit of the pattern. The <bit period> parameter is the time between pulses. Unlike other pulse generators the SF2000 allows you to specify a different bit period for each channel.

Single-step Mode

Single-step mode generally works as normal except that a trigger is required for every pattern bit. What happens is this:

- Arm the channel.
- The first trigger causes the programmed trigger delay before the first pattern bit (or pulse) is output.
- The next trigger outputs the second pattern bit (or pulse).

A pattern length of N requires (N + 1) triggers to complete the normal sequence. For example, a 3-bit deep pattern gets triggered 3 times. The last pattern bit is being output. Channel status is still "running". The next trigger completes the pattern sequence: channel status is "done" and the output is inactive (the pattern has completed). The channel can now be armed again for a new sequence.

Pulse mode works as usual – when a pattern bit is "1" a pulse occurs.

In single-step mode the <MCLKs pattern bit period> parameter is not used. The bit period is strictly defined by the distance between triggers. Channel skew can be used to delay outputs in relation to each other.

Trigger Delay and Skew

The trigger delay parameter specifies how many MCLKs to delay the channel output from the trigger. The skew parameter specifies an additional delay to the output (uses programmable delay line).

Trigger delay moves the start of a pattern in relation to the trigger. This is commonly used to move the output of one channel in relation to another channel. For example, programming trigger delay = 0 for channel 0 and trigger delay = 1 for channel 1, when the channels are triggered the pattern (or pulses) from channel 1 will happen 10ns after channel 0.

The skew parameter specifies an additional delay to the output. Skew is implemented using a programmable delay line that is programmed in 250ps increments. For example a 1ns delay programs the device with value = 4 (plus the calibrated value).

Gate

The IN1 signal can be used to gate the trigger and/or output of any channel. Gate is normally active high – i.e. when high the trigger or output is gated.

Once a channel is triggered the pattern runs to completion.

Gating the output immediately sets the output to the inactive level even if the pattern is running (it only affects the final output).

PulseWave Pattern File Format

PulseWave can use files to save and load patterns. The file extension is usually “sfd”. The format and rules are described here.

- The first line must be “@SignalForge”.
- The second line must be “@SF2000data”.
- Any line whose first character is not "@" is discarded (considered a comment)
- Max 200 chars per line.
- Max 32 data bytes per line.
- Data is always a byte size decimal 0-255.
- Data can be specified in any channel order, interspersed.
- <channel name> are "CH0" - "CH8"
- If more than one pattern depth is specified the last one is used. Pattern depth is the number of bits to use (same as the SF2000 parameter).

Data for a channel is specified as: @data <channel name> < byte > <byte> …

Example: @data CH0 17 255

The pattern length must be specified using: @patternDepth <channel name> <length>

Example: @patternDepth CH1 13

The file must define at least as much data as the specified pattern depth.

When a file is loaded to the SF2000, channels that do not specify any data will issue a warning message and no data for that channel will be loaded. Channels with specified data will always be loaded.

Programming Examples

Note: All operations are based on patterns.

“Set defaults” is used in the examples to put the instrument into a known state. This will set the output high voltage to the default lowest value.

Example: Basic Pattern and Pulse Operation

This example describes how to use pattern mode, and how that pattern is used to output a series of pulses.

To output a pattern of “1011” on channel 0 using PulseWave, do the following:

- Click on “Set Defaults”. Pattern mode is set by default.
- Set the output voltage using the “Output Voltage” window (or leave at default)

- Open the “Channel Pattern” window
- Set the mode to “binary”
- In the “CH0” row of data, click on the first button and enter a value of 4. This will be the pattern depth (as indicated by the tool tip text that shows up when your mouse hovers over the button).
- Click on the data buttons to enter the “1011” pattern.
- Click on “Write” to transfer the pattern to the SF2000.
- Open the “Channel Setup” window.
- Open the “Channel Control” window. Click on “Arm” and you should see the LED light up on the Arm button. Click on “Trigger” to run the pattern once and you should see the Arm button LED go off.

