

Torex...Powerfully Small!

**60V/300mA Synchronous
Step-down DC/DC Converter
XC9702 Series Product Overview**

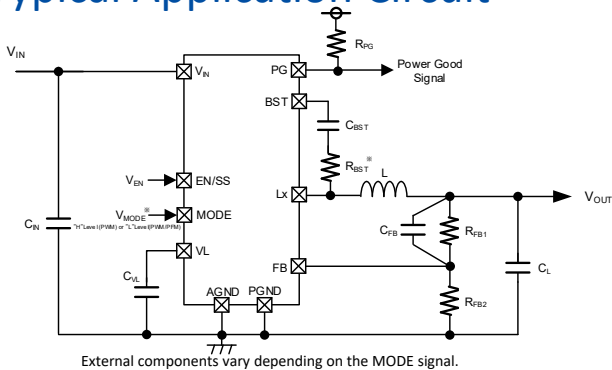
May 2024
TOREX Semiconductor
Rev. 2.1

60V Smallest solution size / Low Iq and high efficiency at light loads / Supports high step-down ratios

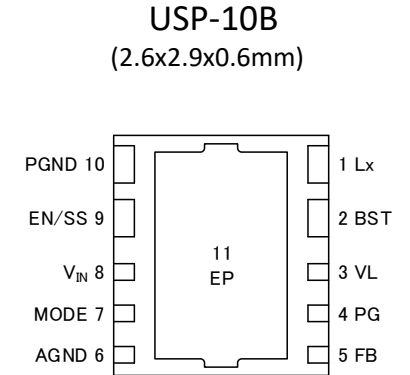
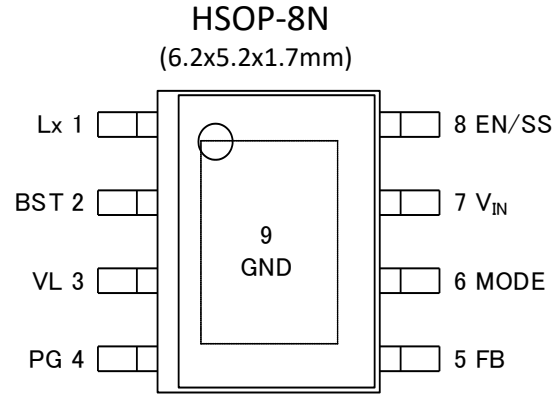
■ Features

Input Voltage	: 4.5V ~ 60.0V (Absolute Max. : 66.0V)
Output Voltage Range	: 2.5V ~ 12.0V (FB: 0.75V±1.5%)
Output Current	: 300mA
Supply Current	: 12µA
Oscillation Frequency	: 1.0MHz
Efficiency	: 83% (V _{IN} =12V, V _{OUT} =5V, I _{OUT} =1mA)
Control Method	: F-PWM (MODE="H") PWM/PFM (MODE="L")
Function	: Soft-start (External Adj.) Power Good UVLO
Protection	: Current Limit, Over Voltage Protection Thermal Shutdown Lx Short Protection
Package	: HSOP-8N, USP-10B
Operating Ambient Temp	: -40°C ~ 125°C

■ Typical Application Circuit

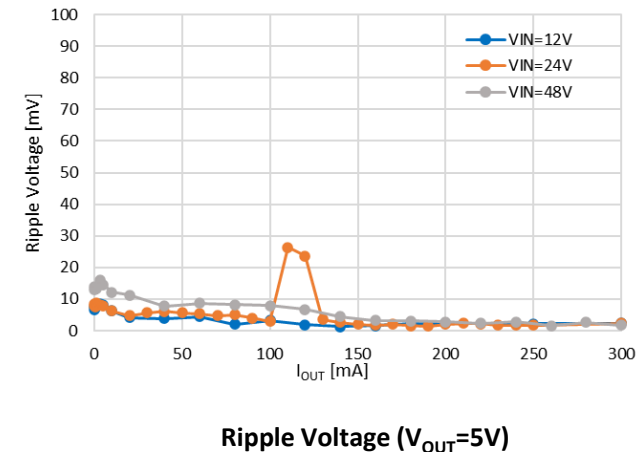
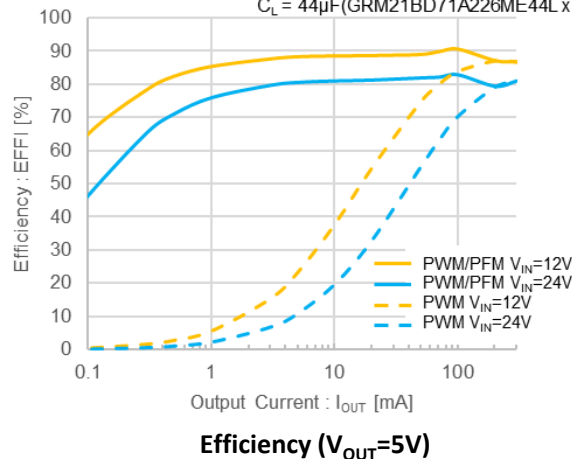


