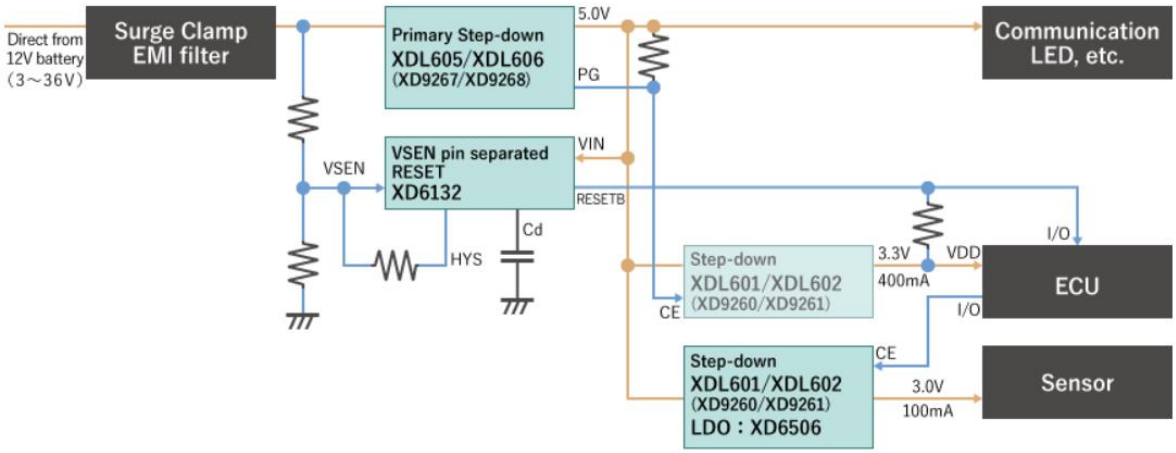
Applications and Solutions for Automotive
Compact units directly connected to 12V battery

Examples of various types of compact units, sensors, and modules to be directly connected to 12V battery.Particular detail is given to the selection of power supply ICs required for miniaturization, and special measures taken to address unstable 12V battery rail.



Block Diagram	Power Supply Requirements	Recommended Products	Features
Step-down For Primary: 12V direct from battery to Secondary	**Specifications** V_{IN}: ~36V V_{OUT}: 5V I_{OUT}: 500mA fosc > 2MHz **Other points** •Compact size / high heat dissipation / low noise •Even if V_{IN} falls below V_{OUT} due to situations such as a cold crank, V_{OUT} is maintained as high as possible	XDL605 / XDL606 (XD9267 / XD9268)	**Inductor built-in step-down DC/DC, PWM (XDL605), PWM/PFM (XDL606)** •Integration of IC and coil achieves high space-saving capabilities, high efficiency, high heat dissipation, and low EMI •Pch SW supports 100% duty ratio to correspond V_{IN} decrease •XD9267 (PWM) and XD9268 (PWM/PFM) with external coil are also available AEC-Q100 Grade-2 V_{IN}: 3~36V (Absolute maximum rating of 40V, and 46V < 400ms) V_{OUT}: 1.8V~5V (Set using external resistance. XD9267 / XD9268: 1V~25V) I_{OUT}: 600mA fosc: 2.2MHz Maximum Duty ratio: 100% (Pch SW) Soft-start: Can be externally adjusted Power Good Package compatible with wettable flanks (XDL605 / XDL606)
Step-down For ECUs	**Specifications** V_{OUT}: 3.0V I_{OUT}: 400mA fosc > 2MHz **Other points** •High efficiency •Low noise	XDL601 / XDL602 (XD9260 / XD9261)	**Inductor built-in HiSAT-COT step-down DC/DC, PWM (XDL601), PWM/PFM (XDL602)** •Low ripple, and low EMI of integrated coil, make it ideal to prevent interference on telecommunications and sensors •High-speed transient response due to HiSAT-COT control •XD9260 (PWM) and XD9261 (PWM/PFM) with external coil are also available AEC-Q100 Grade-2 V_{IN}: 2.5~5.5V V_{OUT}: 0.8V~3.3V (XD9260 / XD9261: 0.8~3.6V) I_{OUT}: 1.5A fosc: 3.0MHz (XD9260 / XD9261: 1.2MHz, 3.0MMHz) Package compatible with wettable flanks (XDL601 / XDL602)

