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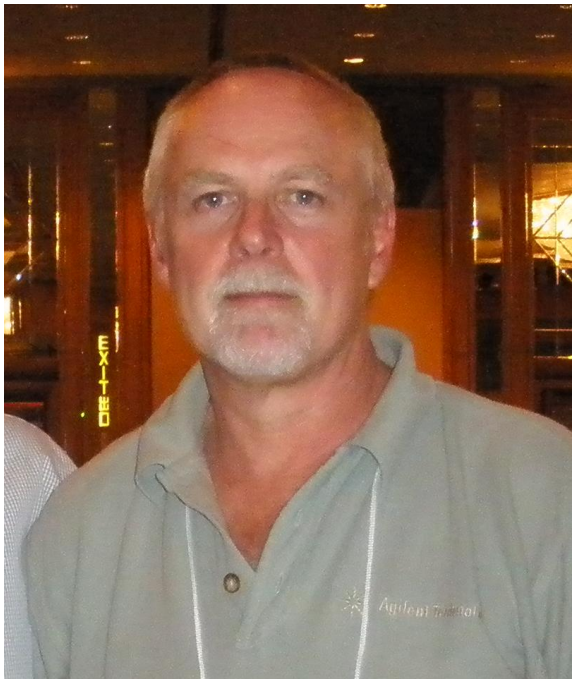
Innovative Source/Measure Units For The N6705/N6700 DC Power Mainframes



Daniel Jaeger
Business Development Manager

Flexible: Mainframes

N6705 DC Power Analyzer Mainframe

N6705B DC Power Analyzer Mainframe, 600W

Designed for the R&D Bench

N6700 Low-Profile MPS Mainframe

N6700B Low-Profile MPS Mainframe, 400W

N6701A Low Profile MPS Mainframe, 600W

N6702A Low Profile MPS Mainframe, 1200W

Designed for Mfg Functional Test

(Small, Flexible and Fast)

Flexible: Mix and Match Power Modules

50 W DC Power Modules (6 models up to 100 V or 10 A)

100 W DC Power Modules (6 models up to 100 V or 20 A)

300 W DC Power Modules (4 models up to 100 V or 15 A)

- For basic DUT or fixture power

50 W High-Performance, Autoranging DC Power Module

100 W High-Performance, Autoranging DC Power Module

300 W High-Performance, Autoranging DC Power Module

- For applications where power supply plays key role as source and measurement instrument

50 W Precision DC Power Module

100 W Precision DC Power Module

- For semiconductor testing and applications requiring precision in the milli- and microampere region

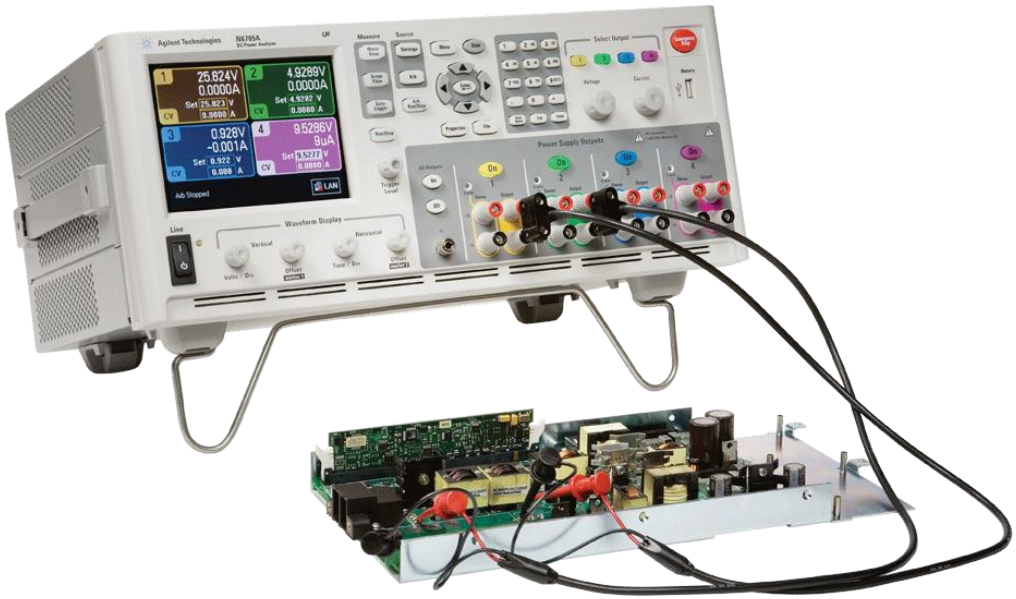
20 W 2-Quadrant Source Measurement DC Power Module

20 W 4-Quadrant Source Measurement DC Power Module

- For semiconductor testing and applications requiring precision in the milli- and microampere region

The N6705B DC Power Analyzer
Boosts the productivity of the R&D Engineer

Integrates multiple instrument functions into a single box



- 1 to 4 advanced power supplies; >22 different models available
- Digital voltmeter and ammeter
- Arbitrary waveform generator
- Oscilloscope
- Data Logger

- All functions and measurements are available from the front panel

Gain insights into your DUT's power consumption
— in minutes, not hours —
without writing a single line of code!