■ Package



■ High Efficiency / Low Ripple Voltage

L = 100µH(LBXHRF5050XAT101MMR)
C_{IN} = 4.7µF(GCM32DC72A475KE02L,
C_L = 44µF(GRM21BD71A226ME44L x 2)



60V High voltage Step-down DC/DC convertor, XC9702 series

- High voltage step-down DC/DC converter to meet requirements for compact and low Iq step-down from 12V/24V line



Ultra-small and low Iq

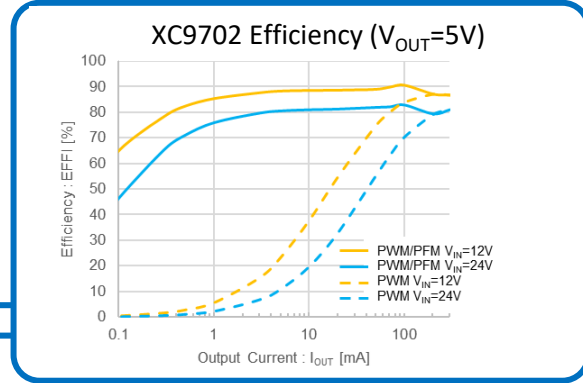
①

②

For FA / Industrial Products

① Ultra-small / High efficiency at light load

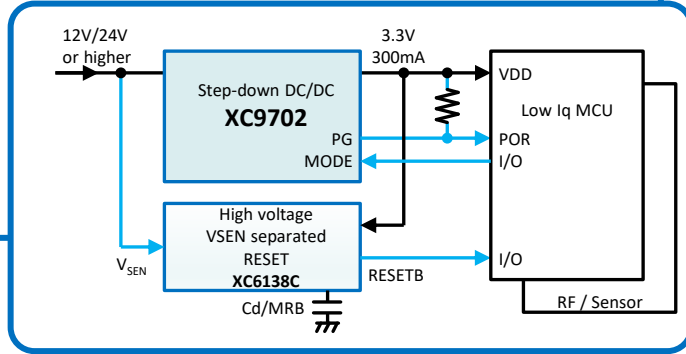
- ✓ 60V Smallest Class Solution Size
- ✓ For low consumption in standby
- ✓ Solving the heat problem of medium and high voltage input LDOs by replacing them with a smaller area.



② High voltage / Low ripple / High temp.

“60V input”, “High step-down ratio”, “MODE(PWM↔PWM/PFM)”, and “+125°C operation”

- ✓ Low ripple 3.3V/5V output from unstable 24V input to FA/sensors
- ✓ Handling input overshoots and high temperatures

