Five Reasons to Switch to the 2460 or 2461 SMU from the 2420 or 2440 SMU for High Current I-V Characterization

TECHNICAL BRIEF

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Introduction

If you are not familiar with a Keithley SourceMeter® Instrument or source measure unit (SMU), the SMU is an instrument that provides precision voltage and current sourcing as well as measurement capabilities. The SourceMeter SMU instrument is both a highly stable DC power source and a true instrument-grade 6½-digit multimeter. The power source characteristics include low noise, precision, and readback, while the multimeter provides high repeatability and low noise current and voltage measurements. The result is a compact, single-channel, DC parametric tester. In operation, these instruments can act as a voltage source, a current source, a voltage meter, a current meter, and an ohmmeter. The SMU offers four-quadrant operation. In the first and third quadrants they operate as a source, delivering power to a load. In the second and fourth quadrants they operate as a sink, dissipating power internally. Voltage, current, and resistance can be measured during source or sink operation.

By linking source and measurement circuitry in a single unit, the SMU offers a variety of advantages over systems configured with separate source and measurement instruments. For example, they minimize the time required for test station development, setup, and maintenance, while lowering the overall cost of system ownership. They simplify the test process itself by eliminating many of the complex synchronization and connection issues associated with using multiple instruments. And their compact half-rack size conserves precious “real estate” in the test rack or bench.

Tektronix/Keithley offers a variety of SMUs to suit your application requirements. If you are considering the purchase of one of Keithley’s 3 amp or 5 amp SMUs, like the 2420 60 V, 3 A, 60 W SourceMeter Instrument or the 2440 40 V, 5 A, 50 W SourceMeter Instrument, this article discusses why you should consider the new 2460 or 2461 SourceMeter Instrument so you can make a smart purchasing decision.

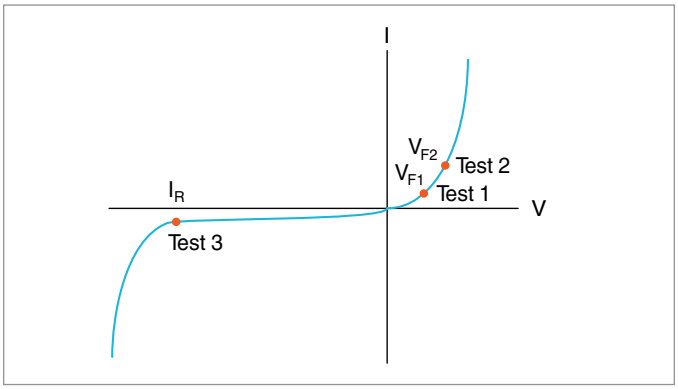
The 2420 and 2440 SourceMeter SMU

The Keithley 2420 and 2440 High Current SourceMeter SMUs are an industry favorite instrument for performing current vs. voltage (I-V) characterization on components such as high current semiconductor devices, power MOSFETs, laser diodes, high brightness LEDs, power management devices, circuit protection devices, and much more. The 2420 and 2440 finds their way into advanced research and development applications where new materials and devices are being innovated. The 2420 and 2440 are unique instruments, able to source up to 3 A at 20 V and 5 A at 10 V, respectively, and provide the user with the ability to create I-V sweeps directly from the front panel.

Figure 1. The Keithley 2420 and 2440 High Current SourceMeter SMUs.

Both the 2420 and 2440 enable the user to create a number of sweep types to greatly accelerate testing with automation hooks, including Linear Staircase, Logarithmic Staircase, and Custom Sweep. These sweep types could be programmed for single-event or continuous operation. They are ideal for I/V, I/R, V/I, and V/R characterization.

In addition to the three sweep types, the 2420 and 2440 also have a built-in test sequencer, which is referred to as a Source Memory List. The Source Memory List provides faster and easier testing by allowing the user to setup and execute up to 100 different tests that run without PC intervention. Each point of a Source Memory List can contain source settings, measurement settings, and pass/fail criteria. The pass/fail test can be executed as fast as 500 µs per point. For example, if you were testing something as simple as a diode, an example test sequence might look like **Figure 2**.



Test	Pass/Fail Test	If Passes Test	If Fails Test
Test 1	Check V_{F1} at 100 mA against pass/fail limits	Go to Test 2	1. Bin part to bad bin 2. Transmit data to computer while handler is placing new part 3. Return to Test 1
Test 2	Check V_{F2} at 1 A against pass/fail limits	Go to Test 3	
Test 3	Check leakage current at –500 V and test against pass/fail limits	1. Bin part to good bin 2. Transmit readings to computer while handler is placing new part 3. Return to Test 1	

Figure 2: Example Diode Test Sequence

The 2420 and 2440 SMUs continue to be used in labs and production floors around the world 20 years after their first release launch.

However, the test and measurement (T&M) industry continues to evolve and demands the adoption of new features that will make this industry workhorse a legacy so that a new SMU can dominate for another 20 years. The T&M industry is also facing a number of component obsolescence issues that are impacting legacy instruments like the 2420 and 2440. Their lives are coming to an end. With this in mind, the first thoughts that will probably cross your mind are, "What do I do if Keithley is no longer going to sell the 2420 and 2440? How do I replace this great instrument? What does Keithley offer to help me replace the 2420 or 2440?" The answer is Keithley's new 2460 and 2461 High Current Graphical SourceMeter SMUs.