DC Power Analyzer has sourcing and measurement capability

Sourcing functions

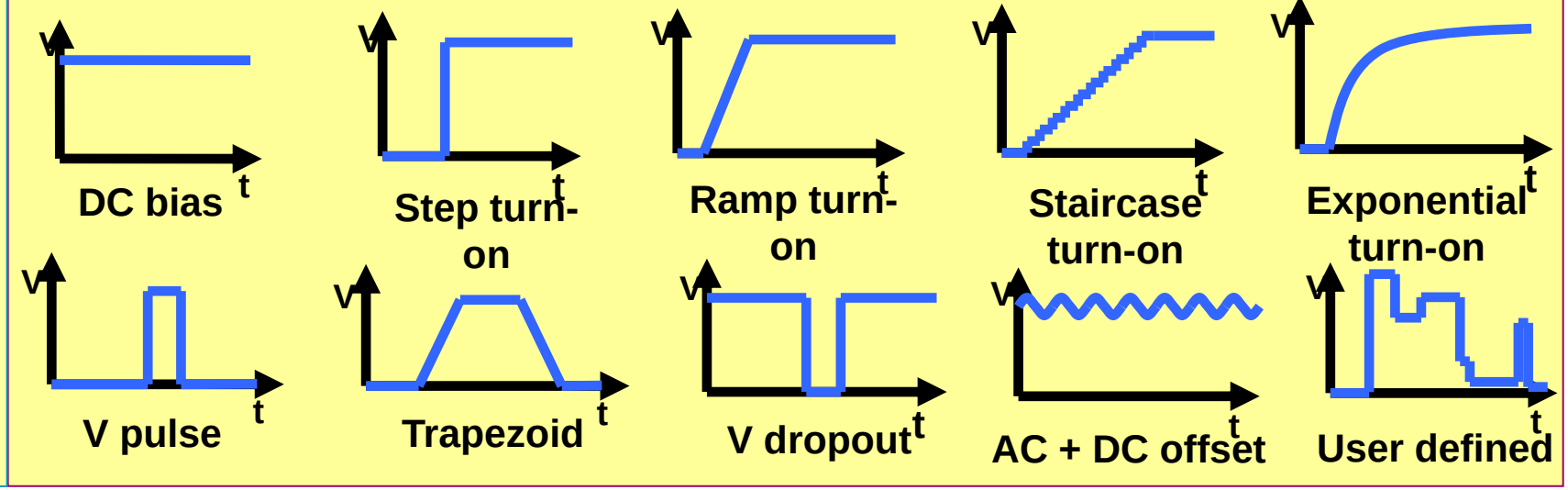
- Simple DC bias
- Arbitrary waveform generator-like functions
- Sequencing outputs

Measurement functions

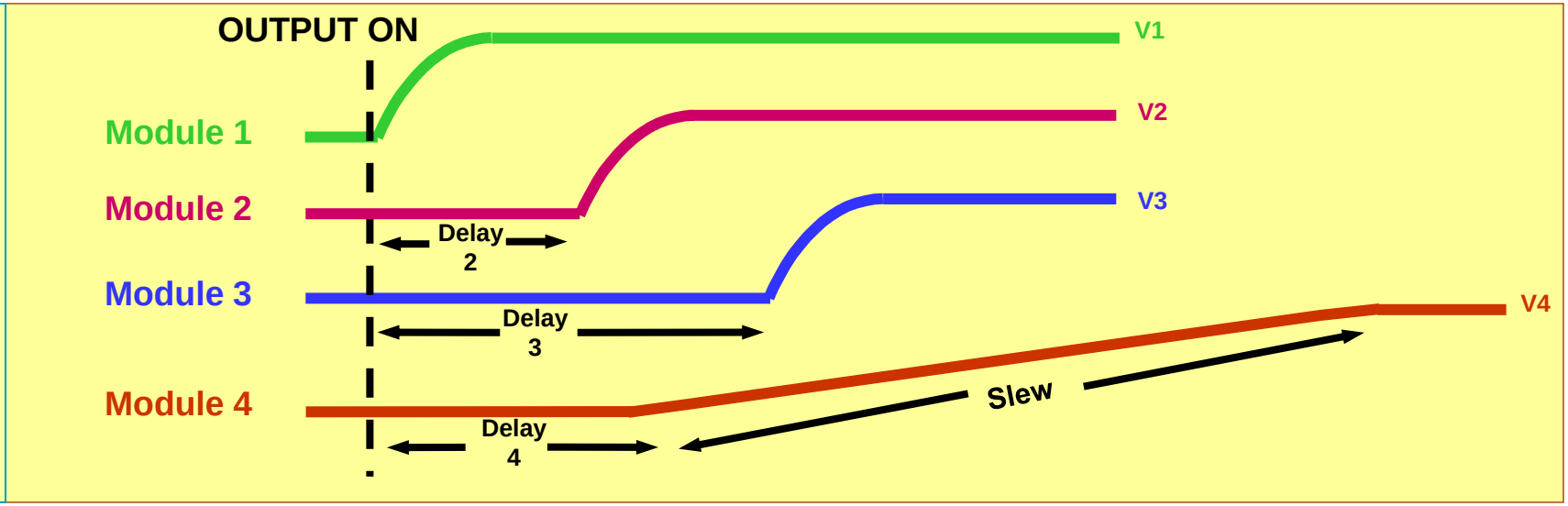
- DC measurements
- Oscilloscope-like functions
- Datalogger function

Agilent N6705 Sourcing Capabilities

Output waveforms



Output sequencing



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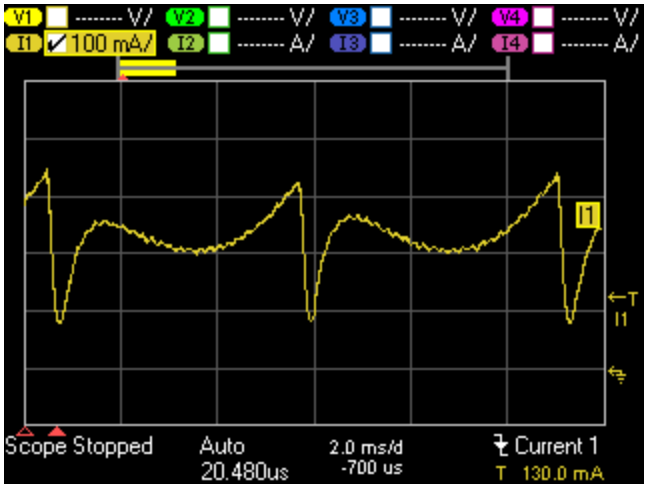
Agilent N6705 Measurement Capabilities

Meter View

DC measurements on all 4 outputs

All can be controlled from front panel w/o prog.

