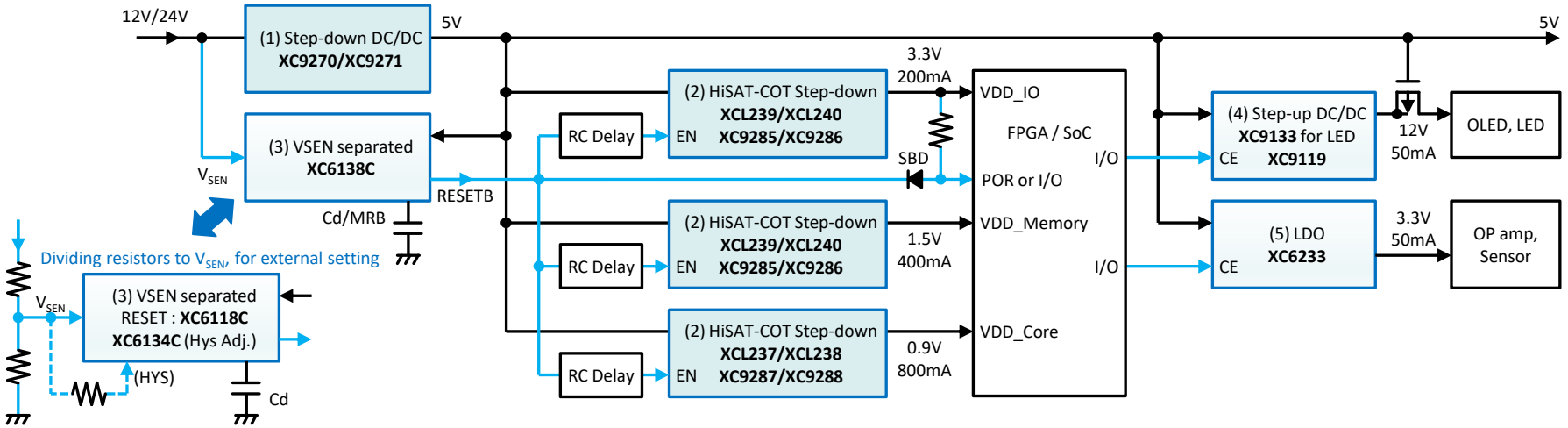
12V/24V : Multiple power rail solutions

12V/24V POL multiple rail and Positive/Negative power supply

● Challenges : Small / High efficiency / Heat source dispersion / Low EMI power supply from 12V/24V, Start-up/Shutdown sequence



Block1	Product	Features
(1) Primary Step-down DC/DC	**XC9270 / XC9271**	30V, PWM, PWM/PFM, 300kHz/500kHz, 2A
(2) Step-down DC/DC	**XCL239 / XCL240** NEW	Built-in inductor, HiSAT-COT, F-PWM, PWM/PFM 3MHz, 1A
	XCL237 / XCL238 NEW	Built-in inductor, HiSAT-COT, F-PWM, PWM/PFM 3MHz, 1.5A
	XC9285 / XC9286 NEW	HiSAT-COT, F-PWM, PWM/PFM 1.2MHz, 1A
	XC9287 / XC9288 NEW	HiSAT-COT, F-PWM, PWM/PFM 1.2MHz/3MHz, 1.5A
(3) RESET IC	**XC6138** NEW	High Voltage Low Iq Sense pin: 76V, 0.15µA@12V Ultra-low Iq 0.5µA, Release Delay adj., Selectable Hysteresis
	XC6118 / XC6134	Separated Sense pin, Delay adj., Hysteresis adj. (XC6134)
(4) Step-up DC/DC	**XC9119 / XC9133**	~19.5V, PWM, 1MHz, 100mA@5V→12V, For LED: XC9133
(5) LDO	**XC6233**	High-speed PSRR=75dB, 200mA, Inrush prevention

(1) Primary Step-down DC/DC for 12V/24V input

Input voltage range, output current, and frequency suitable for industrial products.

(2) Step-down DC/DC for FPGA/SoC (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, XCL237/XCL238)

(3) 12V/24V input monitoring Voltage Detector

12V/24V input monitoring and driving RC delay for Start-up/Shutdown sequence.
Outputs voltage drop signal to FPGA/SoC, then shutdown each DC/DC.

