

Keysight Basic Instruments

Issue #4 - 2016



The convenient solution
for validating adaptive
fast USB battery charging



PROMOTIONS

Save 25% on new software when you trade an instrument with embedded software

Choose from > 230 standalone and embedded software applications compatible with bit error rate testers, oscilloscopes, signal generators, signal analyzers, vector network analyzers, and more. Promo code #6.000.

Find out more at:
www.keysight.com/find/tradeinsoftware

Offer valid through December 31, 2016.

ReMEMber to upgrade your bench program

FREE memory upgrades when you advance to Keysight's next-generation Truevolt digital multimeters and Trueform waveform generators.

For applicable models and more information:
www.keysight.com/find/remember_bench

Offer valid through December 31st, 2016.

Supercharge your DSO to an MSO for free

Keysight was the inventor of the mixed-signal oscilloscope (MSO) and engineers use this logic analysis capability to solve their most challenging problems. This promotion provides the advantages MSO capability for free.

Only valid for orders of new MSO 3000T and 4000 X-Series oscilloscopes through Keysight distributors with promo Code 6.004.

Find out more at:
www.keysight.com/find/supercharge.mso

Offer extended from September 30th, 2016 till December 31, 2016.

HIGHLIGHTED

BenchVue software for the PC makes it simple to connect, record and achieve results with your instruments without programming



Look For This Icon throughout the catalog to identify enabled products.

- Visualize multiple measurements simultaneously
- Easily capture data, screen shots & system state
- Rapidly prototype custom test sequences
- Measurement data export to Excel, Word and MATLAB in only three clicks Monitor and control your bench from mobile devices

Download the *no cost* version today:
www.keysight.com/find/benchvue

Measurement Hint

If you need to verify product performance over a wide temperature range or find the cause of failure at high or low temperatures, you know most probes are limited to 0 to 50 °C. Operate them outside that range and you risk damage. But Keysight offers extreme-temperature probing solutions that operate at -40 to +85 °C and beyond. Measure with the probe head and accessories inside the temperature chamber and the probe pod and scope outside.

www.keysight.com/find/probes

Keysight Our Distributor Network

RIGHT Instrument. RIGHT Expertise. Delivered RIGHT Now.

Keysight and our network of Keysight Authorized Distributors have teamed up to provide fast, easy access to the world's largest selection of off-the-shelf T&M instruments. It's the best of both worlds: Keysight's measurement expertise and product breadth combined with speed, convenience and same-day shipping from our distribution partners. It's never been easier to get the right instrument in the right hands, right away.

SPOTLIGHT

Complex test, simple solution— validate adaptive fast USB battery charging

Smart phones, phablets, tablets—the only thing growing faster than their capabilities and usage is their power consumption. To maintain acceptable run time, they now require much larger lithium ion batteries. In fact, 9,000 mAh batteries are now commonplace in tablets.

Despite their size, these batteries often need recharging before day's end. And the marginal power delivery of current USB adapters means that can take overnight. But two new innovations are addressing this dilemma: specifications for higher power delivery over USB, with the introduction of USB Type-C, and adaptive fast charging battery management systems.

New innovations resolve charging issues

They define an infrastructure to deliver much higher power of up to 100 watts, through greater currents up to 5 amps and greater voltage up to 20 volts. That means USB power is no longer a limiting factor for fast charging of larger batteries.

Independent of the USB specifications, many devices have incorporated proprietary adaptive fast USB charging technology. This technology makes use of the legacy USB infrastructure. When connected to a non-compatible device, the charging adapter's output remains at the USB-default 5-volt level. Otherwise it delivers higher power, primarily by increasing voltage to 20 volts, as shown in *Figure 1*.

Together these innovations can typically charge a battery up to 80 percent of its capacity within an hour.

Safety and reliability come first

Although it's a customer-pleaser, adaptive fast USB charging is considerably more complex and must carefully manage battery charging to assure safety and reliability. The engineer who designs the charging system must thoroughly validate all aspects of operation during development.

