

# Electronics World

www.electronicsworld.co.uk

December/January 2023

Volume 128

Issue 2023

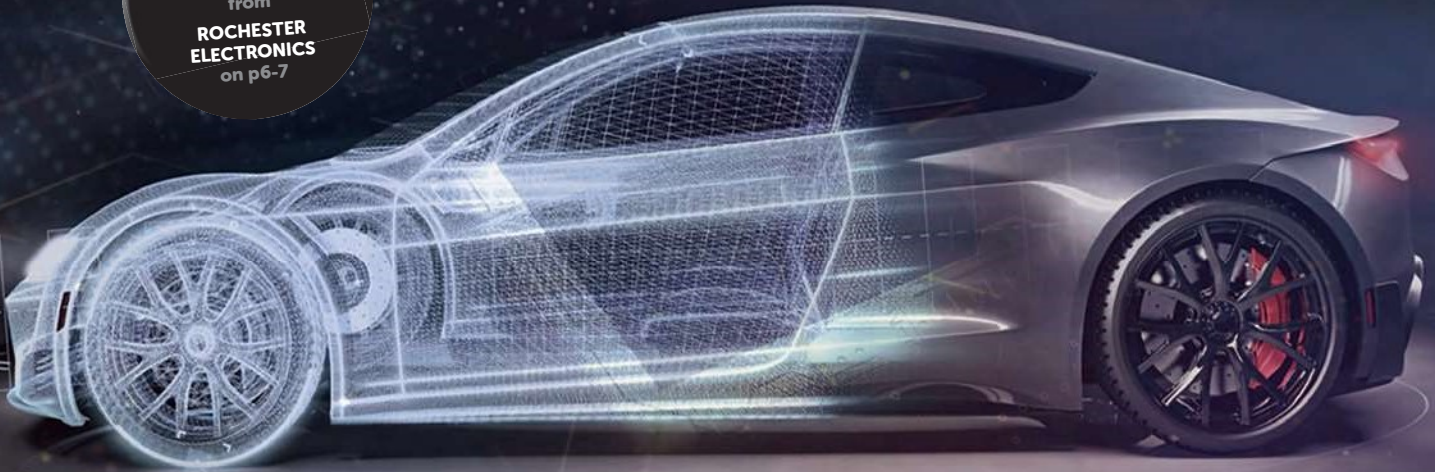
£5.90

## WE KEEP YOUR BUSINESS MOVING.

The world's largest continuous source of semiconductors.

Continuation  
of semiconductor  
supply into 2023

from  
ROCHESTER  
ELECTRONICS  
on p6-7



**Rochester  
Electronics®**  
www.rocelec.com

Authorised Distribution | Licensed Manufacturing | Manufacturing Services

### SPECIAL REPORTS

- Aviation
- Embedded design
- Enclosures
- Industrial electronics
- Connectors
- T&M



Every Bench.  
Every Engineer.  
Every Day.

 **SIGLENT®**

# Contents

## Regulars

### 04 Trend

### 05 Technology

### 08 Circuit Drill

By Sulaiman Algharbi Alsayed,  
Managing Director, Smart PCB Solutions

### 10 EMC

By design engineers, REO UK, and  
Dr Min Zhang, EMC consultant, Mach One Design

### 12 Optical Isolation

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

### 17 Electric Vehicles

By Vicor design engineers

### 19 Event

Southern Manufacturing and Electronics 2023

### 48 Products

### 49 Buyers guide

### 50 Contact directory

### 51 Web locators

Cover supplied by Rochester Electronics. More on pages 6-7

## Features

### 20 A control panel for driving the world

By Bernardo Kastrup, System Development Engineer

### 24 Embedded systems for robotic applications

By Display Technology technical team

### 26 Test and measurement requires high-accuracy and high-precision data acquisition solutions

By Maithil Pachchigar, System Applications Engineer,  
Analog Devices

### 32 Smart sensors in industrial applications keep the pressure off

By Richard Mount, Sales Director,  
Swindon Silicon Systems

### 34 Make linear actuator design flexible with non-contact position sensing

By Anders Karlsson, Product Line Manager for linear  
actuators, Thomson Industries

