

The **Rejistor** is a precision-adjustable passive resistor enables in-circuit, precision, analog calibration in a revolutionary way. Each **Rejistor** can be adjusted and fixed to 0.1% precision (or better) using electrical signals. The adjustment process provides precision control of the resistance of each resistor in the pair for set-on-test applications.

Low-power **Rejistors** are suitable for applications where the total power dissipation (in the pair) does not exceed 1mW.

Precision adjustment of the resistance of each **Rejistor** is accomplished by means of a proprietary procedure which semi-permanently adjusts the resistive poly-silicon element in a closed-loop system under control of **Rejistor** Calibration tools and Rejust-it software. The adjustment process is typically complete within 1-2 second.<sup>1</sup>

Adjustment changes the physical properties of the resistors. No external memory or boot-up is required. The material is physically altered to have a new electrical response. After adjustment, the **Rejistor** is stable in the range from -55°C to +125°C.

Resistance can be matched to within 0.1%, or better, of the target value. The **Rejistor** is ideal for gain setting, offset and bias adjustment, voltage adjustment and a variety of high-precision analog applications. The **Rejistor** features the lowest noise and the widest bandwidth of any adjustable resistor technology.

Each Low-TCR **Rejistor** is temperature stable, maintaining 0ppm/K  $\pm 100$ ppm/K TCR across the adjustment range. Relative TCR between both **Rejistors** is  $\pm 10$ ppm/K.

Rejistors are available in lead-free, RoHS and Green packages. The **Rejistor** is available in 16-pin QFN package.

## BENEFITS

- Precision electrical in-circuit adjustment
- Externally adjust or calibrate parameters on circuits or sensors at final assembly
- Adjustment process isolated from circuit allowing true in-circuit calibration
- Single chip solution to calibrate voltages, currents, offsets, gains, etc.
- No mechanical moving parts, ideal for vibration sensitive applications
- Improved reliability, dependability; dust and moisture resistance over mechanical parts
- Dynamic adjustment provides cost and labor savings
- Eliminates labor-intensive select-on-test adjustment
- Flexibility reduces rework cost
- Potential for multiple adjustments
- Lowest noise and widest bandwidth of any adjustable resistor technology
- In-circuit adjustment allows system calibration after encapsulation or packaging

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## ELECTRICALLY ADJUSTABLE 4.7K $\Omega$ 1:5 RESISTOR PAIR

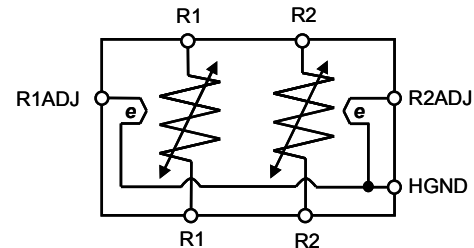


Figure 1: Functional Block Diagram

PARAMETER	SPECIFICATION
R1 Resistance (as-manufactured)	4.7K $\Omega$
R1 Minimum adjustable resistance	3.3K $\Omega$
R2 Resistance (as-manufactured)	23.5K $\Omega$
R2 Minimum adjustable resistance	16.5K $\Omega$
Adjustment Precision	0.1% or 0.01% <sup>1</sup>
TCR	0 $\pm$ 100ppm/K
R1 Rated Power	0.125mW
R2 Rated Power	0.625mW

## FEATURES

- Electrically adjustable 4.7K $\Omega$ , 1:5 dual resistor
- Each Resistor is independently electrically adjustable to any value from its as-manufactured value down 30%, with accuracy 0.1% or better
- Bi-directional, continuous value adjustment within active range
- Long Term Stability 0.5%, see Table 5
- Stable Temperature Coefficient as resistance is adjusted - TCR: 0 $\pm$ 100ppm/K
- Suitable for operation from -55 to +125°C, refer to Table 2
- Low noise: Typ -15dB
- Passive device requires no power during operation
- In-circuit adjustable at wafer, component, board or system level
- QFN 16-pin RoHS, Pb-Free and Green packages

## APPLICATIONS

- Anywhere precision calibration is required
- Gain control and offset adjustment
- Reference voltage and current adjustment
- Precision Voltage Regulator calibration
- Filter tuning
- RF Amplifier biasing
- Opto-electronics
- Frequency Control devices
- Mechanical or digital potentiometer replacement
- Suitable for high-frequency applications

<sup>1</sup> Adjustment precision is limited by temperature control, accuracy of measurement and adjustment equipment and may increase adjustment time  
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**Table 2: RATINGS – Rejustors**  $0^{\circ}\text{C} < T_A < +70^{\circ}\text{C}$  and rated power; unless otherwise noted.