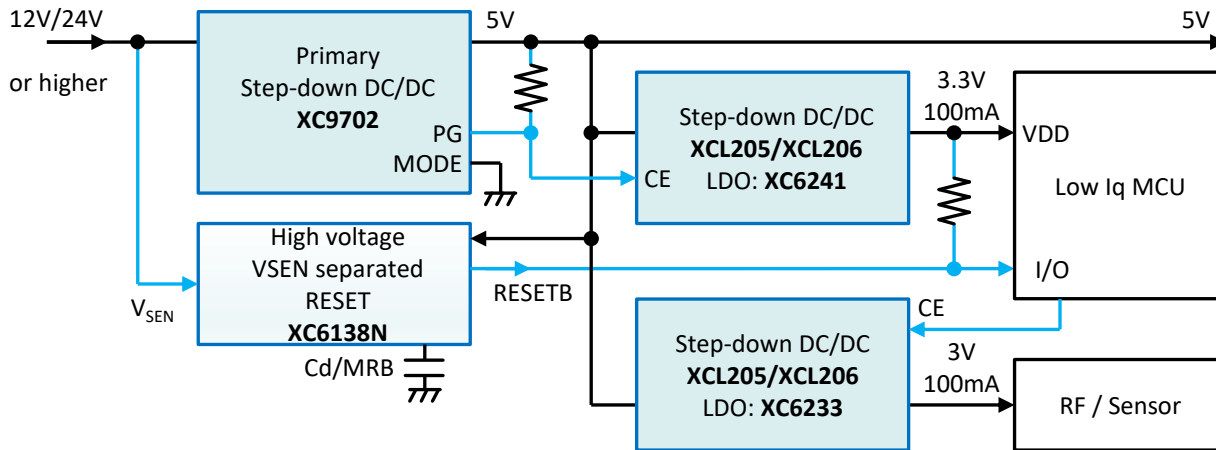


Ideal for miniaturization / heat reduction due to high voltage / small size / low Iq.
Also suitable for replacing conventional high-voltage LDOs.
➤ **Sensors and security for Factories / Buildings / Facilities, etc.**

In addition, 125°C operating temperature and 60V operation for overshooting
➤ **Suitable for various FA sensors**

■ Various small devices and modules with 12V/24V or higher input : Industrial sensors / IoT

- Once step-down to 5V, then generate 3.3V

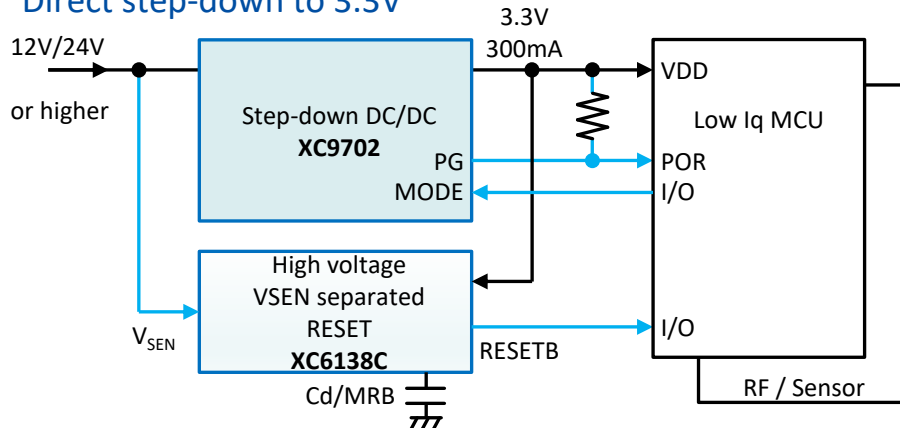


Supplies power to MCUs, sensors, etc., by stepping down from 12V/24V or higher to 5V, and then stepping down to 3.3V, 3.0V, etc.

Controls the sequence of the subsequent power supply with the PG of the XC9702.
 MODE "H" ⇒ PWM
 MODE "L" ⇒ PWM/PFM

Supervises 12V/24V power voltage with XC6138N and monitor output to MCU.

- Direct step-down to 3.3V



Direct step-down from 12V/24V to 3.3V.
 Power source for small sensors used in FA.

Control method can be changed dynamically with the MODE pin.

MODE "H" : PWM ⇒ Low noise (For sensors, etc.)
 MODE "L" : PWM/PFM ⇒ High efficiency at light load

■ 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

- 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



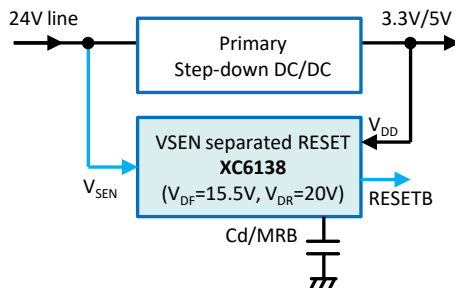
60V 300mA DC/DC : XC9702
World's smallest class of solution size
9.4mm x 7.4mm = 69.6mm²

➤ Voltage detector with large release/detection difference : XC6138, 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.