### 38 5G growth in aviation applications

By Future Market Insights analysts

### 40 Plasma treatment for wire bond improvement

By Henniker Plasma design and  
development engineers

### 44 The life and times of the RJ45 connector

By Tom Hennessey, Business Manager, GTK

### 46 Condensation-free enclosures protect electrical components, indoors and outdoors

By Spelsberg application engineers



**ADVANCED INTERCONNECTIONS**  
THE POWER OF CUSTOM

Prototype to Production Volumes  
IC Sockets • Adapters • Board to Board Connectors

WWW.ADVANCED.COM • 800.424.9850

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

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

Harriet Campbell  
Tel: +44 (0)1622 699184  
Email: hcampbell@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

ISSN: 1365-4675  
PRINTER: Buxton Press Ltd

SUBSCRIPTIONS:  
Subscription rates:  
1 year digital only - £40  
1 year print & digital (UK only) - £75  
1 year print & digital (Overseas) - £180  
Email: membership@electronicsworld.co.uk  
www.electronicsworld.co.uk/subscribe

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

Follow us on  
Twitter  
@electrowo



Join us on  
LinkedIn



**EURO QUARTZ**  
ACCURATE  
SECURE  
TRACEABLE

See us at Engineering Design Show, Coventry Building Society Arena, October 12 & 13. Stand H4.

INDUSTRY SECTORS: DEFENCE | MEDICAL | AEROSPACE | COMMUNICATIONS | ELECTRONICS

IN-HOUSE PRODUCTION | UK-MADE SMD MILITARY AND INDUSTRIAL CLOCKS  
5G OSCILLATORS | MICRO-MINIATURE | OCXOs | TCXOs | VCXOs | ITAR-FREE OSCILLATORS

t: +44(0)1460 230000 | e: sales@euroquartz.co.uk | w: www.euroquartz.co.uk

# Optically-isolated analogue output modules for a 0-5V to -5V - +5V signal converter

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

This month we will discuss the third and fourth optically-isolated analogue output modules for a 0-5V to -5V - +5V signal converter, which provide voltages from -5V to +5V. Module 1, shown in Figure 1, requires four DC power supplies: isolated +12V, +5.00V, -12V and +12V, whereas Module 2, shown in Figure 2, requires three DC supplies: isolated +12V, -12V and +12V.

### Module 1

Module 1's circuit contains the Positive Unipolar Photovoltaic Isolation Amplifier 3 (PUPIA3 – explained previously), with a HCNR201 high-linearity analogue optocoupler providing photovoltaic isolation. The circuit's input stages to the left of HCNR201 are isolated from its output stages to its right.

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

LM358P-1A's output is connected to the input of the PUPIA3, which consists of:

1. Input: R1, R2, LM358P-1B;
2. HCNR201;
3. Output: P1, R3, C3, LM358P-2A.

Providing  $0.00V \leq V_{IN} \leq 5.00V$ , PUPIA3's output voltage will range between 0.00V and 5.00V. This output

is connected to the non-inverting input terminal of LM358P-3A. Jumper S1 (shown here as a switch for clarity) is used to choose either the isolated 0-5V analogue output, when S1 is open, or when closed, the 0-5V to -5V - +5V isolated analogue output.

With S1 open, the circuit works as explained in the optically-isolated 0-5V analogue output design. Here we will only consider the 0-5V to -5V - +5V signal converter – optically-isolated analogue output operation mode, i.e., with S1 closed.

This design is used to level shift the unipolar 0-5V input to a bipolar -5V to +5V output. When  $0.00V \leq V_{IN} \leq 5.00V$ , LM358P-3A, with its bipolar supply voltages, acts with the transfer function of:

$$V_{OUT} = \left(1 + \frac{R4 + P2}{R5}\right) V_{IN} - 5$$

After adjusting P2's value, we obtain  $R4 + P2 = R5$ , then:

$$V_{OUT} = 2V_{IN} - 5$$

A buffer amplifier (voltage follower) LM358P-3B is used on the output of LM358P-3A. Dual series Schottky barrier diodes D1 and D2 divert any overcurrent from  $V_{OUT}$  to the positive or negative power supply. A ferrite bead in series

