MBFC-01
Rejustor™-Based Sensor Alarm Compensator

The MBFC-01 sensor signal conditioner from Microbridge Technologies Inc. is an integrated analog CMOS solution for compensating a resistive sensor's 10x as-manufactured resistance variations and large negative temperature coefficients of sensitivity.

By using an adjustable current source, the MBFC-01 sources the appropriate current through the sensor's resistance to set the analog output voltage to a specific level, for sensors with as-manufactured resistance from 0.68KΩ to 6.8KΩ. By using a calibrated on-chip temperature-dependent reference, the MBFC-01 compensates for the sensor's large negative TC of sensitivity approximately -2%/°C (-20000ppm/°C). By using an on-chip comparator, the digital output of the MBFC-01 toggles when the sensor signal crosses the reference detection threshold, (outputs a logic low when the sensor's resistance goes low), thus providing a calibrated and temperature-compensated threshold alarm.

On-chip passive ***Rejustors*** provide adjustability of sourced current, adjustability of room-temperature reference voltage, and adjustability of the reference's negative temperature dependence.

FEATURES

- Sources current through the sensors wide resistance range 0.68KΩ to 6.8KΩ.
- Adjustable temperature-compensated threshold detection.
- Single 5V supply operation, low power consumption.
- Low cost.
- In-circuit adjustment at board or system level.
- RoHS compliant.

APPLICATIONS

- Residential LP (liquefied petroleum) gas alarm, using sensors such as Figaro's TGS2610.

Figure 1: MBFC-01 Functional Block Diagram

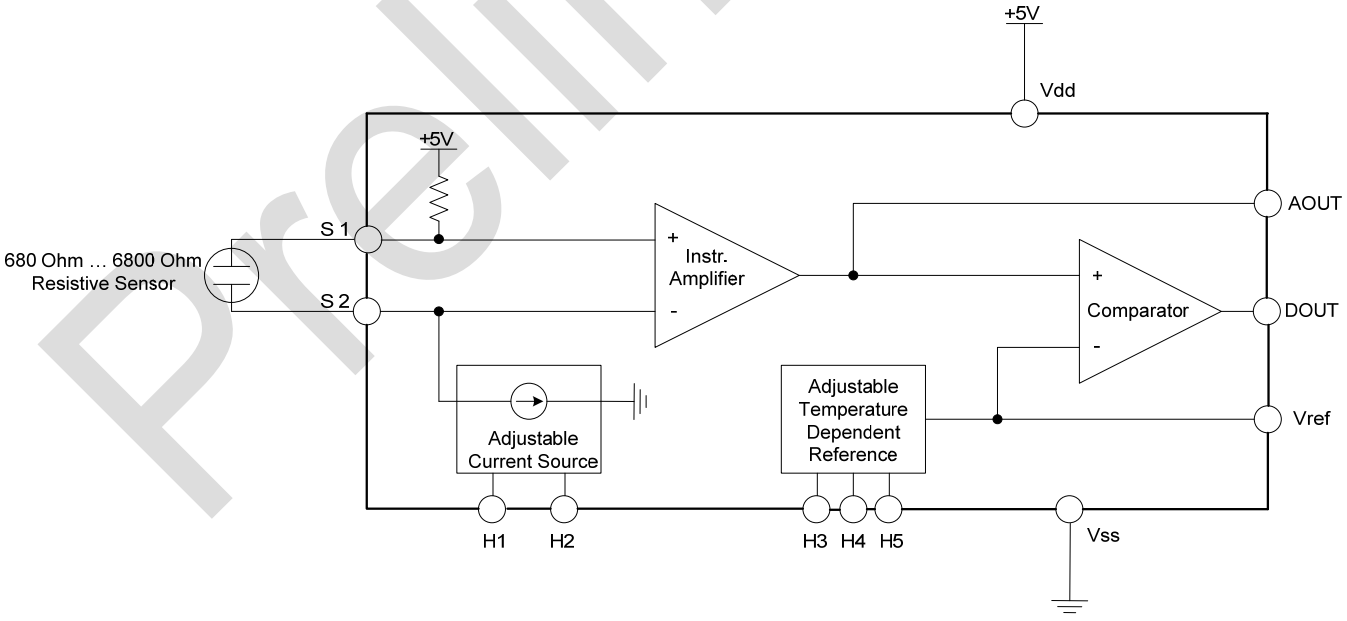


Table 1: ELECTRICAL SPECIFICATIONS
Test conditions T= +20ºC, Vdd = 5.0VDC (Regulated), unless otherwise specified.

