Introduction to capturing waveforms

The Model 2651A System SourceMeter® Instrument offers a unique feature not found in most SourceMeter® instruments. In addition to a traditional integrating ADC, the Model 2651A also features a fast sampling ADC. The fast ADC of the Model 2651A allows the instrument to take measurements at high-speed offering capabilities similar to an oscilloscope. This allows you to capture data at up to one million samples per second with over 5000 readings in a single burst. This feature allows simultaneous current and voltage measurements without any additional hardware and offers 18-bit resolution providing for high accuracy even at high-speed. The Fast ADC of the Model 2651A System SourceMeter® Instrument allows this instrument to be used in a broad range of applications such as negative bias temperature instability (NBTI) testing and transient thermal analysis.

In this example, we will demonstrate how to use the fast ADC of the Model 2651A System SourceMeter® Instrument to capture both the current and voltage waveforms of high power pulses.

Equipment needed for this example

To run this test you will need the following equipment:

- Model 2651A System SourceMeter® Instrument.
- GPIB cable or Ethernet cable to connect the Model 2651A to a computer.
- Additional cable and connector assemblies as required to make connections to the DUT (for example, Model 2651A-KIT). See Device connections (on page 2) for a schematic of required connections.

Set up communication

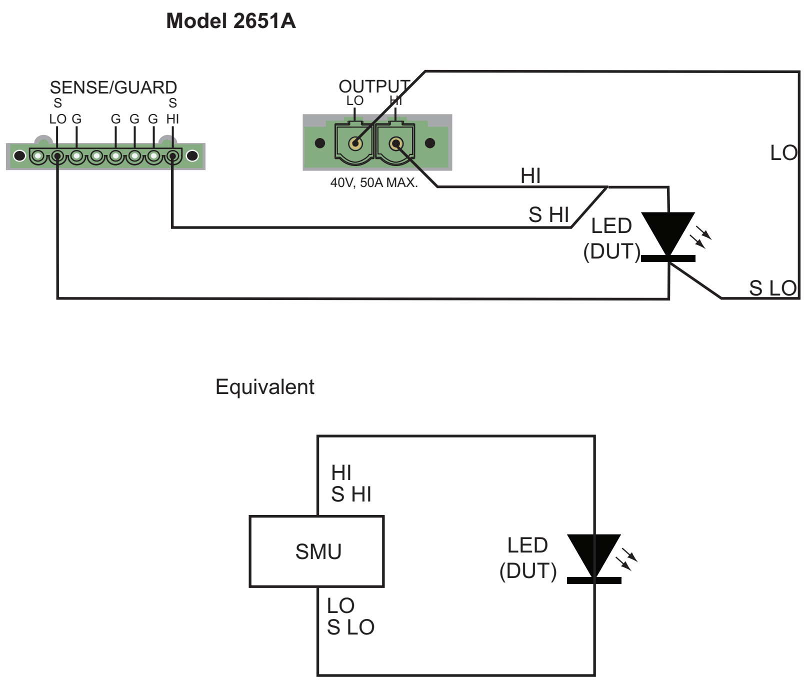
The communication setup is illustrated in the following diagram. GPIB is used as an example, but this application can be run using any of the supported communication interfaces for the instruments.

Figure 1: GPIB communication example for fast ADC

Device connections

To run the test, make the connections as illustrated in the following figure. To ensure good contact, use care when making connections.

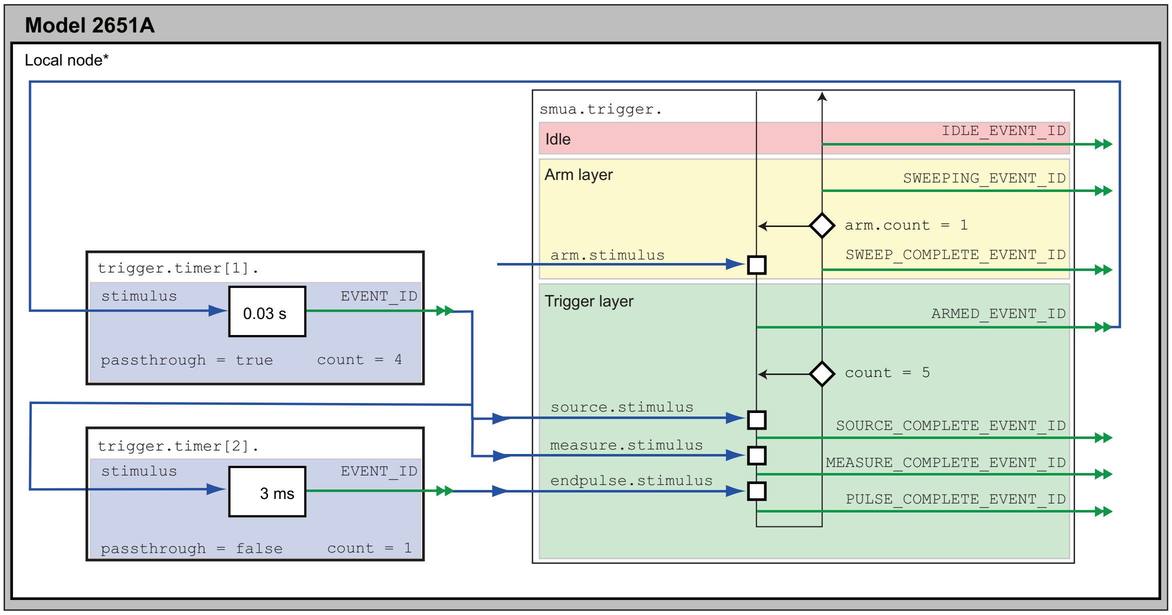
Figure 2: Connections for fast ADC example