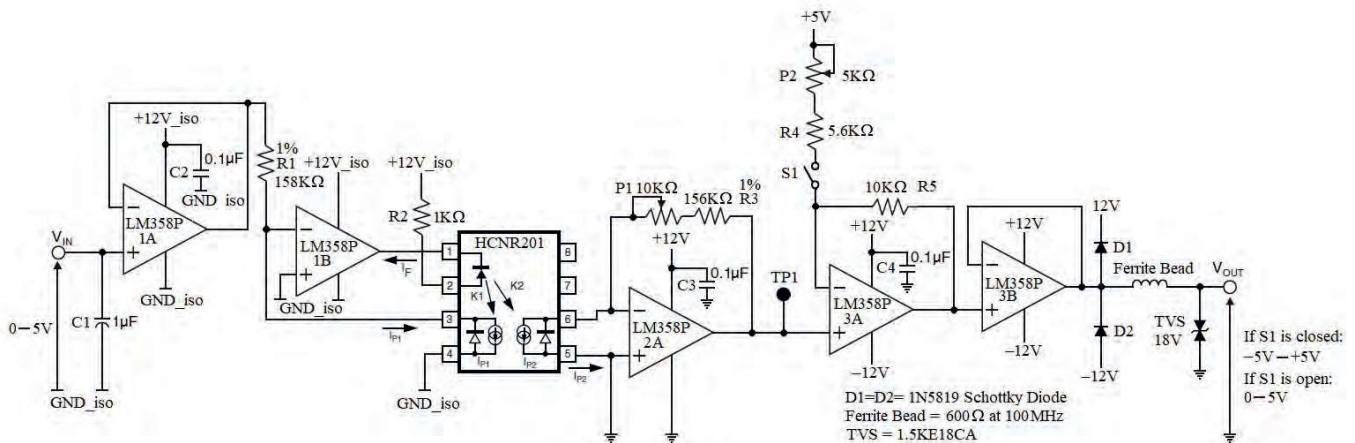
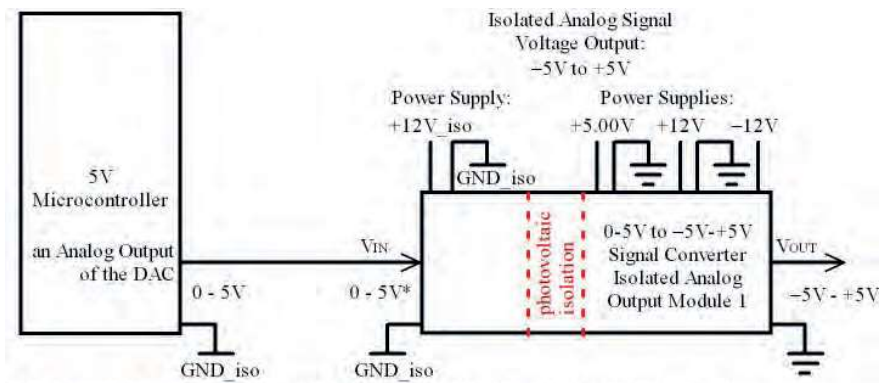


Figure 1: Optically-isolated 0-5V to -5V - +5V signal converter – Module 1



\*: It is assumed that  $0.00V \leq V_{IN} \leq 5.00V$ . When  $0.00V \leq V_{IN} \leq 5.00V$ ,  $V_{OUT} = (2V_{IN} - 5)$ .

Figure 2 : Module 1 connections

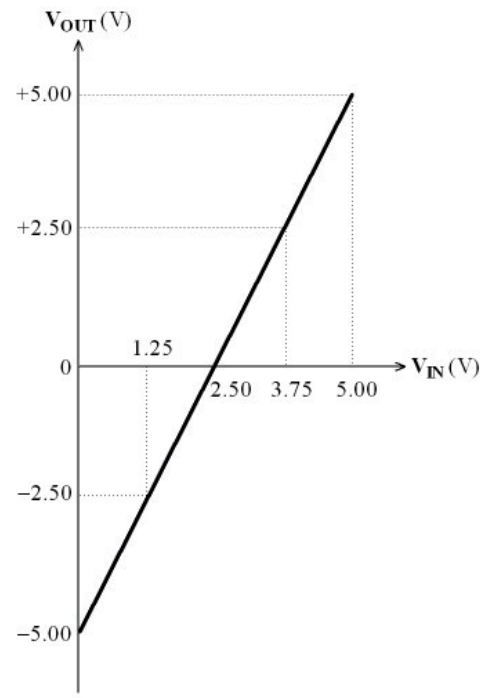


Figure 3:  $V_{OUT}$  vs.  $V_{IN}$  for Modules 1 and 2

$V_{IN}(V)$	$V_{OUT}(V)$
5.00	+5.00
..	..
4.50	+4.00
..	..
4.00	+3.00
..	..
3.75	+2.50
..	..
3.50	+2.00
..	..
3.00	+1.00
..	..
2.50	0.00
..	..
2.00	-1.00
..	..
1.50	-2.00
..	..
1.25	-2.50
..	..
1.00	-3.00
..	..
0.50	-4.00
..	..
0.00	-5.00

