

## PROGRAMMABLE CURRENT LOOP (4mA TO 20mA)

The DAC<sub>OUT</sub> of the FGD40xx can be used to design a programmable current loop from 4 to 20mA (4mA when DAC<sub>OUT</sub>=0, 20mA when DAC<sub>OUT</sub>=2.5V). The DC voltage output of the DAC<sub>OUT</sub> has a voltage range of -2.500 to +2.500; for current sinking application 0 to +2.5V the design in Figure 2 can be used. For 0V DAC<sub>OUT</sub>, load the serial input register of the DAC with the code in Figure 1. In order to have 4mA through the current loop for 0V DAC<sub>OUT</sub>, we use an offset voltage reference of 2.5V.

In Figure 2, A1 is connected as a voltage follower amplifier which drives a very high impedance MOSFET Q2 and its negative input is connected to the current sense resistor R = 125Ω. Assuming no current is going in to the inputs of A1, the voltage developed at the positive input of A1 must be equal to the voltage of the negative input which is given by  $I_o * R = V_A$ , Eq1.

In Figure 2, RG is used to suppress any oscillations due to the MOSFET gain and parasitic capacitors. C1 provides compensation to stabilize A1 and Q2. A N channel low voltage MOSFET provides feedback when the current loop is open. In addition, the parasitic diode of Q1 limits the output of A1 to -1 volt thus preventing A1's output from reaching the negative saturation point (-5V). The no loop current condition is sensed by A2 which monitors by its negative input the voltage developed at R by  $I_o$ . When the voltage at the negative input of A2 drops below 0.3V, the output of A2 goes high turning on Q1 and turning off Q2. A2 in Figure 1 is used as a comparator and by adjusting the voltage at its positive input any other trip point for  $I_o$  can be implemented. Also the output of A2 can be used to flag a processor or through an LED a visual flag can be generated.

0000 1000 0000 0000  
 |  
 MSB  
 DAC  
 and Full Scale = 2.5V  
 0000 1111 1111 1111  
 FIGURE 1

Equation 1 implies that the voltage VA at the positive input of A1 is proportional to the output loop current.

$$\text{It can be shown that } V_A = \frac{V_{REF} * R_3 + V_{IN} * R_2}{R_3 + R_2} \quad \text{Eq2}$$

$$\text{Equation 3 } I_o = \frac{V_{REF} * R_3 + V_{IN} * R_2}{(R_3 + R_2) * R} = \frac{2.5 * R_3 + \text{DAC}_{OUT} * R_2}{(R_3 + R_2) * 125}$$

for the values in Figure 1:

$$\text{Equation 4 } I_o = \frac{2.5 * 2.5 + 10 * \text{DAC}_{OUT}}{1562.5} = 0.004 + 0.0064 V \text{DAC}_{OUT}$$

checking Equation 4, when  $V \text{DAC}_{OUT} = 0$ ,  $I_o = 0.004\text{A}$  and  $\text{DAC}_{OUT} = 2.5\text{V}$ ,  $I_o = 0.004 + 0.016 = 20\text{mA}$

Q2 can be any MOSFET provided that you operate the transistor well within the SOA CURE. An IRF 220 will operate from 3V up to 200Vdc and will provide 4mA to 20mA. Other current loops can be generated if R, R1 and R2 are changed.

