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## General Information

### Supported models

**CAUTION** Do not install this firmware on Series 2600 (Models 2601, 2602, 2611, 2612, 2635, 2636), Series 2600A (Models 2601A, 2602A, 2611A, 2612A, 2635A, 2636A), or Series 2600B (Models 2601B, 2602B, 2604B, 2606B, 2611B, 2612B, 2614B, 2634B, 2635B, 2636B) instruments.

This firmware is intended for use on the following Keithley Instruments product models:

2651A, 2657A

### Installation instructions

For detailed firmware installation instructions, refer to the “Upgrading the firmware” topic in the “Maintenance” section of the reference manual for your instrument. The reference manual is available online at <http://www.tek.com/support>. If you decide to upgrade the firmware in your instrument, follow the instructions in the manual. Alternatively, you can arrange to have Keithley Instruments upgrade your firmware at the factory by calling your local Keithley Instruments support office.

### Upgrade considerations for the Model 2651A

The following table lists the considerations that should be made when deciding whether to upgrade your Model 2651A instrument firmware to version 1.2.0.

Consideration for upgrade	From version 1.0.0	From versions 1.0.1, 1.0.2, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.6, 1.1.8
Recalibration required?	No	No
Backward compatibility concerns?	No	No
Requalification recommended?	Yes <sup>1</sup>	No
Should you upgrade?	Review <sup>2</sup>	Review <sup>2</sup>

### Upgrade considerations for the Model 2657A

The following table lists the considerations that should be made when deciding whether to upgrade your Model 2657A instrument firmware to version 1.2.0.

Consideration for upgrade	From version 1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.6, 1.1.8
Recalibration required?	No
Backward compatibility concerns?	No
Requalification recommended?	No
Should you upgrade?	Review <sup>2</sup>

<sup>1</sup> This release introduces fixes that affect range change timing. These fixes may affect tests that are sensitive to settling delays. See the “Compatibility concerns” section for more information.

<sup>2</sup> Review the entire list of changes made in all firmware versions between your current version and version 1.2.0. Upgrade if any of the fixes or enhancements are needed.

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## Version 1.2.0 Release

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### Overview

Version 1.2.0 is an enhancement release of the Series 2650A firmware.

### Compatibility

Version 1.0.1 introduced a fix that affects the range change timing of the source-measure unit (SMU) current source of the Model 2651A. This fix, which exists in all subsequent versions, may affect tests that are sensitive to timing. If you are upgrading to 1.2.0 from 1.0.0, See PR44354 in the “Critical fixes” section of the Version 1.0.1 Release for more detail.

### Critical fixes

PR61958 **Models affected:**

2651A, 2657A

**Symptom:**

The embedded web applications (Reading Buffers, Flash Upgrade, TSB Embedded, and TSP Express) relied on an outdated and unsupported version of Java. Note that the new web applications are only functional if the LAN password is blank or disabled for the web interface.

**Resolution:**

The Reading Buffers, Flash Upgrade, and TSB Embedded were re-implemented using modern web technologies. TSP Express was removed.

### Enhancements

PR61585 **Models affected:**

2651A and 2657A

**Enhancement:**

This release includes support for the new `localnode.license` Test Script Processor attribute.  
Example: `print(localnode.license)`

### Noncritical fixes

There were no noncritical fixes included in this release. See the “Enhancements” section for more information about release content.

### Known issues

See Version 1.1.8 Release: Known Issues.

## Version 1.1.8 Release

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### Overview

Version 1.1.8 is an enhancement release of the Series 2650A firmware.

### Compatibility concerns

Version 1.0.1 introduced a fix that affects the range change timing of the source-measure unit (SMU) current source of the Model 2651A. This fix, which exists in all subsequent versions, may affect tests that are sensitive to timing. If you are upgrading to 1.1.8 from 1.0.0, See PR44354 in the “Critical fixes” section of the Version 1.0.1 Release for more detail.

### Critical fixes

There were no critical fixes included in this release. See the “Enhancements” section for more information about release content.

### Enhancements

E1171 **Models affected:**  
2651A and 2657A

**Enhancement:**

This release includes support for new internal flash memory devices found on digital board revision F or later, while maintaining support for the original flash memory on earlier hardware revisions. Hardware revisions that contain the new internal flash memory devices cannot be downgraded below firmware version 1.1.8. Earlier hardware revisions can still be downgraded below 1.1.8. To determine the digital board revision, inspect the data returned by the `print(localnode.info())` remote command. The `DigBrdRev` key contains the digital board revision.

### Noncritical fixes

There were no noncritical fixes included in this release. See the “Enhancements” section for more information about release content.

### Known issues

PR46099 **Models affected:**  
2651A, 2657A

**Symptom:**

For some numeric entry fields, after editing a value and then pressing the navigation wheel, the EDIT indicator remains lit until the cursor is moved or the value is accepted.

**PR46100 Models affected:**

2651A, 2657A

**Symptom:**

When nonprintable control codes are embedded in the text passed as parameters to display functions such as `display.settext()`, the control codes cause the display to malfunction. Some of the possible effects are:

- The displayed text is corrupted.
- The instrument beeps or buzzes.
- The display shuts down and displays a "NO COMM LINK" message.

**PR46252 Models affected:**

2651A, 2657A

**Symptom:**

Loading the firmware update web application while TSB Embedded is running causes TSB Embedded to display the error queue dialog box with many "null" errors in it.

**PR47323 Models affected:**

2651A, 2657A

**Symptom:**

When overwriting an existing script, TSB Embedded does not save the script if there is an error in the script. No error message is reported by TSB Embedded, and overwriting the script appears successful.

**Workaround:**

Monitor the front-panel display of the instrument when overwriting a script using TSB Embedded. The script is not saved if there are any errors shown on the front-panel display.