Table 1: Example input and output voltages for Modules 1 and 2, assuming  $0.00V \leq V_{IN} \leq 5.00V$

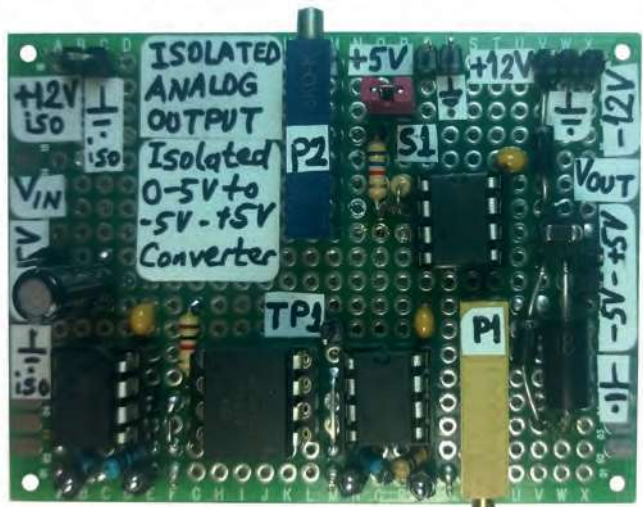
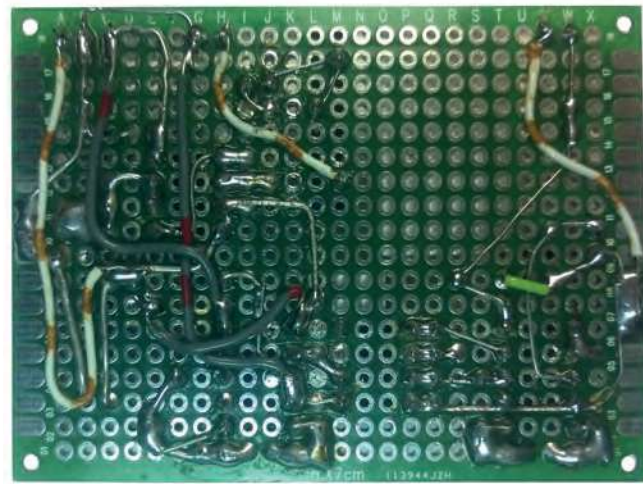


