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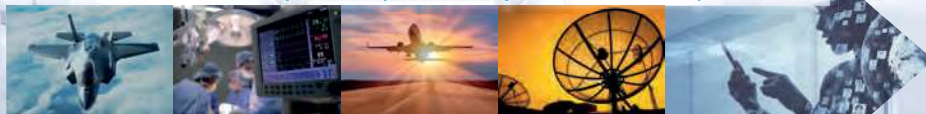


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# Optically-isolated analogue output module for a 0-5V to 0-10V signal converter

By Professor Murat Uzam, Department of Electrical and Electronics Engineering, Yozgat Bozok University, Turkey

In this instalment we will cover the second optically-isolated analogue output module – for a 0-5V to 0-10V signal converter that requires two DC power supplies: +12V and isolated +12V; see Figures 1 and 2.

This circuit contains the Positive Unipolar Photovoltaic Isolation Amplifier 3 (PUPIA3 – explained before) with an HCNR201 high-linearity analogue optocoupler for photovoltaic isolation. The circuit’s input signal (to the left of HCNR201) is isolated from its output (to the right of HCNR201).

Due to a limited current drive capability, the buffer amplifier (a voltage follower) LM358P-1A is used on the DAC output; its output is connected to the PUPIA3 input.

In this design, PUPIA3 consists of:

1. R1, R2, LM358P-1B as input;
  2. The high-linearity analogue optocoupler, HCNR201; and
  3. P1, R3, C3, LM358P-2A as output.
- Providing the PUPIA3’s input is  $0.00V \leq V_{IN} \leq 5.00V$ , PUPIA3’s output will be limited between 0.00V and 5.00V.

PUPIA3’s output is connected to the non-inverting input terminal of LM358P-2B. Jumper S1 (shown here as a switch for clarity) is used to choose the operating mode – either isolated 0-5V analogue output operation by opening S1, or by

closing it, 0-5V to 0-10V signal converter with isolated output operation. For the purposes of this discussion, we consider S1 closed.

The LM358P-2B op-amp is used to obtain a non-inverting operational amplifier with the transfer function:

$$V_{OUT} = \left(1 + \frac{R4 + P2}{R5}\right) V_{IN}$$

After adjusting the value of P2, we obtain  $R4 + P2 = R5$ , therefore:

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

The output gain of the amplifier becomes positive in value, so  $V_{OUT}$  is in-phase with  $V_{IN}$ . Dual series Schottky barrier diodes D1 and D2 divert any overcurrent from  $V_{OUT}$  to the power supply or ground. A ferrite bead is connected in series with the output path to add isolation and decoupling from high-frequency transient noises. A TVS (transient voltage suppressor) is used to filter and suppress any  $V_{OUT}$  transients. This circuit can supply up to 20mA.

In this design, the input is powered by +12V, and the output by another +12V supply isolated from the input.

