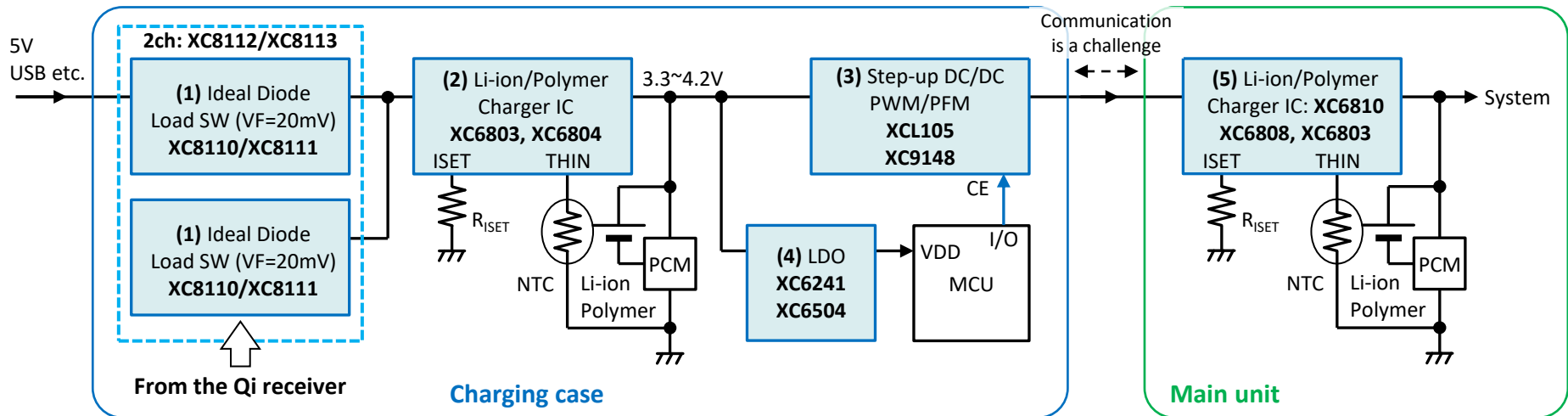


# Typical power supply configurations and ICs to the charging case and main unit

## ■ Configuration with charging IC in the main unit

- How to disable the step-up IC (3) on the case side after charge completion of the Li battery on the main unit.
  - It is common to use **three contacts** to communicate the charging status of the main unit side to the case side.
  - If the charger IC (5) on the main unit has a **Two-wire communication** using the power line for the state of charge, it is possible with two contacts.
    - ✓ See configuration on [Page 5](#) using the charging IC **XC6810**, which supports **Two-wire communication**.
- OR connection of USB and Qi using ideal diode load switches **XC8110/XC8111**, **XC8112/XC8113**.