**PR47350 Models affected:**

2651A, 2657A

**Symptom:**

The `tspnet.tsp.runscript()` command does not properly handle errors when an invalid script or invalid script name is provided.

**PR47613 Models affected:**

2651A, 2657A

**Symptom:**

The `tspnet.tsp.rhtablecopy()` function may return erratic results or make the instrument unresponsive.

**PR47614 Models affected:**

2651A, 2657A

**Symptom:**

The instrument may fail to operate correctly after an “Out of memory” error. The instrument may ignore commands sent over the command interfaces and may ignore front-panel operations.

**Workaround:**

To avoid out-of-memory issues, leave 1 MB of dynamic memory available for instrument use. The `meminfo()` function can be used to monitor the actual free memory remaining. When the free memory drops below 1000 KB, the instrument may encounter an “Out of memory” error. The “Memory considerations for the run-time environment” section of the 2651A Reference Manual or 2657A Reference Manual explains how to determine the amount of memory needed for reading buffers and sweeps.

**PR47615 Models affected:**

2651A, 2657A

**Symptom:**

In prompting mode, if a `tsplink.reset()` command initiated from another command interface is executing when the instrument receives an abort message, a prompt for the abort message may not be generated. The instrument will abort properly, even though the prompt is not generated.

**PR47616 Models affected:**

2651A, 2657A

**Symptom:**

Aborting a `tsplink.reset()` command or aborting a script executing a `tsplink.reset()` command may take a long time because the `tsplink.reset()` command is allowed to complete before execution is aborted. The `tsplink.reset()` command may take several seconds when a large number of nodes are connected together.

**PR47617 Models affected:**

2651A, 2657A

**Symptom:**

The instrument may incorrectly generate an “Out of memory” error when allocating a reading buffer. When there is insufficient memory to allocate the reading buffer, the garbage collector should automatically run to reclaim any unused memory before generating the “Out of memory” error. The garbage collector often fails to run, and the instrument issues an “Out of memory” error.

**Workaround:**

To work around this issue, call the `collectgarbage()` function prior to creating a new reading buffer.

**PR47618 Models affected:**

2651A, 2657A

**Symptom:**

TSB Embedded does not generate any errors or warnings when TSP® Express is active. The tool appears to work but will not show any saved scripts, nor will it run new scripts.

**PR47619 Models affected:**

2651A, 2657A

**Symptom:**

Executing a `tsplink.reset()` while overlapped measurements are in progress causes the instrument to become unresponsive.

**PR47620 Models affected:**

2651A, 2657A

**Symptom:**

When using TSP-Net, time-outs may occur earlier than programmed. For example, with `tspnet.timeout` set to 5 seconds, the `tspnet.read()` function may actually time out after only 4.7 seconds.

**PR47621 Models affected:**

2651A, 2657A

**Symptom:**

When loading a script using an invalid script name, the instrument loads the script as the anonymous script and does not generate an error.



## **Version 1.1.7 Release**

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### **Overview**

Version 1.1.7 was never released.

## Version 1.1.6 Release

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### Overview

Version 1.1.6 is a maintenance release of the Series 2650A firmware.

### Compatibility concerns

Version 1.0.1 introduced a fix that affects the range change timing of the source-measure unit (SMU) current source of the Model 2651A. This fix may affect tests that are sensitive to timing. See PR44354 in the “Critical fixes” section of the Version 1.0.1 Release for more detail.

### Critical fixes

**PR51705 Models affected:**

2657A

**Symptom:**

Sometimes when the DUT experiences a sudden break down the unit throws a spurious “SMU TOO HOT” error or “ADC triggering Failure” and then locks up.

**Resolution:**

This issue has been corrected.

**PR56398 Models affected:**

2657A

**Symptom:**

When using the 2657A as a V-source, and charging a capacitive device to high voltages (over 1500V) while limiting the discharge current to low currents (around 20mA), the device under test may break down.

**Resolution:**

This issue has been corrected.

## Version 1.1.5 Release

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### Overview

Version 1.1.5 is a maintenance release of the Series 2650A firmware.

### Compatibility concerns

Version 1.0.1 introduced a fix that affects the range change timing of the source-measure unit (SMU) current source of the Model 2651A. This fix may affect tests that are sensitive to timing. See PR44354 in the “Critical fixes” section of the Version 1.0.1 Release for more detail.

### Noncritical fixes

**PR51705 Models affected:**

2657A

**Symptom:**

Sometimes the unit throws a spurious “SMU TOO HOT” error.

**Resolution:**

This issue has been corrected.

**PR48901 Models affected:**

2651A

**Symptom:**

With open leads, rapidly executed contact check measurements erroneously return a reading of 0 ohms, instead of the expected reading of 9.91E+37.

**Resolution:**

This issue has been corrected.

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## Version 1.1.4 Release

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### Overview

Version 1.1.4 is a maintenance release of the Series 2650A firmware.

### Compatibility concerns

Version 1.0.1 introduced a fix that affects the range change timing of the source-measure unit (SMU) current source of the Model 2651A. This fix may affect tests that are sensitive to timing. See PR44354 in the “Critical fixes” section of the Version 1.0.1 Release for more detail.

### Noncritical fixes

**PR51316 Models affected:**

2651A, 2657A

**Symptom:**

Java 7 update 51 security changes are blocking web applets from running. Series 2650A web applications (Flash Upgrade, TSB Embedded, Reading Buffers, and TSP Express) are blocked from running in Java version 7 update 51 because the JAR file manifest does not contain the Permissions attribute.

**Resolution:**

This issue has been corrected.