The time that each bit of the pattern is output depends on the “bit period” parameter. A value of 100 MCLKs would be 1000ns per bit.

To output pulses instead of the pattern:

- Change the “Pulse Mode” button in the “Channel Setup” window to ON (this enables pulse mode).
- Arm and trigger the channel. The output will be three pulses: bit period 0, 2, and 3.

You can use the “Channel Setup” window to change the bit period (pulse period), pulse width, and other parameters.

Chapter 6

Theory of Operation

All operations are synchronous using the master clock MCLK (except the analog pulse option described elsewhere). MCLK is 100 MHz unless driven by an outside source. This gives a 10ns resolution for each programmable parameter (e.g. bit period / pulse period, pulse width).

The underlying operation is always a 16k deep (per channel) pattern generator driven by MCLK. The pattern rate is a multiple of MCLK. Patterns may be run per-trigger, continuously looped, or stepped bit-by-bit (trigger per bit).

When pulse mode is enabled the pattern itself is not output, but instead each "1" bit of the pattern determines where a pulse will occur. A "0" bit keeps the output inactive. The pulse width is programmable (must be less than the pattern bit period).

For example, if the SF2000 is programmed for bit period = 100 (1us), using the pattern "1011", and not using pulse mode, the output would go high for 1us, low 1us, high 2us, then back low until the next trigger. If pulse mode was enabled the output would be a pulse at 0us, 2us, and 3us.

Available triggers are input signals IN0 and IN1, plus a global rate generator. Triggering can also be done by the front panel trigger button or under software control. All channels using the same trigger source (including software trigger) are triggered synchronously.

Programming Interface

The programming interface complies with the IEEE488.2 and SCPI-1999.0 standards.

IEEE488.2-2004 (Standard Digital Interface for Programmable Instrumentation) describes how to send commands to instruments and how to send responses to controllers. It defines some frequently used "housekeeping" commands explicitly, but each instrument manufacturer was left with the task of naming any other types of command and defining their effect

SCPI 1999.0 Standard Commands for Programmable Instruments (SCPI) is the new instrument command language for controlling instruments that goes beyond IEEE 488.2 to address a wide variety of instrument functions in a standard manner. SCPI promotes consistency, from the remote programming standpoint, between instruments of the same class and between instruments with the same functional capability. For a given measurement function such as frequency or voltage, SCPI defines the specific command set that is available for that function.

SCPI Conformance Information

Unless otherwise specified, commands and queries are performed as described by the SCPI standard.

For complete programming information, refer to the SCPI Programmer's Manual which may be downloaded from the Support page of the Signal Forge Web site. To obtain a hardcopy of the manual, send a request to sales@signalforge.com.

User-developed Programming

The USB port appears in Microsoft Windows as a virtual COM port. Programming of a virtual COM port is the same as a physical COM port using the COM port interface that Windows includes with its programming languages such as Basic, C++, and C#. It is also supported by programs such as LabView©, LabWindows/CVI, and HP VEE.

The command interface uses SCPI (Standard Commands for Programmable Instruments) which is a common programming interface for lab devices. SCPI is a set of ASCII commands sent to the SF2000 over the USB connection (COM port). The SCPI API is described in a separate SCPI Programmers Manual (available for download from the Support page of the Signal Forge web site www.signalforge.com).

Chapter 7

Calibration and Accuracy

The SF2000 factory calibrated but may also be calibrated by the end user. Calibration is done for the output voltage and channel-to-channel skew.

When an output voltage is set, the voltage is dynamically sampled just before the output transistor driver. The voltage drop through the diode (0.65 – 0.85V) is calibrated using a small load. If your application has a large load then the output voltage may be lower and need to be compensated by programming a higher (e.g. 0.2V) voltage depending on the desired accuracy.

Calibration Interval

Calibration should be checked yearly.

Procedure

Calibration should take place in an environment in which the temperature is the same as the temperature at which the unit will be used.