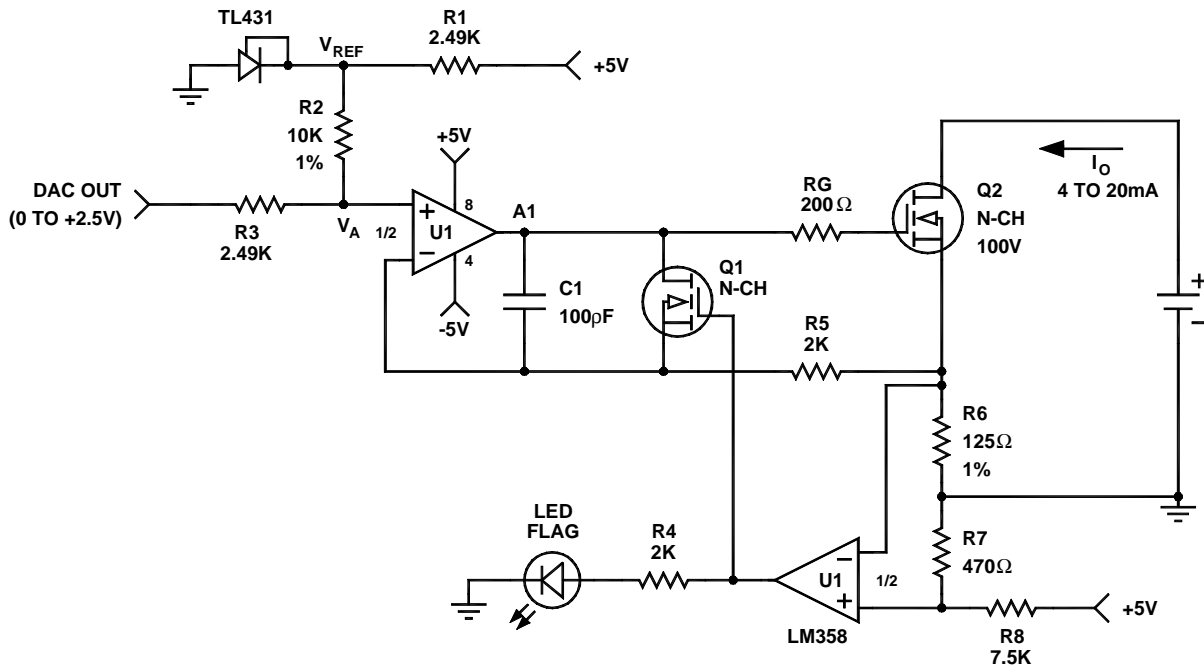


FIGURE 2

In Figure 2, a current sourcing loop of 4mA to 20mA is given.