For this module, we assume  $V_{IN}$  comes from the 5V microcontroller’s DAC

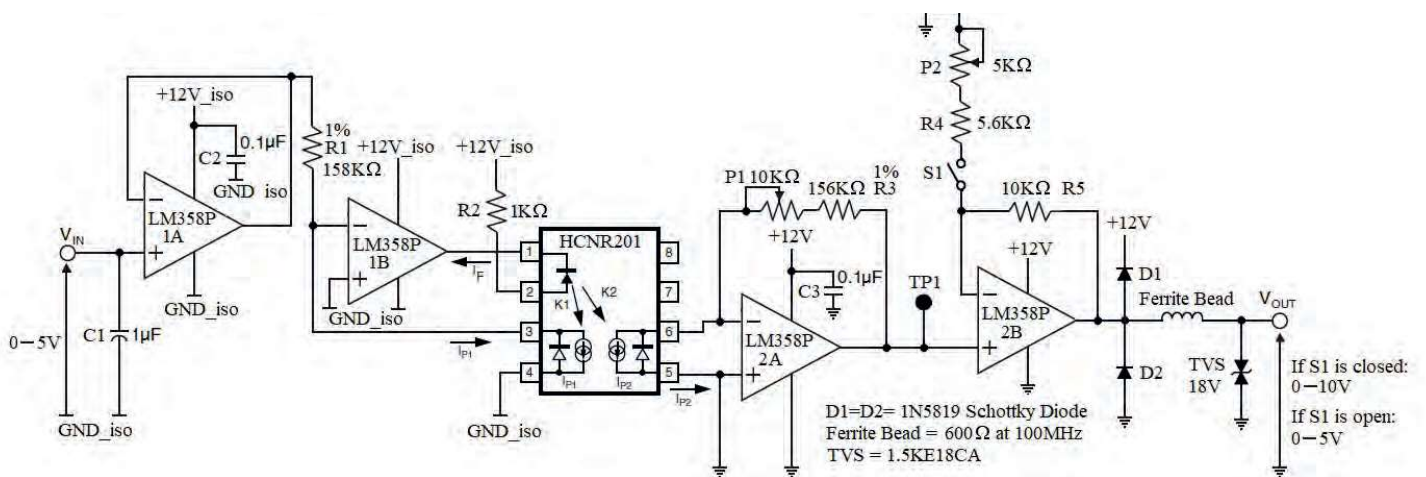


Figure 1: Optically-isolated 0-5V to 0-10V signal converter output module

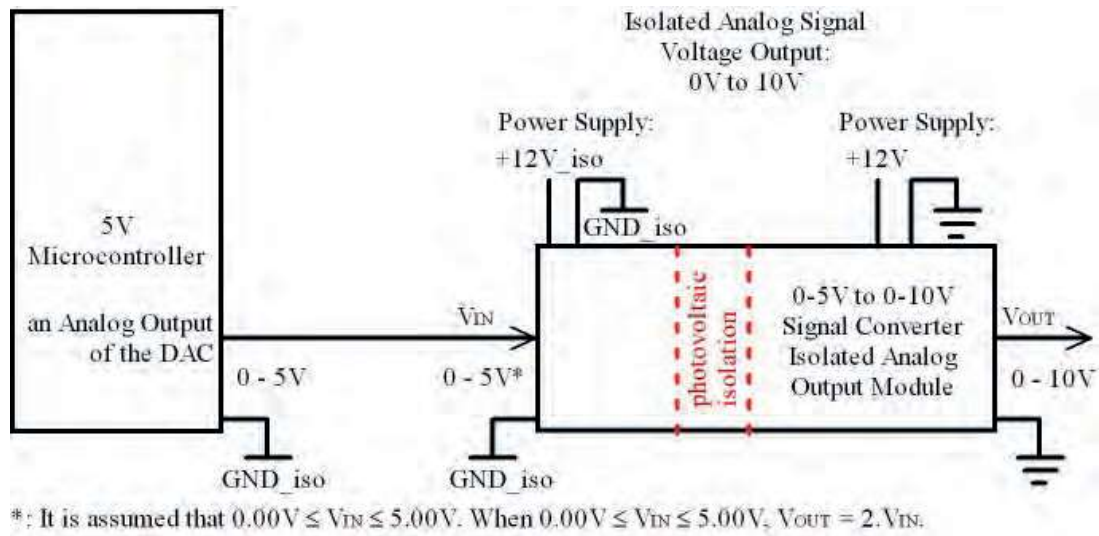


Figure 2: The module's connections

output, and  $0.00V \leq V_{IN} \leq 5.00V$ .  
 When  $0.00V \leq V_{IN} \leq 5.00V$ ,  $V_{OUT} = 2V_{IN}$ .  $V_{IN} = 0-5.00V$ , so  $V_{OUT} = 0-10V$ ; see Figure 3.  
 Table 1 shows some voltage examples

for the module, with its PCB shown in Figure 4.  
 To calibrate the circuit, with S1 open, set  $V_{IN}$  to +5.00V, and then by adjusting P1 make  $V_{OUT} = +5.00V$ .

- Calibration steps with S1 consist of:
1. Setting  $V_{IN}$  to +5.00V and by adjusting P1 ensure that  $V_{TP1} = +5.00V$ .
  2. Setting  $V_{IN}$  to +5.00V and by adjusting P2 ensure that  $V_{OUT} = +10.00V$ . **EW**

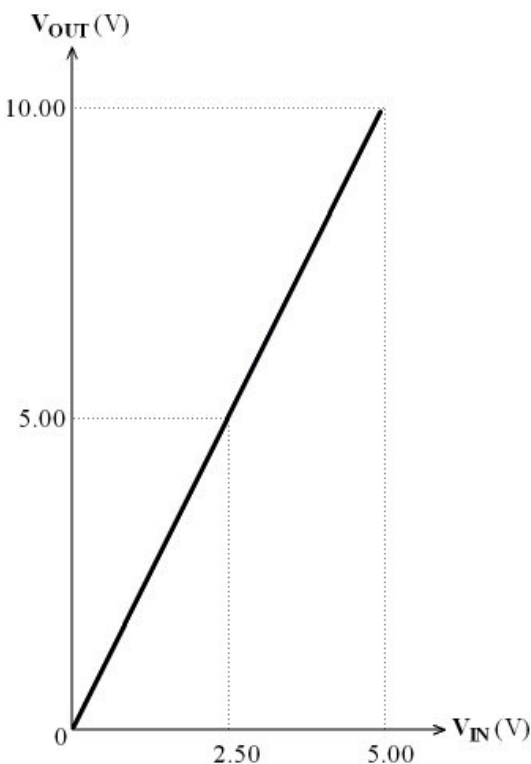


Figure 3:  $V_{OUT}$  vs.  $V_{IN}$  for the module

$V_{IN}(V)$	$V_{OUT}(V)$
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: Voltage examples for the module, assuming  $0.00V \leq V_{IN} \leq 5.00V$

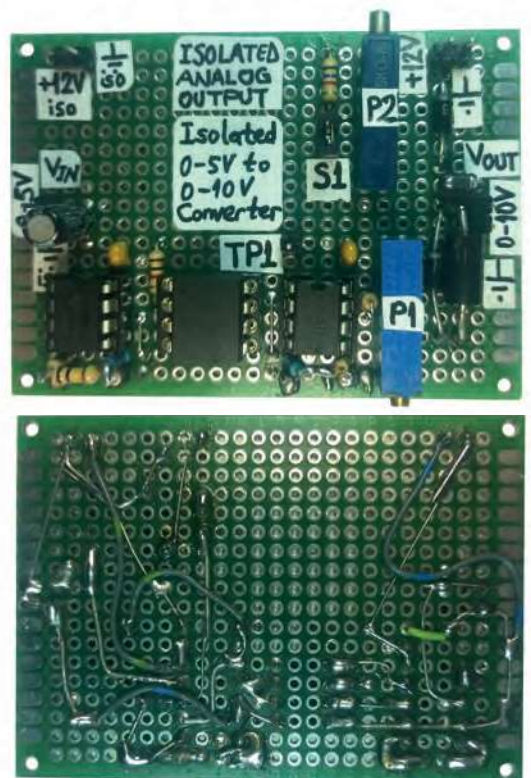


Figure 4: The module's prototype PCB