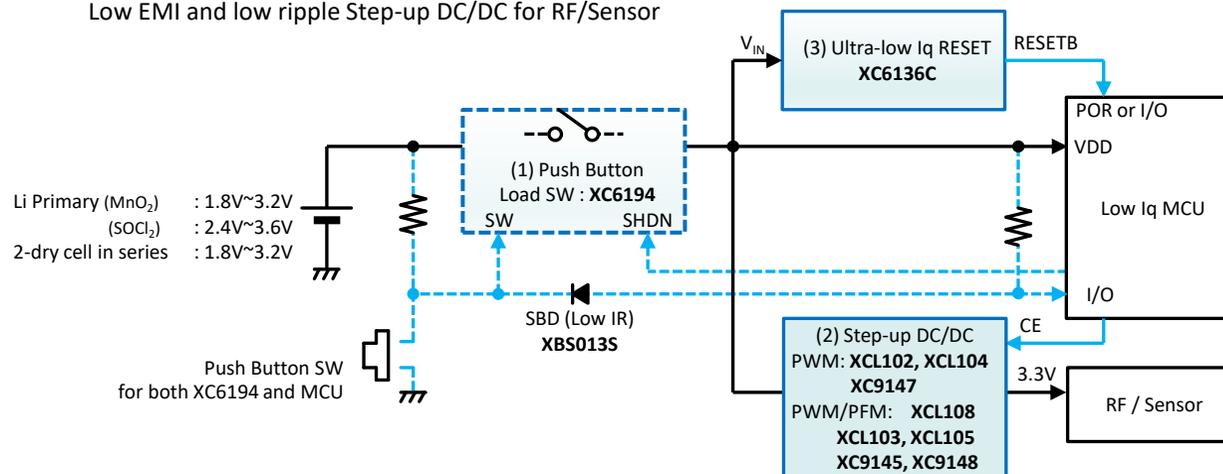


Primary Battery : Small and Low Consumption Solutions

■ 3V Li Primary battery or 2-dry cell : Supplying battery voltage to MCU directly

- Challenges : Preventing discharge of battery after shipment / Countermeasure for system freeze
Low EMI and low ripple Step-up DC/DC for RF/Sensor



	Product	Features
(1) Push button SW	XC6194 FEATURED	$I_{STB}=1nA$, Shutdown function(Ship/Main power SW) For system freeze (XC6194A), Preventing liquid leakage (UVLO)
(2) Step-up DC/DC	XCL102 / XCL103	Built-in inductor, F-PWM, PWM/PFM 3MHz, 450mA@3.3V→5V
	XCL104 / XCL105 FEATURED	Built-in inductor, F-PWM, PWM/PFM 1.2MHz, 710mA@3.3V→5V
	XCL108 NEW	Ultra-low Iq: 400nA, PWM/PFM 1.2MHz, 300mA@3.3V→5V, $V_{ST}=1.6V$
	XC9145 FEATURED	Ultra-low Iq: 400nA, PWM/PFM 1.2MHz, 430mA@3.3V→5V, $V_{ST}=1.6V$
	XC9147 / XC9148 FEATURED	F-PWM, PWM/PFM 1.2MHz/3MHz, 750mA@3.3V→5V
(3) RESET IC	XC6136	Iq=100nA class Ultra-low Iq

(1) Push Button Load SW with Shutdown function : XC6194

Shutdown at shipment **to reduce the discharge current from the battery to 1nA**.
 For Main power SW / Forced shut-down at system freeze / Prevention of battery liquid leakage.