You must be able to simultaneously measure the adapter's voltage and current being sourced to the mobile device, together with the voltage and current directly charging the battery. These

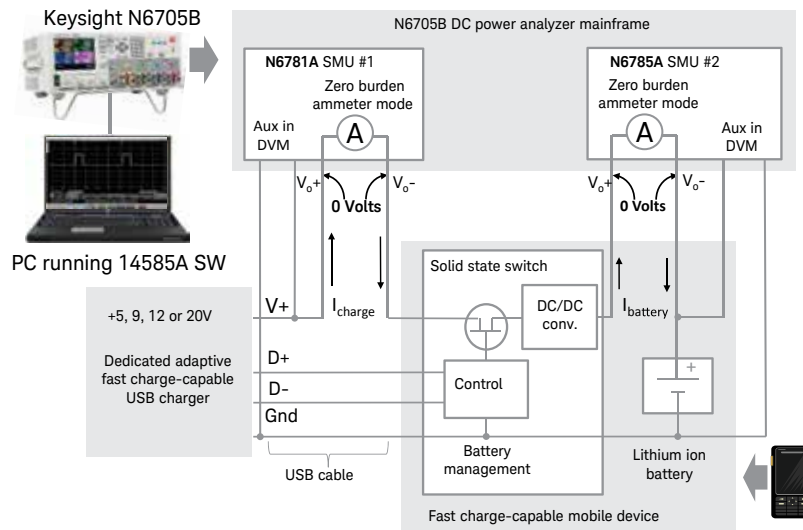


Figure 2. The setup for validating a device's adaptive fast USB charging performance combines a Keysight power analyzer mainframe, two source/measure units, and control-and-analysis software for advanced power supplies running on a PC.

measurements need to be continually logged over the charging cycle. After the measurements are captured, the data needs to be analyzed for the following:

- USB default +5 V operation
- Adaptive fast-charge negotiation process
- Percent of charge reached for fixed durations, such as 30 and 60 minutes
- Total time to 100% charge
- Correct charge termination

Easily validate complex adaptive fast-charge performance

The solution starts with a Keysight N6705B DC power analyzer mainframe. Add to that N6781A 20 V, 3 A, 20 W or N6785A 20 V, 8 A, 80 W source-measure units. These units can be used

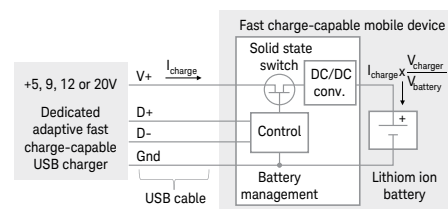


Figure 1. The adaptive fast USB battery charging system can charge a 9,000 mAh battery in an hour.

to supply the charging power, act as a load for the charger, or operate in their current measure-only mode, acting as zero-burden ammeters. These units feature an auxiliary DVM input to log voltage and current simultaneously, providing accurate voltage, power, and energy measurements.

The 8 A, 80 W capability of the N6785A is an excellent match for the current, power, and voltage levels encountered in testing adaptive fast USB charging systems.

Keysight's 14585A control-and-analysis software lets you quickly set up and run, and then capture, display, and analyze the results of adaptive fast-charge performance. Data-log operating mode provides long-term capture, but the unit can also sample at a sufficiently high rate to examine details of short-term activities. *Figure 2* shows the complete solution.

Learn more about applying this solution in our app note "Evaluating Adaptive Fast USB Battery Charging of Mobile Devices"

www.keysight.com/find/usbcharging

Keysight offers a complete solution set from simulation to compliance for many USB Type-C design and test challenges. For more info, visit:

www.keysight.com/find/typec

Find a Keysight distributor today at
www.keysight.com/find/distributor

Basic Instruments | Issue #4 - 2016 03

DC Power Supplies, Source and DC Loads

POWER DELIVERY SOLUTION: Validate a device's adaptive fast USB charging performance with this convenient set-up

N6700 modular power system family



- N6700:** Ideal DC power supply solution for automated test systems
- Small 1U mainframe (400, 600, 1200 W); up to four modules per mainframe
 - More than 30 programmable DC power modules: basic, high performance, precision and SMU; available in 20 to 500 W
- BenchVue software enabled