The Keithley 2460 and 2461 High Current Graphical SMU

The Keithley 2460 and 2461 High Current SourceMeter® SMUs combine an innovative five-inch touchscreen graphical user interface (GUI) to make testing intuitive and minimize the learning curve to help engineers and scientists learn faster, work smarter, and invent easier.

Figure 3. Keithley 2460 and 2461 High Current Graphical SourceMeter SMUs.

With 7 A DC source current and measure capability on both the 2460 and 2461, along with the 10 A/1000 W pulse current capability combined with dual 18-bit 1 MS/s digitizers on the 2461, both SMUs are optimized for characterizing and testing high power materials, devices, and modules, such as silicon carbide (SiC), gallium nitride (GaN), DC-DC converters, circuit protection devices, solar cells and panels, high brightness LEDs and lighting systems, electrochemical cells and batteries, and much more. But the capabilities of the 2460 and 2461 go far beyond the user interface.

As mentioned, the 2461 has dual 18-bit 1 MS/s digitizers. The two built-in 1 MS/sec, 18-bit digitizers make it possible to acquire both voltage and current waveforms simultaneously without the need to use a separate instrument. This added value enables the user to capture and display real device operation, waveforms, and transient events. The digitizing functions employ the same DC voltage and current measure ranges that the standard A/D converter uses. In addition, the voltage digitizing function uses the same DC voltage 10 GΩ input impedance levels to reduce loading significantly on the device under test (DUT).

The 2460 and 2461 are not only great replacements for the legacy 2420 and 2440 SMUs, but they truly provide much more value. Let's explore the unique capabilities and values the 2460 and 2461 offer for you compared to the 2420 and 2440.

How the 2460/2461 outperform the 2420/2440: A side-by-side comparison

When you look at the 2460/2461 and 2420/2440 side by side, the two SMUs are quite different (**Figure 4**).

Figure 4: The 2460/2461 versus the 2420/2440 side by side.

Some of the initial difference should be obvious. Notice the complete difference in the front panel. The 2420/2440 uses a 2-line Vacuum Fluorescent Display (VFD) and a total of 31 functional front panel buttons compared to the 2460/2461's five-inch, full color, high resolution capacitive touch screen and only 10 physical function keys and buttons. Another difference is the control knob on the 2460/2461. The control knob helps the user navigate the touchscreen and interact with touchscreen options without even touching the screen. Additionally, the 2460/2461 has a USB port on the front panel for saving data and screen captures.

Reason #1: Usability

A big advantage the 2460/2461 have over the 2420/2440 is in the area of usability and user experience. The 2460/2461 use a flat icon-driven menu structure as shown in **Figure 5** for fast instrument configuration including setting up I-V test sweeps that will be discussed shortly. The iconic menu approach is far superior to the menu architecture used on the 2420/2440, which more resembles that of an operating system file folder. This means it could be difficult to find what you want to configure, and the settings could be a few layers deep. This is not efficient, and it does result in many users raising issues on how hard it is to navigate the menus from the front panel.

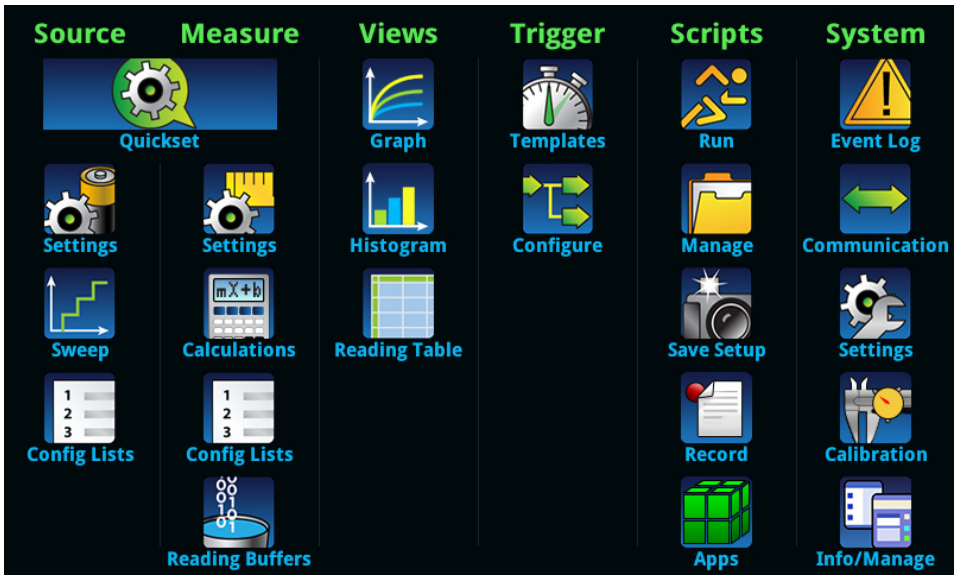


Figure 5. Flat menu approach.

Why does the 2460/2461 use the icon menu approach and why use a touchscreen? Why not use a soft-key menu system? Touchscreens are the next step in the "faster time to answer" progression. The "see it, touch it, do it" quality of touchscreens not only makes these products fun to use but has made them more accessible to those who might otherwise be hesitant to try them. Touchscreens support faster, more intuitive learning, and faster setup times. And, because their operation is so intuitive, touchscreens can also give users more confidence in what they're doing, drastically reducing user learning curves and training requirements while improving accuracy and efficiency.

With the 2460/2461, operators at all levels of testing sophistication can become expert users practically from the first touch because its intuitive design is highly "learnable." On-board, context-sensitive help even eliminates the need to consult a user manual to get the instrument up and running and minimizes the need to consult a manual during use. With simplified setups configured from the front panel, the 2460/2461 support faster time to measurement and drastic improvements in test productivity. As much as 50% of the steps required to configure the instrument has been reduced.

