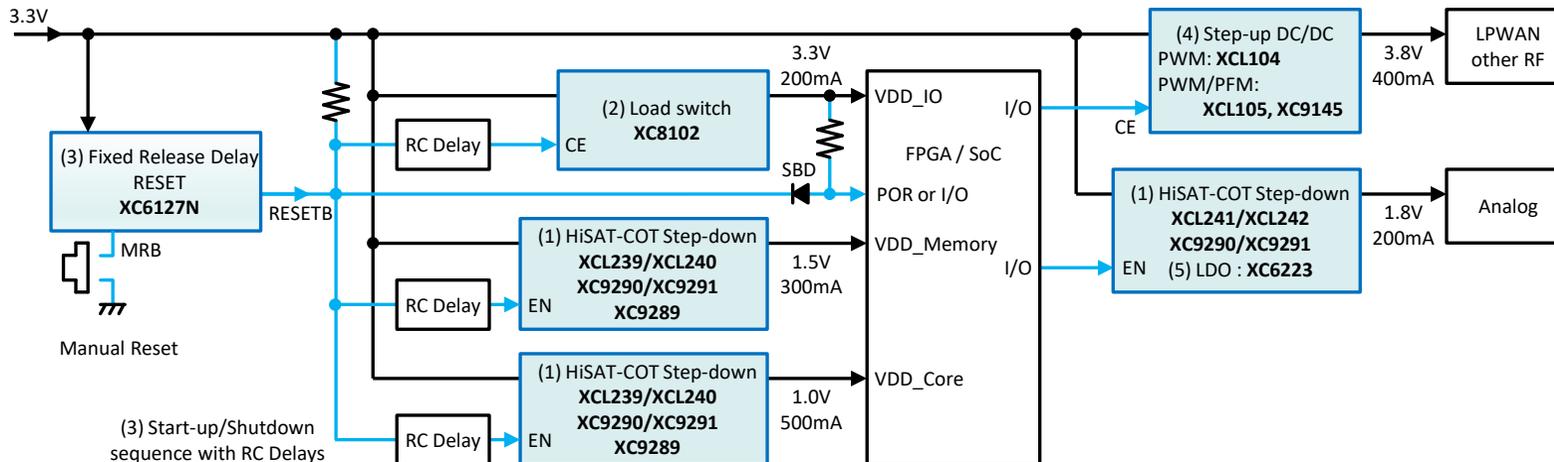


# 3.3V : Small Solutions for Multiple Power Rails

## ■ Compact multiple power supplies for MCU/SoC/FPGA, sensors, and various modules

- Challenges : Fast transient response/High stability, Small size/High efficiency/Heat dispersion/Low EMI, Start-up/Shutdown sequence



Block	Product	Features
(1) Step-down DC/DC	<b>XCL241 / XCL242</b> <small>NEW</small>	Built-in inductor, <b>HiSAT-COT</b> , F-PWM, PWM/PFM 1.2MHz, 500mA, Ultra-low EMI
	<b>XCL239 / XCL240</b> <small>NEW</small>	Built-in inductor, <b>HiSAT-COT</b> , F-PWM, PWM/PFM 3MHz, 1A
	<b>XC9289</b> <small>NEW</small>	<b>HiSAT-COT</b> , Ultra-small, F-PWM-PWM/PFM MODE selectable 1.2MHz/3MHz, 1.5A
	<b>XC9290 / XC9291</b> <small>NEW</small>	<b>HiSAT-COT</b> , Smallest area, F-PWM, PWM/PFM 4MHz/6MHz, 600mA
(2) Load SW	<b>XC8102</b>	Low Iq, Small size, 400mA, Foldback current limit
(3) RESET IC	<b>XC6127</b>	Low Iq, High accuracy, Selectable Release delay, Manual reset
(4) Step-up DC/DC	<b>XCL104 / XCL105</b> <small>FEATURED</small>	Built-in inductor, F-PWM, PWM/PFM 1.2MHz, 710mA@3.3V→5V
	<b>XC9145</b> <small>FEATURED</small>	Ultra-low Iq: 400nA, PWM/PFM 1.2MHz, 430mA@3.3V→5V, V <sub>ST</sub> =1.6V
(5) LDO	<b>XC6223</b>	High speed PSRR=80dB, 300mA, Inrush prevention

### (1) Step-down DC/DC for MCU/SoC/FPGA, RF/Sensor (POL power supply)

High-speed transient response **HiSAT-COT** controlled DC/DC arranged as POL.  
Built-in inductor **Micro DC/DC** realizes miniaturization and low EMI.  
**(XCL241/XCL242, XCL239/XCL240)**

For RF and other analogs requiring even lower noise  
Ultra-low EMI Built-in inductor **Micro DC/DC XCL241/XCL242,**  
**World's smallest solution size XC9290/XC9291.**

### (4) 3.3V input monitoring and Start-up/Shutdown Power supply sequence

Monitored by voltage detector with Manual reset function : **XC6127**  
**RC delay** to the EN(CE) pin of each DC/DC is **driven by XC6127**  
for start-up/shutdown sequence.