Figure 4: Module 1 prototype circuit board



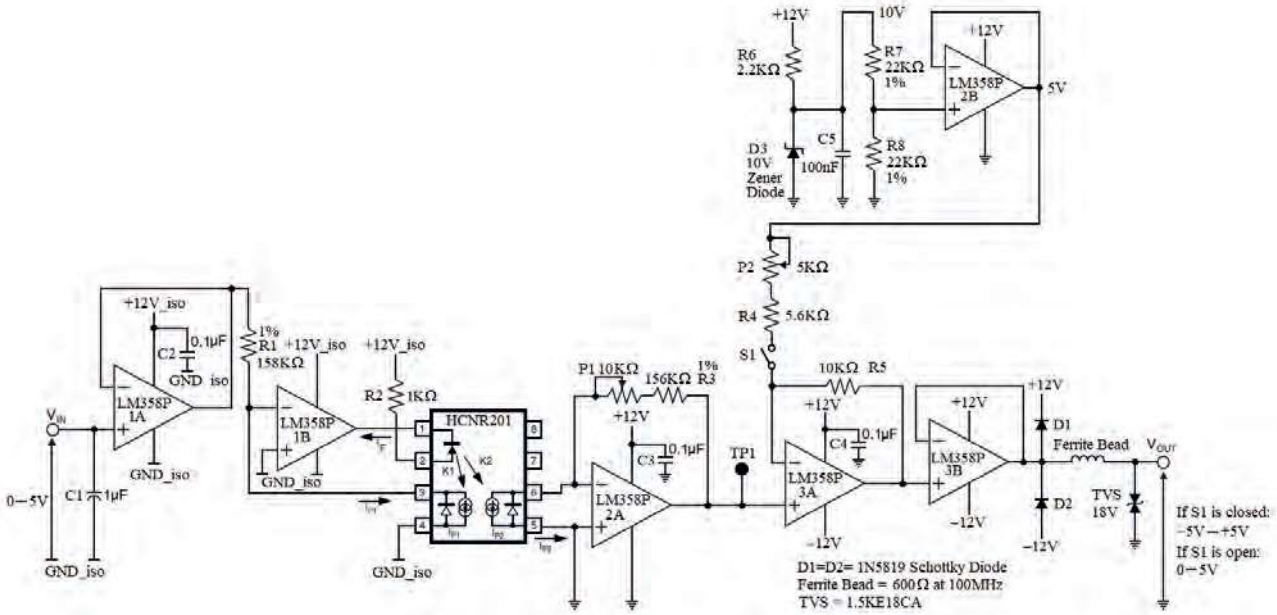


Figure 5: Module 2 circuit

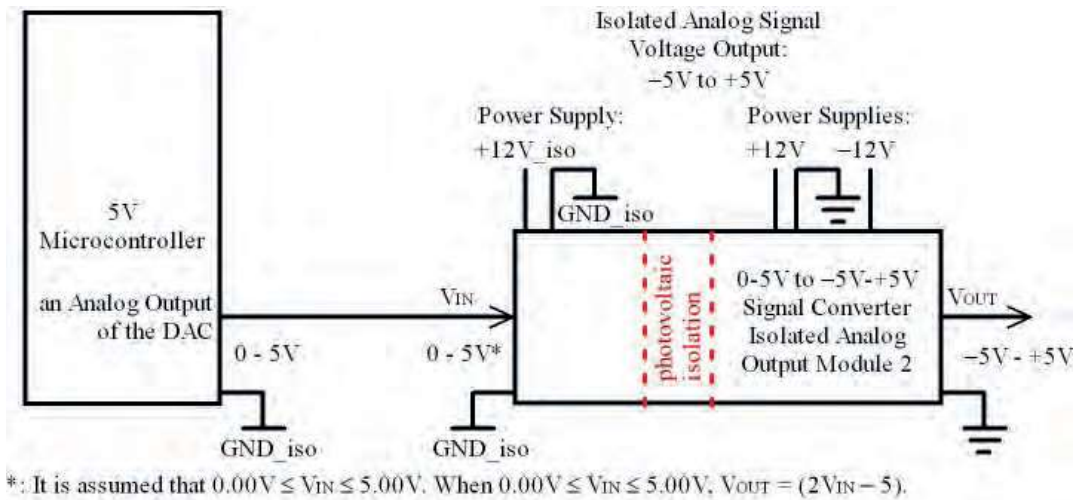


Figure 6: Module 2 connections

with the output path adds isolation and decoupling from high-frequency transient noises. A transient voltage suppressor (TVS) is used to filter out any transients entering from  $V_{OUT}$

In this design, the circuit's input is powered by +12V, whereas its output is powered by +5.00V, +12V and -12V, isolated from the +12V at the input. The circuit can supply up to 20mA.

We have assumed that  $V_{IN}$  comes from the DAC output of a 5V microcontroller with  $0.00V \leq V_{IN} \leq 5.00V$ . When  $0.00V \leq V_{IN} \leq 5.00V$ ,  $V_{OUT} = 2V_{IN} - 5$ . The input voltage range

$V_{IN} = 0.00-5.00V$ , hence  $V_{OUT} = -5.00V$  to  $+5.00V$ ; see Figure 3.

Table 1 shows examples for input and output voltages for the two modules, with the prototype circuit boards shown in Figures 4 and 7.

To calibrate with S1 open: Set  $V_{IN}$  to +5.00V, and by adjusting P1 make  $V_{OUT} = +5.00V$ .

With S1 closed, the calibration steps are:

1. Set  $V_{IN}$  to +5.00V and then by adjusting P1 make  $V_{TP1} = +5.00V$ .
2. By adjusting P2, make sure that when  $V_{IN} = 0.00V$ ,  $V_{OUT} = -5.00V$  and, also,

when  $V_{IN} = +5.00V$ ,  $V_{OUT} = +5.00V$ .