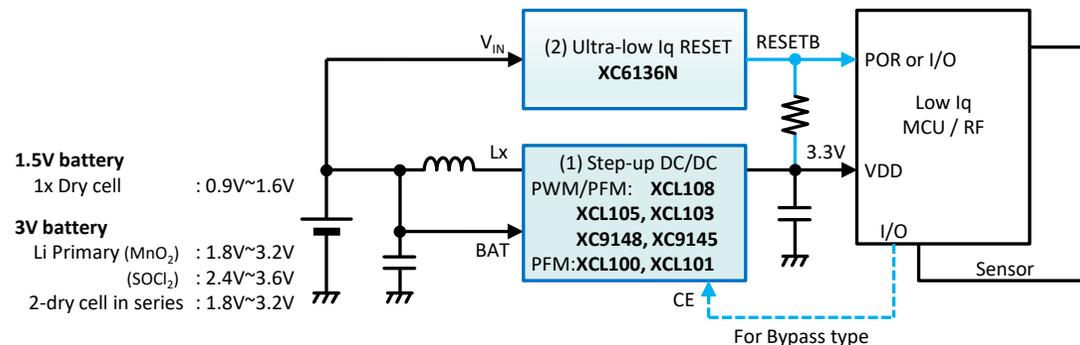
(2) Step-up DC/DC for RF/Sensor

- Step-up when only in use, cut-off by Load disconnection function when not in use.
- **Built-in inductor Micro DC/DC** is suitable due to small size and low EMI.
(XCL102/XCL103, XCL104/XCL105, XCL108)
- For RF/sensors always operating
400nA Ultra-low Iq PWM/PFM step-up XCL108 and XC9145 achieving high-efficiency always.
- When low ripple is important
PWM step-up DC/DC XCL102, XCL104, and XC9147 are suitable for low ripple regardless of load.

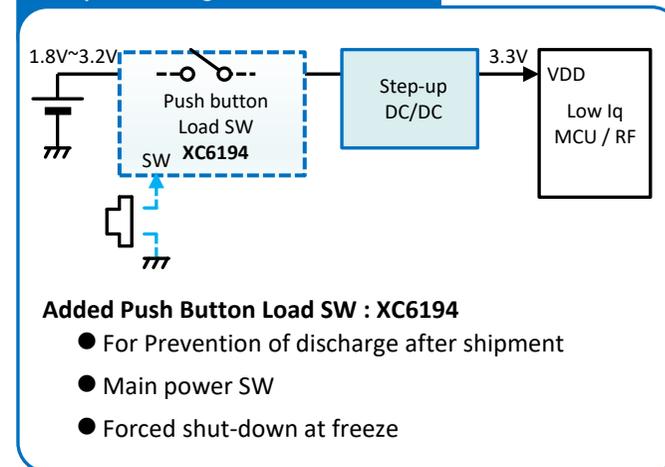
Primary Battery : Small and Low Power Consumption Solutions

From 3V Li Primary battery, 1 or 2-dry cell : Supplying boosted voltage to MCU

- Challenges : High efficiency / low EMI / Low ripple Step-up DC/DC
Small / Low Iq / Long battery life



Example of adding Shutdown Function



	Product	Features
(1) Step-up DC/DC	XCL100 / XCL101	Built-in inductor, Low Iq PFM 80mA@3.3V→5V, UVLO (XCL100)
	XCL103 FEATURED	Built-in inductor, PWM/PFM 3MHz, 450mA@3.3V→5V
	XCL105 FEATURED	Built-in inductor, PWM/PFM 1.2MHz, 710mA@3.3V→5V
	XCL108 NEW	Ultra-low Iq: 400nA, PWM/PFM 1.2MHz, 300mA@3.3V→5V, V _{ST} =1.6V
	XC9145 FEATURED	Ultra-low Iq: 400nA, PWM/PFM 1.2MHz, 430mA@3.3V→5V, V _{ST} =1.6V
	XC9148 FEATURED	Low Ron Bypass, PWM/PFM 1.2MHz/3MHz, 750mA@3.3V→5V,
(2) RESET IC	XC6136	Iq=100nA class Ultra-low Iq

(1) Step-up DC/DC for MCU

(a) For low power consumption

- General use - Supply with always boosting at high efficiency
For 3V battery : Iq=400nA PWM/PFM step-up DC/DC XCL108 and XC9145
High efficiency 89.9%@10μA
For 1.5V battery : **Built-in inductor PFM Step-up Micro DC/DC XCL101**
- Low Iq power technique - Boost only when MCU is active
Use products with "Bypass" function to boost only when necessary, and supply through battery voltage when the MCU is in sleep mode for even lower power consumption. (**XCL101C, XCL103E, XCL105B/E/H/K, XC9148B/E/H/K**)

(b) For Small / Low EMI

Use **Built-in inductor Micro DC/DC (XCL101, XCL103, XCL105, XCL108)**

Low Power Consumption by Utilizing Operation Range of MCU/SoC : VSET, Bypass

■ Achieving longer battery life & low power consumption by changing the output voltage based on an operation of MCU/SoC

