DATA SHEET

X8712A IoT Device Battery Life Optimization Solution

Battery, the Heart of IoT Devices

Wireless devices have increased by leaps and bounds over the years with the increasing adoption of wireless networking technologies across the globe. The demand for smart, connected devices is also fueling the growth of Internet-of-Things (IoT) devices market. As such, battery life, time to market and product reliability are now more crucial than ever.

For some medical or industrial IoT devices, life of users can be at stake if the battery does not live up to expectations. Some IoT devices do not have a low battery indicator, hence, users depend heavily on the warranted battery life specifications, making the battery life claim more crucial than ever. Hence, IoT device developers today face a monumental task starting from the product design up to design validation when it comes to accurately predicting the device's battery life and putting it down on paper for their customers.

Typical challenges include:

- How to measure the battery life to substantiate the battery life expectancy claim to customers?
- What are the critical events that contribute to the power consumption and when frequently these events happen? How to set a trigger for events of interest?
- What design changes or tradeoffs to make to optimize battery life?
- How to solve all the above with the least amount of time to meet project schedule?

As an R&D engineer for IoT devices, you need tools to help you quickly obtain deeper insights into your device's design so that you can accelerate troubleshooting and design verification tasks.

Estimating battery runtime is critical, but not enough.

To get the most out of your IoT device's battery, you need to understand what RF and sub-circuit events are causing battery charge consumption. This will enable you to make the hardware and firmware programming decisions that will optimize your battery's runtime.

KEYSIGHT TECHNOLOGIES

The New Way to Perform Battery Drain Analysis

How the X8712A Works

To easily estimate the battery life of your new IoT device, firstly, you need to determine what are the sub-systems that make up your device; for example, RF radio, display, beeper, vibrator etc., and how much current each sub-system will draw until your device's battery runs out.

Figure 1 - The X8712A consists of the X8712A-DPA DC Power Analyzer, source measure units, electronic load modules, X8712AD RF Event Detector and the KS833A1B Event-Based Power Analysis software

The X8712A helps you determine the total power consumption of your device using the powerful Keysight X8712A-DPA DC Power Analyzer and its Source Measure Unit (SMU) and electronic load modules, RF event detector together with the KS833A1B Event-based Power Analysis Software. It captures RF and/or DC events from your IoT device, synchronously match the events to the current consumption and estimates the battery life of your device.