1. Power up the SF2000 for 30 minutes prior to calibration to allow for temperature soak.
2. Start up PulseWave and navigate to the “Calibration” window.
3. Follow the instructions on the screen.
4. In order to ensure the new values are correct, power the SF2000 off and on and verify the new calibration settings by setting up an appropriate output condition for each calibration.

Chapter 8

General Safety and Warranty Information

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it. To avoid potential hazards, use this product only as specified.

Only qualified service personnel should perform service procedures.

To Avoid Fire or Personal Injury

Use Proper Power Adapter. Use only the power module provided with this product.

Connect and Disconnect Properly. Do not connect or disconnect external header pin leads while they are connected to a voltage source (turn the SF2000 and external control logic simultaneously).

Observe All Terminal Ratings. Consult the product manual for ratings information before making connections to the product.

Do Not Operate Without Cover. Do not operate this product with the cover removed.

Do Not Operate With Suspected Failures. If you suspect there is damage to this product, have it inspected by qualified service personnel.

Operate Within Operating Range. No not operate this product outside the operating ranges specified on the manual.

Do not operate in Wet/Damp Conditions.

Do Not Operate in Explosive Atmosphere.

Keep Product Surfaces Clean and Dry.

Warranty

Signal Forge warrants that the products that it manufactures and sells will be free from defects in materials and workmanship for a period of one (1) year from the date of shipment. If a product proves defective within the respective period, Signal Forge will repair or replacement the product without charge.

EXCEPT AS PROVIDED HEREIN, SIGNAL FORGE MAKES NO WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL SIGNAL FORGE BE LIABLE FOR INDIRECT, SPECIAL OR CONSEQUENTIAL DAMAGES.

Appendix

1

Software Update Procedure

The embedded firmware may be updated by the user as new revisions become available by following the procedure below. Note that all output activity will be suspended while the software update is in process.

Software updates are posted to the Support page of the Signal Forge web site.

Procedure

1. Download the latest revision. The filename format is “SF2000_dwn_X_Y”” where X is the version and Y the revision.
2. Start PulseWave and select “Misc” then “Download Firmware”.
3. Select the file you received from Signal Forge and the download will begin. Downloading normally takes about 30 seconds.

Appendix 2

Product Line

Table 4 Signal Forge Product Line

Model	Description
SF2000	Pattern and Pulse Generator
SF1010	Portable Signal Generator with SCPI interface
SF1020	Battery Powered Signal Generator
1800M	RF Expansion Module 950 MHz to 1.8 GHz for SF1010
2500M	RF Expansion Module 1.5 GHz to 2.6 GHz for SF1010
SF-BRK	1U Rack Mount Bracket - Holds 3 SF1010/1000 and attaches to a standard 19" chassis.
USB-6	Standard USB to type B- cable
Cable-6	Serial Cable, DB9 Male to DB9 Female, 6Ft. Use with USB adapter for SF1010.
USB Adapter	USB 2.0 to DB9 Serial converter (with 2.5ft cable). Use with cable-6 for SF1010. Plug and play, USB Type A male to D-9 male.

Note

The SF1010 supersedes the SF1000 and is recommended for all new applications. However, the SF1000 is still available.

How to Buy

Buy Online

Products may be purchased directly from the Signal Forge web site at www.signalforge.com.

PulseWave, EZ Wave and EZ Terminal software may be downloaded for free from the Products page of the Signal Forge web site. If you have a problem downloading the software, send a request to sales@signalforge.com and a copy of the requested software will be sent to you via email.

Purchase Orders

Purchase Orders may be submitted via email to sales@signalforge.com or fax to 512-275-3735.

Quotes

If you require a quote, please send a request for quote to Signal Forge sales at sales@signalforge.com or call 512-275-3733, ext 1.

For a complete description, pricing and ordering information, visit the Product page of the Signal Forge web site: www.signalforge.com.

SIGNAL FORGE, LLC

SF2000 User Manual v1.0

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