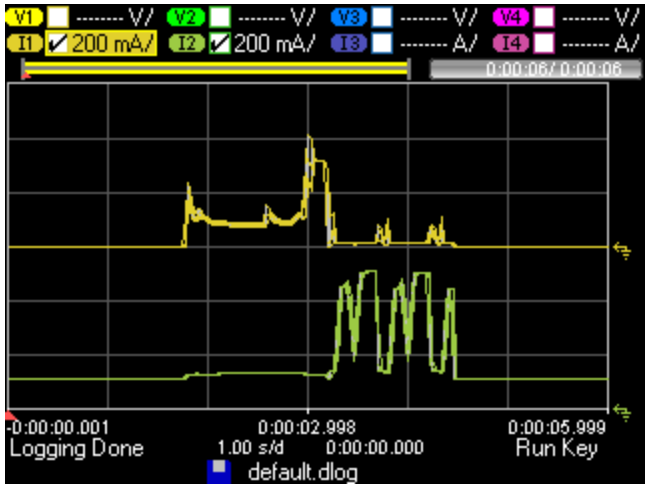
Scope View



Voltage and/or current waveform capture

Actual screenshots

Data Logger



Log data for seconds, hours, days even weeks

New N6700 Products Summary

PRODUCT	APPLICATION	FEATURES
 N6781A 2-Quadrant SMU for Battery Drain Analysis 20V ±1A / 6V ±3A, 20W	• Battery drain logging & analysis • Battery run-down logging & analysis	• Battery emulation • Auxiliary DVM input • Seamless measure-ment ranging
 N6782A 2-Quadrant SMU for Functional Test 20V ±1A / 6V ±3A, 20W	• Chip set test • PMU test • Active device test	• Fast load response • Fast ARB generator • Hi-speed digitizing • Mult. meas. ranges
 N6784A 4-Quadrant SMU for General Purpose ±20V ±1A / ±6V ±3A, 20W	• Semiconductor test • Discrete device test • Passive device test	• Additional sourcing ranges
 N6705B DC Power Analyzer Mainframe Intro: 6/21/2010	Supports new apps • Battery run-down • Semiconductor test • >20 A load apps	Supports new models • DVM connector port • Lower leakage current • Heavy wire rear exits
 14585A Control and Analysis Software Intro: 6/21/2010	Enhances N6705B: • Battery drain testing • All kinds of functional testing	Enhances N6705B: • Statistics • Add'l waveform gen. • Control 4 N6705B • Much, much more

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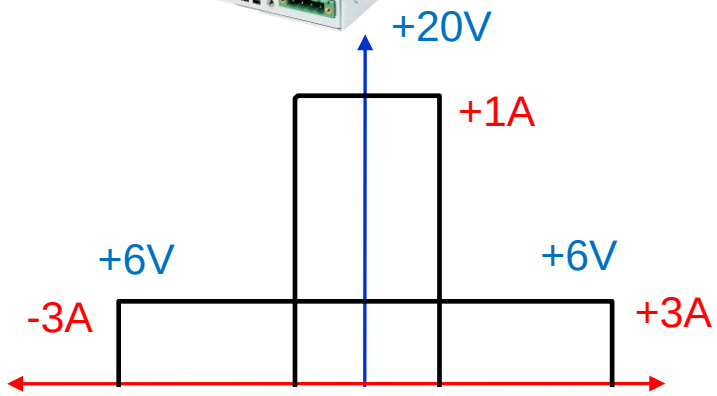
N6781A Battery Drain Analyzer

Single-wide module, 2-quadrant operation

Voltage Source and Current Source

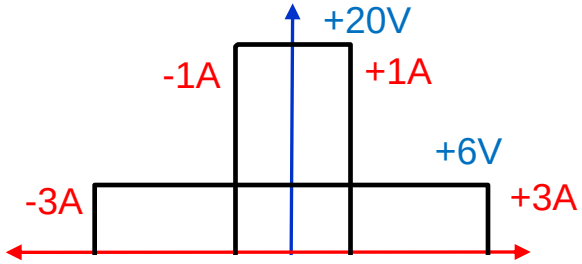
- “Glitch free” operation
- Excellent transient response with a peak deviation of 30 mV in response to 0.15A/µs slew
- Stable with capacitive loads up to 150 µF
- Programmable output resistance: -40mΩ to +1Ω
- Auxiliary voltage measurement input for battery rundown test



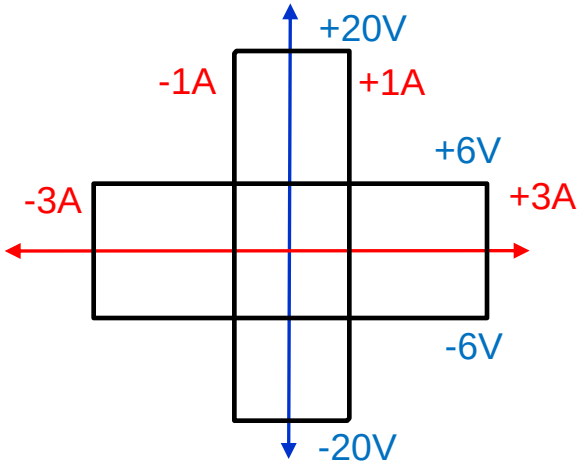
Measurement

- Built-in digitizer of 200,000 samples/second

N678xA Usability Enhanced via Front Panel Modes

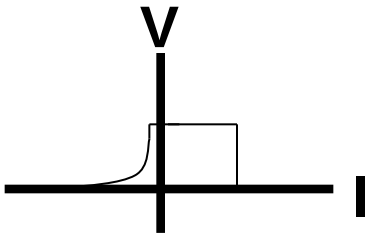


N6781A, N6782A 2-Quadrant Source Capabilities

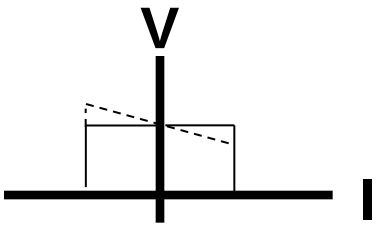


N6784A 4-Quadrant Source Capabilities

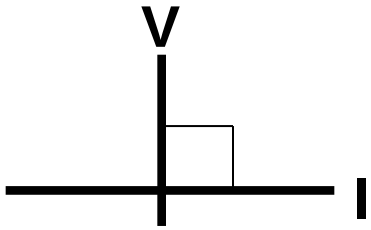
- To simplify using the new BDA module, select one of the modes below
- Keeps operation in quadrant and behavior that is best fit for the application



