Use of a D/A Converter to Vary the Output Voltage of a DC/DC Converter

■ General Description

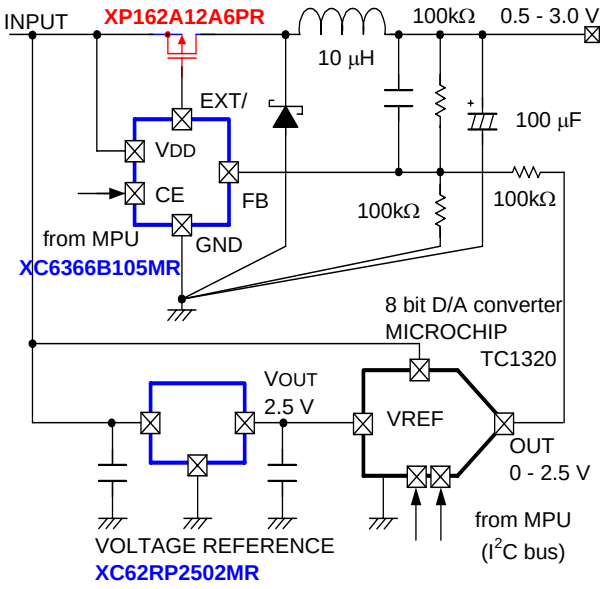
There is a need to control the output voltage of a DC/DC converter from an external source.
In recent years, electronic products in most cases incorporate digital control, making use of a CPU.
This paper explains circuits incorporating a D/A converter that can be connected via a direct interface to a CPU.
A voltage-outputting D/A converter is used.
The FB version of a DC/DC converter is used. (The output voltage in the case of the FB version is set by external resistors.)
The circuits are usable for either step-down or step-up applications and at either FB voltage of 1 or 0.9 V.

■ Circuits

Example 1 (See figure below for component constants.)
Output voltage: 0.5 to 3.0 V
Resolution: 8 bits; 1 LSB: 10 mV
D/A converter full scale: 255
D/A converter output voltage: 0 to 2.5 V
D/A converter setting: 255 for output voltage of 0.5 V
D/A converter setting: 0 for output voltage of 3 V

Example 2 IC: XC9103/4/5 series Output voltage: 3 to 8 V
Resolution: 10 bits; 1 LSB: 5 mV, VREF voltage: 2 V
D/A converter full scale: 1024
D/A converter output voltage: 0 to 2 V
D/A converter setting: 1023 for output voltage of 3 V
D/A converter setting: 0 for output voltage of 8 V
RFB1=270 kΩ, RFB2=50 kΩ, RDAC=108 kΩ

Fig. 1



■ Calculation

As a first step, choose an arbitary value for RFB2.

$$\frac{1}{RFB2} = \left[\frac{\frac{VOUTmax}{VFB} - 1}{RFB1} \right] - \frac{1}{RDAC}$$

$$RDAC = \frac{VDAC\ variation}{VOUT\ variation} \times RFB1$$

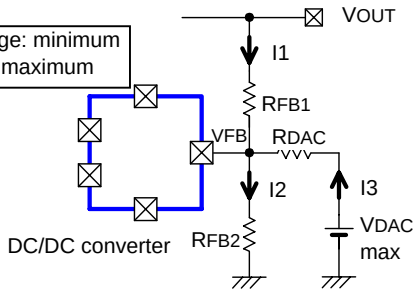
$$VOUTmax = \left[\frac{RFB1}{RFB2} + \frac{RFB1}{RDAC} + 1 \right] \times VFB$$

$$VOUTmin = \left[\frac{RFB1}{RFB2} + 1 \right] \times VFB - \frac{RFB1}{RDAC} \times (VDACmax - VFB)$$

■ Principle of Operation

DC/DC converter output voltage: minimum
D/A converter output voltage: maximum

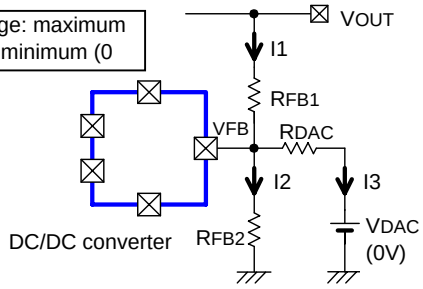
Fig. 3



The output voltage, VOUT, decreases if current flows into the FB pin from the output voltage of the D/A converter, VDAC.
The output voltage, VOUT, is inversely proportional to the output voltage of the D/A converter, VDAC.
I1 = I2 - I3, VOUT = I1 * RFB1 + I2 * RFB2

DC/DC converter output voltage: maximum
D/A converter output voltage: minimum (0

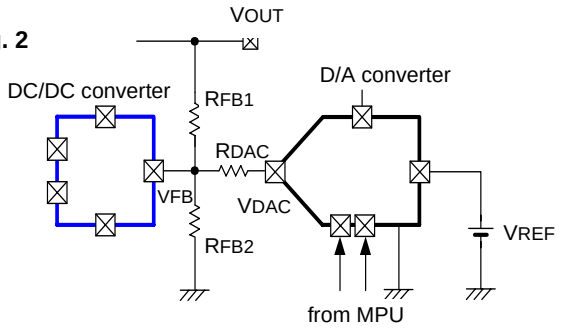
Fig. 4



When the output voltage of the D/A converter, VDAC, is lower than the voltage at the FB pin, current flows from the FB pin to GND.
When the output voltage of the D/A converter, VDAC, is zero, the output voltage becomes the maximum (VOUTmax).

■ Basic Circuit

Fig. 2



The output voltage of the D/A converter is passed through a resistor so that current is added at the FB pin to vary the output voltage of the DC/DC converter.
A constant-voltage power supply is used as the reference voltage to the D/A converter.