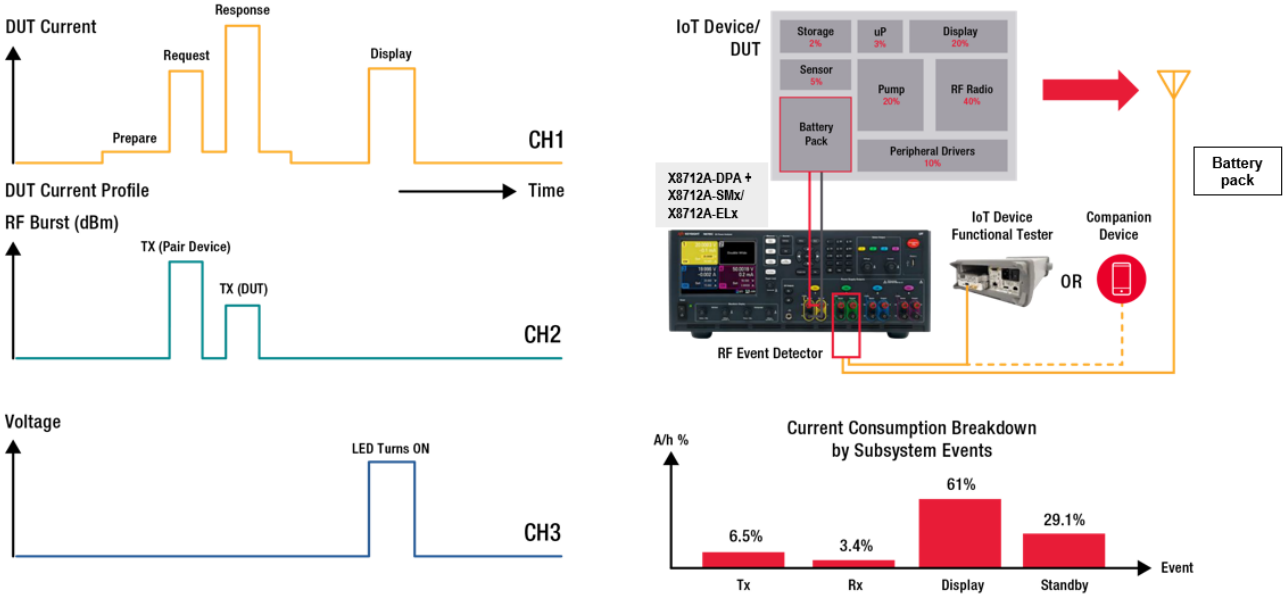


Figure 2 - The X8712A Event-based Power Consumption Analysis Concept

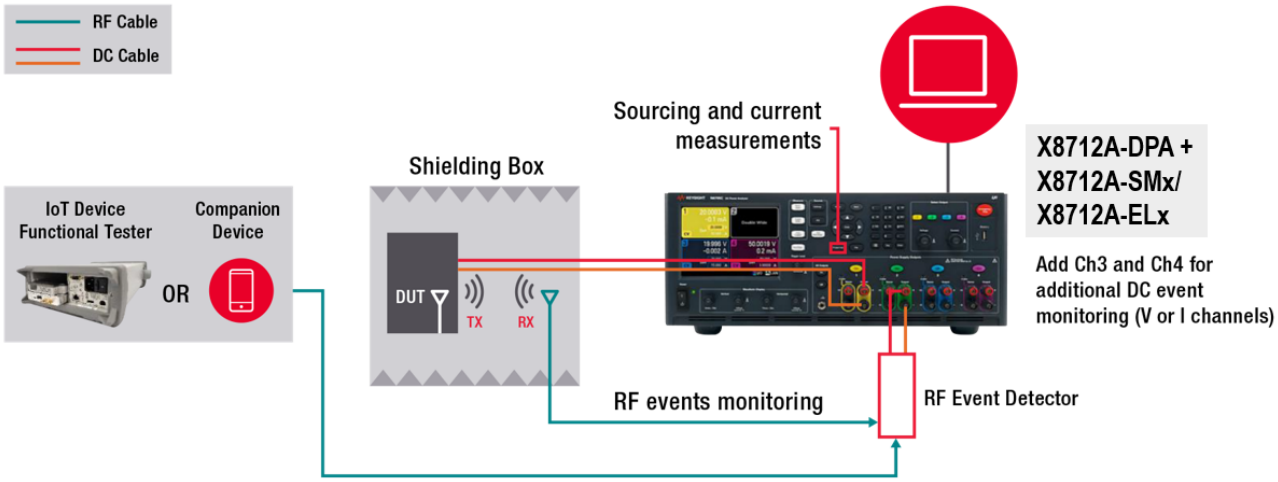


Figure 3 - The X8712A synchronizes and correlates current consumption with RF/DC events

X8712A-DPA DC Power Analyzer, Source Measure Units (SMUs) and DC electronic load modules

The N6705C DC power analyzer can measure DC voltage and current to and from the device under test (DUT). The SMU modules consist of battery emulators tailored for powering IoT devices (up to 80 W) and measuring current drain from nA to A using patented seamless current ranging technology, while the DC electronic load modules are used for event monitoring.