- N6705B:** Deep insight into DUT power consumption—without assembling a complex test system
- Integrated benchtop unit holds up to four N6700 Series modules (600 W total)
 - DMM, scope, arb, and data logger features
 - Source/measure units and application-specific modules
- BenchVue software enabled

N6781A, N6785A 2-quadrant source/measure units



- N6781A:** 20 V, ± 1 A or 6 V, ± 3 A, 20 W
N6785A: 20 V, 15 V, 10 V, 6 V, 80 W
- designed specifically for battery drain analysis
 - programmable output resistance mimics battery's internal resistance
 - auxiliary DVM to log voltage at the same time as current

14585A control and analysis software for advanced power supplies



- easily access your power supply's advanced sourcing and measurement features
- four modes of operation: scope, data logger, CCDF, and ARB
- accurately capture current drain measurements from seconds to days at up to 200,000 measurements per second directly to a PC
- complements the N6705 DC power analyzer's front-panel controls

HIGH PERFORMANCE DC POWER: Anticipate new demands with high speed, versatility, and accuracy

B2900A Series precision source/measure units



- Display I-V curves on the front panel
 - 6.5-digit sourcing/measurement resolution
 - Wide application coverage from 100 nV / 10 fA to 210 V / 3 A DC and 10.5 A pulsed
 - Multiple free software control options to fit your particular application
- BenchVue software enabled

B2960A Series low noise power sources



- Precision current and voltage source with ultra-low noise 10 μ Vrms
 - 6.5 digit resolution (100 nV / 10 fA)
 - Innovative and precision ARB capability; six built-in waveforms with speeds up to 10 kHz
- BenchVue software enabled

DC Power Supplies and AC Source/Analyzers

HIGH VALUE BASIC DC POWER: Solid performance and robust features help you achieve more on lower budgets

E36100 Series DC power supplies



- 30 to 40 W outputs
 - Compact, 2U 1/4-rack form factor
 - High-contrast OLED display viewable from any angle
 - Intuitive on-screen menus
- BenchVue software enabled

E3600 Series DC power supplies



- Output noise as low as 1 mVp-p/0.2 mVrms
 - Fast load transient response time (<50 μ s)
 - 30 to 200 W outputs
- BenchVue software enabled

N5700 and N8700 Series system DC power supplies



- 45 models in compact 1U (750 and 1500 W) and 2U (3.3 and 5 kW) packages
 - Up to 600 V or up to 400 A
 - Programmability and built-in V & I measurements simplify test set ups
- BenchVue software enabled

STABLE, RELIABLE AC POWER: Make sure your designs can handle unpredictable real-world power

AC6800 Series basic AC sources



- Four models, 500 to 4000 VA (dual range 135/270 Vrms, up to 120 A)
- Intuitive user interface
- Access and control the source remotely using a standard Web browser

6800B Series performance AC sources/analyzers



- Complete AC power test solution
- Three models, up to 1750 VA (300 Vrms, up to 80 A)
- Extensive power measurement capabilities (rms, peak, DC, AC+DC, THD, and more)
- Built-in arbitrary waveform generator to simulate many types of power waveforms

Data Acquisition Units

Modular flexibility and universal channels for a wide range of measurements with no external signal conditioning

34980A multi-function switch/measure unit



- High performance, 8-slot mainframe with 6 1/2 digit DMM and built-in signal conditioning
- Choose from 21 plug-in modules, up to 1024 1-wire (560 2-wire) channels or 4096 cross points


34970A/72A data acquisition switch units



- Low-cost, 3-slot unit with 6 1/2 digit DMM and built-in signal conditioning
 - Choose from 8 plug-in modules, up to 120 1-wire (60 2-wire) channels or 96 cross points
 - 34972A has built-in Web interface
- BenchVue software enabled