**PR51339 Models affected:**

2651A, 2657A

**Symptom:**

Running any of the Series 2650A web applications (Flash Upgrade, TSB Embedded, Reading Buffers, and TSP Express) brings users to a Keithley support login website.

**Resolution:**

This issue has been corrected.

**PR51343 Models affected:**

2651A, 2657A

**Symptom:**

When running any of the Series 2650A web applications (Flash Upgrade, TSB Embedded, Reading Buffers, and TSP Express), a Java security prompt may ask for your confirmation for running the application. An incorrect application name is shown on the security dialog window.

**Resolution:**

This issue has been corrected.

PR51347 **Models affected:**

2651A, 2657A

**Symptom:**

The links to download a Java plugin on those web applications were broken.

**Resolution:**

This issue has been corrected.

## Version 1.1.3 Release

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### Overview

Version 1.1.3 is a maintenance release of the Series 2650A firmware.

### Compatibility concerns

Version 1.0.1 introduced a fix that affects the range change timing of the source-measure unit (SMU) current source of the Model 2651A. This fix may affect tests that are sensitive to timing. See PR44354 in the “Critical fixes” section of the Version 1.0.1 Release for more detail.

### Enhancements

PR46062 **Models affected:**  
PR49025 2657A

#### Enhancement:

Bit 10 of the `status.questionable` register now functions as the `HIGHV_NOT_READY` bit. When this bit is set, it indicates that either the interlock is not engaged, or that the interlock was engaged recently and the high voltage supply is still stabilizing. If the interlock is engaged and this bit is set, attempting to turn the output on will result in error 5052, "Interlock engaged; system stabilizing".

PR48795 **Models affected:**  
PR48806 2651A, 2657A

#### Enhancement:

Keithley has updated its digital signature on all of its Series 2650A Java web applications (TSP Express, TSB Embedded, Flash Upgrade, and Reading Buffers) to a stronger 2048-bit certificate.

### Noncritical fixes

PR49407 **Models affected:**  
PR50286 2651A, 2657A

#### Symptom:

If `smuX.trigger.measure.stimulus` is nonzero, and `smuX.trigger.measure.action` is set to `smuX.ENABLED`, then measurement overruns are not reported.

#### Resolution:

This issue has been corrected.

PR50616 **Models affected:**  
PR50694 2651A, 2657A

#### Symptom:

In the `KIPulse` factory script, the step size ratio `b` is calculated incorrectly in functions `ConfigPulseIMeasureVSweepLog` and `ConfigPulseVMeasureISweepLog`.

#### Resolution:

This issue has been corrected.

## Version 1.1.2 Release

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### Overview

Version 1.1.2 is a maintenance release of the Series 2650A firmware.

### Compatibility concerns

Version 1.0.1 introduced a fix that affects the range change timing of the source-measure unit (SMU) current source of the Model 2651A. This fix may affect tests that are sensitive to timing. See PR44354 in the “Critical fixes” section of the Version 1.0.1 Release for more detail.

### Critical fixes

**PR47348 Models affected:**

2651A, 2657A

**Symptom:**

When `smuX.source.offmode = smuX.OUTPUT_ZERO` and `smuX.source.offfunc = smuX.OUTPUT_DCAMPS`, turning the SMU off leaves the hardware in an invalid state. The effective voltage in this state is:

- The value of `smuX.source.levelv` if `smuX.source.func` is set to `smuX.OUTPUT_DCVOLTS`
- The value of `smuX.source.limitv` if `smuX.source.func` is set to `smuX.OUTPUT_DCAMPS`

The effective current limit in this state is unpredictable, but can exceed the standard operating area of the SMU.

**Resolution:**

This issue has been corrected.

### Enhancements

**PR47036 Models affected:**

2651A, 2657A

**Enhancement:**

A new command to restore the factory defined global variables has been added. The `restoreglobals` command will overwrite all factory defined global variables except `node` with the factory default value. Use `tsplink.reset()` to reset the node table.

**PR47061 Models affected:**

2651A, 2657A

**Enhancement:**

TSP Express now fully supports Series 2600B instruments.

**PR47145 Models affected:**

2651A, 2657A

**Enhancement:**

The `tspnet.tsp.rhtablecopy()` command will use the `readings` synchronous table of a reading buffer by default if one isn't specified in the name parameter. For example, `tspnet.tsp.rhtablecopy(myConnection, "myBuffer")` and `tspnet.tsp.rhtablecopy(myConnection, "myBuffer.readings")` are equivalent.

**PR47151 Models affected:**

2651A, 2657A

**Enhancement:**

The USB interface has been improved and now supports most flash drives now on the market.

**PR47154 Models affected:**

2651A, 2657A

**Enhancement:**

The QYE, DDE, EXE, and CME bits in the Standard Event Status register of the status model are now set on the master node in addition to the remote node when a remote node generates an error that is logged to the error queue of the master node.

**PR47162 Models affected:**

2651A, 2657A

**Enhancement:**

When you insert an unrecognized USB device into the USB port, the instrument will now generate an error 1124, "Unrecognized USB device" to indicate that the device is unrecognized.

**PR47163 Models affected:**

2651A, 2657A

**Enhancement:**

The instrument will now generate an error 1125, "USB overcurrent condition" when the instrument shuts down the USB port because the device inserted into the port is drawing too much current.

**PR47325 Models affected:**

2657A

**Enhancement:**

High-C mode is now available in TSP Express for Model 2657A instruments with newer hardware (SMU board revision E or later).



## Noncritical fixes

**PR46156 Models affected:**

2651A, 2657A

**Symptom:**

Mounting a USB flash drive during boot operation, or while the instrument is otherwise accessing its nonvolatile memory, can cause the instrument to become unresponsive. Certain flash drives appear to be more susceptible than others.