Parameter	Minimum	Typical	Maximum	Units	Notes
Power Supply Vdd	4.95	5.0	5.05	VDC	must be regulated
Supply Current		4.0		mA	at R sensor = ~2.5kOhm
Operating temperature	-10		+50	ºC	1
Sensor Resistance (Rs)	0.68		6.8	KΩ	2, 3
Sensor Tempco of sensitivity		approx - 2		%/ºC	4
AOUT adjustment range (analog output voltage)		from < +2.0 to >+2.5		V	5
AOUT adjustment resolution		+/-80		mV	5,6
Vref @20ºC adjustment range		from < +2.0 to >+2.5		V	5
Vref @20ºC adjustment resolution		+/-80		mV	5,6
Vref Tempco adjustment range		between -50 and -30		mV/ºC	4
Vref Tempco adjustment resolution		+/-3		mV/ºC	4

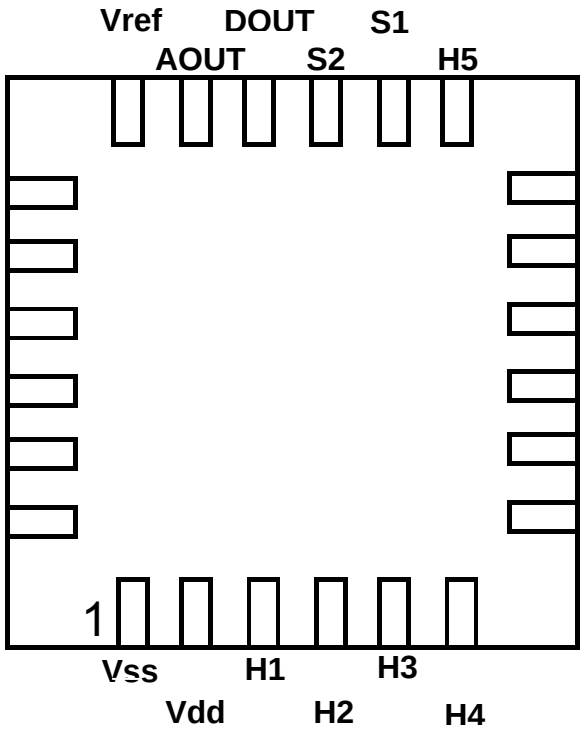
[1] Contact Microbridge for other temperature ranges.
[2] This is the sensor resistance range through which the MBFC-01 can source the appropriate current, in order to give AOUT (voltage) ~2.2V at room temperature.
[3] Contact Microbridge for different resistance range.
[4] Contact Microbridge for different Tempco range.
[5] For ambient temperature variations within +/-1ºC.
[6] Due to large temperature sensitivity of the sensor and estimated +/-1ºC temperature stability during calibration. For better resolution, better temperature stabilization during calibration would be necessary (e.g. +/-0.2ºC).

PIN FUNCTIONAL DESCRIPTION

Table 2: MBFC-01 PIN FUNCTION DESCRIPTIONS

Signal	Pin Number	Description	Function
Vss	1	Supply Ground	Ground
Vdd	2	Supply Voltage	Supply
H1, H2 H3, H4 H5	3,4,5,6, 13	***Rejustor*** adjustment signal inputs for adjustment of sensor input current, Vref level and Vref Tempco	Adjustment signals applied between **H1, H2, H3, H4, H5** and Vss under ***Rejust-it*** control. Signals are only connected during adjustment.
S1	14	Sensor Input 1	Sources current to the resistive sensor, and accepts signal from the resistive sensor.
S2	15	Sensor Input 2	Sources current to the resistive sensor, and accepts signal from the resistive sensor.
DOUT	16	Digital Voltage Output	Output toggles when sensor measurand crosses threshold as defined by Vref. Normally high, active low.
AOUT	17	Analog Voltage Output	Temperature-uncompensated analog output (referenced to Vss). Signal is used to provide feedback during adjustment.
Vref	18	Vref Analog Voltage Output	Temperature dependent Vref analog output (referenced to Vss). Signal serves as reference for temperature-dependent sensor signal. Signal is used to provide feedback during adjustment.

MBFC-01 PACKAGE PINOUT IN 4mm x 4mm QFN (see Table 2 above):



GENERAL OVERVIEW

The MBFC-01 sensor signal conditioner from Microbridge Technologies Inc. is a low-cost, single-supply integrated analog CMOS solution for compensating a sensor's 10x as-manufactured resistance variations and large negative temperature coefficients of sensitivity. It is optimized to operate with sensor resistances between 0.68KΩ to 6.8KΩ, which have a negative temperature coefficient of sensitivity of approximately -2%/°C. Handling of different resistance ranges and handling of different temperature coefficients are also available – contact Microbridge.