KS833A1B Event-based Power Analysis Software

The KS833A1B Event-based Power Analysis Software helps you analyze the data acquired with the X8712A-DPA DC power analyzer, SMU or electronic DC load modules by providing a visual representation of the RF signals of your IoT device in dB or non-RF signals in DC voltage measurements and maps these signals to the current measurement in a single graph. Its capabilities include:

- Automated correlation between RF or DC signals to power consumption in a single display
- Single shot waveform capture
- Individual event's post data analysis
    - Current consumption in percentage
    - Occupied time in percentage
- Battery life estimation
- Triggering function by each channel
- In-depth current analysis by zones/segments
- CCDF statistical analysis
- Save and recall settings which include raw data and instrument settings
- Export raw data and measurement results in .csv format for post analysis

Figure 4 - The key capabilities of the KS833A1B Event-based Power Analysis Software

Key Benefits of the X8712A

1. Detect Design Weaknesses with Quick and Effortless Event-Based Power Consumption Analysis

The X8712A automatically correlates critical RF or DC events of your device to the power consumed, down to the sub-system or events level. With this capability, you are able to identify the events or sub-systems that are consuming the most current and optimize it accordingly to meet the battery life requirements.

With its wide dynamic range current measurement from nA to A and fast 20 µs sampling rate, the X8712A is also able to accurately capture the dynamic current consumption of your device as it transitions between different operating states, from sleep/idle mode drawing the least current to active transmitting mode drawing the most.

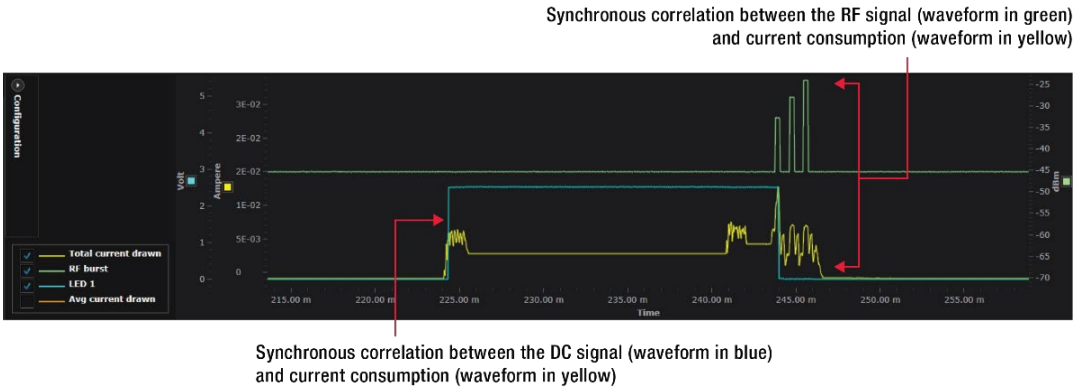


Figure 5 - DC (blue), RF (green), and current (yellow) measurements are synchronized

In-depth Current Analysis

The KS833A1B provides post measurement analysis where you can further analyze the current consumption for a particular subsystem which you are interested in.

RF or DC Events Analysis

You can adjust the upper and/or lower trigger threshold levels in order to segregate events based on the signal level that you have obtained in the waveform display.