Oscilloscopes and Applications

InfiniiVision X-Series oscilloscopes

- Up to 1,000,000 waveforms/sec update rate
- MegaZoom IV responsive, uncompromised smart memory
- 5 or 6 instruments in 1 oscilloscope
- Fully upgradable—bandwidth, MSO, serial analysis, built-in WaveGen function generator, or digital voltmeter and counter
-  BenchVue software enabled

www.keysight.com/find/infiniivision



Model	Description	Bandwidth	Channels	Sample rate	Memory depth	Standard warranty	Calibration period	Special triggers	Built-in instruments
2000 X-Series	Basic R&D bench <ul style="list-style-type: none"> – 50,000 wfms/s update rate – 8.5-inch display – Serial bus options 	70 MHz to 200 MHz	2, 2+8, 4, 4+8	Up to 2 GSa/s	Up to 1 Mpts	5 years	2 years	Serial protocol	8 digital channels, 20 MHz FG, 5-digit counter, 3-digit DVM
PROMOTION	3000T X-Series	Everything the 2000X has plus <ul style="list-style-type: none"> – 1,000,000 wfms/s update rate – Advanced math and power analysis – Capacitive touch screen 	2, 2+16, 4, 4+16	Up to 5 GSa/s	4 Mpts and segmented memory standard	3 years	3 years	Serial protocol Zone touch	16 digital channels, 20 MHz AWG, 8-digit counter and totalizer, 3-digit DVM
	4000 X-Series	Everything the 3000T has plus <ul style="list-style-type: none"> – 12.1-inch capacitive touch screen – FFT, USB 2.0 pre-compliance and FPGA applications – Up to four active probes 					2 years		16 digital channels, Dual 20 MHz AWG, 5-digit counter, 3-digit DVM

InfiniiVision Software Applications



Serial protocols and triggering

I2C, SPI, RS232, UART, USB 2.0, CAN, LIN, FlexRay, Audio, MIL-STD 1553, ARINC 429

Features

Dual-channel WaveGen, jitter, real-time eye diagram, integrated voltmeter, 10-digit counter, mask limits, USB signal quality, video/TV, FPGA dynamic probe, power analysis

See the complete list of apps at www.keysight.com/find/scope-apps

DOWNLOAD YOUR NEXT INSIGHT

Keysight software is downloadable expertise. www.keysight.com/find/download_trials

HIGHLIGHTED

Get some great tips on how to better use your scope at the Keysight Oscilloscope Learning Center:

www.oscilloscopelearningcenter.com

Watch the "2-Minute Guru playlist" on the Keysight Oscilloscopes YouTube Channel with Oscilloscope how-to video series, new videos every Tuesday! The basics for beginners, and some helpful tips for more advanced users: www.youtube.com/user/KeysightOscilloscope

Handheld Oscilloscopes and Probes

Big scope performance with a small scope price

1000 Series oscilloscopes



- 50 to 200 MHz, 2- and 4-channel DSO models with up to 20 kpts memory
- 5.7-inch color display offers powerful signal capture and display
- Up to 2 GSa/s sample rate
- Accelerate your productivity with 23 automatic measurements, an 11-language user interface, USB connectivity, and a standard educator's kit

N7007A extreme temperature 400-MHz passive probe



- Temperature range: -40 to +85 °C
- Low-cost, high-impedance probe with rugged tip perfect for general-purpose applications
- 2-meter cable length ideal for hard-to-reach automotive test points
- Banana-to-socketed tip adapter compatible with differential active probes

For a complete list of available probes: www.keysight.com/find/probes

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Basic Instruments | Issue #4 - 2016 05