Some may question whether this graphical instrument interface approach is for everyone or only for novice or infrequent users. Some experienced instrument users might be hesitant to adopt touchscreen technology because they're accustomed to working with front panels with buttons, keys, and knobs and need the tactile feedback that pressing a button or turning a knob provides. The good news with the 2460/2461 is that the physical and touchscreen buttons have audio feedback when pressed and the knob incorporates a tactile feel when turning and pressing it. The touchscreen displays results using larger, more legible numerals and fonts, provide more details about the measurement, and offers graphing capabilities, which earlier single- or dual-line VFD displays couldn't provide. The intuitive, highly learnable nature of touchscreen-based interfaces can also drastically reduce training time, increase operator accuracy, and improve overall operational efficiencies, which helps drive down the cost to own.

Reason #2: Sweep configurations

As previously mentioned, the 2420/2440 provide three sweep types, linear, log, and custom sweeps. Configuring a sweep in the 2420/2440 requires a number of menu and pushbutton selections as you can see in **Figure 6**. Configuring a sweep starts by hitting the CONFIG button on the front panel and working through various selections from the sweep configuration menu tree. This can be time consuming and prone to making mistakes.

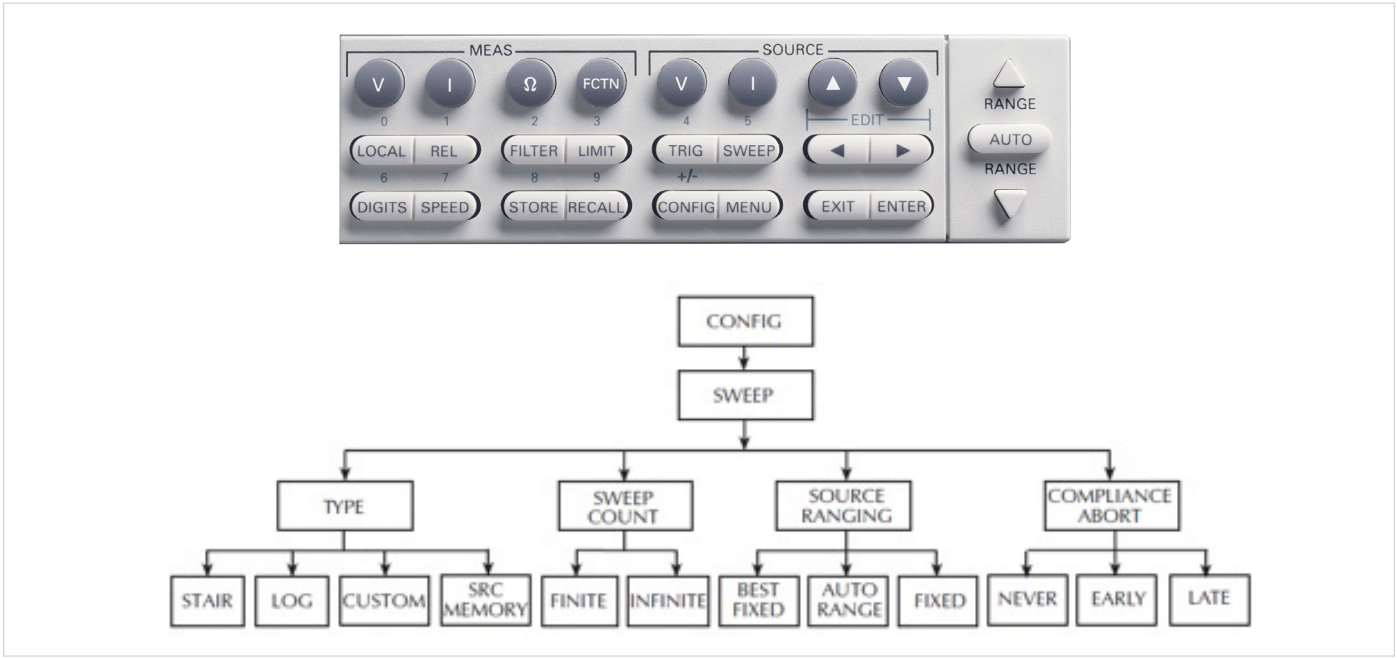


Figure 6: Sweep configuration menu tree and front panel.

The 2460/2461 can perform linear staircase, logarithmic staircase, linear dual staircase, logarithmic dual staircase, and custom sweeps from the front panel or from a remote interface. Setting up sweeps is simple. You press the **MENU** key from the front panel. Then, under **Source** column of the menu, touch the **Sweep** icon. The **SWEEP SETTINGS** screen is displayed. Everything you need to create a sweep is right there. The screen is swipable to see all of the options available. This eliminates the need to deal with all the cumbersome menuing on the 2420/2440, saving valuable time.