### (4) Step-up DC/DC for LPWAN and other RF

Low ripple/Low EMI Built-in inductor **Micro DC/DC : XCL104/XCL105, XC9145**

# HiSAT-COT® Control for Fast Transient Response

## ■ TOREX original COT control : HiSAT-COT®

### ● Technical trend and challenges

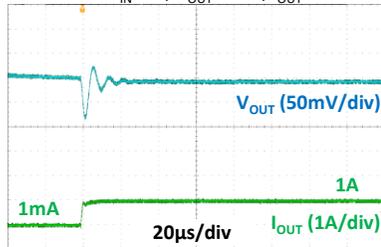
- Stable power supply including transient response to MCU/SoC/FPGA, etc.
- Miniaturization of circuits including peripheral components, and low EMI.

### ● TOREX Proposal : HiSAT-COT® controlled Step-down DC/DC converter

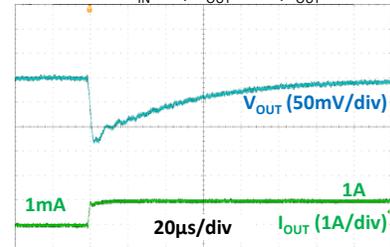
#### ➤ Significantly faster transient response

- Compared to conventional PWM and PWM/PFM control, it achieves **overwhelmingly fast response** and thus **good voltage stability**.

HiSAT-COT®  $V_{IN}=5V, V_{OUT}=1.8V, I_{OUT}=1mA \rightarrow 1A$



Conventional  $V_{IN}=5V, V_{OUT}=1.8V, I_{OUT}=1mA \rightarrow 1A$



#### ➤ Miniaturization including peripheral components

- High-speed transient response enables **significant reduction of large capacitance** required due to lack of response of conventional PWM.
- Unlike conventional PWM phase compensation, load capacitance CL can be reduced. Also **supports a significant reduction in effective capacitance due to the bias effect of ultra-small Ceramic capacitors**.

HiSAT-COT®



Conventional

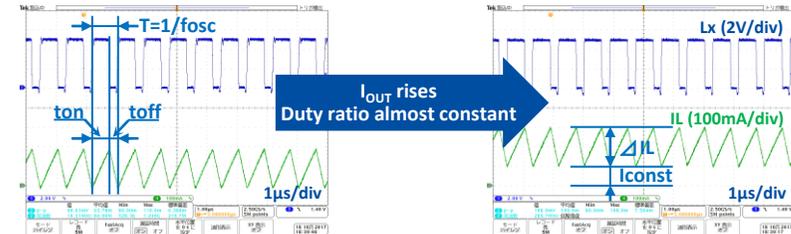


## Overview of COT control and HiSAT-COT®

### What is COT (Constant on time) control?

- PFM control with the "ton" determined by  $V_{IN}$  and  $V_{OUT}$  voltages, resulting that appears to be PWM control with constant frequency ( $f_{osc}$ ). **High-speed PFM comparator enables fast transient response.**
- Generate "ton" in CCM of the targeted  $f_{osc}$  from the  $V_{IN}$  and  $V_{OUT}$  set voltages so that it appears to be a constant frequency PWM control.

### ● CCM (Continuous Conduction Mode) operation



- Ideal Duty ratio and  $t_{on}$  of step-down DC/DC at CCM PWM operation are  $t_{on} = (1/f_{osc}) \times \text{Duty} = (1/f_{osc}) \times (V_{OUT} / V_{IN})$ .  
If there is no loss, **Duty ratio is constant** even if  $I_{OUT}$  rises.

### ● How to determine the oscillation frequency of COT control

- Generate the  $t_{on}$  of COT control to be the  $t_{on}$  of ideal PWM control.
- Continuous mode operation with this  $t_{on}$  operates with the same duty as PWM control at the oscillation frequency  $f_{osc}$ .

### ● COT issues and HiSAT-COT®

HiSAT-COT improves the issues of COT control with its own circuits.

- Improved issue of increased oscillation frequency due to output current.
- Improved the deterioration of load stability with an original circuit with an additional amplifier.