**Resolution:**

This issue has been corrected.

**PR46307 Models affected:**

2651A, 2657A

**Symptom:**

Performing a serial poll using the VXI-11 interface does not clear the status byte's RQS bit as expected.

**Resolution:**

This issue has been corrected.

**PR46476 Models affected:**

2651A, 2657A

**Symptom:**

If `smuX.measure.autozero` is set to `smuX.AUTOZERO_AUTO`, then executing `smuX.trigger.initiate()` when `smuX.trigger.measure.action` is not equal to `smuX.DISABLE` will cause `smuX.measure.autozero` to be set to `smuX.AUTOZERO_OFF` at the conclusion of the resulting sweep.

**Resolution:**

This issue has been corrected.

**PR46481 Models affected:**

(A)

2651A, 2657A

**Symptom:**

Sending a properly terminated message using the `device_write()` command causes errors -363, "Input buffer overrun" and -420, "Query UNTERMINATED" when the "end" flag is not set.

**Resolution:**

This issue has been corrected.

PR46481 **Models affected:**  
(B) 2651A, 2657A

**Symptom:**

Performing a `device_read()` operation with an I/O timeout parameter value of zero causes the instrument to reply immediately with an error code of 15 (I/O Timeout).

**Resolution:**

This issue has been corrected.

PR46549 **Models affected:**  
2651A, 2657A

**Symptom:**

If the last known mDNS hostname is 64 characters or longer, the instrument becomes unresponsive when connected to the LAN. A few minutes later it shows "FATAL ERROR e60 v04" on its front-panel display.

**Resolution:**

This issue has been corrected.

PR46600 **Models affected:**  
2651A, 2657A

**Symptom:**

The maximum length for the instrument's hostname is 15 characters on the LXI IP Configuration page and 255 characters for the `lan.config.dns.hostname` remote command attribute. The maximum length for both should be 63 characters.

**Resolution:**

This issue has been corrected.

PR46695 **Models affected:**  
2651A, 2657A

**Symptom:**

The file selection filter in the Flash Upgrade, Reading Buffers, TSB Embedded, and TSP Express web applications does not default to the correct selection when running the web applications in Java 7.

**Resolution:**

This issue has been corrected.

**PR46708 Models affected:**

2651A, 2657A

**Symptom:**

When you attempt to save data from dedicated reading buffer 2 (SMA\_BUFFER2) to non-volatile memory by using the front panel, the instrument will save reading buffer 1 (SMUA\_BUFFER1) instead.

**Resolution:**

This issue has been corrected.

**PR46857 Models affected:**

2651A, 2657A

**Symptom:**

During a voltage sweep, if source autoranging is enabled, the first source point after a range change is approximately 2% of full-scale higher than intended.

**Resolution:**

This issue has been corrected.

**PR46905 Models affected:**

2651A, 2657A

**Symptom:**

In Test Script Builder Embedded, if you attempt to save a script when the nonvolatile memory is full, the instrument generates an error as expected but the unsuccessfully saved script still shows up in the list of user scripts.

**Resolution:**

This issue has been corrected.

**PR47140 Models affected:**

2651A, 2657A

**Symptom:**

The `tspnet.termination()` function does not generate an error when you attempt to change the termination sequence of a TSP connection.

**Resolution:**

The `tspnet.termination()` function now generates an error 2420, "Termination locked while using TSP connection," when you attempt to change the termination sequence of a TSP connection.

**PR47141 Models affected:**

2651A, 2657A

**Symptom:**

The *start* and *end* parameters to the `tspnet.tsp.rhtablecopy()` function are supposed to be optional but the instrument will generate an error if they are omitted.

**Resolution:**

This issue has been corrected.

**PR47144 Models affected:**

2651A, 2657A

**Symptom:**

TSP-Net connections to TSP instruments only work correctly on the first connection. Attempting to open a TSP-Net connection to the same instrument after closing the first connection will fail.

**Resolution:**

This issue has been corrected.

**PR47146 Models affected:**

2651A, 2657A

**Symptom:**

TSP-Net connections to some telnet servers may fail to communicate.

**Resolution:**

This issue has been corrected.

**PR47155 Models affected:**

2651A, 2657A

**Symptom:**

When certain errors are generated, the bit set in the Standard Event Status register of the status model does not match the bit dictated by the SCPI standard. For example, some errors cause the EXE bit to set, but the SCPI standard dictates that the DDE bit is set for that same error.

**Resolution:**

This issue has been corrected.

**PR47164 Models affected:**

2651A, 2657A

**Symptom:**

When multiple command messages separated by newline characters are sent in a single VXI-11 write operation, the instrument does not interpret the command messages separately. This can lead to the instrument ignoring the commands and generating inappropriate errors.

**Resolution:**

This issue has been corrected.

**PR47224 Models affected:**

2651A, 2657A

**Symptom:**

The `tspnet.tsp.rhtablecopy()` command generates an error 2413, "TSPnet invalid reading buffer table," if the length of the name parameter exceeds 63 characters.

**Resolution:**

This issue has been corrected.

**PR47239 Models affected:**

2657A

**Symptom:**

If the overvoltage protection (OVP) limit is set and then the source polarity is changed, the OVP limit becomes less accurate than expected. When this occurs, the OVP limit may be as much as 20 V above or below the configured value.

**Workaround:**

Set the OVP limit again while the new polarity is active to correct the issue.

**Resolution:**

This issue has been corrected.

**PR47313 Models affected:**

2651A, 2657A

**Symptom:**

When setting `smuX.sense` to `smuX.SENSE_CALA`, the effective source range is determined by the `smuX.measure.rangeY` setting instead of the `smuX.source.rangeY` setting. To properly calibrate range R, `smuX.measure.rangeY` must be set to R before setting `smuX.sense` to `smuX.SENSE_CALA`.