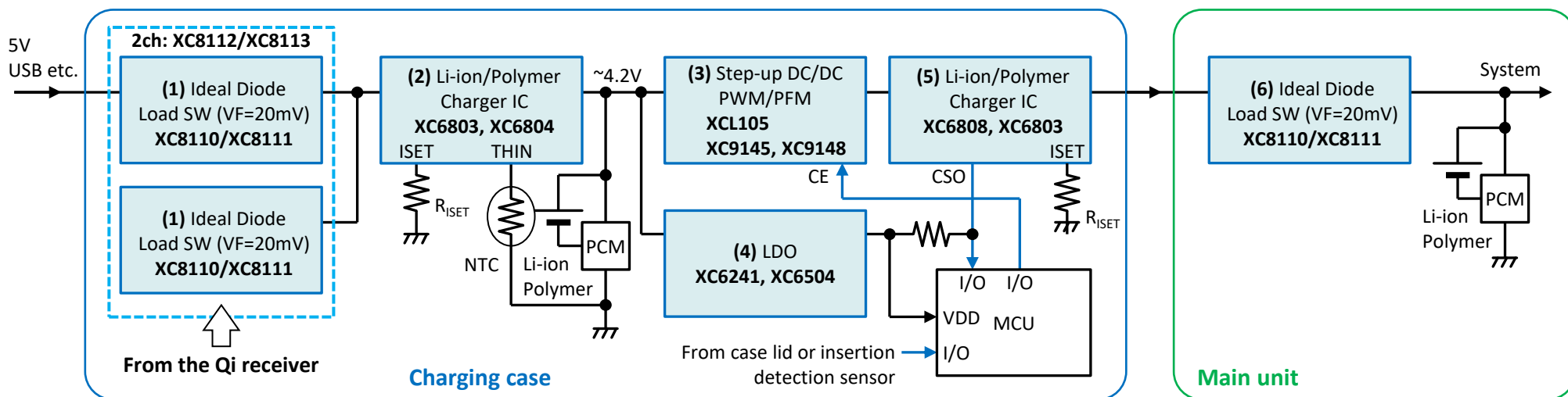
|                             | Product  | Features  |
|-----------------------------|--|---|
| (1) Ideal Diode Load Switch | <b>XC8110 / XC8111</b>                                     | True Reverse current prevention Ideal Diode Load SW<br>VF=20mV, 500mA (XC8110), 1A (XC8111), IEC 62368-1 certified                    |
|                             | <b>XC8112 / XC8113</b><br><small>UNDER DEVELOPMENT</small> | 2ch True Reverse current prevention Ideal Diode Load SW<br>VF=20mV 2ch x 500mA (XC8112), 2ch x 1A (XC8113),<br>IEC 62368-1 certified. |
| (2) Li Charger IC           | <b>XC6803 / XC6804</b>                                     | CC/CC Charger, CC=40~280mA/~800mA, Batt Temp Monitor  |
| (3) Step-up DC/DC           | <b>XCL105</b>  | Built-in inductor, PWM/PFM, 1.2MHz, 590mA@3.3V→5  |
|                             | <b>XC9148</b>  | Hi-efficiency, PWM/PFM, 1.2MHz/3MHz, 750mA  |

|                   | Product   | Features   |
|-------------------|---|--|
| (4) LDO           | <b>XC6241</b>   | Iq=0.6μA, PSRR=60dB, GO, 150mA   |
|                   | <b>XC6504</b>   | Iq=0.6μA, Cap. Less, 150mA   |
| (5) Li Charger IC | <b>XC6810</b><br><small>(See configuration on Page 5)</small> | 3.5V~28V, CV=3.80V~4.40V, CC=1mA~25mA<br>Battery Temperature Monitor, Charge ON/OFF, Current path<br>Charge status & Battery voltage monitoring<br>Shutdown/Wake-up, Two-wire communication to Cradle<br>Supports various types of energy harvesting |
|                   | <b>XC6808 / XC6803</b>  | CC/CV Charger, CC=5~40mA/~240mA, Batt Temp Monitor   |

# Configuration in which charging of the Li battery in the main unit controlled by the charging case

## ■ Configuration without Charger IC in the main unit

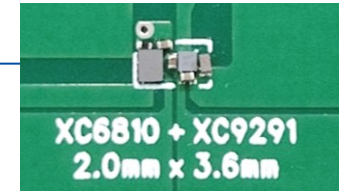
- The main unit consists only of an **Ideal Diode Load Switch** with reverse current prevention.
  - The main unit is compact, low-cost and simple, and can be controlled by **only two contacts (5 V and GND)** with the charging case.
    - ✓ **Ideal Diode Load Switch (6) in the main unit** prevents the voltage of the internal Li battery from being output to the contact on the main unit.
  - The charging case monitors the charge of the Li battery in the main unit and controls the termination of power supply after its charge completion.
    - ✓ Charge completion is detected by the MCU at the CSO pin of the Charger IC (5) for the main unit, so that the Step-up IC (2) can be stopped.



|                                     | Product  | Features   |
|-------------------------------------|--|--|
| (1), (6)<br>Ideal Diode Load Switch | <b>XC8110 / XC8111</b>                                     | True Reverse current prevention Ideal Diode Load SW<br>VF=20mV, 500mA (XC8110), 1A (XC8111), IEC 62368-1 certified |
|                                     | <b>XC8112 / XC8113</b><br><small>UNDER DEVELOPMENT</small> | 2ch True Reverse current prevention Ideal Diode Load SW<br>VF=20mV 2chx500mA(XC8112), 2chx1A(XC8113), IEC 62368-1  |
| (2) Li Charger IC                   | <b>XC6803 / XC6804</b>                                     | CC/CC Charger, CC=40~280mA/~800mA, Batt Temp Monitor   |
| (3) Step-up DC/DC                   | <b>XCL105</b>  | Built-in inductor, PWM/PFM, 1.2MHz, 710mA@3.3V→5 V   |
|                                     | <b>XC9148</b>  | Hi-efficiency, PWM/PFM, 1.2MHz/3MHz, 750mA@3.3V→5V   |
|                                     | <b>XC9145</b>  | Iq=400nA, PWM/PFM, 1.2MHz, 430mA, V <sub>ST</sub> =1.6V  |