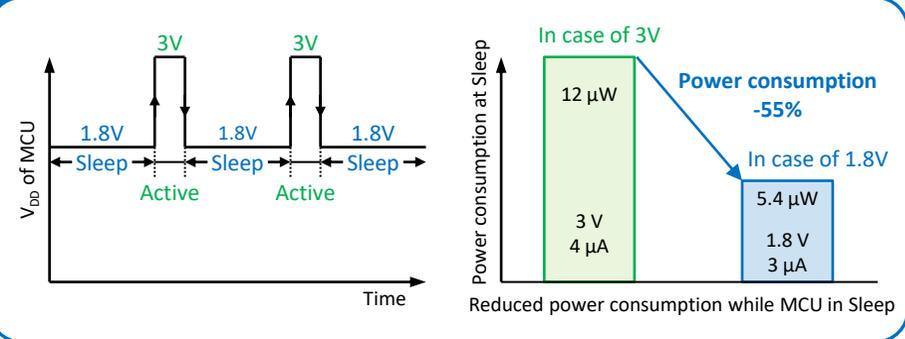
● Technical trend and challenges

- Current MCU/SoC can operate in a wide voltage range (e.g. 1.6 to 3.8V).
- 3V is required for the analog part and high-speed processing, but a low supply voltage such as 1.8V can be used during sleep mode. This results in lower power consumption.

● TOREX Proposal : Low power consumption by changing output voltage

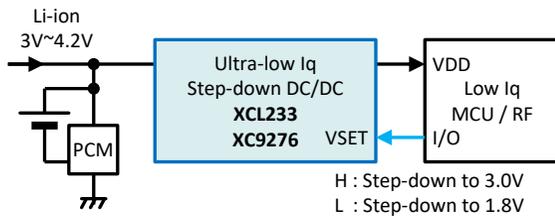
- Dynamically changing output voltage according to MCU/SoC operation, greatly reducing power consumption in standby state.

Change supply voltage according to MCU operation



➤ Ultra-low Iq Step-down DC/DC with VSET function : XCL233, XC9276

- V_{OUT} can be switched by the VSET pin.
- 200nA Ultra-low Iq achieves always high efficiency: 85.5%@10µA

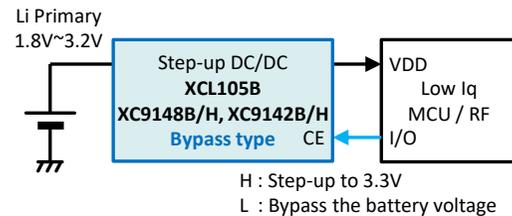


■ Ultra-low Iq VSET (V_{OUT} selectable) function Step-down DC/DC

Product	Features	V_{IN} (V)	V_{OUT} (V)	I_{OUT} (mA)	Package
XCL233 <small>NEW</small>	Built-in inductor VSET (V_{OUT} selectable) $I_q=200nA$, PFM	1.8 ~ 6.0	0.5 ~ 3.6 2 values	150	CL-2025-03 (2.5x2.0x1.04mm)
XC9276 <small>FEATURED</small>	VSET (V_{OUT} selectable) $I_q=200nA$, PFM	1.8 ~ 6.0	0.5 ~ 3.6 2 values	150	USP-8B06 (2.0x2.0xh0.33mm) SOT-26W (2.8x2.9x1.3mm) WLP-6-03 (1.72x1.07xh0.33mm)

➤ Step-up DC/DC with Bypass function : XCL105B, XC9148B/H, XC9142B/E

- Switching between voltage boost and battery voltage through
- During MCU sleep, supplying through battery voltage, and Iq of the IC is 0µA.



■ Bypass type Step-up DC/DC

Product	Features	V_{IN} (V)	V_{OUT} (V)	I_{OUT} (mA) @3.3V→5V	Package
XCL105B <small>FEATURED</small>	Built-in inductor PWM/PFM, 1.2MHz	0.65 ~ 6.0 $V_{ST} = 0.9$	1.8 ~ 5.5	710	DFN3030-10B (3.0x3.0xh1.7mm)
XC9148B/H <small>FEATURED</small>	PWM/PFM 1.2MHz/3MHz	0.65 ~ 6.0 $V_{ST} = 0.9$	1.8 ~ 5.5	750	USP-6C (1.8x2.0xh0.6mm) SOT-89-5 (4.5x4.6xh1.6mm)
XC9142B/E	PWM/PFM 1.2MHz/3MHz	0.65 ~ 6.0 $V_{ST} = 0.9$	1.8 ~ 5.5	500	SOT-25 (2.9x2.8xh1.3mm) USP-6C (1.8x2.0xh0.6mm) WLP-6-01 (1.08x1.28xh0.4mm)