**Module 2**

Figures 5, 6 and 7 show the optically-isolated analogue output Module 2, with its connections to the DAC output of a 5V microcontroller. As with Module 1, the circuit is also PUIPA3 based, with a high-linearity analogue optocoupler (HCNR201) providing photovoltaic isolation.

Module 2 operates exactly the same way as Module 1, and it contains all the same components as Module 1, but with R6, D3 (10V Zener diode) and C5

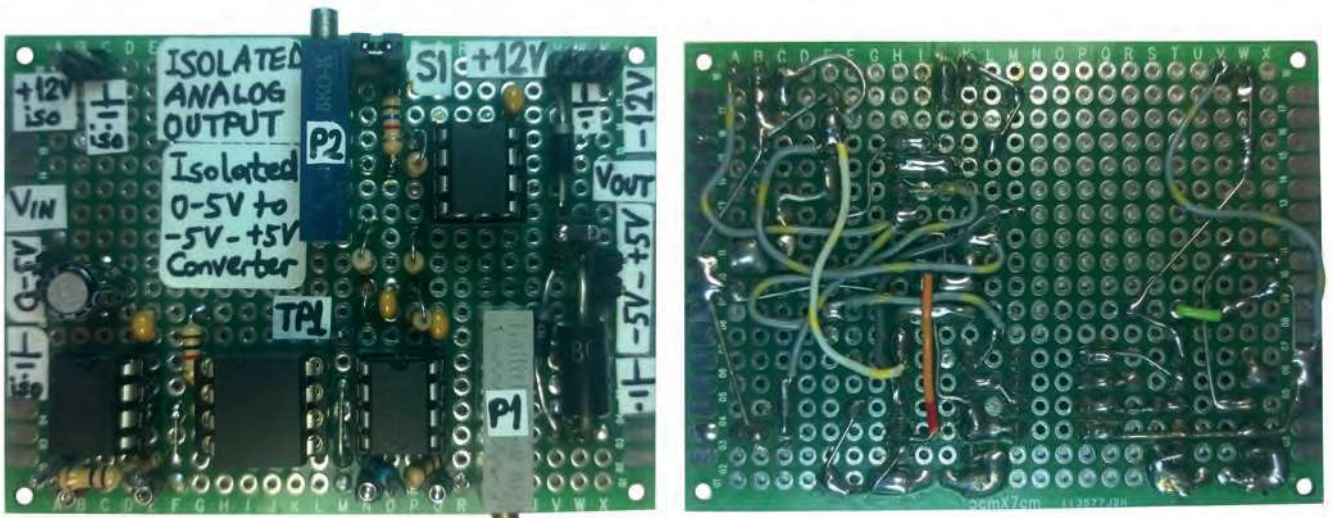


Figure 4: Module 2 prototype circuit board

to provide a 10.00V reference voltage from a +12V power supply. This 10.00V reference is then divided by resistors R7 and R8 to obtain +5.00V, which is connected to the non-inverting input of the buffer amplifier LM358P-2B, with an output fixed at +5.00V and capable of sourcing up to 20mA.

Unlike Module 1, in this design the circuit's output is powered by only +12V and -12V that are isolated from the +12V applied to the circuit's input.

For proper operation, make sure that  $R7 = R8$ .

To calibrate the circuit when S1 is

open, set  $V_{IN}$  to +5.00V and by adjusting P1 make  $V_{OUT} = +5.00V$ . When S1 is closed:

1. Set  $V_{IN}$  to +5.00V and by adjusting P1 make  $V_{TP1} = +5.00V$ .
2. By adjusting P2, make sure that when  $V_{IN} = 0.00V$ ,  $V_{OUT} = -5.00V$  and, also, when  $V_{IN} = +5.00V$ ,  $V_{OUT} = +5.00V$ . **EW**

# FANS AND BLOWERS FOR PRESSURISED AIR AND SUCTION APPLICATIONS

We provide worldwide, perfectly engineered miniature high-performance fan and blower solutions for demanding air pressure, vacuum and flow applications.



Micronel UK Ltd.  
Unit 53, The Arches Industrial Estate  
Alma Road, Windsor, Berkshire SL4 3HY  
United Kingdom

Phone +44 1753 641 412  
info@micronel.co.uk  
www.micronel.com