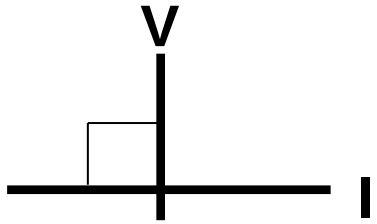
Standard DC Supply



Battery Emulator with programmable Rout

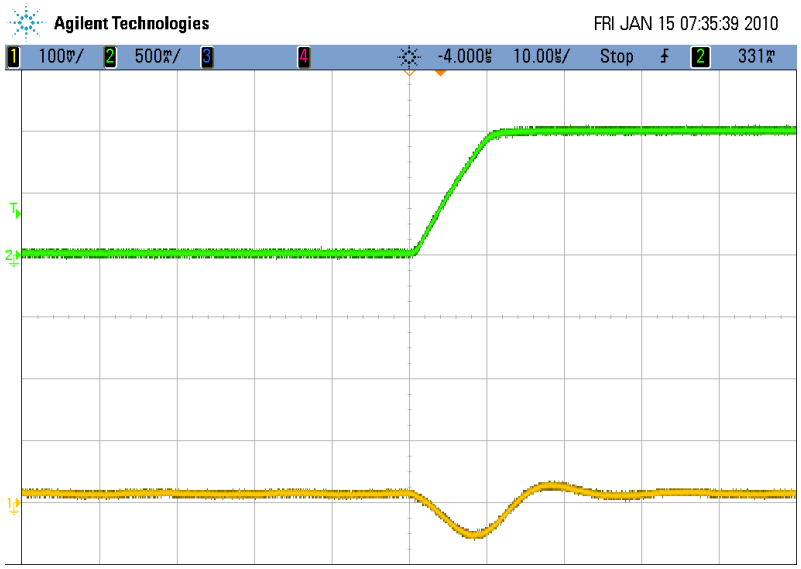


Battery Charger



CC or CV Load (Electronic Load)

N678xA Fast Voltage Transient Response Performance



N6781A providing ~60 mV transient drop

N6762A providing ~500 mV transient drop

- Mobile digital wireless devices draw current in fast pulses
- Requires a stable voltage with minimum transient voltage drop
- The N678xA SMUs provide about 8X or better performance over GP DC sources
- The same transient response is achieve regardless of seamless ranging operation!
- **Key Tip!:** Correct remote sense wiring, bandwidth compensation setting and load capacitance must all be considered for optimum performance
- **Key Tip!:** OSC and/or OV protect at output enable usually incorrect set up

Agilent N6781A & N6782A Accuracy and Seamless Ranging

Voltage				
Range	**20 V**	**6 V**	**1 V**	**100 mV**
Programming Accuracy	±(0.025% + 1.8 mV)	±(0.025% + 600 µV)		
Measurement Accuracy	±(0.025% + 1.2 mV)		±(0.025% + 75 µV)	±(0.025% + 50 µV)

Seamless measurement between these 3 ranges

Current						
Range	**3 A**	**1 A**	**300 mA**	**100 mA**	**1 mA**	**10 µA**
Programming Accuracy	±(0.04%+ 300µA)	±(0.04%+300µA)	±(0.03%+150µA)			
Measurement Accuracy	±(0.03% + 250 µA)			±(0.025% + 10µA)	±(0.025% + 100 nA)	±(0.025% + 8 nA)

Seamless measurement between these 3 ranges

- Seamless ranging continually changes ranges without glitch and does not lose readings
- 200 kHz, 18-bit digitizer, with seamless ranging, acts likes single range of ~28-bits
- Allows for accurate measurements from Amps to µA during a single scope sweep or data log (1,000,000:1)

N6784A General Purpose SMU Accuracy

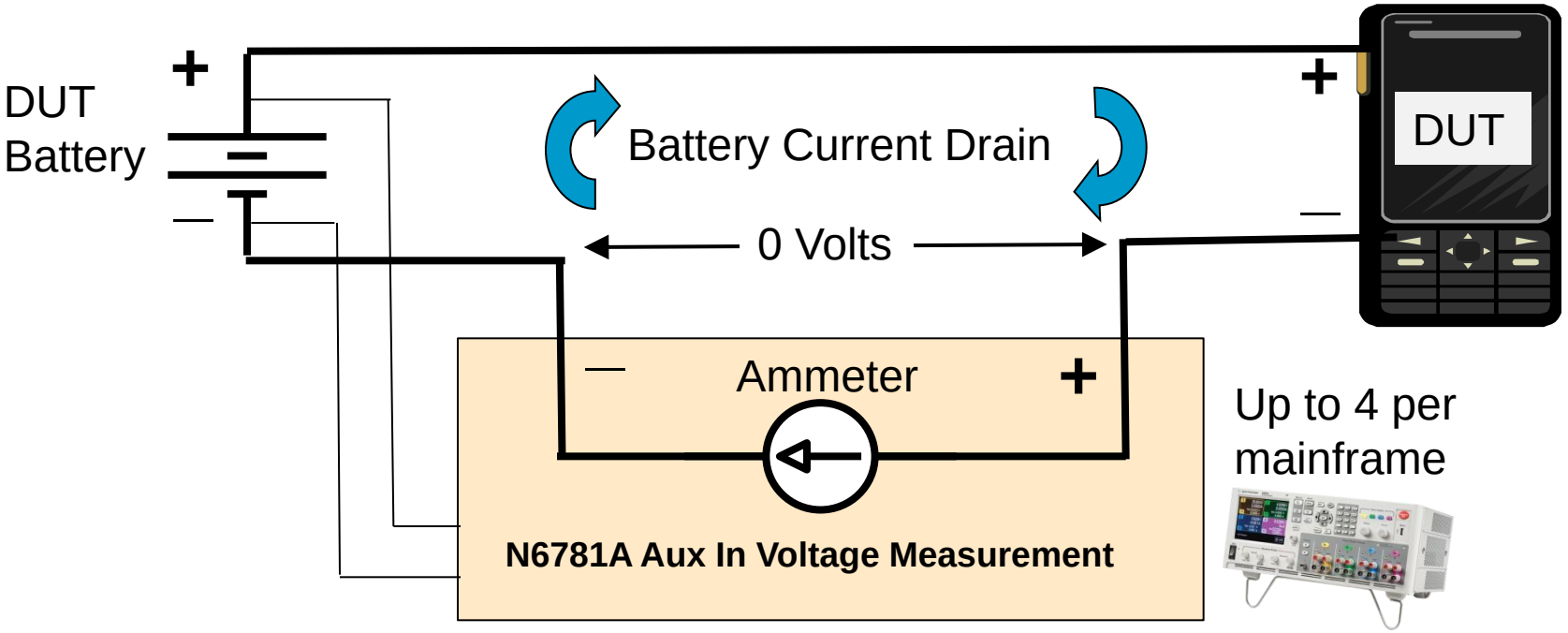
Voltage					
Range	**20 V**	**6 V**	**1 V**	***600 mV***	**100 mV**
Programming Accuracy	±(0.025% + 1.6 mV)	±(0.025% + 600 μV)		*±(0.025% + 200μV)*	
Measurement Accuracy	±(0.025% + 1.2 mV)		±(0.025% + 75 μV)		±(0.025% + 50 μV)

