The bottom detection comparator method can be used to achieve extremely stable output voltage control compared to the voltage/current control method even when there is current overload or a large difference between the input and output voltages. Another feature of this method is that no phase compensation circuit is required. Herein, FUJITSU SEMICONDUCTOR introduces a new product that realizes improved output voltage precision and low output ripple operation through the addition of a novel proprietary circuit to this bottom detection comparator method.

**Introduction**

Among the many products that FUJITSU SEMICONDUCTOR develops, it has a focus on power management ICs for image processing SoCs used in digital household appliances and game machines. This time, we have developed “MB39A214,” a 2-channel synchronous rectification down conversion DC/DC converter IC that has our new proprietary circuit added to the bottom detection comparator method. This method is employed for these products.

In the bottom detection comparator method, switching control in OFF time is executed with fixed ON time while constantly
comparing the output voltage against the reference voltage using a high-speed comparator. This method excels in “high-speed overload responsiveness” and “stable low on-duty operation.” One of its prominent features is that no phase compensation circuit is required.

The conventional bottom detection comparator method has a problem that some output ripple voltage is required for control.

This product has overcome this problem through the addition of our new proprietary circuit. Furthermore, it has a built-in PFM (Pulse Frequency Modulation) function to improve the efficiency under small loads, which is essential for recent energy-saving products that consider the environment. Both stable low-voltage output and energy saving can be realized with this product.

Product Features

- 2-channel Nch/Nch synchronous rectification down conversion type
- Method: Low output voltage ripple addressed, bottom detection comparator method
- High efficiency
- Power supply voltage range: 6V to 28V
- Output voltage range: 0.7V to 5.3V
- Maximum output current: 15A possible (with external FET)
- Oscillation frequency: 310kHz/620kHz/1MHz (selected)
- Ultrahigh-speed overload responsiveness
- Low on-duty operation addressed (high-efficiency, stable operation even with a large difference between input and output voltages)
- High-precision reference voltage: 0.7V ± 0.7% (Ta=25°C)
- Dramatic reduction in external parts: can be constructed with external parts such as 2 input-output capacitors, 1 coil, 1 Power MOS-FET: (dual), 3 chip resistors, and 3 capacitors per channel (including common parts for 2 channels)
- Built-in PFM function: Selection between automatic PFM/ PWM switching mode and fixed PWM mode is possible
- Selection of PAF (Prohibit Audio Frequency) ON and OFF for audio restriction function is possible when the PFM function is enabled
- Substantial protective functions: Undervoltage lockout circuit block (UVLO), overcurrent protection, over temperature protection, undervoltage protection, and overvoltage protection
- Built-in load-independent soft-start function
- Built-in FET for output voltage discharge: Requires no external discharge resistor
- Package: TSSOP-24: 4.4mm × 6.5mm × 1.2mm (0.5mm-pitch)

Functions

Figure 1 presents the conversion efficiency–load current characteristics of this product, Figure 2 its load response waveform, Figure 3 the block diagram and timing diagram for the bottom detection comparator method of a conventional product, Figure 4 the block diagram and timing diagram for this product (with the addition of our proprietary circuit), Figure 5 a comparison of the features of a conventional product and this product, and Figure 6 an application example.
Main control method
This product is an Nch/Nch synchronous rectification down conversion type DC/DC Converter IC that adopts the bottom detection comparator method, addressing low output voltage ripple. It addresses ultrahigh-speed overload responsiveness with fixed ON time and OFF time control as well as low on-duty operation. No phase compensation circuit is required. Our proprietary circuit generates a slope that is equivalent to the ripple on the reference voltage within the IC with the addition of coil current gradient of the synchronous rectification period (tOFF) to the reference voltage (INTREF). As illustrated in Figure 4, the reference voltage (INTREF) results in comprising the ripples. Therefore, no output ripple is needed and stable operation is addressed even under low output voltage ripples.

Oscillation frequency
The oscillation frequency can be selected from among 310kHz, 620kHz, and 1MHz. It is set up by the GND connection, open, or VB connection of the FREQ pin.

PFM function and PAF function
In automatic PFM/PWM switching mode, this product operates in the PFM mode or the PWM mode depending on the load current. The PFM mode lowers the oscillation frequency
depending on the load current when the load becomes smaller and improves the conversion efficiency characteristics by reducing the self-consumption of current. This product also has a built-in PAF function, which fixes the lower limit of oscillation frequency to 30kHz so that it will not be in the audio (approx. 20Hz to 20kHz) when the oscillation frequency is reduced under the PFM mode.

The automatic PFM/PWM switching mode, automatic PFM/ PWM switching mode with PAF function, and fixed PWM mode are set up by the GND connection, open, and VB connection of the MODE pin, respectively.

- **Load-independent soft-start function**
  The soft-start function prevents the inrush current at output voltage startup. The soft-start period is set up for each CH by the capacitor connected to the CS pin. This soft-start function is independent of the load and can thus be used in the startup sequence setup and so forth.

- **Output discharge function**
  The output of each CH has a built-in FET for output capacitor discharge. By setting the EN pin for each CH to “H”→“L” (start → stop), FET for discharge is turned ON (Ron = 20Ω) and discharges the output capacitor. The discharge operation is stopped when the output decreases to 0.15V. This function also operates when output is stopped by the various protective functions in addition to the EN pin control.
■ Overcurrent protection function
This function controls the current so that the output current will not exceed the set current value. In addition, the output voltage drops when the output current reaches the restriction value. In this case, output from both CHs is stopped (latch stop) when the conditions of undervoltage protection function are satisfied.

The current restriction value is set up by connecting a resistor to the ILIM pin. Whereas the ON resistor for FET on the synchronous side is used for current detection, this product also has a built-in circuit for reducing the temperature dependency of the ON resistor.

■ Over temperature protection function
This function protects the IC from thermal destruction. It stops the output from both CHs and discharges the output capacitor from discharge FET when the joint temperature reaches +150°C. It starts up both CHs with soft-start operation when the joint temperature drops to +125°C (automatic recovery).

■ Undervoltage protection function
This function stops the output when the output voltage drops to an abnormal level. When the output voltage drops to 70% of the set voltage or lower for 150μs or longer, output from both CHs is stopped and the output capacitor is discharged by the discharge FET (latch stop).

■ Overvoltage protection function
This function stops the output when the output voltage rises to an abnormal level. When the output voltage rises to 115% of the set voltage or higher for 15μs or longer, latch stop is executed on output from both CHs. At this time, the main side FET is turned OFF and the FET on the synchronous side is turned ON (latch stop).

Applications
Figure 6 presents an application example. This product is optimal for applications in digital TVs, BD recorders, multifunction printers, amusement devices, and so forth. Power supply to the core or I/O image processing SoC, DDR2/3 memory, and so forth is addressed with 1 chip.

Evaluation Board
We offer an evaluation board for single unit evaluation of this product.