The MBFC-01 fundamentally provides a voltage reference for comparison with the changing resistance of the connected resistive sensor. The reference is temperature conditioned, and drives a threshold detector. ***Rejustors*** set the voltage drop across the sensor, compensating the as-manufactured resistance of the sensor. Logic output DOUT is a logic signal derived from the difference between the sensor and the temperature conditioned reference. When the output voltage from the sensor is less than the reference the output is set low.

By using an adjustable current source, the MBFC-01 sources the appropriate current through the sensor's resistance to set the analog output voltage to a specific level. For example, regardless of whether the sensor's as-manufactured resistance is 0.68KΩ or 6.8KΩ, the MBFC-01 can be adjusted to source the appropriate current to set the AOUT voltage to 2.25V, for example, when the sensor is exposed to a specific test condition measurand (e.g. if the sensor is a TGS2610, with test gas condition 1800±50ppm of isobutene in air, at 20±2ºC, 65±5%RH). The MBFC-01 also contains an on-chip temperature-dependent reference voltage, whose level and temperature coefficient can each be adjusted. This temperature-dependent reference is intended to roughly imitate the sensor's large negative TC of sensitivity, approx. -2%/°C (-20000ppm/°C). The temperature dependence (slope of Vref vs. T) of each MBFC-01 conditioner sample can be adjusted to roughly match the (typically more non-linear) temperature dependence of each individual sensor's signal. Next, an on-chip comparator compares the AOUT voltage to the Vref voltage, which should normally be approximately the same

as each other at any given temperature. In this way, the comparator gives a digital output, which toggles when the sensor signal crosses the reference detection threshold. For example, if the sensor signal AOUT in a quiescent state is normally somewhat higher than Vref, this quiescent output will be a logic high. Then, if an increase in the sensor's measurand causes the sensor's resistance to go low, then AOUT will also go low, causing the comparator to output a logic low DOUT. In this way, the MBFC-01 provides a calibrated and temperature-compensated threshold alarm. DOUT output current is limited to 1mA.

Rejustors are used in conjunction with active amplification elements to create a unique analog sensor conditioner. On-chip passive ***Rejustors*** provide adjustability of sourced current, adjustability of room-temperature reference voltage, and adjustability of the reference's negative temperature dependence. Once adjusted, ***Rejustors*** maintain their resistance indefinitely with high stability and precision. ***Rejustors*** can be re-adjusted any time, as required. Essentially the material properties of the ***Rejustor*** are adjusted to compensate for deviations in the material properties of the sensor.

REJUSTOR-BASED ADJUSTMENT

Rejustor adjustments are performed with LabVIEW-based ***Rejust-it*** software. The auxiliary pins (**H1 – H5)** are required only during the short time period during which the ***Rejustors*** are being adjusted. The resistance of the ***Rejustors*** is adjusted by applying computer-controlled analog signals between **Hn** and **Vss** (where 'n' represents heater elements 1 through 5). The ***Rejustors*** are automatically adjusted under ***Rejust-it*** software control.

Rejustors are adjusted using LabVIEW-based ***Rejust-it*** software from Microbridge Technologies. ***Rejust-it*** software operates with Rejustor Calibration Tools in a closed loop to adjust the ***Rejustors*** to achieve the desired output condition while monitoring both the output and the input. ***Rejust-it*** works with off-the-shelf hardware such as ADC (analog to digital converters) to monitor the system. DAC (digital to analog converters) are used to generate pulses to adjust the ***Rejustor***. Off-the-shelf hardware is available from equipment providers such as National Instruments. The low-cost MBK-408A Rejustor Calibration Tool from Microbridge Technologies Inc can also be used to adjust the MBFC-01.

Recognizing that these pins (H1 – H5) are only required during calibration may affect design of the calibration fixture. In normal operation these pins can be left open, or grounded, with no impact. The calibration fixture can be designed to allow connection to the auxiliary pins with pogo-pins, probes or similar temporary connections. Optionally, a header can be designed on the PCB to allow connection between **H1 – H5** and the calibration hardware.

Once the ***Rejustors*** have been adjusted no further action is required. ***Rejustors*** retain their resistance in their material properties and no further changes are required. No boot-up or warm period is required for the ***Rejustors***. ***Rejustors*** may subsequently be readjusted as required.