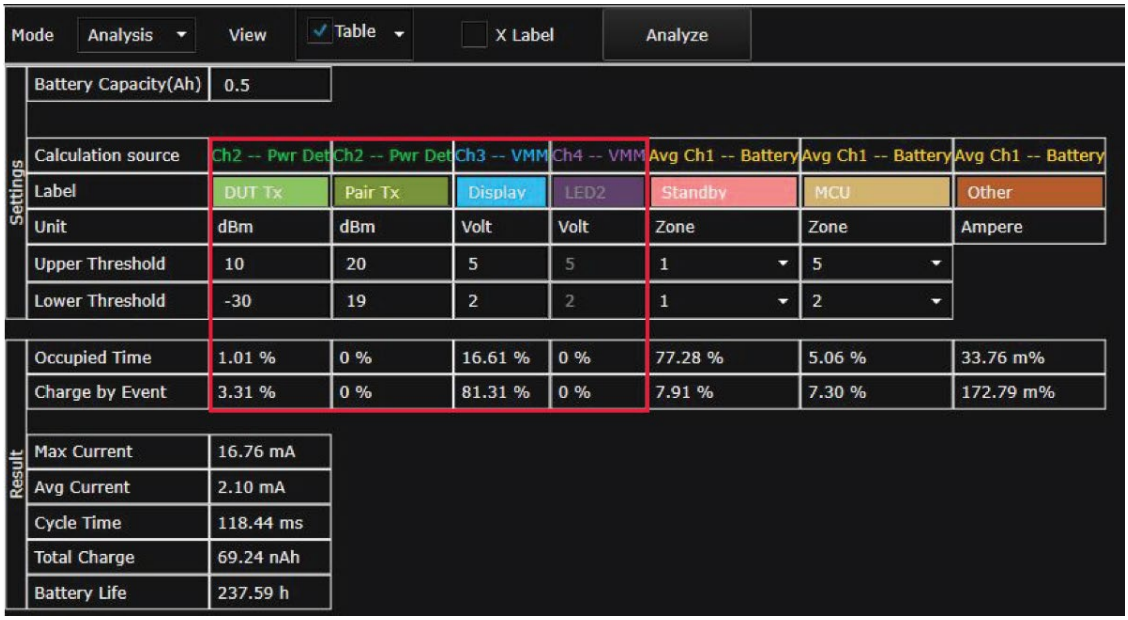
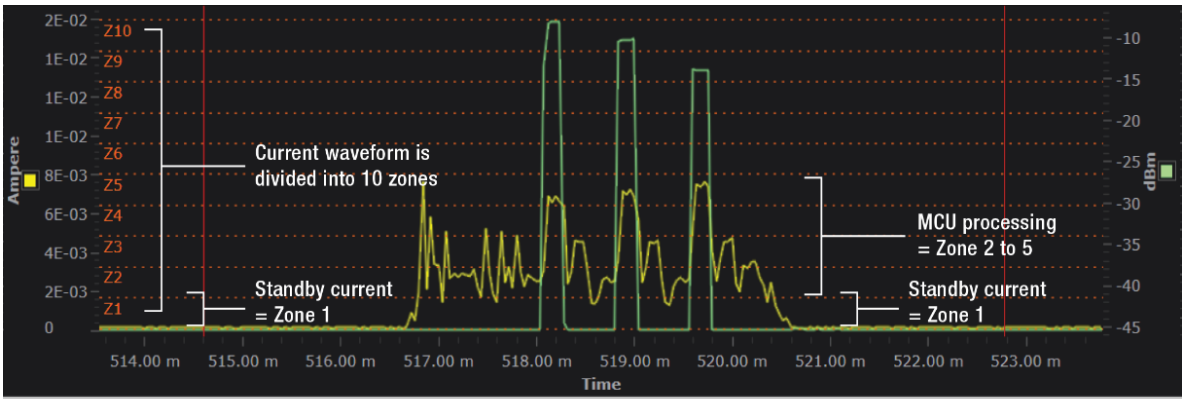


Figure 6 - Segregate events based on the signals measured in channels 2, 3, and 4

The KS833A1B automatically divides the current waveform into vertical zones (user defined, from ‘2’ to ‘20’). Using the zones, you can segregate events with different current levels into segment(s) to instantly calculate the segment’s occupied time and current consumption in % (see Figure 8).

This helps you perform post analysis to optimize your design for that particular event or subsystem.



Calculation source	Ch2 -- Pwr Det	Ch2 -- Pwr Det	Ch3 -- VMM	Ch4 -- VMM	Avg Ch1 -- Battery	Avg Ch1 -- Battery	Avg Ch1 -- Battery
Label	DUT Tx	Pair Tx	LED1	LED2	Standby	MCU	Other
Unit	dBm	dBm	Volt	Volt	Ampere	Ampere	Ampere
Upper Threshold	10	20	5	5	1	5	
Lower Threshold	-30	19	2	2	1	2	
Occupied Time	7.28 %	0 %	0 %	0 %	64.56 %	28.16 %	0 %
Current Consumption	27.21 %	0 %	0 %	0 %	21.37 %	51.42 %	0 %

Figure 7 - You can segregate the current waveforms into different segments using the “current zones function.” In this example, the standby current waveform is in Z1 (zone 1) and the MCU pre-post processing current waveform is in Z2 to Z5

Figure 8 - Obtain the segment’s occupied time and charge consumption

Complementary Cumulative Distribution Function (CCDF) Statistical Analysis

The KS833A1B Event-based Power Analysis software provides CCDF profiles of a selected area to help you analyze distribution profiles.