|                   | Product                | Features                        |
|-------------------|------------------------|---------------------------------|
| (4) LDO           | <b>XC6241</b>          | Iq=0.6μA, PSRR=60dB, GO, 150mA  |
|                   | <b>XC6504</b>          | Iq=0.6μA, Cap. Less, 150mA      |
| (5) Li Charger IC | <b>XC6808 / XC6803</b> | CC/CV Charger, CC=5~40mA/~280mA |

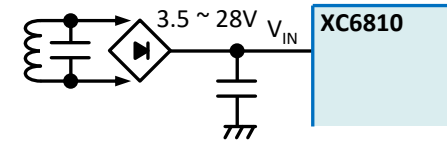
# Ultra-compact Charger IC with 2-wire communication for the main unit



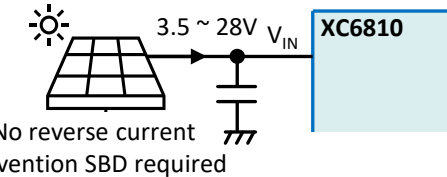
## Multi-function Charger IC for small Li batteries

- Two-wire communication supported (**XC6810xxxE/F/G/J types**).
  - Current modulation of the power input line using the CSO pin and transmission of the state of charge to the Charging case in frequency.  
 Charge level (32, 16, 8kHz for < 60%, < 90%, 90% ≤), Charge completion (4kHz) / Stopped (OFF) / Error (1kHz)
  - Charging case can be turned on and off by detection of a simple current sense circuit (R+OPamp) in it.
- Also available with OUT switched off/on depending on the presence/absence of V<sub>IN</sub> input (A, B, E, F).
- Various functions such as Shutdown/Wake-up function and wireless power supply support are available.

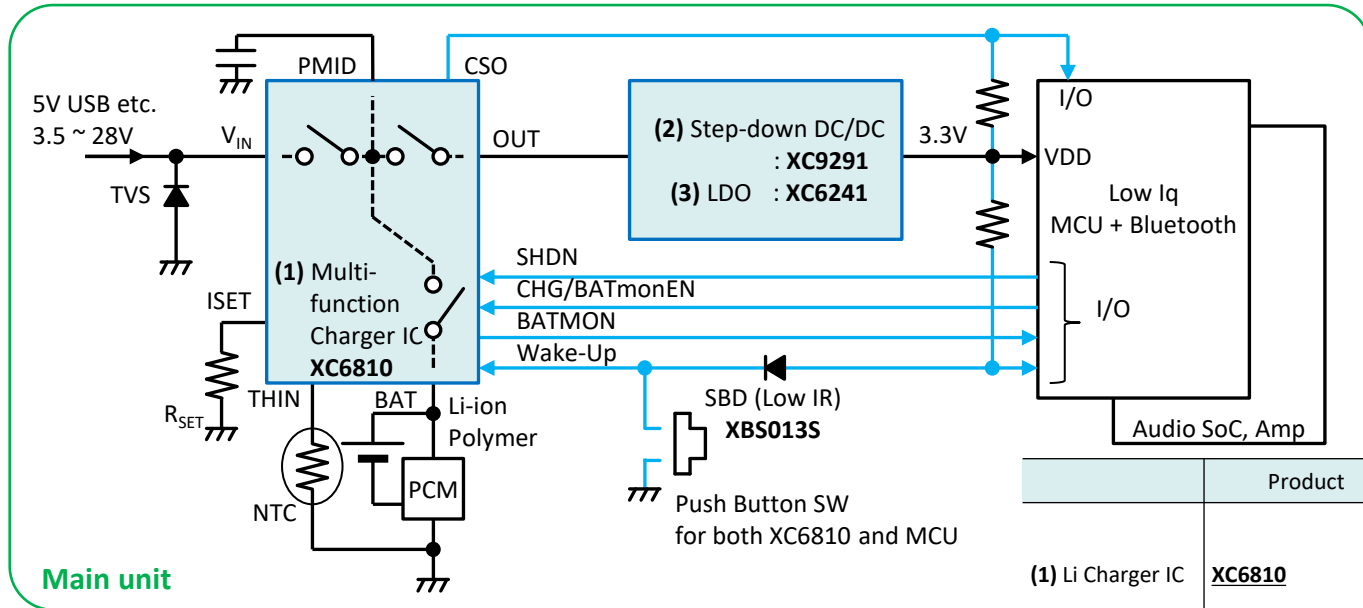
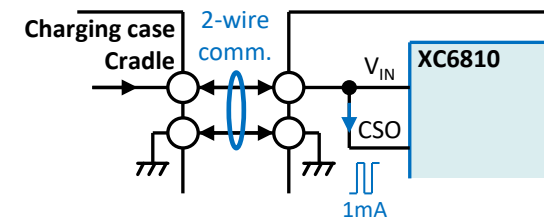
### Wireless power transfer