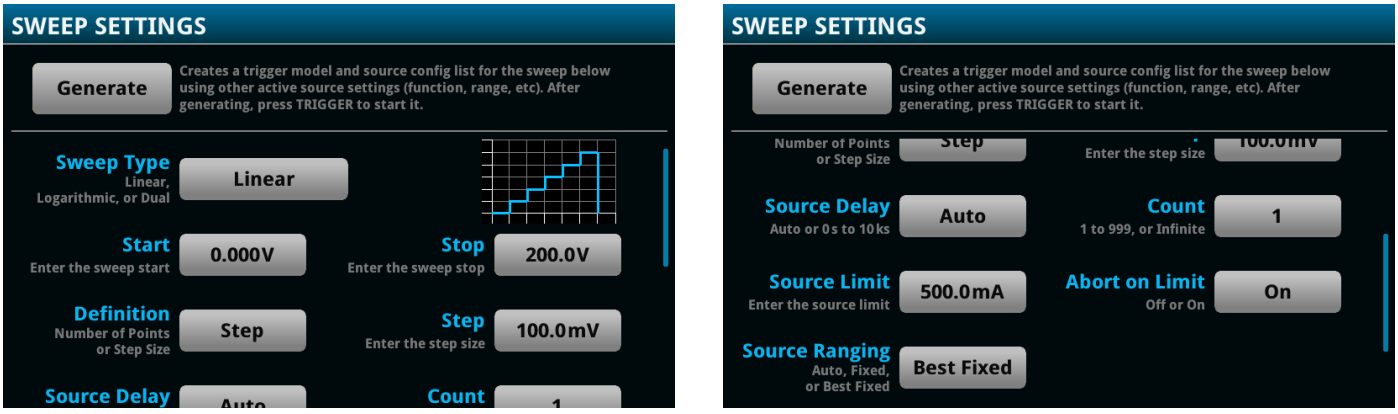


Figure 7: Sweep setting screens. Swipe up or down on the screen to view all options

When you generate a sweep, the 2460/2461 creates a source configuration list and a trigger model that contain the settings you selected for the sweep. To run the sweep, press the **TRIGGER** key.

Reason #3: Displaying results

The 2420/2440 display the measured voltage or current on the primary line and the current or voltage source value and compliance value on the secondary display as shown in **Figure 8**. If you want to look at the results of a sweep, you need to recall the results from the menu and display each one individually, which could be a time consuming task. The only other option would be to download under PC control the test results back to the PC for analysis in Excel.

Figure 8: Display contents of the 2420 SMU

The user interface on the 2460/2461 is quite different. The 2460/2461 home screen has three display regions (**Figure 9**).

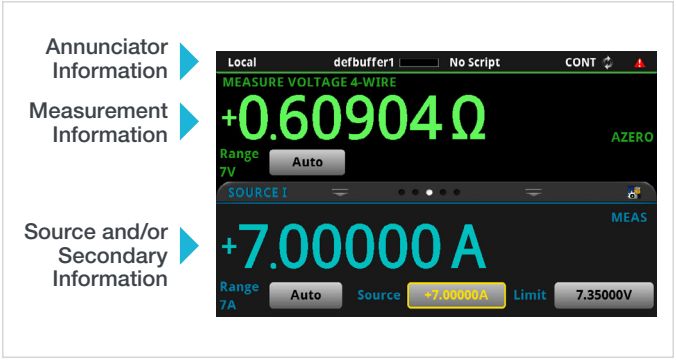


Figure 9: Breakdown of the 2460/2461 touchscreen display

The on-screen buttons indicate the configuration settings, including the measurement range and set values. When the instrument is in Auto-Ranging mode, the display will also indicate the range on which the instrument is operating and update as ranges change.

The touchscreen's swipe capability in the Source and/or Secondary Information section simplifies and allows you to view other detailed measurement information quickly without the need to navigate a confusing menu structure. **Figure 10** illustrates three typical swipe views.

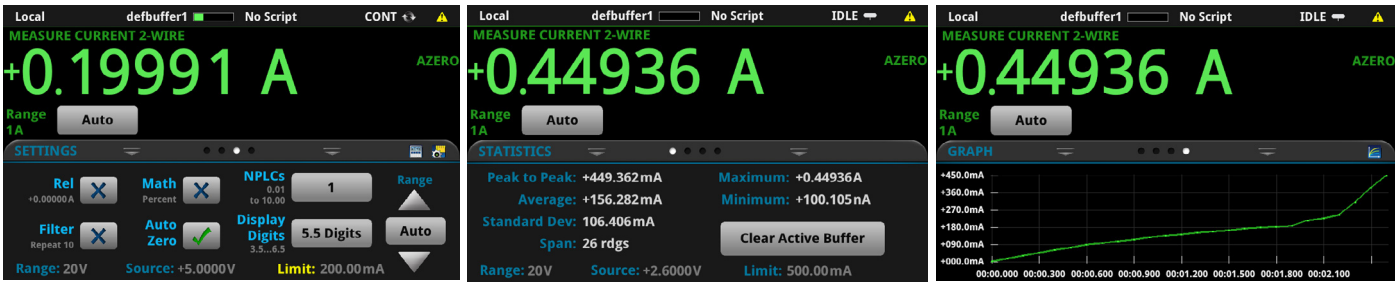


Figure 10: Three various swipe screen views on the secondary information line of the 2460/2461.

One of the superior values of the 2460/2461 display compared to the 2420/2440 is the ability to convert raw data to information right at your fingertips. A full graphical plotting window converts raw data and displays it immediately as useful information, such as semiconductor I-V curves and waveforms. The instrument supports exporting data to a spreadsheet for further analysis, dramatically improving productivity for research, benchtop testing, device qualification, and debugging.

Figure 11: Built-in data display, charting, and spreadsheet export functions simplify converting test results into useful information.

The graph and histogram charts support pinch and zoom to get deeper insights of a particular part of the plot. The 2460/2461 also supports vertical and horizontal cursors, just like on an oscilloscope, which you can adjust to get more detailed information. Finally, the **READING TABLE** view enables you to scroll through all of the readings and actually see where the readings fall on the plot. When using the dual 18-bit 1MSa/s digitizers of the 2461, you can plot the results from both A/Ds as shown in the top image of Figure 11. This is far superior to the 2420/2460 where you can only look at one data point at a time.