Further Lower Consumption / Battery Life : Ideal Diode, Push Button Load SW

■ Ideal Diode to reduce power loss of diode

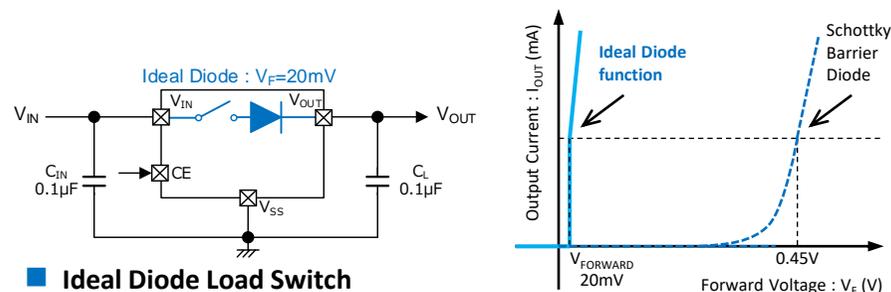
● Technical trend and challenges

- Many diodes used in each power lines for reverse current prevention, etc.
- SBD generates about 0.4V of VF loss and reverse current due to leakage, and the loss is more than 0.4W at IF=1A, which is an obstacle to high efficiency and miniaturization.

● TOREX Proposal : Significantly reducing VF loss

➢ Ideal Diode Load SW: XC8110 / XC8111, XC8112 / XC8113

- Achieving VF=20mV. Loss is 1/20 of SBD@200mA or less and 1/6@500mA. Parallel connection of XC8112/XC8113 halves VF at high current.
- Leakage current is 0 μ A, preventing reverse current harmful to batteries.
- IEC 62368-1:2018 certified with current limit and other protections.



■ Ideal Diode Load Switch

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

■ "Ship function" to prevent battery discharge during shipment.

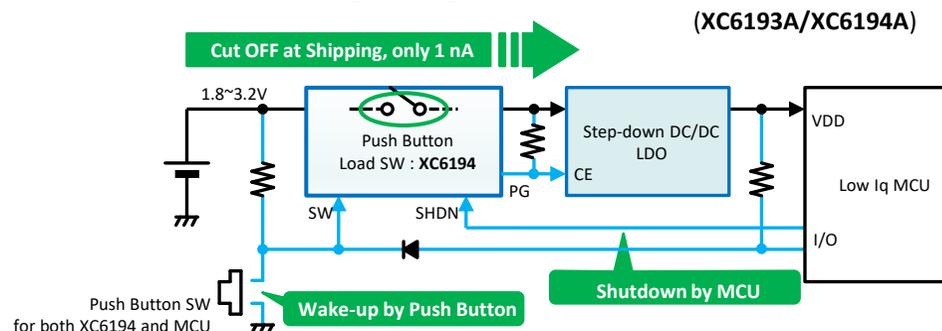
● Technical trend and challenges

- Discharge current from the battery after shipment is so large that the battery may not be usable at the time of usage.
- Due to an increase in the number of devices with built-in batteries and the need to ensure water resistance, the conventional method of preventing discharge by using plastic insulating tabs has become difficult.

● TOREX Proposal : Preventing battery discharge by Ship function

➢ Push Button Load SW: XC6194 (1A) / XC6193 (1A + External Pch FET)

- **Ship function** greatly reduces discharge after shipment to 1nA.
- **Useful as main power switch as well.**
Turn ON by the push-button, and OFF by the signal from MCU to SHDN after processing termination. Safety shutdown is possible.
- **At system freeze, long pressing the push button forces OFF.**



■ Push Button Load Switch with Ship function

Product	Features	V _{IN} (V)	R _{on}	I _{OUT}	Package
XC6193 <small>FEATURED</small>	I _{STB} =1nA Shutdown function (Ship/Main power SW) For system freeze	1.8 ~ 6.0	140m Ω	Internal 1A + External Pch FET	USP-8B06 (2.0x2.0xh0.33mm)
XC6194 <small>FEATURED</small>	(XC6193A/XC6194A) UVLO: Prevents battery leakage			1A	