**Resolution:**

This issue has been corrected.

**PR47314 Models affected:**

2651A, 2657A

**Symptom:**

Attempting to set `smuX.sense` to `smuX.SENSE_CALA` on the 500 V source range should generate error 5004, "Operation conflicts with CALA sense mode." Instead, it appears to succeed without error, but in doing so changes `smuX.source.rangev` to 1500 V.

**Resolution:**

This issue has been corrected.

**PR47378 Models affected:**

2651A, 2657A

**Symptom:**

In TSP Express, running tests with high capacitance mode enabled generates error code 5069, "Autrorange locked for HighC mode," for the following configurations:

- Source voltage, measure voltage
- Source current, measure current
- Source current, measure current and voltage

**Resolution:**

This issue has been corrected.

## Version 1.1.1 Release

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### Overview

Version 1.1.1 is the initial release of the Series 2650A firmware for the Model 2657A. This version of the Series 2650A firmware is intended to be used on the Model 2657A only. Do not install this version on a Model 2651A instrument.

### Compatibility concerns

This version of the Series 2650A firmware is intended to be used on the Model 2657A only. Do not install this version on a Model 2651A instrument.

### Enhancements

**PR42774 Models affected:**

2651A

**Enhancement:**

In TSP Express, the measure range now follows the source range when the measure function is the same as the source function.

**PR43569 Models affected:**

2651A

**Enhancement:**

A new remote setting has been added that allows control over which limit value (power or current/voltage) is displayed on the front panel. Please refer to the latest user documentation for details.

**PR43805 Models affected:**

(A)

2651A

**Enhancement:**

TSP Express now supports composite SMUs in series configuration. Please refer to the "Combining SMU outputs" section in the reference manual for details and important safety precautions.

**PR43805 Models affected:**

(B)

2651A

**Enhancement:**

An "Identify" button has been added to the combining SMU dialog window. Pressing this button will flash an identification message on the front panel display of each SMU that makes up the selected composite SMU. At the same time, a corresponding connection diagram is shown to help verify the necessary connections.

PR43805 **Models affected:**  
(C) 2651A

**Enhancement:**

For negative-polarity pulsed sweeps, TSP Express will automatically set all zero bias and source levels to a negative number very near zero ( $-1e-30$ ) to avoid a 100  $\mu$ s penalty for source polarity changes.

PR43805 **Models affected:**  
(D) 2651A

**Enhancement:**

TSP Express now rounds calculated composite source and measure values to a maximum of nine decimal places.

PR43889 **Models affected:**  
2651A

**Enhancement:**

TSB Embedded now precedes commands typed in the command console command line with "TSP>" when echoing the command in the response window to clarify what has been typed versus what has been received from the instrument.

PR44450 **Models affected:**  
2651A

**Enhancement:**

The LXI implementation has been updated to comply with version 1.4 of the LXI standard.

PR44460 **Models affected:**  
2651A

**Enhancement:**

TSB Embedded now changes the cursor to an hourglass for lengthy operations.

PR44565 **Models affected:**  
2651A

**Enhancement:**

In TSP Express, project settings information (including sweep/SDM parameters) is now recorded in exported .csv data files.



**PR45777 Models affected:**

2651A

**Enhancement:**

Errors with a severity of SERIOUS are now displayed on the front panel until you press the EXIT key.

In response to this enhancement, the severity of following errors have been downgraded from FATAL to SERIOUS, in order to more accurately reflect their impact:

1121, "Unreleased firmware; Instrument performance is unqualified."

1122, "Interlock or power supply failure"

2000, "Flash download error"

2004, "Incompatible version"

**Noncritical fixes****PR42960 Models affected:**

PR43356 2651A

**Symptom:**

Recalling a saved setup from the front panel display while the limit is in a format for higher range may result in a limit value that has less resolution than its original saved value.

**Resolution:**

This issue has been corrected.

**PR43533 Models affected:**

2651A

**Symptom:**

The severity levels of many SMU errors are misleading.

**Resolution:**

The severity levels of several SMU errors have been reduced. Please refer to the updated user documentation for the complete list of errors and their updated severity levels.

**PR43569 Models affected:**

2651A

**Symptom:**

The `reset()` function and the `setup.recall()` function do not restore which limit value (power or current/voltage) is being displayed on the front panel.

**Resolution:**

This issue has been corrected.

**PR43862 Models affected:**

2651A

**Symptom:**

The web application "Reading Buffers" status details does not show values for status bit 0 (BO), which is used for the Fast ADC status.

**Resolution:**

A new column has been added to show bit 0 of the reading buffer's status values. The new column is labeled "FastADC" for Series 2650A instruments. It is labeled "Reserved" for Series 2600A and Series 2600B instruments.

**PR44020 Models affected:**

PR44243

2651A

**Symptom:**

When `smuX.source.func = smuX.OUTPUT_DCAMPS` and `smuX.source.offfunc = smuX.OUTPUT_DCVOLTS`, and measurements are stored to a reading buffer with the output off, the buffer indicates current as the source function. A similar issue arises when `smuX.source.func = smuX.OUTPUT_DCVOLTS` and `smuX.source.offfunc = smuX.OUTPUT_DCAMPS`.

**Workaround:**

This issue can be avoided by setting `smuX.source.func` to `smuX.source.offfunc` before making measurements with the output off.

**Resolution:**

This issue has been corrected.

**PR44089 Models affected:**

2651A

**Symptom:**

TSB Embedded incorrectly applies syntax coloring to commands with embedded quotes. An example of an embedded quote is `print('Hello " "')`.

**Resolution:**

This issue has been corrected.