Configuring the trigger model

To output precisely timed high power pulses and accurately capture the pulse with the fast ADC, the trigger model of the Model 2651A System SourceMeter® Instrument must be used. Using the trigger model, we can output pulses as large as 50 A with pulse widths as small as 100 μs and position our measurements with microsecond resolution. The image below is a diagram of the trigger model used in this example.

Figure 3: Trigger model configuration for fast ADC example



* Local node: Since only one instrument is being used in this example, the local node is used.

In this example, Timer 1 is used to control the time between pulses while Timer 2 is used to control the pulse width. Timer 1 also controls the start of the measurements, starting them at the same time it triggers the pulse and thus overlapping the measurements with the pulse.

When the trigger model of the Model 2651A is initialized, the following occurs:

The SMU's trigger model leaves the idle state, flows through the Arm Layer, enters the Trigger Layer, outputs the ARMED event trigger, and then pauses at the Source Event where it waits for an event trigger.

Timer 1 receives the ARMED event trigger and begins its countdown while passing the event trigger through to both the SMU's Source Event and Measure Event simultaneously.

The SMU's Measure Event receives the event trigger from Timer 1 and begins to take measurements. Because measurements have been configured to be asynchronous, the Measure Event begins its execution before the Source Event has completed and will continue to take measurements even after the End Pulse Event has executed. For more information, see "Using the remote trigger model" in the *Model 2651A Reference Manual*.

The SMU's Source Event receives the event trigger from Timer 1, begins to output the pulse, and then waits the programmed source delay (if any) before it outputs the SOURCE_COMPLETE event to Timer 2 and allows the SMU's trigger model to continue.

Timer 2 receives the SOURCE_COMPLETE_EVENT_ID event trigger from Timer 1 and begins its countdown.

The SMU's trigger model continues to the End Pulse Event where it pauses and waits for an event trigger from Timer 2.

Timer 2's countdown expires and Timer 2 outputs an event trigger to the SMU's End Pulse Event.

The SMU's End Pulse Event receives the event trigger from Timer 2 and outputs the falling edge of the pulse, after which it allows the SMU's trigger model to continue.

The SMU's trigger model then compares the current Trigger Layer loop iteration with the trigger count:

- If the current iteration is less than the trigger count, then the Trigger Layer repeats and the SMU's trigger model reaches Source Event where it waits for another trigger from Timer 1. The trigger model then repeats from step 3.
- If the current iteration is equal to the trigger count, then the SMU's trigger model exits the Trigger Layer, passes through the Arm Layer and returns to Idle.

Example program usage

This script's functions allow the parameters of the test to be adjusted without rewriting and re-running the script. To execute the test, either call `CapturePulseV()` (to capture a voltage pulse) or `CapturePulseI()` (to capture a current pulse), passing in the appropriate values as parameters.

The parameters of the `CapturePulseV()` function are contained in the following table:

CapturePulseV() parameters

Parameter	Units	Description
pulseLevel	Volts	The voltage level of the pulse
pulseWidth	Seconds	The width of the pulse
pulseLimit	Amps	The current limit of the pulses to output
numPulses	Not applicable	The number of pulses to output

An example call to this function is as follows:

```
CapturePulseV(10, 300e-6, 50, 5)
```

This call will output five 10 V pulses with a 300 µs pulse width. The pulses will be limited to 50 A and have a 1% duty cycle. At the completion of the pulsed outputs, the SMU outputs will be turned off. The resulting data from this test will be returned in an Excel compatible format (you can cut and paste the output from the console) that can be used for graphing and analysis.

The parameters of the `CapturePulseI()` function are contained in the following table:

CapturePulseI() parameters

Parameter	Units	Description
pulseLevel	Amps	The current level of the pulse
pulseWidth	Seconds	The width of the pulse
pulseLimit	Volts	The voltage limit of the pulses to output
numPulses	Not applicable	The number of pulses to output

An example call to this function is as follows:

```
CapturePulseI(50, 300e-6, 50, 5)
```

This call will output five 50 A pulses with a 300 µs pulse width. The pulses will be limited to 10 V and have a 1% duty cycle. At the completion of the pulsed outputs, the SMU outputs will be turned off. The resulting data from this test will be returned in an Excel compatible format (you can cut and paste the output from the console) that can be used for graphing and analysis.