(4) Step-up DC/DC for OLED/LED and other I/O : Medium voltage step-up **XC9119.**

HiSAT-COT® Control for Fast Transient Response

TOREX original COT control : HiSAT-COT®

● Technical trend and challenges

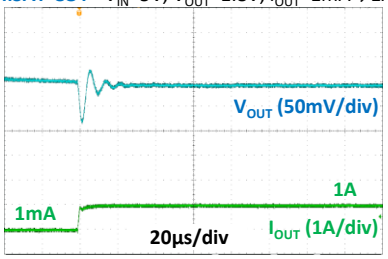
- Stable power supply including transient response to MCU/SoC/FPGA, etc.
- Miniaturization of circuits including peripheral components, and low EMI.

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

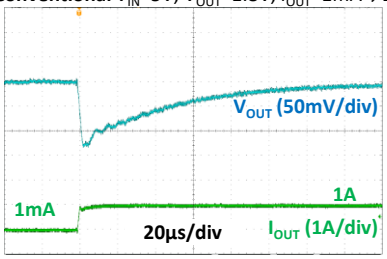
➢Significantly faster transient response

- 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→1A



Conventional V_{IN}=5V, V_{OUT}=1.8V, I_{OUT}=1mA→1A

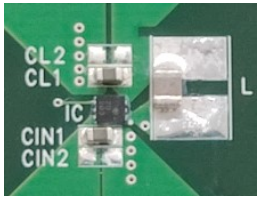


➢Miniaturization including peripheral components

- 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 (fosc).
  High-speed PFM comparator enables fast transient response.
- Generate **"ton"** in CCM of the targeted fosc 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 ton of step-down DC/DC at CCM PWM operation are
  ton = (1/fosc) x Duty = (1/fosc) x (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 ton of COT control to be the ton of ideal PWM control.
- Continuous mode operation with this ton operates with the same duty as PWM control at the oscillation frequency fosc.

● 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

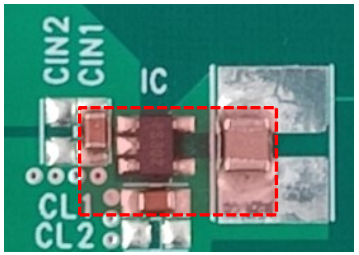
- For stable operation of devices, it is important to place power supply ICs close to MCUs and FPGAs. Especially in cases where multiple power supplies are required, selecting power supply ICs suitable for POL (Point of Load) is a challenge.
- Miniaturization of power circuits including ICs and low EMI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

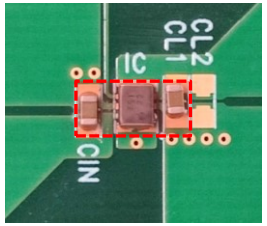
9.6×5.8mm = 56mm²



Stand-alone DC/DC
External parts : 3 pcs

65% reduction

6.5×3.0mm = 19.5mm²



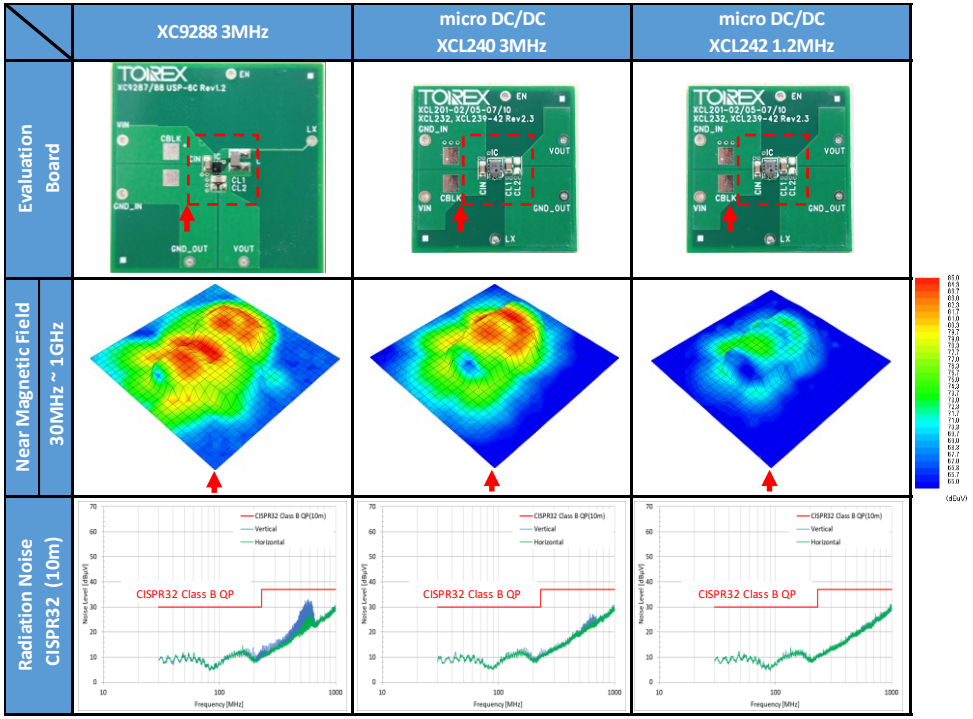
Built-in inductor Micro DC/DC
External parts : 2 pcs