### Solar and Other Energy Harvesting



### Charge state communication to Charging case



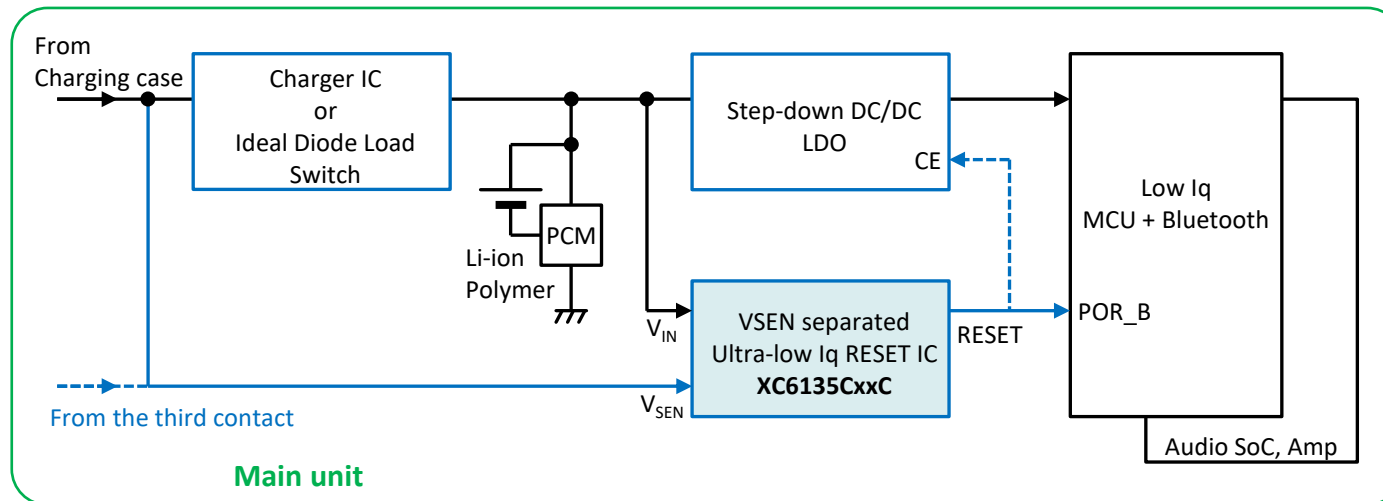
Main unit

|                     | Product   | Features   |
|---------------------|---|--|
| (1) Li Charger IC   | <b>XC6810</b>   | 3.5V~28V, CV=3.80V~4.40V, CC=1mA~25mA<br>Battery Temperature Monitor, Charge ON/OFF, Current path<br>Charge status & Battery voltage monitoring<br>Shutdown/Wake-up, Two-wire communication to Cradle<br>Supports various types of energy harvesting |
| (2) Step-down DC/DC | <b>XC9290 / XC9291</b><br><span style="border: 1px solid red; padding: 2px;">NEW</span> | World's smallest class of mounting area<br>F-PWM, PWM/PFM, 4MHz/6MHz, 600mA  |
| (3) LDO             | <b>XC6241</b>   | Iq=0.6μA, PSRR=60dB, GO, 150mA   |

# Appendix: RESET IC to control the operation of the main unit

## ■ A way to turn the main unit off and on depending on whether the $V_{IN}$ input is present or not, as well as to prevent freezing.