Benchtop Digital Multimeters and Waveform Generators

Benchtop DMMs

www.keysight.com/find/DMM



Model	Description	Features							Max reading rate at 4½ digits (rdgs/s)	Built-in PC interfaces
		Digits of resolution	DCV, DCI True RMS ACV/ACI	2- and 4-wire Ω	Freq/period	Diode/cont	Cap.	Temp.		
U3401A	Dual display. Elegantly simple and affordable DMMs with basic capabilities.	4½	•	2-wire Ω only	•	•			N/A	None
U3402A		5½		•						
U3606B	DMM with built-in 30 W power supply. Halves bench/rack space needed for two instruments.	5½	•	•	•	•	•	•	26	USB, GPIB
34450A	Faster measurement speed, ultra-bright OLED with dual display, and basic statistical tools. 	5½	•	•	•	•	•	•	190	USB, serial (RS-232), optional GPIB
34460A	New industry standard. Display DMM results in ways you never have before and measure with unquestioned Truevolt confidence. 	6½	•	•	•	•	•	•	300	USB, GPIB, optional LAN
34461A		6½							1,000	USB, LAN, optional GPIB
PROMO 34465A	More measurements, higher speed, better accuracy, more memory than 34461A. 	6½	•	•	•	•	•	•	50,000	USB, LAN, optional GPIB
34470A		7½								
34420A	Nano volt/μΩ meter. Very accurate, low-level measurements. 	7½	DCV only	•				•	250	serial (RS-232), GPIB
3458A	The fastest, most flexible and most accurate multimeter, ideal multimeter for demanding applications.	8½	•	•	•				100,000	GPIB
B2981A	The world's only graphical picoammeter. 0.01 fA minimum measurement resolution.	6½ (0.01 fA)	DCI only	2-wire only					20,000	USB, GPIB, LAN
B2983A*										
B2985A	The world's only graphical electrometer. Measure down to 0.01 fA and up to 10 PΩ (10×10 ¹⁵ Ω).	6½ (0.01 fA)	DCI, DCV	2-wire only				•	20,000	USB, GPIB, LAN
B2987A*										

*Battery operated  Indicates BenchVue-enabled products

Waveform Generators

- Generate Trueform arbitrary waveforms with less jitter, more fidelity and greater resolution

 BenchVue software enabled

www.keysight.com/find/trueform



Model	Description	Channels	Frequency range	Pulse	Arbitrary waveforms					Modulation		
					Std/Opt arb	# bits	Sample rate	Standard memory/Ch	Optional memory/Ch	AM/FM	FSK	PWM
33210A	General-purpose function and arbitrary waveform generators.	1	10 MHz	5 MHz	Opt	14	50 MSa/s	8 K	–	•		•
33509B	Exclusive Trueform waveform technology with <40 ps jitter and <0.04% THD.	1	20 MHz	20 MHz	Opt	16	160 MSa/s	1 M	16 M	•	•	•
33510B		2										
33511B		1	20 MHz	20 MHz	Std	16	160 MSa/s	1 M	16 M	•	•	•
33512B		2										
33519B		1	30 MHz	30 MHz	Opt	16	250 MSa/s	1 M	16 M	•	•	•
33520B		2										
33521B	Exclusive Trueform waveform technology at higher frequency ranges with <1 ps jitter <0.03% THD.	1	30 MHz	30 MHz	Std	16	250 MSa/s	1 M	16 M	•	•	•
33522B		2										
33611A		1	80 MHz	80 MHz	Std	14	660 MSa/s	4 M	64 M	•	•	•
33612A		2										
33621A		1	120 MHz	100 MHz	Std	14	1 GSa/s	4 M	64 M	•	•	•
33622A		2										

Handheld Test Tools

Retool your expectations

These handheld tools are ready for real-world conditions—and many offer unique functions such as:

- clear readouts from a high-contrast OLED display
- continuity checks with audible and flashing alerts
- low-light troubleshooting with a built-in flashlight

Find more info at www.keysight.com/find/hh

Thermal imager



- 4X more in-camera fine resolution to identify abnormalities faster
- Image logging and temperature trending to monitor temperature changes
- High-temperature range (up to 1200 °C)
- Long standard product warranty – 3 years

Insulation resistance tester



- Wireless insulation resistance testing via PC and smart phone / tablet applications
- Automatic test report generation – 50 V/100 V/250 V/500 V/1000 V test voltages
- Keysight Remote Link solution, with an optional U1117A Infrared (IR)-to-Bluetooth® adapter

Digital multimeters



- Data logging capability
- Long battery life
- CAT III 600 V overvoltage protection or higher
- Keysight Remote Link solution, with an optional U1117A Infrared (IR)-to-Bluetooth adapter

