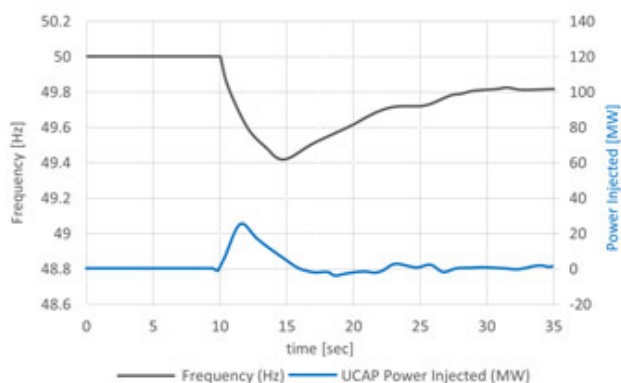


FREQUENCY RESPONSE APPLICATION BRIEF



Ultracapacitor energy storage addresses low inertia grids in the renewable energy transition

Grid response within the first few seconds of a frequency event determines whether a loss of service will occur. Sudden imbalances between generation and load in transmission, distribution, and isolated grids can cause frequency variations that risk stable delivery of electricity within electrical utility systems. As additional non-synchronous renewable generating resources such as solar and wind are added to grids, the system has reduced capability to provide inertia to support grid frequency.



Maxwell's Grid Energy Storage System provides grid inertia by stabilizing frequency drops in milliseconds

- High power density in compact footprint
- 3 to 5x smaller than battery solution
- Up to 1 million cycles, 15 year lifetime*
- Low maintenance
- Scalable – 10's to over 100MW
- More than 8 million Maxwell cells field deployed in grids

*Results may vary. Additional terms and conditions, including the limited warranty, apply at the time of purchase. See the warranty details and datasheet for applicable operating and use requirements.

FREQUENCY RESPONSE APPLICATION BRIEF

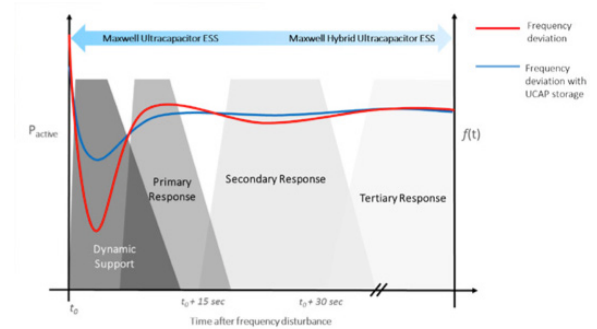
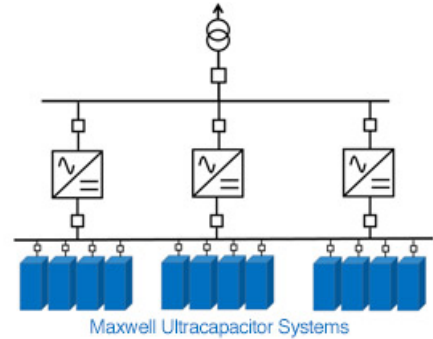
Maxwell ultracapacitor systems and fast responding inverters stabilize frequency excursions by rapidly injecting or absorbing power within a few milliseconds, with continuous power delivery scalable to traditional primary response time durations. This provides immediate response to the power imbalance before slower assets can react.

Ultracapacitors Support System Lifetime, Project Payback

When batteries are deployed for this application, system lifetime degradation rates may be higher than anticipated due to high C-rate charge and discharge cycles. Depending on local requirements for provision of frequency regulation, ultracapacitors, when used in conjunction with batteries, act as a battery buffer minimizing these lifetime degrading changes to maximize system performance reliability.

Maxwell Grid Energy Storage Solutions

Scalable from kW to MW, Maxwell grid energy storage is rackable and stackable, with advanced diagnostic and communications enabling reliable performance and support of high power, fast response applications. Our grid solutions team provides storage sizing, system architecture, and modeling to derive highest value project solutions.



Please visit maxwell.com/gridsystems for more information.

Please contact Maxwell Technologies directly for any technical specifications critical to application. Products and related processes may be covered by one or more U.S. or international patents and pending applications. Please see www.maxwell.com/patents for more information.

Maxwell Technologies, Inc.
Global Headquarters
 3888 Calle Fortunada
 San Diego, CA 92123
 USA
 Tel: +1 (858) 503-3300
 Fax: +1 (858) 503-3301

Maxwell Technologies SA
 Route de Montena 65
 CH-1728 Rossens
 Switzerland
 Tel: +41 (0)26 411 85 00
 Fax: +41 (0)26 411 85 05

Maxwell Technologies, GmbH
 Leopoldstrasse 244
 80807 Munich
 Germany
 Tel: +49 (0)89 4161403 0
 Fax: +49 (0)89 4161403 99

Maxwell Technologies Shanghai Trading Co. Ltd.
 Room 1005, 1006, and 1007
 No. 1898, Gonghexin Road,
 Jin An District, Shanghai
 2000072, P.R. China
 Tel: +86 21 3852 4000
 Fax: +82 21 3852 4099

Nesscap Co., Ltd.
 17, Dongtangiheung-ro
 681beon-gil, Giheung-gu,
 Yongin-si, Gyeonggi-do
 17102, Republic of Korea
 Tel: +82 31 289 0721
 Fax: +82 31 286 6767

MAXWELL TECHNOLOGIES, MAXWELL, MAXWELL CERTIFIED INTEGRATOR, ENABLING ENERGY'S FUTURE, NESSCAP, XP, DURABLU, BOOSTCAP, D CELL, CONDIS and their respective designs and/or logos are either trademarks or registered trademarks of Maxwell Technologies, Inc., and/or its affiliates, and may not be copied, imitated or used, in whole or in part, without the prior written permission Maxwell Technologies, Inc. All contents copyright © 2018 Maxwell Technologies, Inc. All rights reserved. No portion of these materials may be reproduced in any form, or by any means, without prior written permission from Maxwell Technologies, Inc.

Document number: 3002443-EN.1 maxwell.com

Maxwell
 TECHNOLOGIES
 Enabling Energy's Future™