# TOREX Built-In Inductor Micro DC/DC for Achieving Small / Low EMI

## TOREX original Built-in inductor Micro DC/DC XCL Series

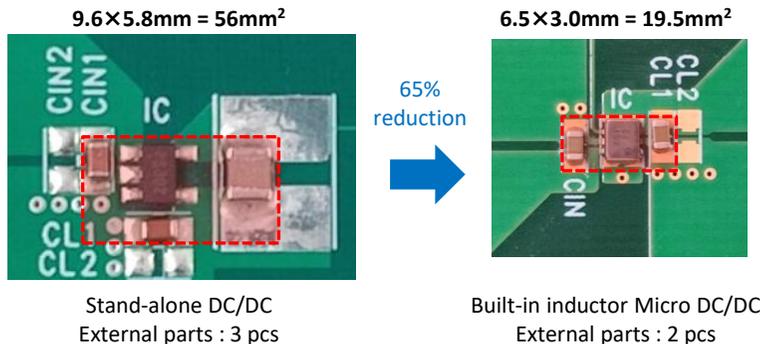
### ● Technical trend and challenges

- For stable operation of devices, it is important to place power supply ICs close to MCUs and FPGAs. Especially in cases where multiple power supplies are required, selecting power supply ICs suitable for POL (Point of Load) is a challenge.
- Miniaturization of power circuits including ICs and low EMI are essential.

### ● TOREX Proposal : Built-in inductor Micro DC/DC

#### ➢ Significant miniaturization of power supply circuit

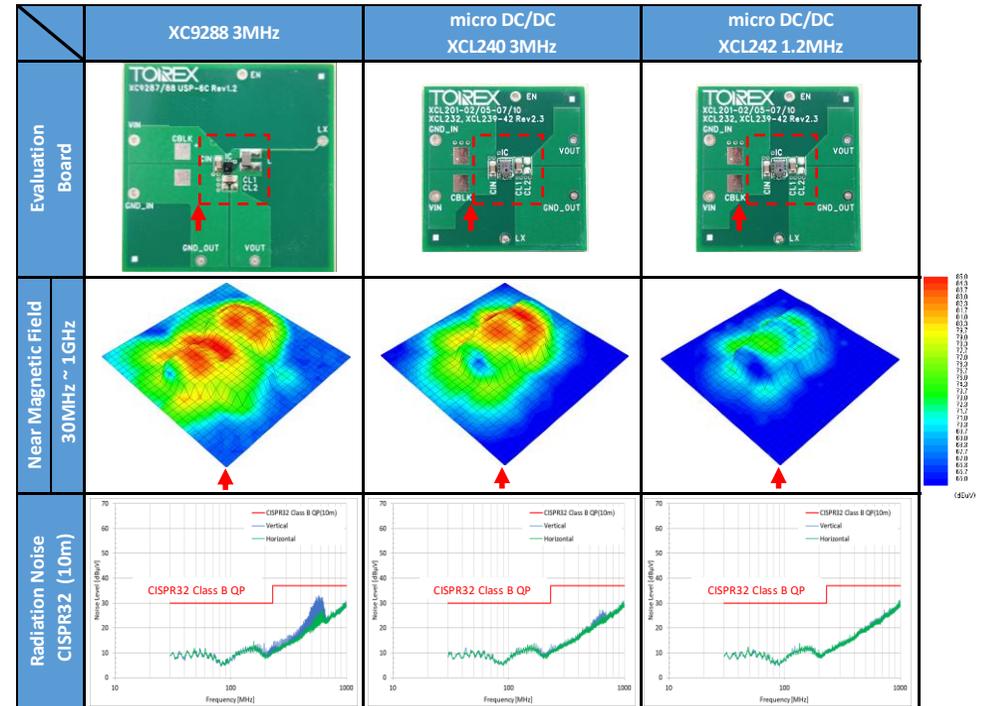
- Achieves a significant reduction in mounting area and providing smallest class of power supply solution.
- Unique package structure / Optimum inductor for the internal IC.
- Efficient heat dissipation performance with structures that connect IC/coil and substrate with low thermal resistance.



#### ➢ EMI reduction due to unique Built-in inductor structure

- ✓ The pocket-type structure covering the IC with a coil and the optimum placement of the IC enable a **significant reduction of radiated noise** compared to the stand-alone IC.
- ✓ Can be placed near RF ICs/Sensors, etc., contributing to miniaturization.

## EMI comparison of Built-in inductor Micro DC/DC and stand-alone DC/DC



### Benefits of POL (Point of Load) power supply and Micro DC/DC & HiSAT-COT®

- Shorter power supply wiring length. In addition to stable operation, reduced capacitors. Heat source dispersion facilitates heat dissipation.
- Using Micro DC/DC XCL Series with built-in inductor for POL converter enables further miniaturization, lower EMI, and easier design.
- HiSAT-COT** provides highly stable power supply, including transient response.