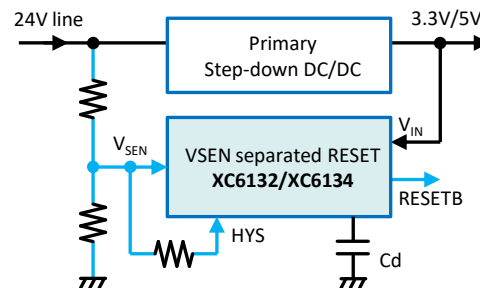
XC6138 : 76V high-voltage sense pin

Wide hysteresis width selectable

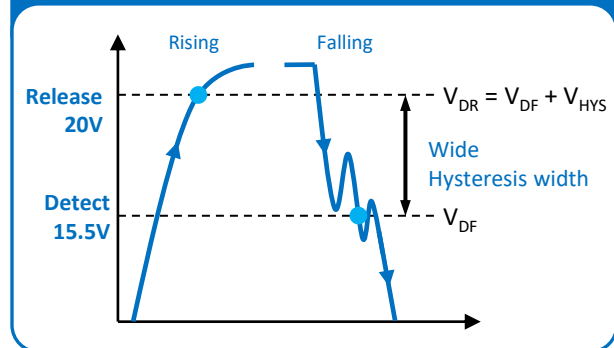


XC6132/XC6134

Hysteresis width set by an external resistor
(XC6132 : V_SEN pin surge voltage protection)



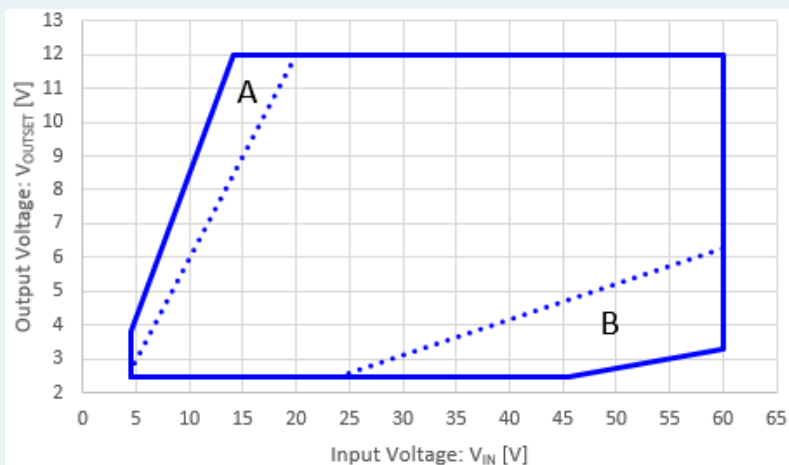
XC6138 : 24V line and voltage monitoring



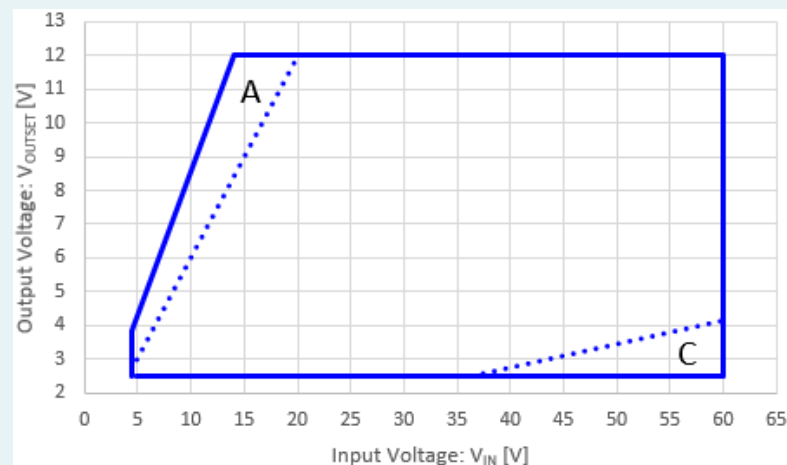
- The area where the DC/DC converter can supply a stable output voltage is called the " Stable output region" and is indicated by the **solid blue line** in the graph below.