Reason #4: Instrument Triggering

It's not uncommon with instrumentation to create triggering configurations that enable the instrument to execute actions based on a particular event. Both the 2420/2440 and 2460/2461 have the means of triggering based on certain events. But there are differences between the trigger models used on the 2420/2440 and the 2460/2461.

With most SMUs, the primary actions of the trigger model are Source, Delay, and Measure. The source action outputs the programmed voltage or current value, and the programmed delay provides a settling period for the source before the measurement is performed.

The 2420/2440 trigger model of two layers, Arm and Trigger, is shown in **Figure 12**. Programmable counters allow operations to be repeated, and various input and output trigger options are available to provide source-measure synchronization between the SourceMeter instrument and other instruments.

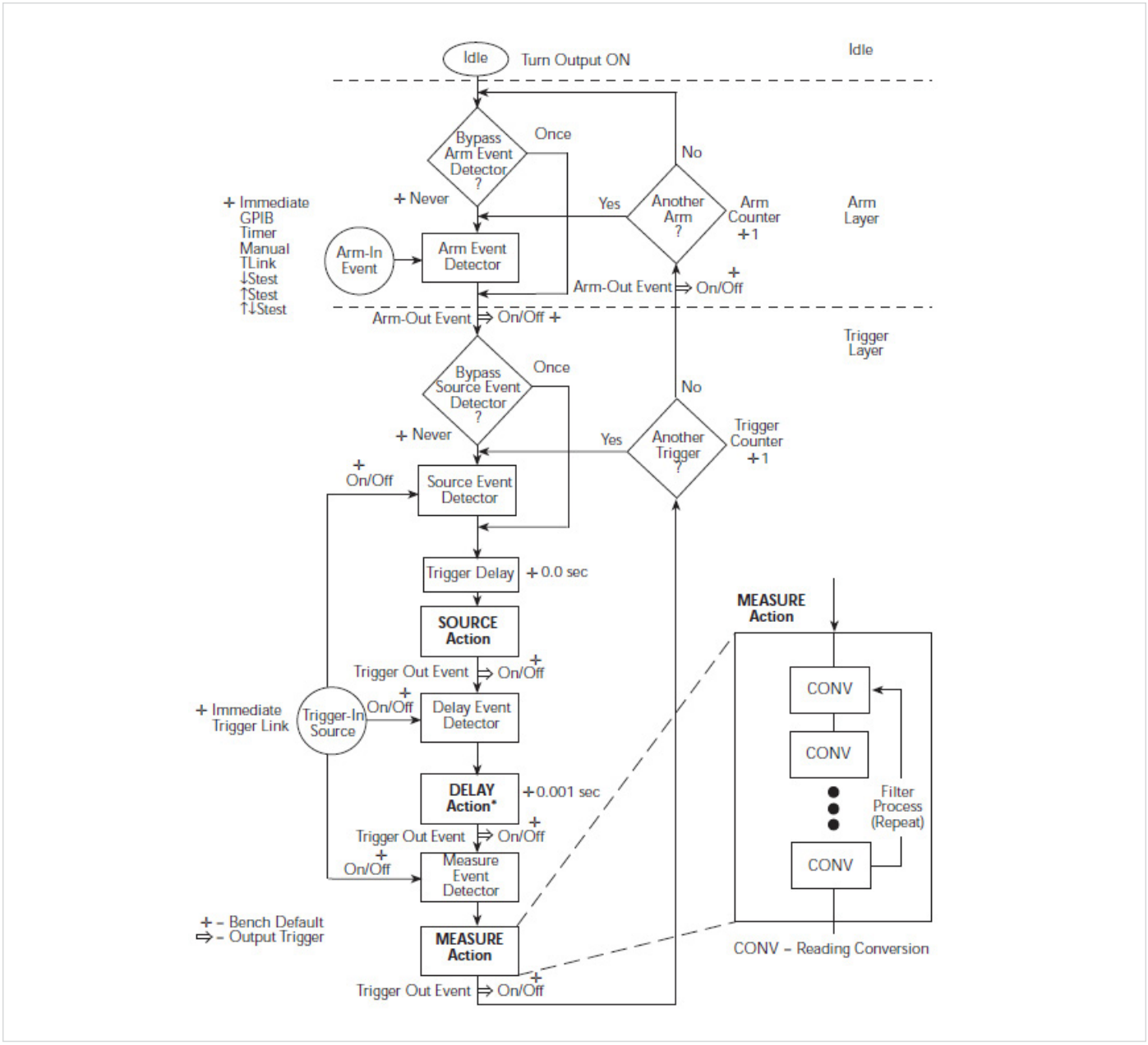


Figure 12: 2420/2440 Trigger Model

The trigger configuration tree looks as follows:

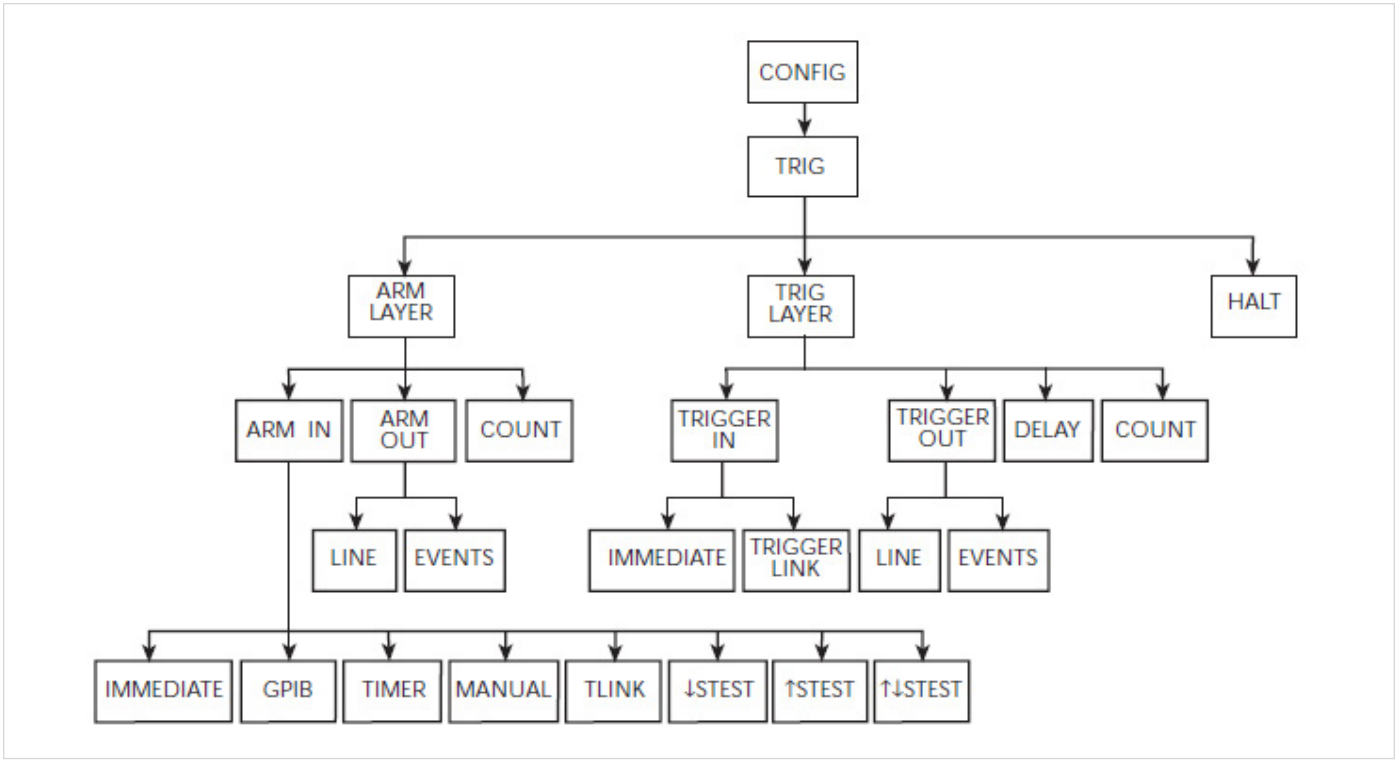


Figure 13: 2420/2440 trigger configuration menu tree.

The operation of the trigger system is vastly different on the 2460/2461 and much more flexible. Where the 2420/2440 only gives you two layers of triggering, the 2460/2461 offers up to 63 block levels, making it more user configurable versus being locked into a fixed two layer system.

The 2460/2461 incorporates Keithley's TriggerFlow® triggering system, which provides user control of instrument execution. TriggerFlow diagrams are created in much the same way that flow charts are developed, using four building blocks:

- Wait – Waits for an event to occur before the flow continues.
- Branch – Branches when a condition has been satisfied.
- Action – Initiates an action in the instrument, for example, measure, source, delay, set digital I/O, etc.
- Notify – Notifies other equipment that an event has occurred.

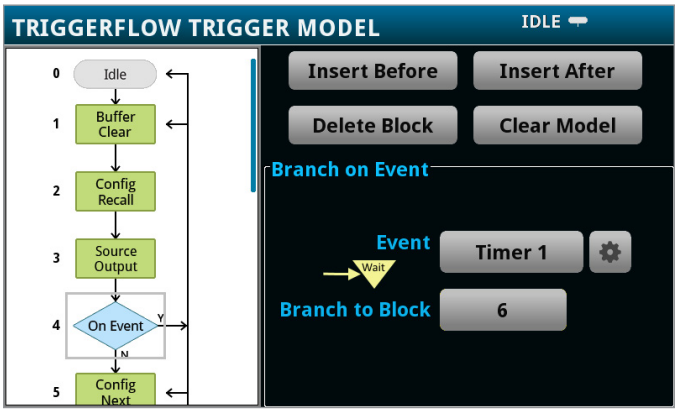


Figure 14: TriggerFlow building blocks allow creating triggering models that range from very simple to highly complex.

A TriggerFlow model using a combination of these building blocks can be created from the front panel or by sending remote commands. With the TriggerFlow system, users can build triggering models from very simple to complex, depending on the needs of the application. The 2460/2461 also includes basic triggering functions, including immediate, timer, and manual triggering.

Reason #5: Programmability

Both the 2420/2440 and 2460/2461 are highly programmable for remote operation. Both the 2420/2440 and 2460/2461 use the Standard Commands for Progammable Instruments

(SCPI) protocol. SCPI defines a standard for syntax and commands to use in controlling programmable test and measurement devices. It is widely implemented by most test and measurement instrument suppliers.