Current							
Range	**3 A**	**1 A**	**300 mA**	**100 mA**	***10 mA***	**1 mA**	**10 μA**
Programming Accuracy	±(0.04%+300μA)	±(0.04%+300μA)		*±(0.03%+12μA)*	*±(0.025%+5μA)*		
Measurement Accuracy	±(0.03%+250μA)			±(0.025% + 10μA)		±(0.025%+100nA)	±(0.025%+8nA)

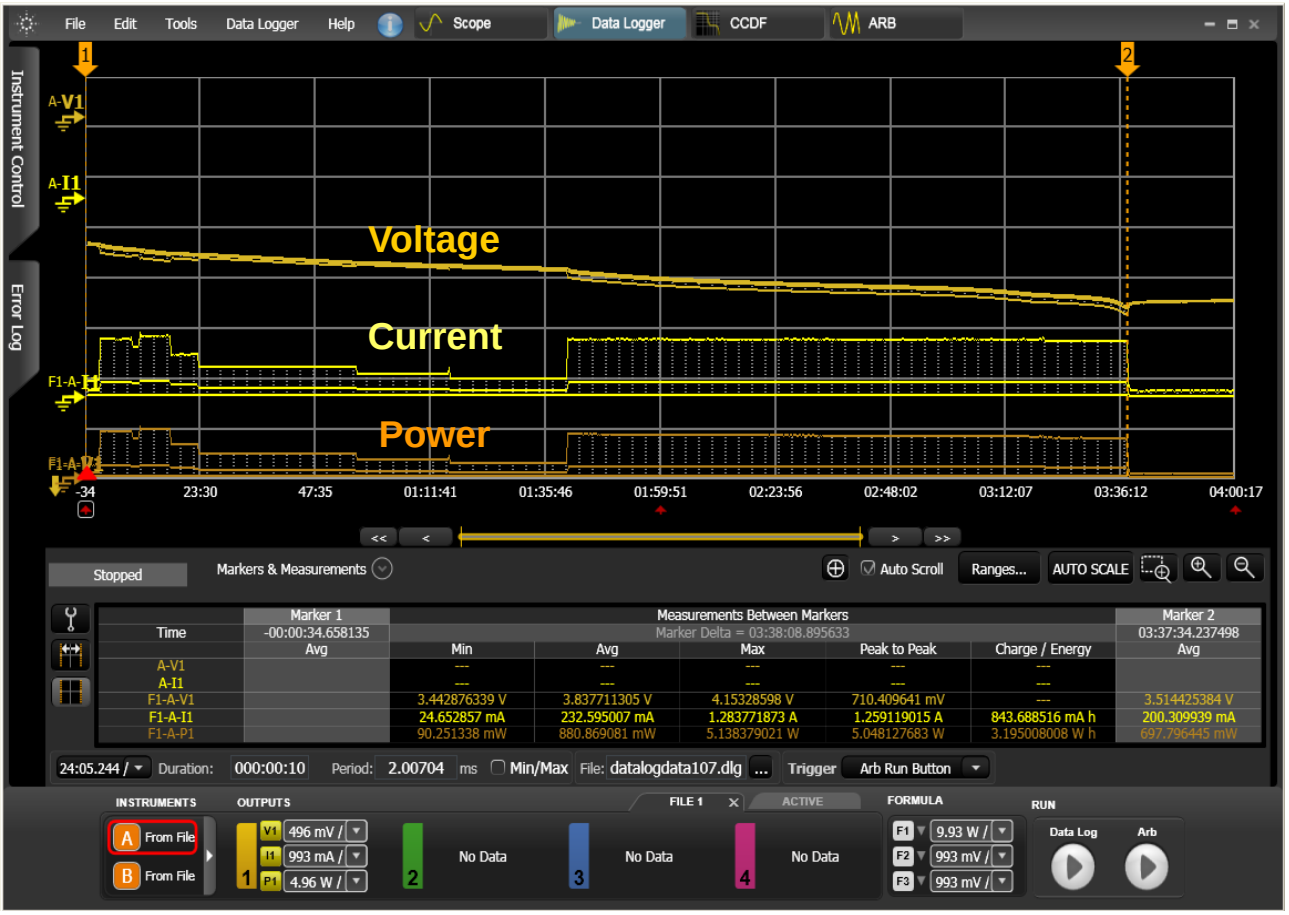
- Additional 600 mV, 100 mA, and 10 mA programming ranges provide extended accuracy and resolution at lower levels for precision sourcing applications
- The N6784A's 200 kHz, 18-bit digitizer does not have seamless ranging

N6781A/2A Measure Only Mode– Zero Burden Ammeter

- Module uses its power output to regulate zero volts across itself while measuring current (in either direction of flow)
- Single reading, scope, or data log
- N6781A Aux DVM input measures battery voltage
- Gives most realistic assessment of DUT operation with actual battery
- Application note under development



