Analogue output moduleof a 0-5V to 0-10V signal converter

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This series of columns is dedicated to a project covering thirteen analogue input modules and seven analogue output modules for 5V microcontrollers' ADC and DAC channels.

Figure 1 shows the analogue output module for a 0-5V to 0-10V signal converter, with Figure 2 showing its connections to the microcontroller. We've assumed V_{IN} is taken from the MCU's DAC output. When $0.00V \le V_{IN} \le 5.00V$, $V_{OUT} = 2V_{IN}$. Input voltage range V_{IN} is 0-5V and, therefore, the output voltage range V_{OUT} is 0-10V; see their relationship in Figure 3.

Jumper S1 (shown as a switch) is used to select the operation mode; open for the 0-5V analogue output mode, and closed for the 0-5V to 0-10V mode. When S1 is open, the circuit works as explained in the previous issue's section, "0-5V analogue output module". Therefore, we'll only consider the 0-5V to 0-10V signal converter analogue output operation mode, i.e. with S1 closed.

We use operational amplifier LM358P-A to obtain a non-inverting op-amp with this transfer function:

$$V_{OUT} = \left(1 + \frac{R1 + P1}{R2}\right) V_{IN}$$

After adjusting the value of P1, we obtain R1+P1 = R2 and, therefore,

$$V_{OUT} = 2V_{IN}$$

The output gain of the amplifier becomes positive, which means the signal V_{OUT} is in phase with the input signal V_{IN}. Buffer amplifier (voltage follower) LM358P-B is used on the output of LM358P-A. Two series Schottky barrier diodes D1 and D2 divert any overcurrent coming from terminal V_{OUT} to the power supply or ground. A ferrite bead in series with the output path adds isolation and decoupling from high-frequency transient noises. A TVS (Transient Voltage Suppressor) is used to filter and suppress any transients coming from terminal V_{OUT}. This circuit can supply up to 20mA output current.

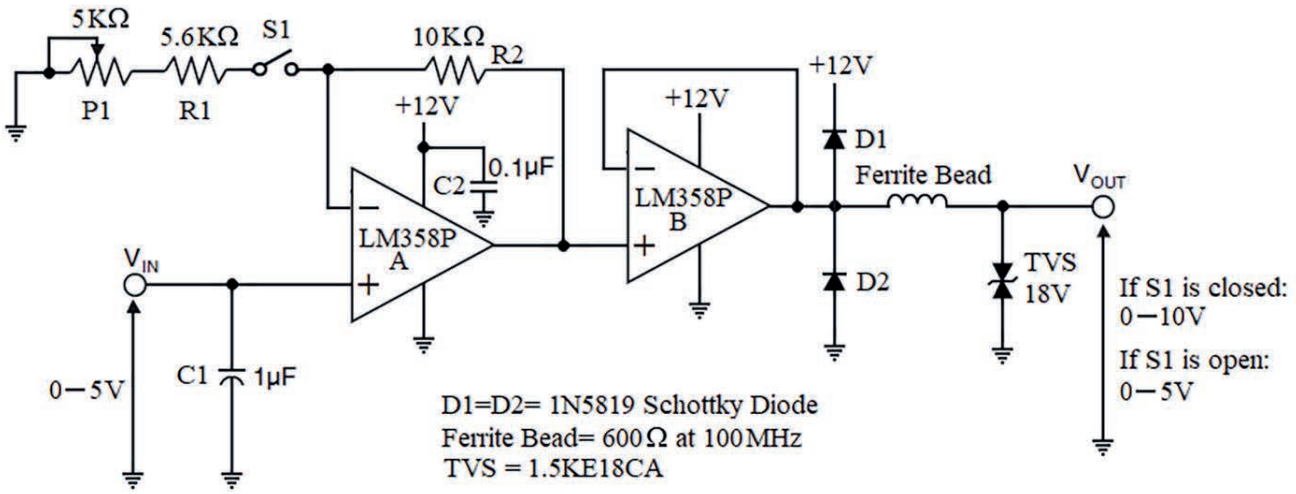
Table 1 shows some example input and output voltages for the 0-5V to 0-10V signal converter ≤ analogue output module, with the assumption that $0.00V \le V_{IN} \le 5.00V$.