**PR44361 Models affected:**

2651A

**Symptom:**

When using TSB Embedded to delete a script from the instrument, there is no prompt to confirm deletion of the script.

**Resolution:**

TSB Embedded now presents a confirmation dialog box before deleting a script.

**PR44370 Models affected:**

2651A

**Symptom:**

Erroneous packets from a DHCP server cause a fatal exception or cause the instrument to become unresponsive. This is known to occur with the DualServer v2.1 DHCP server.

**Resolution:**

This issue has been corrected.

**PR44397 Models affected:**

2651A

**Symptom:**

When exporting a script to a USB flash drive using TSB Embedded, if the script already exists it will be overwritten without warning.

**Resolution:**

Before overwriting a script, TSB Embedded presents a dialog box requesting confirmation that the script should be overwritten.

**PR44412 Models affected:**

2651A

**Symptom:**

When `smuX.measure.autorangeY` is set to `smuX.AUTORANGE_FOLLOW_LIMIT`, explicitly setting the measure range does not properly disable the autorange setting.

**Workaround:**

To ensure proper behavior after using this setting, explicitly set `smuX.measure.autorangeY` to `smuX.AUTORANGE_OFF`.

**Resolution:**

This issue has been corrected.

**PR44414 Models affected:**

2651A

**Symptom:**

When `smuX.measure.autorangeY` is set to `smuX.AUTORANGE_FOLLOW_LIMIT`, the  $Y$  measure range follows the  $Y$  limit range, even when the source function is set to  $Y$ . In this situation, the  $Y$  measure range should follow the  $Y$  source range.

**Workaround:**

This issue can be avoided by setting `smuX.measure.autorangeY` to `smuX.AUTORANGE_FOLLOW_LIMIT` only when the  $Y$  limit is active (only when sourcing the complementary function).

**Resolution:**

This issue has been corrected.

**PR44416 Models affected:**

2651A

**Symptom:**

When the output is off in `smuX.OUTPUT_HIGH_Z` mode and `smuX.source.offfunc = smuX.OUTPUT_DCAMPS`, setting `smuX.source.rangei` causes `smuX.measure.rangev` to change.

**Resolution:**

This issue has been corrected.

**PR44417 Models affected:**

2651A

**Symptom:**

Enabling source autorange when the output is off does not cause the source range to drop to its low range, as would be expected.

**Resolution:**

This issue has been corrected.

**PR44419 Models affected:**

2651A

**Symptom:**

When `smuX.source.autorangeY` is set to `smuX.AUTORANGE_FOLLOW_LIMIT`, and the SMU source function is set to the complement of  $Y$  (for example,  $Y$  is voltage and the SMU is sourcing current), setting `smuX.source.rangeY` erroneously changes `smuX.measure.rangeY`.

**Resolution:**

This issue has been corrected.

**PR44439 Models affected:**

2651A

**Symptom:**

When the output is off in `smuX.OUTPUT_NORMAL` mode and the off function is set to current, setting `smuX.source.offlimitv` such that the combination of the I source range and the new V limit range would cause a transition into the Extended Operating Area (EOA) results in error 5007, "Operation would exceed safe operating area of the instrument."

**Workaround:**

The error can be avoided by lowering the I source range first so that the new V limit range does not cause an EOA transition. Then restore the original, higher I source range.

**Resolution:**

This issue has been corrected.

**PR44449 Models affected:**

2651A

**Symptom:**

When configured as a current source with a voltage limit greater than 10 V, the SMU allows the current source range to be set to values that violate the safe operating area of the instrument. Once the error occurs, the SMU may limit the voltage to a lower value than expected; and any attempt to set the current level, voltage limit, or source function results in error 5007, "Operation would exceed safe operating area of the instrument". Resetting the SMU resolves the issue.

**Resolution:**

The SMU will now generate an error 5007 if you attempt to set the current range to a value that would violate the safe operating area of the SMU.

**PR44473 Models affected:**

2651A

**Symptom:**

TSP Express does not report instrument errors on its "Script Error" dialog box. The errors display on the "Instrument Output" field, but they are not visible unless you select the "Edit" tab.

**Resolution:**

Instrument error messages now display on both the "Script Error" dialog box and the "Instrument Output" field.

**PR44591 Models affected:**

2651A

**Symptom:**

If a power compliance limit has been set, the instrument might not generate an error for exceeding the standard operating area (SOA) when setting ranges or limit values.

**Resolution:**

This issue has been corrected.

**PR44627 Models affected:**

2651A

**Symptom:**

The SWEEPING bit in the Operation Status SMU X Summary register (`status.operation.instrument.smuX`) clears before the SMU recognizes that overlapped operation has completed. Consequently, attempting to execute a SMU command immediately after the SWEEPING bit is cleared can result in error code 5042, "Cannot perform requested action while an overlapped operation is in progress."

**Resolution:**

This issue has been corrected.

**PR44629 Models affected:**

2651A

**Symptom:**

When clearing a reading buffer, any errors encountered will be repeated nine times.

**Resolution:**

This issue has been corrected.

**PR44651 Models affected:**

2651A

**Symptom:**

If measure autoranging is enabled, attempting to set the measure range to a value below the low range setting causes the measure range to be set to the low range instead.

**Resolution:**

This issue has been corrected.

**PR44653 Models affected:**

2651A

**Symptom:**

When the output is off in `smuX.OUTPUT_NORMAL` mode, and `smuX.source.offfunc = smuX.DC_AMPS` and `smuX.source.rangei = 50`, attempting to set `smuX.source.offlimitv` to a value that corresponds to the 40 V range results in error 5007, "Operation would exceed safe operating area of the instrument." Afterward, the `smuX.source.offlimitv` attribute indicates that the limit is 40 V, but in reality the limit has not been changed.