Agilent N6781A SMU Measure-only Operating Mode
Actual Battery Run-down Test Example



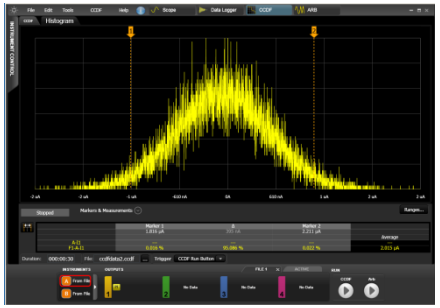
- Battery run-down for a GSM/GPRS handset logged with an N6781A SMU & 14585A SW
- Logged min, avg & max volts, amps, & watts
- By placing markers at start & shutdown points:
  - Avg current = 233 mA
  - Avg voltage = 3.82 V
  - Charge = 843 mA h
  - Energy = 3.19 W h
  - Run time = 3 hr 38 min

14585A Control and Analysis Software

- Compliments N6705B by enhancing & adding capabilities through a PC graphical user interface:
  - Simultaneously control & display up to 4 N6705Bs / 16 outputs
  - Large PC monitor greatly enhances viewing details
  - Data log direct to PC hard drive, limited only be available space
  - Doubles scope mode memory space (1.024 Meg vs. 512 K)
  - Enables battery drain analysis testing (battery run-down, statistics)
  - Adds statistics capabilities (histogram & CCDF) with direct logging for N6781A BDA SMU module only and data logging conversion for others
  - Adds more ARB waveform generation capabilities; new pre-configured waveforms, formula-based generation, record and playback
  - Formula-based traces available enable re-scaling and unit conversion
  - Works with new and existing 22 modules; useful for a lot more than just Battery Drain Analysis
- Some limiting considerations
  - External app; limits data-logging maximum speed (10 Ksps vs. 50 Ksps for the N6705B mainframe directly)

Scope Mode

Data Log Mode



Statistics Mode

N678xA ARB Capabilities and 14585A ARB Enhancements

N678xA ARB sets a new level of performance for family

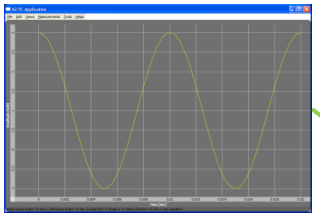
- Voltage programming 3 dB small signal BW: 9kHz to 60 kHz
  Depends on Output Voltage BW setting and capacitive loading
- Current programming 3 dB small signal BW: 120 kHz

14585A ARB features enhanced over N6705B

- 14 built-in ARBs (vs. 7 in N6705)
- Choice of 512-point Variable Dwell or 64K-point Constant Dwell (CD) for built-in ARBs. CD ARBs provide greater resolution on continuously varying signals (no CD built-in ARBs in N6705)
- Formula-based ARBs w/ 28 built-in functions
- Import and modify (offset, period, crop, clip, & mirror) waveform files
- Can sequence 64K-point CD ARBs
- Auto decimation of ARBs when sequenced to fit into 64K-point or 512-point file structure

14585A – Waveform Generator

From Canned Waveform

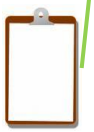


Sine, Triangle, Saw Tooth,
Exponential, Stair Step, Square,
Gaussian, Sinc, Random noise

From Formula

15 primitive function: abs(),acos(),log(), etc
12 high level functions: AM,PWM, gauss(), etc
6 operators: +,-,*,/,^,%

From Memory



Data copied
from Clipboard

Generator Window

Add/Insert/Delete waveforms
Run/Stop waveform
Edit data by sheet
Pan and Zoom in /out
Change time scale/offset
Change vertical scale/offset
Auto scale
Show/change parameter of waveform
Show/change trigger settings

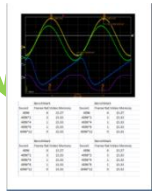
Run

Run the
Arbitrary waveform

Export / Save

Tabbed/CSV/XML text files
Binary format files
Clipboard: Bitmap Image
Clipboard: paste data

Print



One page summary

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14585A – Record and Playback

Record

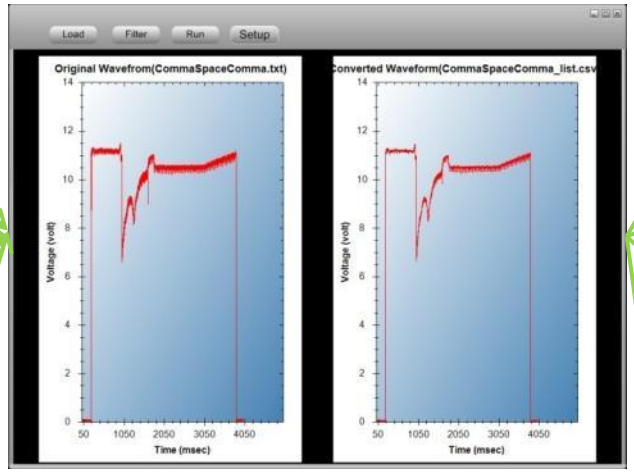
Capture data
with N6705 scope
or data logger

Capture from a different instrument:
NI TDM, LabVIEW Binary,
Tektronix Binary,
Agilent Scope Binary

Import from file:
XML,Text-CSV,
MATLAB, Audio

Import tabular
data from
Clipboard

Data Reduction and
Sample Rate Conversion



Before After

Playback

Run the
Arbitrary waveform

Export data to Excel

Export data to file:
Tabbed/CSV/XML
text files

Export data to
Clipboard
as a Bitmap or
tabular data

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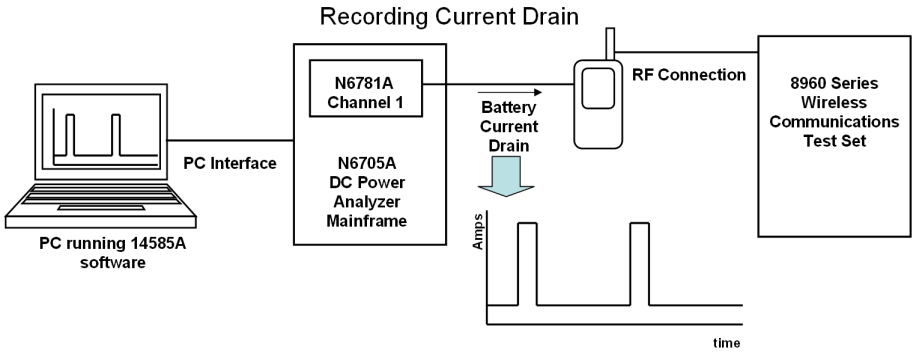
Recording and Playing Back a Load Waveform