The goal of SCPI is to provide a uniform and consistent command set for the control of test and measurement instruments. The same commands and queries control corresponding instrument functions in SCPI equipment, regardless of the manufacturer or the instrument type. However, despite SCPI's intended function as a universal command set, the simple fact that new features are implemented with each new iteration of an instrument means that SCPI command sets will vary between instruments. This is the case with the 2460/2461 given it has more capabilities and options than the 2420/2440.

With some of the new features and ranges on the 2460/2461, there will be some differences in the native SCPI command set of the 2460/2461 compared to the 2420/2440. Some program updates will be required but you will find many of the 2460/2461 commands similar to those of the 2420/2440.

The main hurdle to overcome before taking the initiative to use a different command set is learning the new one, however adjusting to the nuances of a new SCPI command implementation is required every time a different instrument is in use, so it is not a hurdle unfamiliar to users.

When the 2461 was launched, the capabilities of the instrument covered the many ranges and capabilities not just for the 2420 and 2440 but for the legacy 2425 and 2430 as well, which were obsoleted a few years ago. Due to the popularity of these four legacy SMUs, Keithley included 2420/2425/2430/2440 SCPI Emulation Modes, minimizing SCPI code rewriting and maximizing your investment. But, it is important to note that the emulation mode in the 2461 only covers the original capabilities of the 2420/2425/2430/2440 SMUs and does not take advantage of any of the new features of the 2461, including the digitizers for example.

The SCPI command format was developed to be self-descriptive. Each command is intended to describe its own function. All SCPI commands have an extended and abbreviated form. The more verbose form aids in user understanding as the commands hold more characters to help better define the action the specific command performs. The advantage of the abbreviated form is that the user can achieve the same outcome sending fewer characters. Every ASCII character sent and received takes time to propagate from sender to receiver. Therefore, fewer characters translate to less communication time. An example of SCPI commands used in the 2420/2440 is shown in **Figure 15**.

Command	Description	Default parameter	SCPI	Source memory
[:SOURce[1]]	Path to control sourcing:		✓	
:CLEar	Path to clear source:			
[:IMMediate]	Turn selected source off.			
:AUTO <b>	Enable or disable auto clear for source.[1]			
:AUTO?	Query state of auto clear.	OFF		
:MODE <name>	Specify auto clear mode (ALWays or TCOunt).	ALWays		
:MODE?	Query auto clear mode.			
:FUNCtion	Source selection:		✓	
:SHAPe <name>	Model 2430 Only — Select output mode (DC or PULSe).	DC		✓
:SHAPe?	Query output mode.			
[:MODE] <name>	Select source mode (VOLTage, CURRent or MEMory).	VOLTage	✓	✓
[:MODE]?	Query source selection		✓	
:DELay <n>	Specify settling time (in sec): 0 to 9999.999.[2]	0		✓
:AUTO <b>	Enable or disable auto settling time.[2]	ON		✓
:AUTO?	Query state of auto settling time.			
:DELay?	Query source settling time.			
:CURRent	Path to configure I-Source:		✓	
:MODE <n>	Select I-Source mode (FIXed, SWEep, or LIST).	FIXed	✓	
:MODE?	Query I-Source mode.		✓	
:RANGe <n>|UP|DOWN|	Select fixed I-Source range.[3]	1.05e-4	✓	✓[4]
:AUTO <b>	Enable or disable autoranging.	ON	✓	
:AUTO?	Query state of autoranging.		✓	
:RANGe?	Query I-Source range setting.		✓	
[:LEVel]	Set I-Source level (in amps):		✓	
[:IMMediate]	Set level immediately:		✓	
[:AMPLitude] <n>	Specify current level.[3]	0	✓	✓[4]
[:AMPLitude]?	Query current level.		✓	

Figure 15: Example SCPI commands for the Source subsystem on the 2420/2440.

In addition to the 2460/2461 SCPI programming mode and the 2420/2425/2430/2440 SCPI Emulation Modes in the 2461, the 2460/2461 also offers the Test Script Processor (TSP®) scripting mode for creating simple to very complex applications which run right inside the instrument. Let's explore the advantages of TSP and scripting.

Keithley's TSP technology is a flexible hardware/software architecture that allows message-based programming, much like SCPI, with enhanced capabilities for controlling test sequencing/flow, decision-making, and instrument autonomy. TSP-enabled instruments operate like conventional SCPI instruments by responding to a sequence of commands sent by the controller. You can send individual commands to the TSP-enabled instrument the same way you would when using SCPI with any other instrument. Making the switch to TSP technology affords you improved throughput, access to additional interfacing options between both the PC and other instruments, and the convenience of autonomous instrumentation when desired.

The use of an on-board Test Script Processor in the 2460/2461 has made it possible to create a "smart" instrument, with built-in decision making capabilities, which reduces the need to communicate so frequently with an external controller. This approach to test system design allows smart instrument systems to be much more efficient than those that rely on standard SCPI-based programming. TSP technology encompasses both the TSP command set and the TSP scripting language. The TSP scripting language is based on Lua and, when used together with the TSP command set, allows for logic and subroutines that would normally reside on a PC to run inside the instrument, which reduces the amount of data and number of messages sent over the communications bus by a considerable amount.

Making the switch to the TSP command set from SCPI is a simple matter of swapping analogous commands. While that concept seems daunting, it is not so different from learning the different SCPI command sets for each individual instrument model.

This example utilizes the a 2460 SourceMeter® source measure unit to produce an I-V sweep characterization of a solar cell. The voltage is swept from 0 V to 0.55 V in 56 steps. The resulting solar cell current is measured. The current and voltage measurements are stored in a default data buffer (defbuffer1). Finally, the buffer data is returned.