- The voltage supply from the charging case is detected by the ultra-low consumption RESET IC of the SENSE pin ( $V_{SEN}$ ) separated type.
  - With voltage applied : RESET output "L" resets the MCU or turns off the Step-up DC/DC or LDO.
  - No voltage applied : RESET output "H" resets releases the MCU from reset or turns on the Step-up DC/DC or LDO.
- Then releases the reset of the main unit when starting to use it and enables the start of Bluetooth connections, etc.  
 The system is also reset each time it is placed in a Charging case, thus releasing it from a system freeze.
- With two contacts : After charge completion, a low voltage, e.g. 2V, is applied from the charging case through a high resistance and detected by this RESET IC in the main unit.
- With three contacts : The bias of the signal line can be detected by this RESET IC in the same way.



|          | Product       | Features                              |
|----------|---------------|---------------------------------------|
| RESET IC | <b>XC6135</b> | Separated Sense pin, Ultra-low Iq44nA |

# Ideal Diode SW and Step-Up DC/DC Suitable for "OR" Connection

## ■ OR connection of power supply rails

### ● Technical trend and challenges

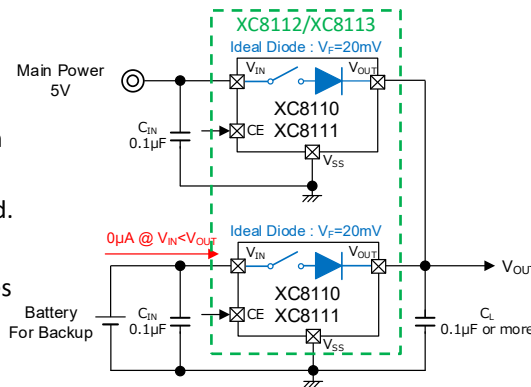
- For high efficiency and long battery life of the device, the circuit using SBD has large loss due to VF. Leakage current of reverse bias is also an issue.
- Difficult to supply stable voltage due to voltage drop and fluctuation caused by the VF characteristic of the diode which may cause unstable operation.

### ● TOREX Proposal : Dedicated ICs for OR connection

- Low consumption design to reduce battery discharge / Easy automatic switching of power supply path without control / Low VF and response to minimize output voltage fluctuation and loss.

### ➤ OR connection with Ideal Diode Load SW : XC8110 / XC8111 (1ch) XC8112 / XC8113 (2ch)

- Low VF: 20mV
- 0μA leakage current from output at reverse bias.
- Various built-in protection functions.  
**IEC 62368-1:2018** certified.
- Low loss requires no heat dissipation and contributes to miniaturization.

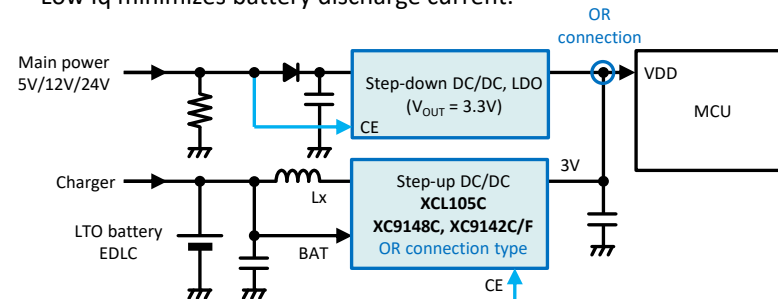


## ■ Load Switch with Ideal Diode function

| Product   | Features   | V <sub>IN</sub> (V) | R <sub>on</sub>     | I <sub>OUT</sub>       | Package  |
|---|--|---------------------|---------------------|------------------------|--|
| <b>XC8110</b><br><small>FEATURED</small>          | VF=20mV<br>3.6μA (Forward bias)<br>0μA (Reverse bias)        | 1.5 ~ 6.0           | 120mΩ               | 500mA                  | WLP-4-02 (0.82x0.82xh0.5mm)<br>SOT-25 (2.9x2.8xh1.3mm)<br>USP-6B06 (1.8x1.5xh0.33mm) |
| <b>XC8111</b><br><small>FEATURED</small>          | IEC 62368-1:2018 certified                                   |                     |                     | 1A                     |  |
| <b>XC8112</b><br><small>UNDER DEVELOPMENT</small> | 2ch (Parallel is allowed)<br>VF=20mV<br>3.6μA (Forward bias) | 1.5 ~ 6.0           | 2ch x<br>120mΩ      | 2 x 500mA<br>or 1 x 1A | USP-8B06 (2.0x2.0xh0.33mm)   |
| <b>XC8113</b><br><small>UNDER DEVELOPMENT</small> | 0μA (Reverse bias)<br>IEC 62368-1:2018 certified             |                     | or<br>1ch x<br>60mΩ | 2 x 1.0A<br>or 1 x 2A  |  |