Item	Conditions	Typical Specifications
Maximum Power		5 times rated power
Nominal Resistance R1		4,700Ω
R1 Rated Power		0.125mW
Nominal Resistance R2		23,500Ω
R2 Rated Power		0.625mW
Operating Temperature	As specified in this datasheet	0°C to +70°C
	As specified in Application Note “ <i>Rejustor</i> Operating Guidelines for -55 to +125C Operation”	-55 to +125°C
	Beyond -55 to +125°C	Contact Microbridge
Isolation Voltage (between any pins)	Subject to power limits	25V
<i>Rejustor</i> Self-heating Coefficient of Resistance, R1		+4000 ppm/mW ±20%
<i>Rejustor</i> Self-heating Coefficient of Resistance, R2		+4000 ppm/mW ±20%
Relative Self-heating Coefficient of Resistance	When both <i>Rejustors</i> carry the same current	±3000 ppm/mW
Total Resistance Tolerance		As-manufactured resistance is ±10% from nominal
Nominal Adjustment range		+0 to -30% from as-manufactured
Nominal Pair Matching	Unadjusted	±2%

**Table 3: TCR CHARACTERISTICS – Rejustors**  $0^{\circ}\text{C} < T_A < +70^{\circ}\text{C}$  and rated power, unless otherwise noted.

Characteristics	Specification (Worst Case)	Test Method or Conditions
Temperature Coefficient Unadjusted Adjusted	0±100ppm/K 0±100ppm/K	
Change in Temperature Coefficient	± 50ppm/K	TCR change in adjusted device relative to unadjusted device, by analysis
Temperature Coefficient Matching of pairs	± 10ppm/K	Adjusted to match resistance, by analysis

**Table 4: PACKAGE ELECTRICAL CHARACTERISTICS**

Characteristics	Specification (Typical)	Test Method or Conditions
QFN Capacitive Loading	0.7pF	Per package pin, by analysis at 100MHz
QFN Mutual Capacitance	0.1pF	By analysis at 100MHz

**Table 5: RELIABILITY DATA**

Characteristics	Limit	Test Method or Conditions
Thermal Shock/ Cycling	+ 0.5% <sup>2</sup>	JESD22-A104, -65°C to 125°C, 1000 cycles at 2 cycles/hour
Overload	+ 0.5% <sup>2</sup>	MIL-R-55342H Par 4.8.6 (Rated Voltage x2.5, 5sec.), Rated voltage based on rated power $V = \sqrt{PR}$
High Temperature Exposure (long-term stability)	+ 0.5% <sup>2</sup>	JESD22-A103 150°C, 1000hrs
Humidity and Moisture Resistance	+ 0.8% <sup>2</sup>	JESD22-A101, 85% RH, 85°C, 1000hrs
Operational Life Test	+ 0.5% <sup>2</sup>	JESD22-A108, 125°C, 1000 hrs., static operation at rated power
Shock	± 0.1%	500G, 1ms duration, X,Y,Z axes each 5 shocks
Vibration, High Frequency	± 0.1%	Max acceleration 20G, 20~2000~20Hz, 8 min, X,Y,Z each 4 sweeps

**Table 6: MANUFACTURABILITY DATA**

Characteristics	Test Method or Conditions
ESD Discharge	JESD22-A114, human body model weakest pin pair, all lead combinations. Class 1A
Solder ability	J-STD-020C, MSL1, 260°C convection reflow for QFN-16 packages