※MIN ON TIME PWMモード : 55ns, IO_{UT}=100mA以下 : 110ns

PWM mode (MODE="H")



PWM/PFM Auto-switch mode (MODE="L")



Please note the following points when using A~C within the stable output range.

Stable output voltage is supplied even in the A~C range.

- A) Transient response may be reduced.
- B) Oscillation of V_{OUT} waveform which increases ripple may occur at light loads where I_{OUT} is 100mA or less.
- C) Operation is stable, although it may not shift to PWM operation even at the maximum output current.

Operation outside the Stable output region

- Under high step-down ratio conditions, abnormal sinusoidal oscillation or pulse skipping may occur.
- Under low step-down ratio conditions, the IC operates at the Maximum Duty Cycle, and the output voltage may drop below the set V_{OUT} voltage.

Even in these cases, there is no malfunction or reduction in product life.

■ Voltage inverting using step-down DC/DC

To obtain an inexpensive inverting voltage using step-down DC/DC.
 To generate an inverting voltage of -2.5V~ -12V from 5V/12V/24V.

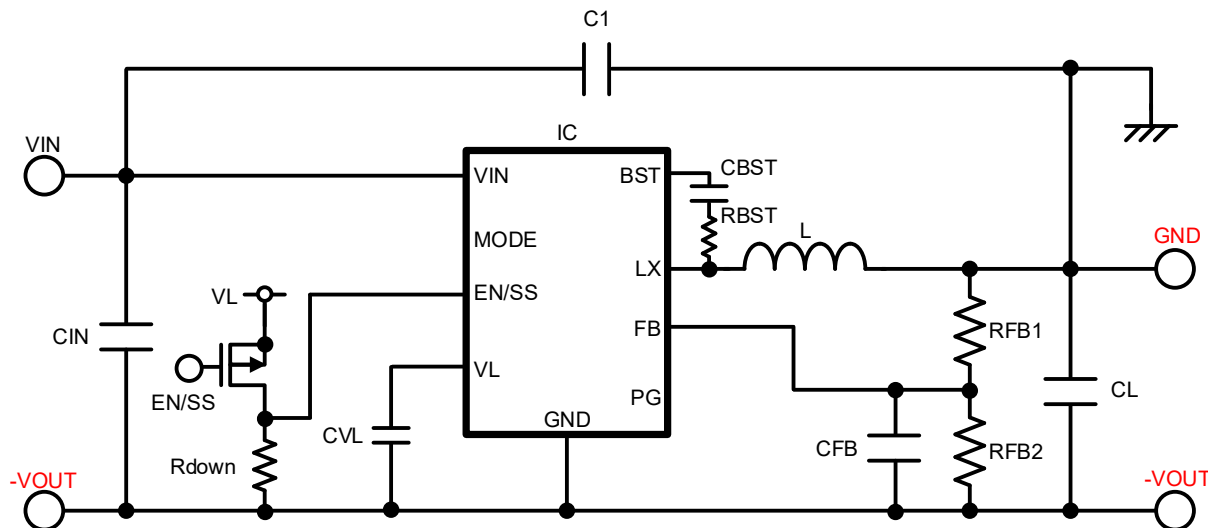
● Applications

- Various negative power supplies (OP amp/measuring amplifiers $\pm 12V$ etc.)
- Gate drive bias (floating power supply / negative power supply)

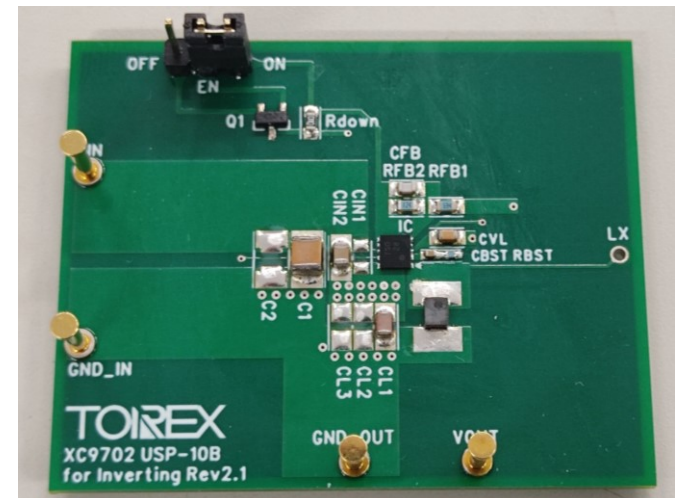
■ Example specifications

Input Voltage	: 4.5V ~ 60.0V + V_{OUT}
Output Voltage	: -2.5V ~ -12.0V
Output Current	: Max. 50mA ~ 100mA
Features	: Inverting voltage generation using step-down DC/DC Small size solution