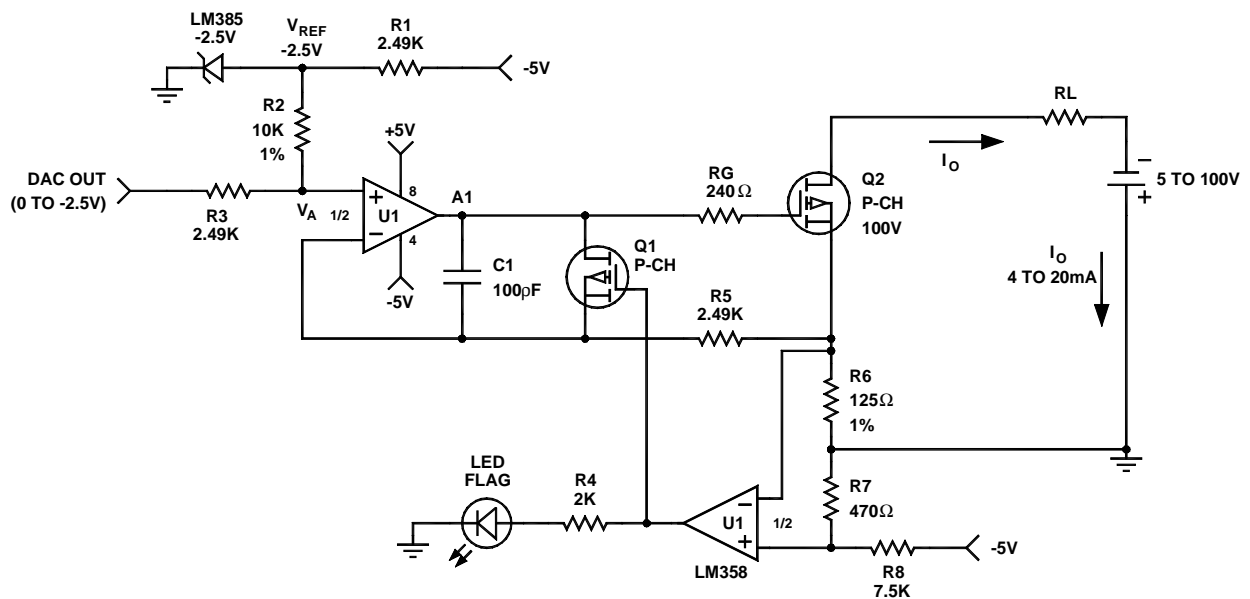
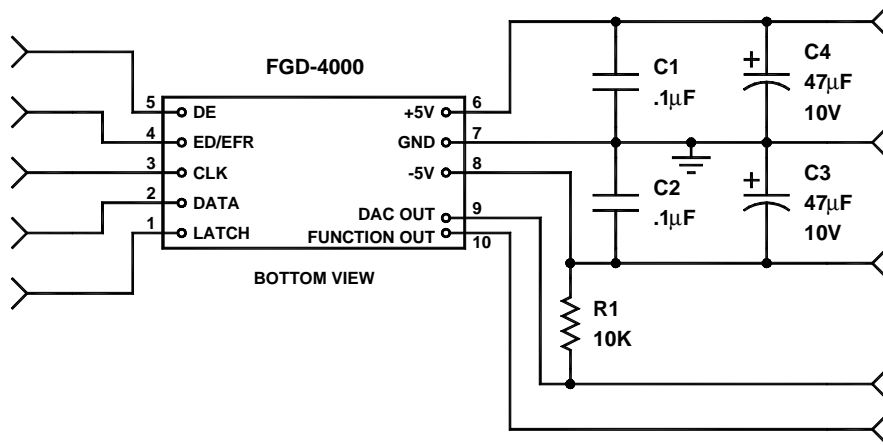
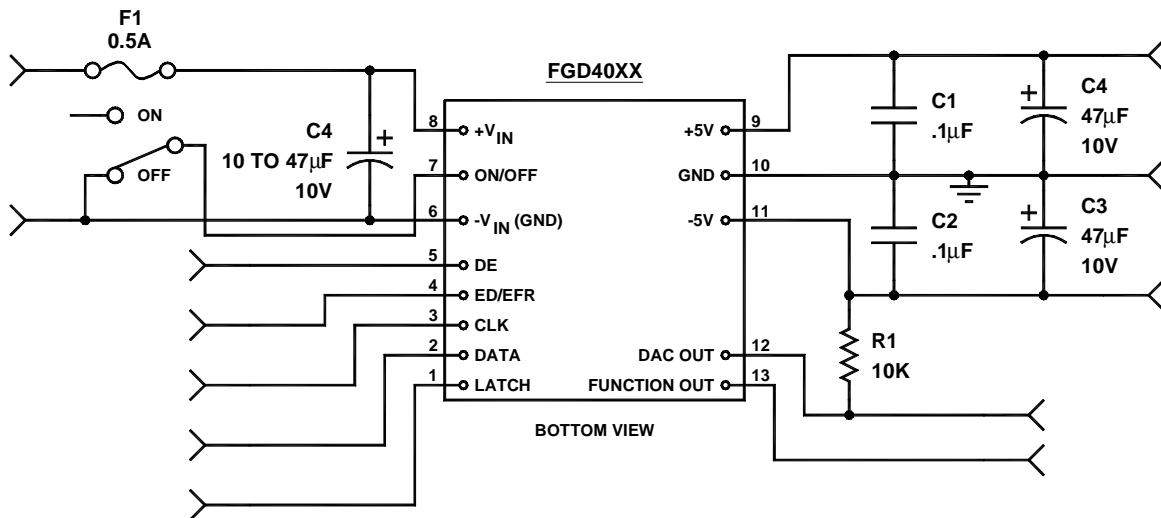


FIGURE 3



Typical Connection Diagram of 1x2

\* The 10kΩ pull-down resistor is required for full power bandwidth frequencies from 15 to 20kHz.



Typical Connection Diagram of 2x2