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Block Diagram	Power Supply Requirements	Recommended Products	Features
Step-down / LDO For sensors	**Specifications** V_{OUT}: 3.0V I_{OUT}: 100mA **Other points** •ON/OFF control from ECU •Low noise	XDL601 / XDL602 (XD9260 / XD9261)	**Inductor built-in HiSAT-COT step-down DC/DC, PWM (XDL601), PWM/PFM (XDL602)** •Low ripple, and low EMI of integrated coil, make it ideal to prevent interference on telecommunications and sensors •High-speed transient response due to HiSAT-COT control •XD9260 (PWM) and XD9261 (PWM/PFM) with external coil are also available AEC-Q100 Grade-2 V_{IN}: 2.5~5.5V V_{OUT}: 0.8V~3.3V (XD9260 / XD9261: 0.8~3.6V) I_{OUT}: 1.5A fosc: 3.0MHz (XD9260 / XD9261: 1.2MHz, 3.0MHz) Package compatible with wettable flanks (XDL601 / XDL602)
		XD6506	**Low consumption, low noise voltage regulator** •Low level of high-frequency noise, suitable for sensors AEC-Q100 Grade-2 V_{IN}: 1.5~6.0V V_{OUT}: 1.2V~5.0V Iq: 0.8μA I_{OUT}: 150mA
RESET For monitoring 12V rail directly from battery	**Specifications** Detect voltage: 6~7V Release voltage: 9V **Other points** •Hysteresis width can be set as desired •Release / detect delay •Can support positive / negative surge voltage in 12V rail	XD6132	**Separated sense (VSEN) pin and capacitor delay type low-power voltage detector** •Separated sense pin uses split resistors, making it ideal for monitoring 12V rail directly from battery •Sense pin include internal surge voltage protection circuit •Can support release / detect delays using one external capacitor •Detect / release delay time ratios can be selected from 4 patterns •Hysteresis external adjustment function makes it possible to set any desired detection / release voltages for stable operation of device AEC-Q100 Grade-1 V_{IN}: 1.6~6.0V Detection voltage: 1.0V (Separated sense pin. Can be set as desired with external divider resistors) Iq: 1.28μA

Solution Overview

Requirements for power supplies are becoming more severe particularly for compact sizes, low noise, and low power consumption, due to an increase in the number of various sensors, controllers, modules, and units controlled by ECU and used in internal automobile components, as well as advancements in their functionality.

Primary step-down DC/DC

These generally have a structure where the voltage is decreased to the common voltage at the first stage, and then decreased further at the second stage to the individual required voltages to be supplied. These are referred to as the primary power supply and secondary power supply respectively.
For primary DC/DC, use a switching frequency of 2MHz or greater in consideration for EMI.
If a light load condition will be experienced for a long time, and a decrease in frequency during that time is allowed, select the PWM/PFM automatic switching type. If it is desired to keep the operating frequency constant regardless of the load condition, select the PWM fixed type.

Also, starting from conditions such as cold cranks or idling stops, or elements such as long harnesses, will cause the power supply line voltage to decrease significantly, so the Pch SW type, which supports a duty ratio of 100% and can easily maintain the output voltage even when there is a drop in input voltage, is suitable in such cases.

Step-down DC/DCs, 36V operation
(absolute maximum rating of 40V, and 46V ≦ 400ms)

XDL605: Inductor built-in PWM
XDL606: Inductor built-in PWM/PFM
XD9267: PWM
XD9268: PWM/PFM

Use the PG (Power Good) pin and soft-start time settings of the primary DC/DC for the rise-up sequence. After sufficient rise-up of the primary DC/DC, the CE is driven by the PG pin to perform rise-up of the secondary DC/DC, to prevent malfunctions of the ECU.

Also, in order to suppress spike noise from the primary input or radiation noise from the connected harness, it is common to use surge clamps or EMI filters at the primary DC/DC input. For information on the filter which is compatible with CISPR 25 of XDL605, refer to the noise data at the following link.

※CISPR25_Class5 Noise Data

XDL605-CISPR25_Class5.pdf[2.6MB]

Solution Overview

Step-down DC/DC for ECU

It is recommended to use a compact, high-speed response, low-noise DC/DC to the secondary power supply for ECU.