**Resolution:**

This issue has been corrected.

**PR44920 Models affected:**

2651A

**Symptom:**

The reading buffers web application inappropriately formats some values when displaying reading buffer data. For example, the 20 mV range displays as 0.01999999952965164 instead of 0.02.

**Resolution:**

This issue has been corrected.

**PR44094 Models affected:**

2651A

**Symptom:**

Setting the current measure range while high-C mode is enabled has no effect.

**Resolution:**

When high-C mode is enabled, the last value assigned to the current measure range is retained and then used to restore the current measure range when high-C mode is disabled.

**PR45121 Models affected:**

2651A

**Symptom:**

You may experience inappropriately degraded performance when using Ethernet raw sockets and telnet sockets. The degradation may occur when a number of small packets are exchanged across the socket. This is caused by the Nagle algorithm which delays Ethernet packets for up to 200 ms waiting to combine small packets for network efficiency.

In most cases packet immediacy is more desirable than network efficiency. The Nagle algorithm should be disabled by default to eliminate this delay.

**Resolution:**

The Nagle algorithm is now disabled by default. If necessary for Ethernet efficiency, set the `lan.nagle` attribute to `lan.ENABLE` to enable the algorithm.

**PR45333 Models affected:**

2651A

**Symptom:**

The IDLE event that occurs at the end of a sweep is generated before the SMU hardware has returned to its idle state.

**Resolution:**

This issue has been corrected.

**PR45478 Models affected:**

2651A

**Symptom:**

An incorrect source level is displayed if you abort a fixed-source-range sweep by pressing the EXIT key or the OUTPUT ON/OFF button on the front panel. The actual source level is the programmed idle level, but the display indicates the last level active in the sweep before it was aborted.

**Resolution:**

This issue has been corrected.

**PR45479 Models affected:**

2651A

**Symptom:**

When a sweep is aborted by a high-priority output off event under certain conditions, the current or voltage source level is incorrectly changed to match the limit value. The paragraphs below describe these conditions and the incorrect outcomes:

Conditions: Sweep source function = Current and Off function = Voltage

Incorrect outcome: The programmed current source value changes to match the current limit value.

Conditions: Sweep source function = Voltage and Off function = Current

Incorrect outcome: The programmed voltage source value changes to match the voltage limit value.

The high-priority output off events that can cause this issue include:

- Pressing the OUTPUT ON/OFF control
- Resetting the TSP-Link
- Detecting a SMU over-temperature condition
- Disengaging the interlock

**Resolution:**

This issue has been corrected.



**PR45539 Models affected:**

2651A

**Symptom:**

Setting the LAN configuration using the LXI web interface does not always work. When this happens, the new LAN setting values are ignored by the instrument.

**Resolution:**

This issue has been corrected.

**PR45615 Models affected:**

2651A

**Symptom:**

When the instrument is configured as a current source on the 50 A range and the output is on, attempting to set the voltage limit to any value results in error 5007, "Operation would exceed safe operating area of the instrument." The instrument should allow voltage limit values up to 10 V.

**Resolution:**

This issue has been corrected.

**PR45650 Models affected:**

2651A

**Symptom:**

In TSP Express, when sweeping current in logarithmic steps, you cannot enter start or stop values smaller than 1  $\mu$ A.

**Resolution:**

TSP Express now allows start and stop values as low as 1 pA.

**PR45698 Models affected:**

2651A

**Symptom:**

Inserting or removing a USB flash drive when the instrument is busy can result in the instrument becoming unresponsive, with the front panel indicating that a "FATAL ERROR" has occurred.

**Resolution:**

This issue has been corrected.

**PR45729 Models affected:**

2651A

**Symptom:**

If `smuX.source.delay` is set to `smuX.DELAY_AUTO`, the effective source delay during sweeps is significantly shorter than it should be. The difference is most noticeable on the 100 nA, 1  $\mu$ A, and 10  $\mu$ A ranges.

**Resolution:**

This issue has been corrected.

**PR45767 Models affected:**

2651A

**Symptom:**

If `smuX.trigger.autoclear` is set to 1 and the `smuX.trigger.ARMED_EVENT_ID` event is used with the `smuX.source.stimulus`, either directly or indirectly through an intermediate trigger object, the source action will not be triggered as expected. If the event is routed through an intermediate trigger object, this only happens when the intermediate trigger object delays the event by less than 1  $\mu$ s.

**Workaround:**

Use a timer to add 1  $\mu$ s of delay between an Armed event and the source stimulus.

**Resolution:**

This issue has been corrected.

**PR45803 Models affected:**

2651A

**Symptom:**

After the `smuX.sense` attribute is changed from `smuX.SENSE_CALA` to either `smuX.SENSE_LOCAL` or `smuX.SENSE_REMOTE`, the actual SMU output level cannot be raised above the programmed level that immediately preceded the sense mode change. Turning the output off when `smuX.source.offmode` is set to `smuX.OUTPUT_HIGH_Z` corrects the issue. Additionally, changing the current source range often corrects the issue.

**Resolution:**

This issue has been corrected.

**PR45816 Models affected:**

2651A

**Symptom:**

If the SMU output is turned off when `smuX.source.offmode = smuX.OUTPUT_NORMAL` and `smuX.source.offfunc = smuX.OUTPUT_DCVOLTS`, the effective current limit does not correspond to `smuX.source.offlimiti` as it should. When the output is in this state, setting `smuX.source.offlimiti` or `smuX.source.limiti` corrects the issue.

**Resolution:**

This issue has been corrected.

**PR45980 Models affected:**

2651A

**Symptom:**

The VXI-11 interface intermittently terminates response messages too early.

**Resolution:**

This issue has been corrected.