➢**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.

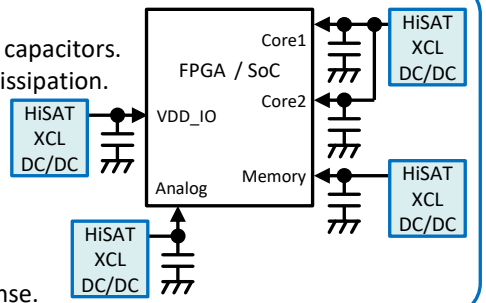
✓Can be placed near RF ICs/Sensors, etc., contributing to miniaturization.

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.



Space-Saving DC/DC and Voltage Monitoring for Medium and High Voltage Inputs

For fluctuating 12V/24 or higher lines

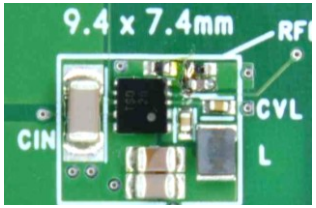
Technical trend and challenges

- Overshooting must be addressed. Power supply inputs of 40 V or higher are also becoming more common, and heat generated by LDOs is also an issue.
- Large fluctuations in the power supply line due to impedance, load fluctuations and induction from motors, etc., must be addressed.

TOREX Proposal : Space-saving step-down DC/DC for high voltage and high step-down ratio, and voltage detector with wide range of release/detection voltage

➢60V 300mA High-voltage Step-down DC/DC : XC9702 NEW

- Supports 60V operation and high step-down ratio.
- Capable of direct step-down from 24V with large fluctuation to 3.3V.
- High efficiency from light loads. F-PWM and PWM/PFM can be selected from MCU by MODE pin.
- Small and Space-saving suitable for replacing LDOs

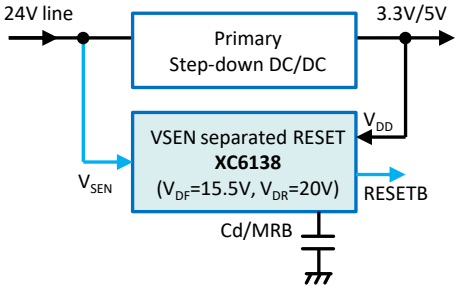


60V 300mA DC/DC : XC9702
World's smallest class of solution size
9.4mm x 7.4mm = 69.6mm²

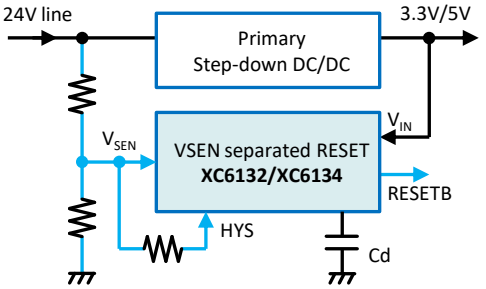
➢Voltage detector with large release/detection difference : XC6138 NEW **, XC6132/XC6134**

- Release voltage is set to a voltage sufficient for rise.
- A large hysteresis is set for Detect voltage, considering large fluctuations in the power supply line. Before the 3.3V/5V line voltage drops, the MCU can be notified to perform stop processing, etc., to ensure stable and safe operation of products.

XC6138 : 76V high-voltage sense pin
Wide hysteresis width selectable



XC6132/XC6134
Hysteresis width set by an external resistor
(**XC6132** : V_{SEN} pin surge voltage protection)



XC6138 : 24V line and voltage monitoring