### ➤ Step-up DC/DC for OR connection : XCL105C, XC9148C, XC9142C/F

- Switching without control when main power is input or disconnected
- When main power is lost, immediately starts boosting to supply power.
- Low I<sub>q</sub> minimizes battery discharge current.



## ■ Step-up DC/DC for OR connection

| Product                                   | Features                             | V <sub>IN</sub> (V)                 | V <sub>OUT</sub> (V) | I <sub>OUT</sub> (mA)<br>@3.3V→5V | Package   |
|---|--------------------------------------|-------------------------------------|----------------------|-----------------------------------|---|
| <b>XCL105C</b><br><small>FEATURED</small> | Built-in inductor<br>PWM/PFM, 1.2MHz | 0.65 ~ 6.0<br>V <sub>ST</sub> = 0.9 | 1.8 ~ 5.5            | 710                               | DFN3030-10B<br>(3.0x3.0xh1.7mm)   |
| <b>XC9148C</b><br><small>FEATURED</small> | PWM/PFM<br>1.2MHz/3MHz               | 0.65 ~ 6.0<br>V <sub>ST</sub> = 0.9 | 1.8 ~ 5.5            | 750                               | USP-6C (1.8x2.0xh0.6mm)<br>SOT-89-5 (4.5x4.6xh1.6mm)                              |
| <b>XC9142C/F</b>                          | PWM/PFM<br>1.2MHz/3MHz               | 0.65 ~ 6.0<br>V <sub>ST</sub> = 0.9 | 1.8 ~ 5.5            | 500                               | SOT-25 (2.9x2.8xh1.3mm)<br>USP-6C (1.8x2.0xh0.6mm)<br>WLP-6-01 (1.08x1.28xh0.4mm) |

# Compact and Space-Saving Power Supply Solutions

## World's smallest product line of area-saving solutions

**XC9290/XC9291**

**NEW**

World's smallest 6.0V 600mA step-down DC/DC

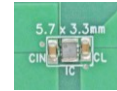
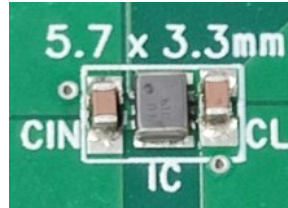


Actual Size

**XCL239/XCL240**

**NEW**

1A Built-in inductor Micro DC/DC



Actual Size

**XC9289**

**NEW**

1.5A HiSAT-COT 1.5A Step-down DC/DC



Actual Size

**XC9702**

**NEW**

60V 300mA Step-down DC/DC

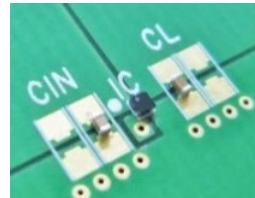


Actual Size

**XC8110/XC8111**

**FEATURED**

Ideal Diode Load Switch 0.5A/1A



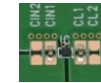
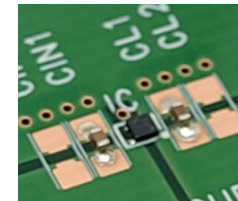
Actual Size