**PR46124 Models affected:**

2651A

**Symptom:**

If an End Pulse overrun occurs within 2  $\mu$ s of a Source overrun, one of the two overruns may not be reported.

**Resolution:**

This issue has been corrected.

**PR46146 Models affected:**

2651A

**Symptom:**

If `trigger.timer[N].delay` is set to a value less than 1  $\mu$ s, the actual delay that results is approximately 20  $\mu$ s. Similarly, if `digio.trigger[N].pulsewidth` or `tsplink.trigger[N].pulsewidth` is set to a value greater than zero but less than 1  $\mu$ s, the resulting trigger pulse is approximately 20  $\mu$ s in width.

**Resolution:**

This issue has been corrected.

**PR46164 Models affected:**

2651A

**Symptom:**

Aborting a measurement operation can leave the measurement engine in an invalid state if all of the following conditions are true:

- The measurement operation was initiated by a sweep or by the `smuX.measure.Y()` command.
- The measure count is greater than one (1).
- The abort occurs simultaneous to either the measure stimulus event or the expiration of the measure interval timer.

Once in this state, all further readings are erroneous and subsequent SMU commands may cause the instrument to become unresponsive. The instrument power must be turned off and then turned back on again to recover. Measurements initiated with the `smuX.measure.overlappedY()` command do not cause this issue when aborted.

**Resolution:**

This issue has been corrected.

**PR46186 Models affected:**PR46249  
2651A**Symptom:**

On rare occasions the instrument boots very slowly, pausing for several minutes with two dots on the front panel display and requiring more than ten minutes total to complete its boot sequence. Afterward, certain commands malfunction, each requiring more than 30 seconds to execute. These commands include:

```
trigger.timer[N].delay  
trigger.timer[N].count  
digio.trigger[N].pulsewidth  
tsplink.trigger[N].pulsewidth
```

When the instrument is in this state, the functionality of any trigger timer, digital I/O, TSP-Link, or SMU measurement operation cannot be relied upon. Turning the instrument off and then on again corrects the issue.

**Resolution:**

This issue has been corrected.

## Version 1.0.2 Release

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### Overview

Version 1.0.2 is a maintenance release of the Model 2651A firmware.

### Compatibility concerns

Version 1.0.1 introduced fixes that affects the range change timing of the source-measure unit (SMU) current source. This may affect tests that are sensitive to timing. See PR44354 in the “Critical fixes” section of the Version 1.0.1 Release for more detail.

### Critical fixes

PR45688 **Models affected:**  
PR45689 2651A

#### Symptom:

Loading scripts over the command interface or from a USB flash drive causes a memory leak. If you load several large scripts or many small scripts in this manner, you will eventually encounter an unexpected error -225, "TSP Memory allocation error: not enough memory" or simply "Out of memory." Once the instrument is in this state, you must turn the instrument off and back on to recover.

#### Resolution:

This issue has been corrected.

### Noncritical fixes

PR46544 **Models affected:**  
PR46620 2651A

#### Symptom:

When sourcing between 70 mA and 101 mA on the 1 A range into a low impedance (less than 1 ohm) DUT, lowering the source range to the 100 mA range causes 5 A to flow. Turning the output off stops the excess current.

#### Workaround:

The issue can be avoided by lowering the current to a level below 70 mA before changing the source range.

#### Resolution:

This issue has been corrected.

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## Version 1.0.1 Release

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### Overview

Version 1.0.1 is a maintenance release of the Model 2651A firmware.

### Compatibility concerns

This version of firmware introduced fixes that affect the range change timing of the source-measure unit (SMU) current source. This may affect tests that are sensitive to timing. See PR44354 in the “Critical fixes” section for more details.

### Critical fixes

PR44354 **Models affected:**

PR45594 2651A

PR45612

PR45613

PR45620

**Symptom:**

PR45622 Transients induced during current source range changes are larger than the specified range change overshoot for the instrument.

PR45626

PR45627

**Resolution:**

This issue has been corrected. Range change timing for the current source was affected by this fix. The affected range changes now take longer than in version 1.0.0, and tests that depend on the source range change time of the current source should be requalified.

### Noncritical fixes

PR43955 **Models affected:**

PR44143 2651A

**Symptom:**

Aborting a measurement operation can leave the measurement engine in an invalid state if all of the following conditions are true:

- The measurement operation was initiated by a sweep or by the `smuX.measure.Y()` command.
- The measurements are being stored in a reading buffer.
- Autoranging is enabled.
- The measure delay is nonzero.

Once in this state, all further readings are erroneous and subsequent SMU commands may cause the instrument to become unresponsive. The instrument power must be turned off and then turned back on again to recover. Measurements initiated with the `smuX.measure.overlappedY()` command do not cause this issue when aborted.

**Resolution:**

This issue has been corrected.

PR44199 **Models affected:**  
PR44200 2651A

**Symptom:**

Aborting a measurement operation can leave the measurement engine in an invalid state if all of the following conditions are true:

- The measurement operation was initiated by a sweep or by the `smuX.measure.Y()` command.
- The measure count is greater than one (1).
- The specified measure interval is smaller than the system can achieve.

Once in this state, all further readings are erroneous and subsequent SMU commands may cause the instrument to become unresponsive. The instrument power must be turned off and then turned back on again to recover. Measurements initiated with the `smuX.measure.overlappedY()` command do not cause this issue when aborted.

**Resolution:**

This issue has been corrected.

PR45262 **Models affected:**  
PR45584 2651A

**Symptom:**

Sending a remote command in excess of 1024 characters over a LAN socket interface results in an erroneous error -285, "TSP Syntax error," in addition to the -363, "Input buffer overrun" error that should be generated.

**Resolution:**

This issue has been corrected.