Clamp meters



- Full-featured digital multimeter capabilities
- CAT III 600 V overvoltage protection or higher
- Keysight wireless remote connectivity solution on some models

Oscilloscopes



- 20 to 200 MHz bandwidth
- Large color display
- High sampling rate and recording length

Capacitance/LCR meter



- 20,000 counts resolution, 0.2% basic accuracy
- Wide LCR ranges with 3 to 5 selectable test frequencies (Up to 100 kHz for U1733C)
- Battery life of 16 hours/AC-powered
- IR-to-USB connectivity for data logging to PC

Counters and LCR Meter

More resolution and speed with graphical display offers more insights

53200A Series RF and universal frequency counters



- Frequency, frequency ratio, time interval, rise/fall time, phase, and much more
- Histograms, trend charts, data logging, and built-in math and statistical functions
- 53230A offers: 20 ps single-shot, burst microwave, and continuous gap-free measurements
- Optional 6 or 15 GHz RF channel
- BenchVue software enabled

Model	Key specifications
53210A	350 MHz RF frequency counter, 10 digits/s
53220A	350 MHz universal frequency counter/timer, 12 digits/s, 100 ps
53230A	350 MHz universal frequency counter/timer, 12 digits/s, 20 ps

Speed, accuracy, and measurement versatility

E4980AL precision LCR meter



- 20 Hz to 300 kHz / 500 kHz / 1 MHz
- Exceptionally low noise at both low and high impedance to improve test quality; 0.05% basic impedance accuracy
- High speed at an affordable price: 12 ms (SHORT), 118 ms (MED), 343 ms (LONG) @ 1 MHz
- 201-point programmable list sweep

RF Signal Generator and Signal Analyzers

Professional performance and compact size for general-purpose testing needs

N9310A RF signal generator



- 9 kHz to 3 GHz CW output, 20 Hz to 80 kHz low frequency (LF) output
- -127 to +13 dBm output level range (max +20 dBm settable)
- -95 dBc/Hz SSB phase noise
- Extensive analog modulation: AM, FM, phase, and pulse modulation

Achieve more on a tight budget: Solid performance with robust measurement features

N9320B basic spectrum analyzer (BSA)



- Frequency range: 9 kHz to 3 GHz
- DANL: -148 dBm with pre-amp on
- 3 GHz tracking generator
- AM/FM and ASK/FSK demodulation analysis
- BenchVue software enabled

N9322C basic spectrum analyzer (BSA)



- Frequency range: 9 kHz to 7 GHz
- DANL: -152 dBm typical, with preamp on
- 7 GHz tracking generator, built-in VSWR bridge
- CISPR compliant EMI filters and quasi-peak detector supported
- BenchVue software enabled

Find a Keysight distributor today at
www.keysight.com/find/distributor

N6705B DC Power Analyzer, N6781/85A SMUs, and 14585A Control & Analysis Software

Deliver exceptional battery life in your devices

The N6781A and N6785A two-quadrant SMUs are designed to power, characterize, and test battery-powered devices (smart phones, tablets, and components).

- 20 V, ± 3 A, 20 W (N6781A); 20 V, ± 8 A, 80 W (N6785A)
- Stable, glitch-free sourcing and sinking (charge/eLoad)
- Seamless dynamic measurements down to nA

The N6705B DC power analyzer is an easy to use R&D tool for sourcing and measuring DC voltage and current into the DUT

- Integrates capabilities of up to four power supplies, with DMM, scope, ARB and data logger capability
- Select any combination of N6700 Series modules (page 7)
- Pair with the 14585A Control and Analysis software can to control up to four N6705 mainframes (16 power supplies) from a single PC



14585A Control and Analysis software

N6705B



N6785A

SEE PAGE 4



Get Greater Reliability—Standard

You've come to expect the highest quality from Keysight. We stand behind our products with a three-year warranty that's standard on all instruments, worldwide.

www.keysight.com/find/ThreeYearWarranty

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