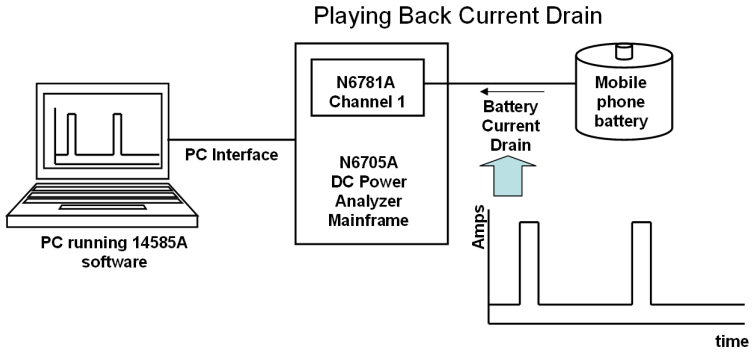
Useful for customers:

- Test capacity of their battery under real world loading
- Test capability of their PMICs under real world loading
- Eliminates complexity of setting up an actual DUT
- Easily allows large scaling of testing without large numbers of DUTs

The N6705B can playback up to 64,000 waveform points:

- use a sampling rate high enough to preserve dynamic characteristics!
- 64K-points and fast sampling rates provide only short playback time. Can playback the waveform file repetitively for extending playback time





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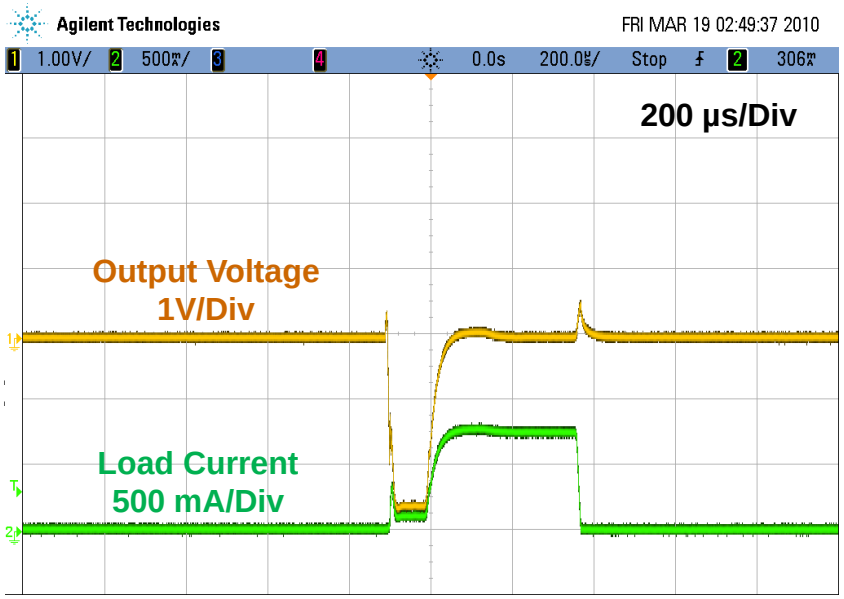
Agilent's Seamless Ranging Resolves Shortcomings of Conventional Auto-ranging Technology For Application

Conventional auto-ranging is not suitable for pulsed battery drain current signals:

- Conventional DMMs are not able to return desired readings when set to auto-ranging:
  - Takes 10's to 100's of ms to range change for valid value. Signal level changes in meantime.
- Conventional Source-Measure Units' output current is also limited by measurement range:
  - Takes 10's to 100's of ms to range change for valid value. Signal level changes in meantime.
  - Constantly current limiting with load pulse with subsequent voltage drop-outs and overshoots
- Seamless Ranging is optimized for application:
  - Measurement is never over-ranged providing a uninterrupted stream of valid readings
  - As an SMU, measurement and sourcing are totally decoupled assuring glitchless output performance



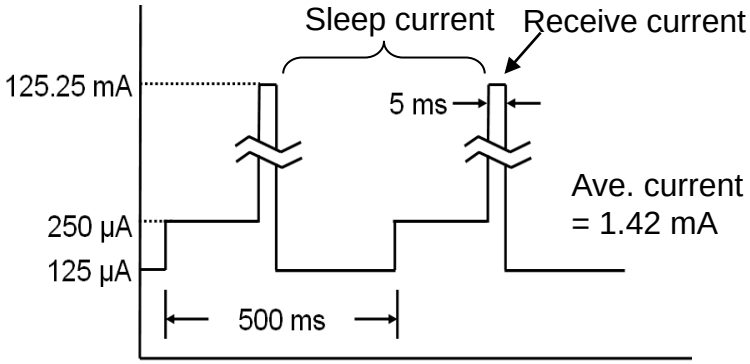
Conventional SMU Set to Auto-ranging Measurement Powering a Pulsed Load (Voltage Drops Out Under Load)

Maximum Digitizing Rate Performance Summary

	14565 with 66319/21	N6705B with N6781A	14585A with N6705B & N6781A
Scope Capture	4 kSamples 15.6 µs sample interval Can capture 64 msec @ max rate	512 kSamples (5.12 µs * # of traces) sample interval[1] Can capture 2.62 sec @ max rate	1.024 MSamples (5.12 µs * # of traces) sample interval[1] Can capture 5.24 sec @ max rate
Data Logging	5 msec integration period (200 points/sec) 15.6 µs sample interval Can capture 5 hours @ max rate	(20.48 µs * # of traces) integration period[2] (50k / # of traces) points/sec 5.12 µs sample interval Can capture ~45 min @ max rate w/ 512 int. RAM Can capture ~6 hours @ max rate w/ 4G USB RAM	(102.4 µs * # of traces) integration period[2] (10k / # of traces) points/sec 5.12 µs sample interval Writes to PC hard drive. Capture time limited only by available space
CCDF/Histo-gram Logging	15.6 µs sample interval Up to 1K hrs @ any rate	Not Available	20.48 µs sample interval Up to 1K hrs @ any rate

Notes:
1. The sample interval time is proportional to number of measurement traces selected. Power traces are calculated so they do not increase sample interval time.
2. The integration period is effectively the sample interval for data logging, with the 5.12 µs the underlying rate of sampling that gets averaged into the integration period. Likewise, the integration period is proportional to the number of measurement traces selected excluding power traces which are calculated.