This function provides a concise way to display long-term dynamic random current drain. It is also an effective way to quantify the impact of design changes—hardware, firmware or software— on current flows in your device.

Since the CCDF profiles have identical behavior on each activity of the device, the profiles can also be leveraged in production testing even with different test instruments to check on device performance.

Figure 9 - Complementary Cumulative Distribution Function (CCDF)

2. Easily Estimate Battery Life

When measuring the power consumption at the sub-system level, the KS833A1B Event-based Power Analysis software calculates the RF or DC event's occupancy time and current consumption contribution in percentage and presents the information in a tabular and chart format. For homogenous signals, this allows you to easily obtain the estimated battery life in hours, in a very short time.

By specifying the battery capacity and area of interest (select specific graph using the region tags), the KS833A1B will display the estimated battery life.

Figure 10 - Battery life predicted based on five full operational cycles and 0.2-Ah battery capacity

To effectively know when a particular RF or DC event occurs, the X8712A provides triggering function for each channel so that you will be able to capture and analyze that event and the current consumed.

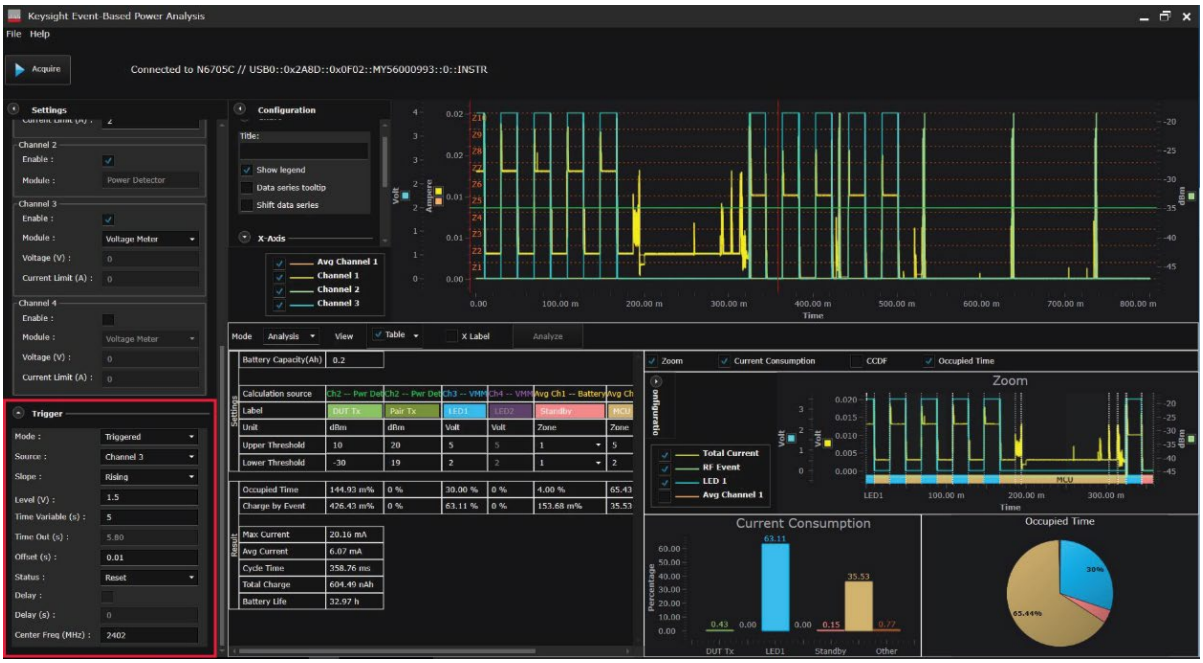


Figure 11 - Use the trigger function to capture a particular event of interest

The X8712A also enables over-the-air signaling DUT monitoring in various real-world operating modes to predict the battery life in real-world operations. This applies to devices with radio formats below 3 GHz. With this, you will be able to simulate the worst-case scenario (like temperature, humidity etc.) to accurately confirm on the life expectancy of your DUT's battery.