■ Typical Application Circuit



■ Evaluation Board



XC9702 Application circuit2 : Multi-channel isolated power supplies using transformers /couple inductors

Multi-channel isolated power supplies using transformers /couple inductors

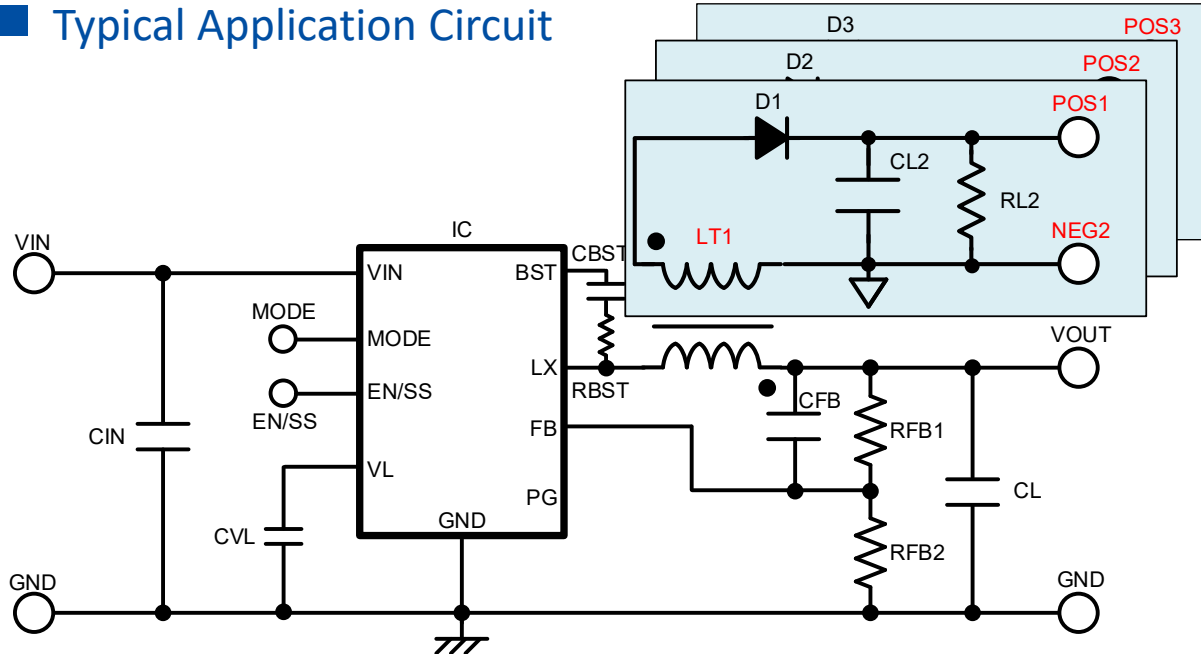
To obtain an inexpensive isolated power supplies using transformers/couple inductors.

To generate multi-channel of small power isolated power supplies
To be used for floating power supplies, inverting power supplies, etc.

Applications

- Isolated power supply
- Various negative power supplies (OP amp/measuring amplifiers $\pm 12V$, $\pm 15V$, etc.)
- Gate drive bias (floating power supply / negative power supply)

Typical Application Circuit



Example specifications

Input Voltage	: 4.5V ~ 60.0V
Output Voltage 1	: 2.5V ~ 12.0V
Output Voltage 2~	: 5V/12V/15V etc
	*depending on the winding ratio
Output Current 1	: Max 100mA ~ 200mA
Output Current 2~	: Max 10mA ~ 20mA
Features	: Floating voltage available. Multi-channel are possible by transformers.

Evaluation Board