Top and bottom views of the prototype circuit board are shown in Figure 4.

Calibration

When S1 is closed, the calibration is as follows: set V_{IN} to +5.00V and, then, by adjusting the value of P1, make sure V_{OUT} is +10.00V. When S1 is open, no calibration is needed. EW

Figure 1: Analogue output module of a 0-5V to 0-10V signal converter



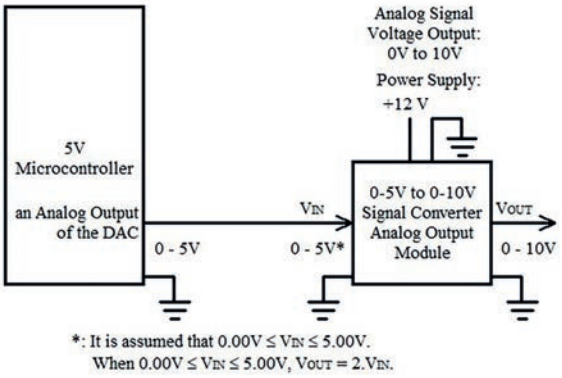


Figure 2: Connection of the analogue output module of a 0-5V to 0-10V signal converter to the analogue output of a 5V microcontroller

V_{IN}(V)	V_{OUT}(V)
5.00	10.00
..	..
4.00	8.00
..	..
3.00	6.00
..	..
2.50	5.00
..	..
2.00	4.00
..	..
0.50	1.00
..	..
0.00	0.00

Table 1: Input and output voltage values for analogue output module of a 0-5V to 0-10V signal converter, assuming 0V ≤ V_{IN} ≤ 5.00V

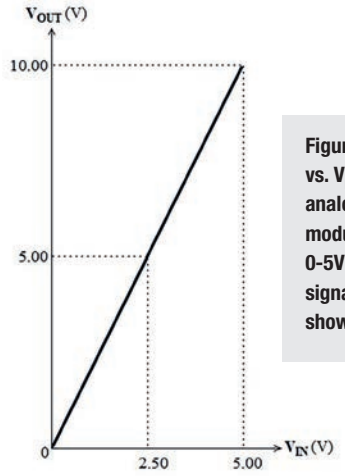


Figure 3: V_{OUT} vs. V_{IN} for the analogue output module of the 0-5V to 0-10V signal converter shown in Figure 1

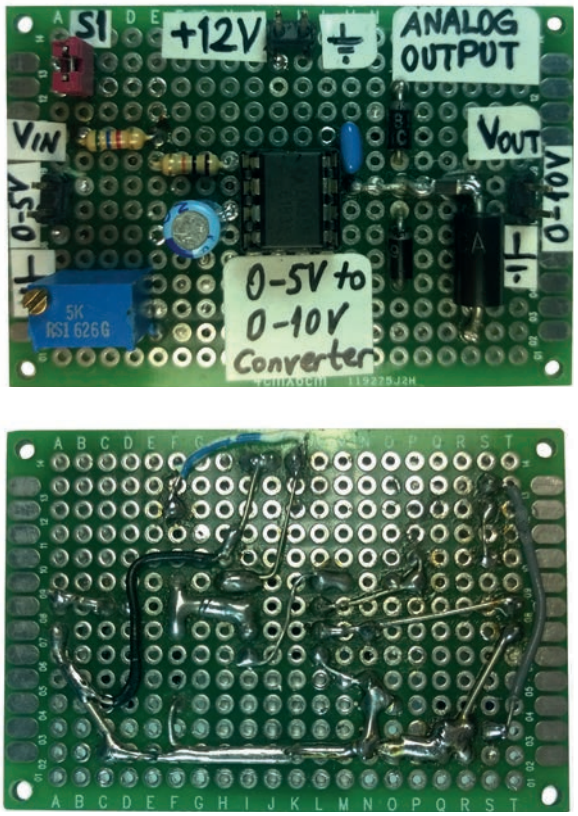


Figure 4: Top and bottom view of the prototype circuit board of the analogue output module of a 0-5V to 0-10V signal converter

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