X8712A Key Characteristics

Number of channels supported	Up to 4 (Ch 1 – Battery Emulator, Ch 2 – RF Power Detector, Ch 3&4 – voltmeter/ammeter/power supply)
Triggering function by channel	Available on all channels

	Number of active channels			
	1	**2**	**3**	**4**
Max. sample size	524,288	262,144	131,072	65,536
Min. time interval	5.12 µs	10.24 µs	20.48 µs	20.48 µs
Max. time interval	0.1 s			

Type	Module	Voltage range	Current limit	Modes	Use in channel	
					Channel 1 – Sourcing/ measurement	Channel 2 to 4 - Monitoring
Source/ measure unit	N6781A	+ 20 V/ 6 V	±1 A/ ±3 A	VM, AM and 2-QPS	Yes	Yes
	N6782A				Yes	Yes
	N6784A				No	Yes
	N6785A (double-wide power module)	20 V/ 15 V/ 10 V/ 6 V	±4 A/ ±5 A/ ±6.7 A/ ±8 A		Yes	Channel 3 only
	N6786A* (double-wide power module)				Yes	Channel 3 only
DC electronic load	N6791A	0 to 60 V	0 to 20 A	VM and AM	No	Yes
	N6792A (double-wide power module)		0 to 40 A		No	Channel 3 only

RF Event Detector Characteristics

Operation frequency range	100 MHz to 2.9 GHz
Dynamic range	40 dB typical
Power measurement range	-40 to 0 dBm
Power accuracy	+/- 3 dB
Maximum input damage power	+15 dBm
DC power	5 V @ 30 mA by micro USB adapter

PC Requirements

The following are the minimum requirements for a PC to be used with the X8712A solution.

- Microsoft Windows 7 Professional (64-bit)
- Microsoft Windows 10 Professional (64-bit)
- At least 1 GB free disk space
- Minimum 1024x768 video monitor, recommended 1366x768 or higher
- Keysight IO Libraries Suite Version 18.1

X8751A RF Shield Enclosure

The X8751A RF shield enclosure kit consists of:

- TC-5910D shield box
- 1x M591012B I/O module
- 1x TC-93023B antenna coupler
- 1x F59105A universal grid fixture (140(W) x 210 (D) x 11(H) mm)
- 1x RF cable, 0.9 m
- 1x SMA male to N male adapter
- 1x RF terminator N 50 Ohm

It provides:

- Reliable high RF shielding up to 6 Hz
- Shock absorber on lid

X8751A is non-RoHS compliant

Typical RF shielding

The shield effectiveness below is measured when the blank panel is mounted; the I/O interface panel results a different shielding effectiveness of the shield box

100 to 2000 MHz	> 70 dB
2000 to 3000 MHz	> 70 dB
3000 to 6000 MHz	> 50 dB

M591012B USB 2.0 I/O Interface Panel

- *Shielding Effectiveness: >60 dB from 0.1 to 6 GHz
- DB25 (p) outside and DB25 (s) inside, 1000 pF Pi filter
- USB A(p), 10 pF Pi filter
- Data line Capacity: 100 VDC, 3 Amps max

Weight	Approx. 5 kg
Physical dimensions	Inside: 130 (W) x 235 (D) x 138 (H) mm Outside: 207 (W) x 424 (D) x 170 (H) mm, lid closed. 435 (H) mm, lid open

Ordering Information for X8712A

All hardware options are optional.

The Test Automation Platform (TAP)-based KS833A1B event-based power consumption analysis software is mandatory.