**XC6241**

**FEATURED**

**, XC6135/XC6136**

150mA LDO with GO function, Ultra-low Iq RESET



Actual Size

## List of Compact and Space-saving Power Supply ICs

|                 | Product              | Features   |                 | V <sub>IN</sub> (V) | V <sub>OUT</sub> (V) | I <sub>OUT</sub> (mA) | Package     | Size                    |
|-----------------|----------------------|--|-----------------|---------------------|----------------------|-----------------------|-------------|-------------------------|
| LDO             | <b>XC6241</b>        | High-speed, i <sub>q</sub> =0.6μA, GO                                | <b>FEATURED</b> | 1.6 ~ 6.0           | 1.5 ~ 5.0            | 150                   | USPQ-4B05   | 1.0 x 1.0 x h 0.33mm    |
|                 | <b>XC6228</b>        | High-speed, PSRR=75dB, 300mA   |                 | 1.6 ~ 5.5           | 1.2 ~ 4.0            | 300                   | USPQ-4B04   | 1.0 x 1.0 x h 0.6mm     |
|                 | <b>XC6504</b>        | Cap. Less, I <sub>q</sub> =0.6μA                                     |                 | 1.4 ~ 6.0           | 1.1 ~ 5.0            | 150                   | USPN-4B02   | 0.75 x 0.95 x h 0.40mm  |
| Step-up DC/DC   | <b>XCL104/XCL105</b> | Built-in inductor, F-PWM, PWM/PFM                                    | <b>FEATURED</b> | 0.65 ~ 6.0          | 1.8 ~ 5.5            | 710 @3.3V→5V          | DFN3030-10B | 3.0 x 3.0 x h 1.7mm     |
|                 | <b>XCL102/XCL103</b> | Built-in inductor, F-PWM, PWM/PFM                                    |                 | 0.65 ~ 6.0          | 2.2 ~ 5.5            | 450 @3.3V→5V          | CL-2025-02  | 2.0 x 2.5 x h 1.04mm    |
| Step-down DC/DC | <b>XCL243/XCL244</b> | Built-in inductor, HiSAT-COT, 700mA, h=0.75mm max                    | <b>NEW</b>      | 2.5 ~ 5.5           | 0.8 ~ 3.6            | 700                   | USP-8B04    | 2.25 x 1.5 x h 0.75mm   |
|                 | <b>XCL239/XCL240</b> | Built-in inductor, HiSAT-COT, 1A                                     | <b>NEW</b>      | 2.5 ~ 5.5           | 0.8 ~ 3.6            | 1000                  | CL-2025-02  | 2.0 x 2.5 x h 1.04mm    |
|                 | <b>XCL233</b>        | I <sub>q</sub> =200nA, Step-down DC/DC, VSET                         | <b>NEW</b>      | 1.8 ~ 6.0           | 0.5 ~ 3.6            | 150                   | CL-2025-03  | 2.0 x 2.5 x h 1.04mm    |
|                 | <b>XC9290/XC9291</b> | HiSAT-COT, 600mA, World's smallest mounting area 3.15mm <sup>2</sup> | <b>NEW</b>      | 2.5 ~ 6.0           | 0.7 ~ 3.6            | 600                   | WLP-5-08    | 0.96 x 0.88 x h 0.33 mm |
|                 | <b>XC9289</b>        | HiSAT-COT, 1.5A, F-PWM, PWM/PFM selectable                           | <b>NEW</b>      | 2.5 ~ 5.5           | 0.8 ~ 3.6            | 1500                  | LGA-8B01    | 1.2 x 1.4 x h 0.3mm     |
|                 | <b>XC9702</b>        | 60V, MODE: F-PWM, PWM/PFM, 1MHz, 300mA, Low I <sub>q</sub> : 12μA    | <b>NEW</b>      | 4.5 ~ 60.0          | 2.5 ~ 12.0           | 300                   | USP-10B     | 2.6 x 2.9 x h 0.6mm     |
| RESET IC        | <b>XC6135/XC6136</b> | Ultra-low I <sub>q</sub> : 88nA Voltage Detector                     |                 | 1.1 ~ 6.0           | 1.2 ~ 5.0            | -                     | USPQ-4B05   | 1.0 x 1.0 x h 0.33mm    |
| Charger IC      | <b>XC6810</b>        | For 1 cell Li-ion, Multi-function Charger IC                         | <b>FEATURED</b> | 3.5 ~ 28            | 3.8 ~ 4.4            | 1 ~ 25                | WLP-12-01   | 1.17 x 1.57 x h 0.33mm  |
| Load SW         | <b>XC8110/XC8111</b> | Ideal diode load SW, V <sub>F</sub> =20mV, IEC 62368-1 certified     | <b>FEATURED</b> | 1.5 ~ 6.0           | -                    | 1000                  | WLP-4-02    | 0.82 x 0.82 x h 0.5mm   |