SCPI	TSP
`"*RST"`	`reset()`
`"SENS:FUNC 'CURR'"`	`smu.measure.func = smu.FUNC_DC_CURRENT`
`"SENS:CURR:RANG:AUTO ON"`	`smu.measure.autorange = smu.ON`
`"SENS:CURR:RSEN ON"`	`smu.measure.sense = smu.SENSE_4WIRE`
`"SOUR:FUNC VOLT"`	`smu.source.func = smu.FUNC_DC_VOLTAGE`
`"SOUR:VOLT:RANG 2"`	`smu.source.range = 2`
`"SOUR:VOLT:ILIM 1"`	`smu.source.ilimit.level = 1`
`"SOUR:SWE:VOLT:LIN 0, 0.55, 56, 0.1"`	`smu.source.sweeplinear("SolarCell", 0, 0.55, 56, 0.1)`
`"INIT"`	`trigger.model.initiate()`
`"*WAI"`	`waitcomplete()`
`"TRAC:DATA? 1, 56, "defbuffer1", SOUR, READ"`	`printbuffer(1, 56, defbuffer1.sourcevalues, defbuffer1.readings)`

Figure 16: A 2460 example comparing SCPI to TSP commands.

This example could be taken a step further by using these basic TSP commands in conjunction with the full power of the TSP scripting language. The Test Script Processor in enabled instruments uses scripting with the TSP command set. This allows for data interpretation to be handled locally by the instrument, as opposed to remotely by a controlling PC running programs such as Microsoft Excel. The calculations required to identify key points of data can be done by the instrument and displayed on the front panel or returned to an external computer.

The 2460/2461's TSP capability can help improve test throughput and increase the overall functionality of the SMU. TSP affords the user a multitude of advantages over SCPI, including the ability to return multiple readings at once, improved throughput, and better readability. Flexibility is a key asset of the TSP command set, allowing the user to tune their experience to their specific needs. TSP can be used in a similar manner to SCPI by being run from a controlling PC with TSP commands acting as analogous replacements to SCPI commands. It can be used to write scripts that are run locally on the instrument, or to manage large networks of other TSP enabled connected instruments.

To learn more about TSP technology and transitioning from SCPI to TSP programming, we encourage you to read the application notes How to Transition Code to TSP from SCPI and How to Write Scripts for Test Script Processing (TSP®), both available at www.tek.com.

Summary

The 2460 and 2461 are new and modern source measure units with an extremely powerful user interface, triggering, programming, and configuration capability compared to the legacy 2420 and 2440. The 2460 and 2461 also have a price advantage over the 2420 and 2440, which makes them much more attractive to purchase. Both the 2420 and 2440 have served customers extremely well for over 20 years, but their life is approaching the end. The 2460 and 2461 are great replacements for the 2420 and 2440, capable of serving the same applications and making it much easier for the user to do more with the instrument. The graphical SMU is designed so that you spend less time learning the SMU and spend more time making measurements and reviewing results and information faster to make better engineering decisions. When time to market is so critical today to achieve a competitive advantage, the 2460 and 2461 will help you achieve that goal. With all the new capabilities of the 2460 and 2461, combined with Keithley's decades of expertise in developing high precision, high-accuracy SMU instruments, the 2460 and 2461 will be your "go-to instruments" for high-current source and measurement applications in the lab and in the test rack.

Comparison Table: 2420, 2425, and 2440 with 2460

2420/2425/2440	2460
Max Voltage: 60 V/100 V/40 V	Max Voltage: 100 V
Max Current: 3 A/3 A/5 A	Max Current: 7 A
DC Power: 60 W/100 W/50 W	DC Power: 100 W
Wideband Noise: 10 mV rms typ.	Wideband Noise: 2 mV rms typ.
Sweep Types: Linear, Log, Custom, Source-Memory	Sweep Types: Linear, Log, Dual Linear, Dual Log, Custom
5000 Point Reading Buffer	>250,000 Point Reading Buffer
>2000 Readings/second	>3000 Readings/second
SCPI Programming	SCPI Programming + TSP Scripting
GPIB, RS-232	GPIB, USB, Ethernet (LXI)
Front/Rear Banana Jacks	Front: Banana Jacks. Rear: Mass Screw Terminal Connection

Comparison of 2461 vs. 2420, 2425, 2430, 2440

Feature	2461	2420/2425/2440	2430
Max Voltage	100 V	60 V/100 V/40 V	100 V
Max DC Current	7 A	3 A/3 A/5 A	3 A
Max Pulse Current	10 A	NA	10 A
DC/Pulse Power	100 W/1000 W	Up to 100 W/NA	100 W/1000 W
Digitizers	Dual 18-bit 1 MS/s	None	None
Wideband Noise	<4.5 mVrms typ.	10 mVrms typ.	10 mVrms typ.
Sweep Types	Linear, Log, Dual Linear, Dual Log, Custom	Linear, Log, Custom, Source-Memory	Linear, Log, Custom, Source-Memory
Reading Buffer Size	>2 Million Point Reading Buffer	5000 Point Reading Buffer	5000 Point Reading Buffer
Programming Command Type	SCPI Programming + TSP Scripting	SCPI	SCPI
PC interface	GPIB, USB, Ethernet (LXI)	GPIB, RS-232	GPIB, RS-232
Signal Input Connections	Front: Banana Jacks Rear: Mass Screw Terminal Connection	Front/Rear Banana Jacks	Front/Rear Banana Jacks

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