Model numbers	Description	Quantity
X8712A-RFD	X8712AD RF Event Detector	1
X8712A-DPA	N6705C DC Power Analyzer, Modular, 600 W, 4 Slots	1
X8712A-SMU	N6781A 2-Quadrant Source/Measure Unit for Battery Drain Analysis, 20V/1A or 6V/3A, 20W	Up to 4
X8712A-SM2	N6782A Source/Measure Unit for Functional Test, 2-Quadrant, 20V/1A or 6V/3A, 20W	Up to 4
X8712A-SM4	N6784A 4Q General-Purpose Source/Measure Unit, 20V/1A or 6V/3A, 20 W	Up to 3
X8712A-SM6	N6786A Source/Measure Unit for Functional Test, multiple ranges, 80 W, double-wide	Up to 2
X8712A-SM8	N6785A 2-Quadrant Source/Measure Unit for Battery Drain Analysis, multiple ranges, 80 W, double-wide	Up to 2
X8712A-EL1	N6791A Module, 100 W, single-wide	Up to 3
X8712A-EL2	N6792A Module, 200 W, double-wide	1
KS833A1B	Event-Based Power Consumption Analysis software	1

Examples of Two-channel Configurations

Option Number	Description	Quantity
Hardware		
X8712A-DPA	N6705C DC Power Analyzer, Modular, 600 W, 4 Slots	1
X8712A-SMU	N6781A 2-Quadrant Source/Measure Unit for Battery Drain Analysis, 20 V, ±1 A or 6 V, ±3 A, 20 W	2
X8712A-RFD	X8712AD RF Event Detector	1
Software		
KS833A1B	Event-Based Power Consumption Analysis software	1

or

Option Number	Description	Quantity
Hardware		
X8712A-DPA	N6705C DC Power Analyzer, Modular, 600 W, 4 Slots	1
X8712A-SMU	N6781A 2-Quadrant Source/Measure Unit for Battery Drain Analysis, 20 V, ±1 A or 6 V, ±3 A, 20 W	1
X8712A-SM8	N6785A 2-Quadrant Source/Measure Unit for Battery Drain Analysis, multiple ranges, 80 W, double-wide	1
X8712A-RFD	X8712AD RF Event Detector	1
Software		
KS833A1B	Event-Based Power Consumption Analysis software	1

Example of a Four-channel Configuration

Option Number	Description	Quantity
Hardware		
X8712A-DPA	N6705C DC Power Analyzer, Modular, 600 W, 4 Slots	1
X8712A-SMU	N6781A 2-Quadrant Source/Measure Unit for Battery Drain Analysis, 20 V, ±1 A or 6 V, ±3 A, 20 W	4
X8712A-RFD	X8712AD RF Event Detector	1
Software		
KS833A1B	Event-Based Power Consumption Analysis software	1

Ordering Information for X8712AS - the X8712A IoT Device Battery Life Optimization Solution Software

For KS833A1B event-based power consumption analysis software order only (without hardware)

Model number	Description	Quantity
X8712AS	X8712A IoT Device Battery Life Optimization Solution Software	1

KS833A1B Software – License Types and Terms

Perpetual license type and support subscription	
R-X5Q-001-A R-X6Q-001-L KS833A1B-1FP	Node-locked (single PC) 12 months, node-locked, support subscription License redemption in KSM
R-X5Q-002-B R-X6Q-002-L KS833A1B-1NP	Floating (single site) 12 months, floating, support subscription License redemption in KSM
R-X5Q-004-D R-X6Q-004-L KS833A1B-1TP	Transportable 12 months, transportable, support subscription License redemption in KSM
Time-based software license and support subscription	
R-X4Q-001-L KS833A1B-1FL	12 months, node-locked license, software support subscription License redemption in KSM
R-X4Q-002-L KS833A1B-1NL	12 months, floating license (single site), software support subscription License redemption in KSM
R-X4Q-004-L KS833A1B-1TL	12 months, transportable license, software support subscription License redemption in KSM

* One-year support subscription is included.

Accessories

X8751A RF Shield Enclosure Kit

• Suitable for small device under tests. • Includes I/O module, antenna coupler, grid fixture and RF cable *Not available in Europe
Model number: X8751A

Related Information

X8712A IoT device functional test solution	http://www.keysight.com/find/X8712A
Keysight N6700 Modular Power System Family	https://literature.cdn.keysight.com/litweb/pdf/N6700-90001.pdf

For more information on the X8712A, please visit: www.keysight.com/find/X8712A

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