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# Contents

## Regulars




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## Features






EDITOR: Stella Josifovska
Tel: +44 (0)1732 883392
Email: svetlanaj@electronicsworld.co.uk

SALES: Kalil Kayani
Tel: +44 (0)1622 699129
Email: KKayani@datateam.co.uk

PRODUCTION/DESIGN: Tania King
Email: tking@datateam.co.uk

MEDIA DIRECTOR: Louise Tiller
Tel: +44 (0)1622 699104
Email: ltiller@datateam.co.uk

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datateam Business Media
15A London Rd, Maidstone
ME16 8LY, United Kingdom

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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 ≤ VIN ≤ 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

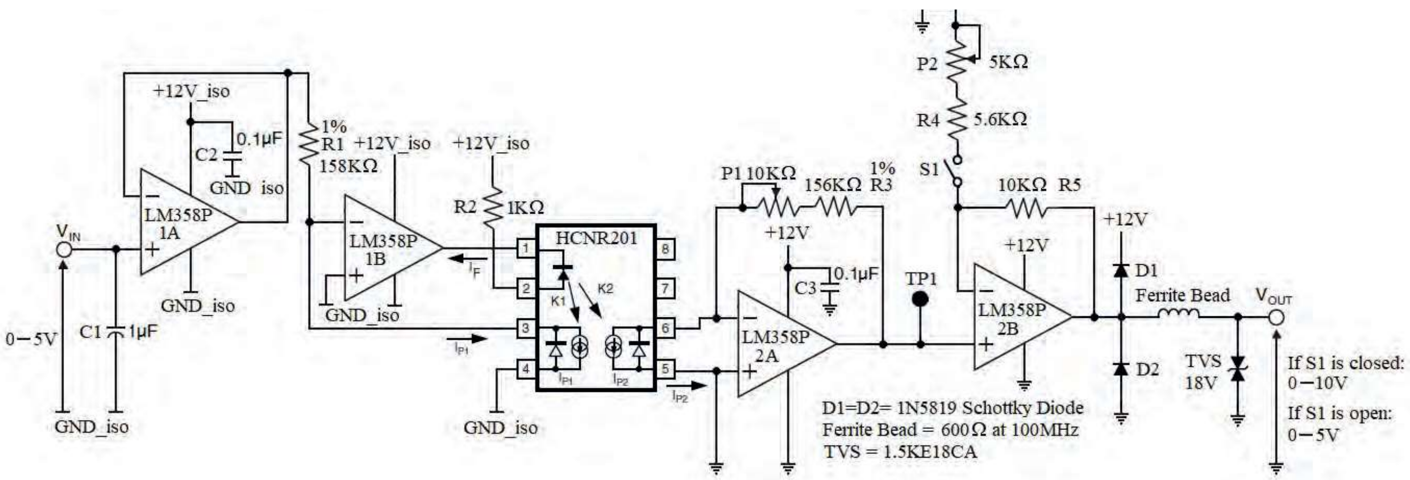


Figure 1: Optically-isolated 0-5V to 0-10V signal converter output module

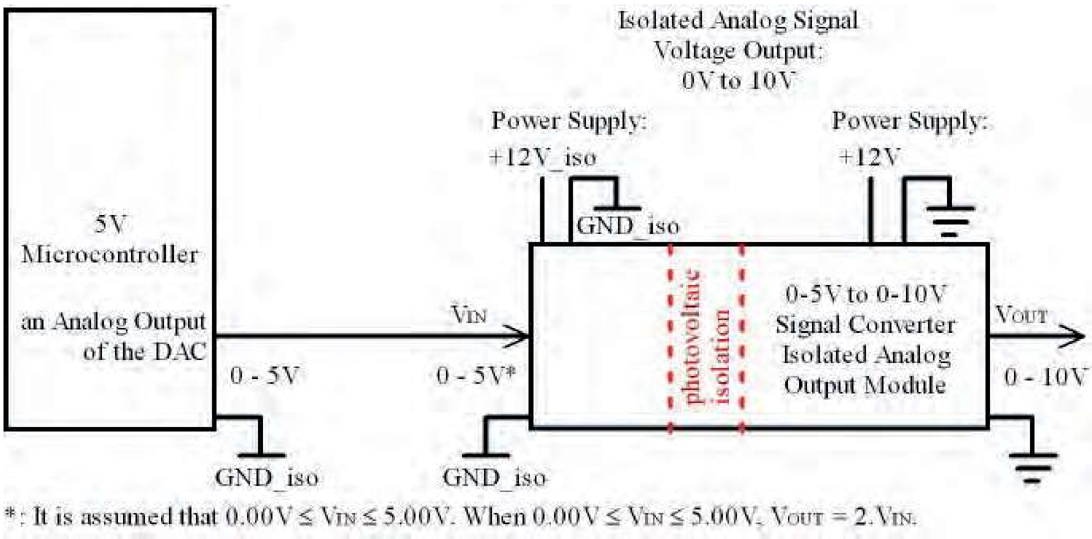


Figure 2: The module's connections

output, and $0.00V \le V_{IN} \le 5.00V$.

When 0.00V ≤ VIN ≤ 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

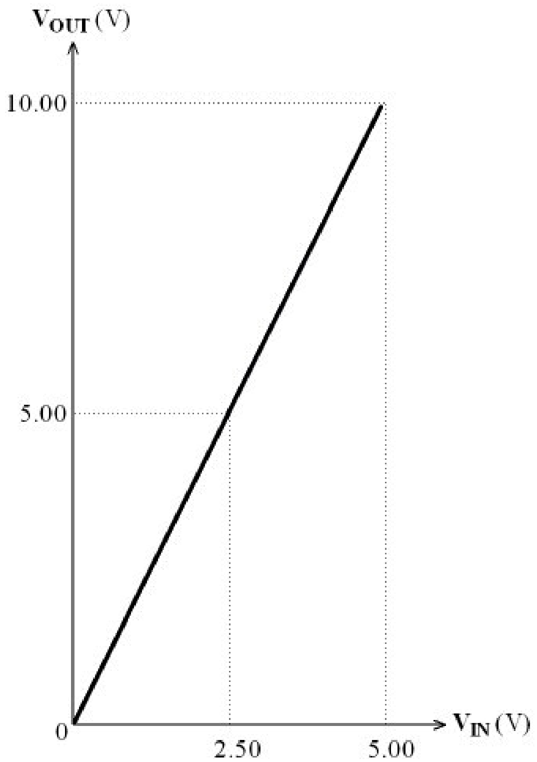


Figure 3: $V_{OUT}$ vs. $V_{IN}$ for the module

| VIN(V) | VOUT(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 $0.00V \le V_{IN} \le 5.00V$

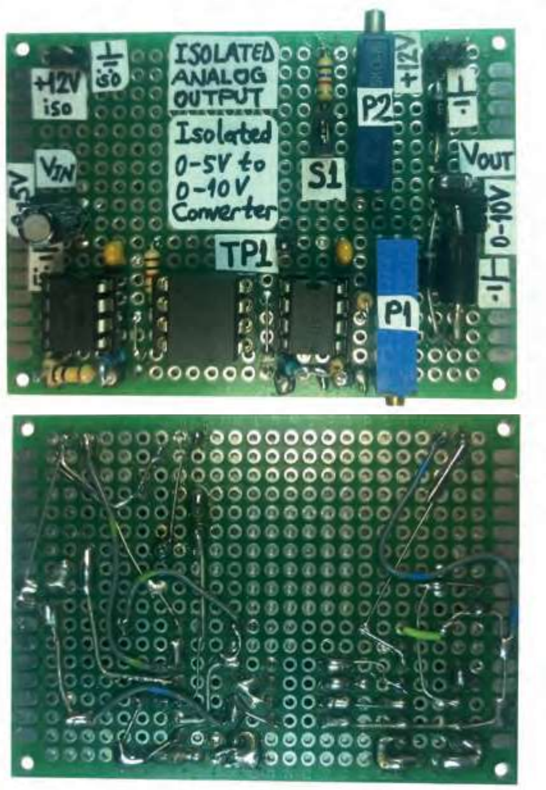


Figure 4: The module's prototype PCB