Step-down DC/DCs
XDL601: Integrated coil type PWM, high-speed transient response, low EMI
XDL602: Integrated coil type PWM/PFM, high-speed transient response, low EMI
XD9260: PWM, high-speed transient response
XD9261: PWM/PFM, high-speed transient response

Although it is common to use a value of 2MHz or greater for the DC/DC switching frequency, since it is not directly connected to the outside using a harness as with a primary DC/DC, a relatively lower frequency may be used in some cases for greater efficiency. The XD9260 and XD9261 include both 3.0MHz and 1.2MHz types for this reason.

DC/DC for sensors, and LDO

Due to their low noise, the same DC/DCs used in ECUs are suitable for sensor power supplies as well. Also, if low noise/ripple is important, LDOs which have low power and low noise are ideal. These have two cases: a case where the LDO input is obtained from 5V as shown in the diagram above, and a case where it is obtained from a 3.3V rail for ECUs.

Step-down DC/DCs
Refer to components for ECUs
Voltage regulato
XD6506: Low power

The sensor is only turned ON when necessary, so the CE signal is controlled by the ECU.

RESET IC for input voltage monitoring

Voltage detector with a separated sense (VSEN) pin is used for monitoring the input voltage on the primary side.
Monitoring the input Voltage to helps to ensure stable operation and is useful for power sequencing (when implementing start-up and shut-down sequences).
The VSEN pin uses divider resistors which are connected to the primary side input voltage supply. The divider circuit allows the Voltage Detector to monitor voltages that exceed the absolute maximum voltage range of the IC.

The voltage detector signal is needed when the MCU is operational, so the voltage detector is powered from the primary output. And the RESETB output is connected to the MCU's I / O and is monitored by the MCU.

Voltage Detector
XD6132: Separated Sense pin, HYS (hysteresis) external adjustment,
External Cd for release / detect delays, Sense pin surge voltage protection circuit

Solution Overview

The overall operation combining this voltage detector with the PG functions of the DC/DC are as shown below.
Example: Case where primary V_{IN}: 12V directly from battery, V_{OUT} of primary DC/DC: 5V, Detection voltage of voltage detector: 7V, release voltage: 9V

(a) During application of input voltage or recovery after cold crank
When the 12V directly from the battery rises up and the primary DC/DC rises up so that the output voltage reaches 5V, PG becomes "H".This causes the secondary stage CE to go "H" and the secondary DC/DC starts-up and supplies voltage to the ECU.
If the Voltage Detector input voltage exceeds the release voltage of 9V, RESETB becomes "H" and the ECU is notified that the input voltage is normal.
The Voltage Detector is not monitoring the DC/DC output voltage, so it is necessary to set a release delay time (using the Cd pin capacitor) which takes into account the rise-up time of the DC/DC's output Voltage.

(b) During input voltage drop and cut-off
If the input voltage falls below the detect voltage of 7V, RESETB becomes "L" and the ECU is notified of the voltage drop.
In response to this signal, the ECU can decide to safely stop operation before the DC/DC output voltage drops or it may need to execute back-up procedures to save important data before the power fails.

Benefits can be provided here by HYS (hysteresis) external adjustment and detect delay times.

- HYS (hysteresis) external adjustment
  In the example, the detection / release voltages = 7V / 9V, but generally voltage detectors have a release voltage fixed at a level of roughly +5% of the detection voltage, so it is not possible to designate detection / release voltages which have consideration for cold cranks in this way.
  Voltage detectors with HYS (hysteresis) external adjustment function makes it possible to set any desired detection voltage and release voltage using an external resistor, which is essential for applications with direct connection to battery due to their severe fluctuations.
- Setting of detection delay time
  If the voltage drop is only for a very short duration it can be desirable not to stop the ECU, so to avoid false resets the detectuon delay function is used.

As we have seen, small, compact DC/DCs and Voltage Detectors can be used to a configure a simple power supply, optimised for safe, efficient operation.
In the past, Voltage Regulators were used more frequently, but due to the increase in ECUs installed in automobiles, with greater emphasis now placed on overall power efficiency and reducing the system power consumption, DC/DCs are increasingly becoming the preferred choice for new designs.
Furthermore, by controlling with a voltage detector with special functions as described above, it is possible to realize more suitable control for the safe and accurate operation required for Automotive equipments.