Accurate Standby Current Drain Measurement Demo Set Up



Laptop or PC running Agilent 14585A software

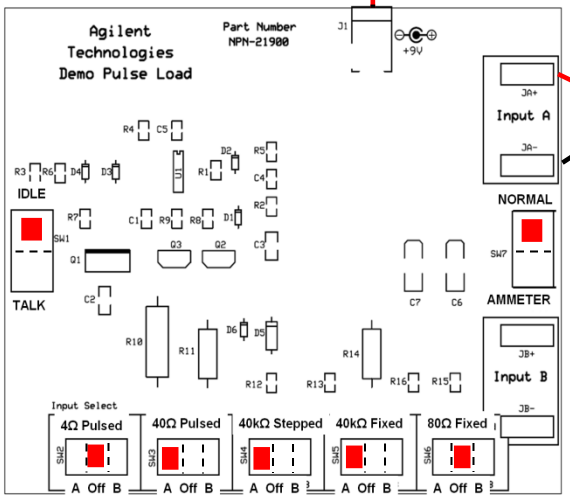
Pulsed demo load simulates mobile phone standby mode current drain

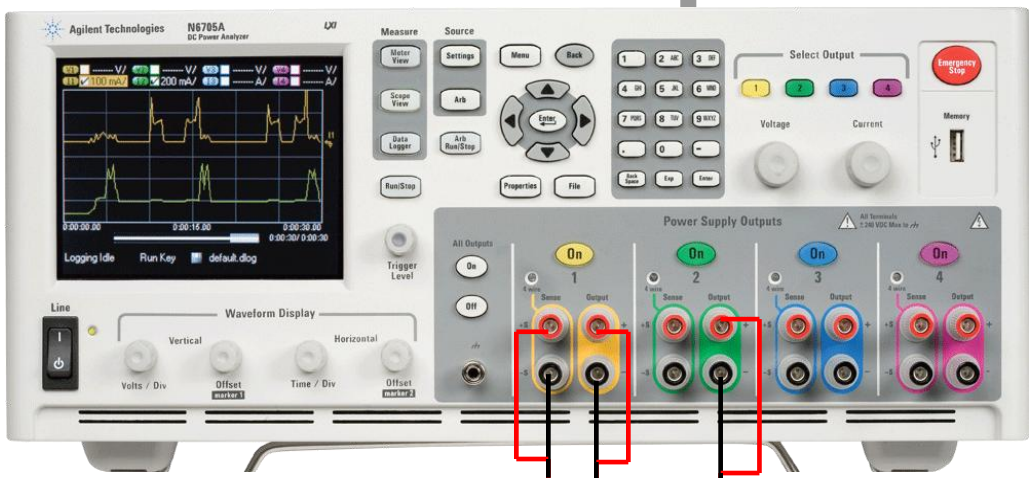
9V DC in

Load in

N6705B DC Power Analyzer with N6781A Source Measure Module

LAN cable





DC power cable assembly

Seamless Measurement Demo

Datalogging Demo

Accurate Standby Current Drain Measurement Results

Current				
Range	**3 A**	**100 mA**	**1 mA**	**10 µA**
Measurement Accuracy	±(0.03% + 250 µA)	±(0.025% + 10µA)	±(0.025% + 100 nA)	±(0.025% + 8 nA)

Seamless measurement between these 3 ranges

Accuracy for this standby current drain example, based on ranging:

Parameter	Auto Off	Auto On	Improvement
Overall DC accuracy (1.42 mA avg)	**17.4%**	**0.273%**	**64 X**
Pulse Valley DC accuracy (188 uA avg)	**133%**	**0.078%**	**1,705 X**
Pulse Valley AC noise floor current	**~500 µA p-p**	**~20 µA p-p**	**25 X**

- Accurate measurement of mA-level idle and µA-level sleep currents is necessary for optimizing battery life
- Averaging in data logging acts as programmable filter to move the noise floor down even further
- A conventional, fixed range measurement system would need to be effectively 25-bit accurate with 28 bits of resolution to provide comparable performance!

In Summary…

Optimizing battery life on wireless devices continues to be a top priority

Wireless devices operate in short bursts of activity to conserve power

- Applicable to a very wide variety of devices
- Resulting battery current drain is pulsed

The high peak and low average values of battery drain signals are challenging for traditional test equipment to measure accurately:

- Dictates needing DC measurement offset errors of ~0.0001%
- Traditional test equipment offset error of ~0.02 to 0.1% is too high!
- Traditional auto-ranging measurement technology not suitable

Innovation in the form of seamless ranging resolves the inherent problem of DC measurement offset error for accurately measuring battery current drain

Thank You

N678xA Differences

	N6781A	N6782A	N6784A
2 Quadrant	Yes	Yes	No
4 Quadrant	No	No	Yes
Seamless Measurement	Yes	Yes	No
4 Measurement Ranges	Yes (Seamless and Fixed)	Yes (Seamless and Fixed)	Yes (Fixed)
Current Programming Ranges	2	2	4
Programmable Output Resistance	Yes	No	No
Auxiliary DVM input for battery run down test	Yes	No	No
Battery Emulation Mode	Yes	No	No
Battery Charger Emulation Mode	Yes	No	No