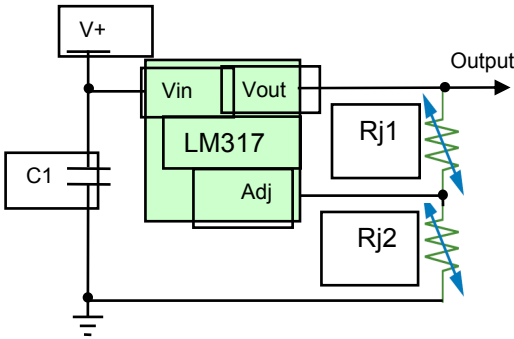
**PACKAGING OPTIONS**

**Table 7: NOMINAL PACKAGE DIMENSIONS**

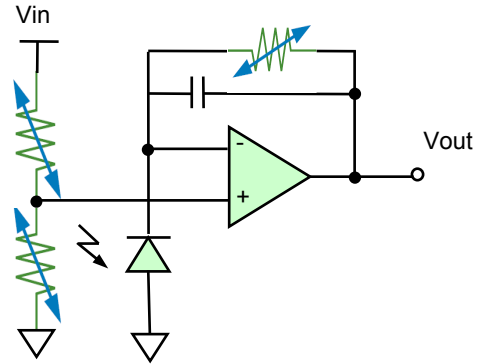
Type	Lead Count	Body Width	Body Length	Lead Pitch	Lead Width	Lead Length	Body Thickness	JEDEC/ EIAJ
QFN	16	3.0mm	3.0mm	0.5mm	0.25mm	0.4mm	0.85mm	MO-220

<sup>2</sup> Where indicated, drift specifications refer to resistance drift in the positive direction. Best performance is achieved at adjustments larger than 10% down from the as-manufactured resistance.

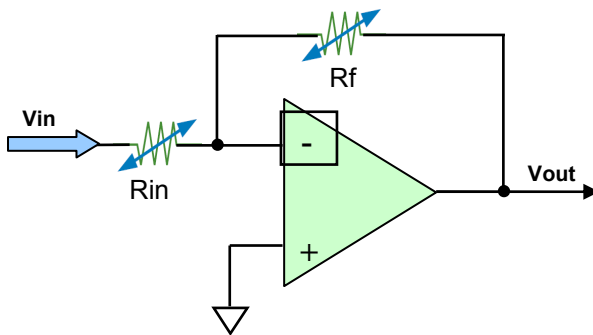
**APPLICATION EXAMPLES**



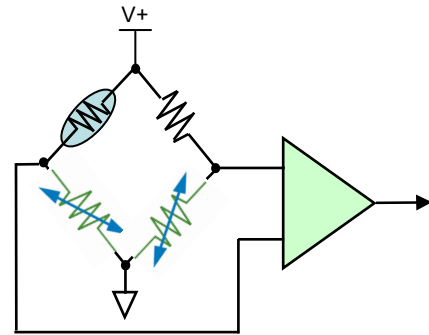
**Figure 2: Voltage Regulator Application Circuit**



**Figure 4: Adjustable Photo-Detector**



**Figure 3: Basic Op Amp Application**



**Figure 5: Sensor Offset Correction**

**FUNCTIONAL DESCRIPTION**

Microbridge **Rejutors** represent a technology revolution in resistive adjustment for precision electronic systems. Each **Rejutor** in the dual package provides independent, precision adjustment of resistance in a continuous range for in-circuit, set-on-test adjustment of a wide variety of analog electronic circuits and systems.

**Rejutors** are adjusted in-circuit to meet the precision requirements of the application. For example, the **Rejutor** can be adjusted to provide an output voltage (Figure 2) or adjust a gain setting (Figure 3). In all cases, the exact resistance value of the **Rejutor** is less important than the desired output parameter of the circuit being adjusted. The **Rejutor** is the only pure-passive resistive element that can be adjusted at final assembly, using only electrical signals. Furthermore, unlike laser-trimmed resistors, **Rejutors** can be adjusted bi-directionally.

**Rejutors** are adjusted using **Rejutor** Calibration Tools, such as the MBK-408A – Low cost, high-precision **Rejutor** Calibration tool. **Rejutors** can also be adjusted with a high-volume, high-precision Calibration tool based on the National Instruments NI-DAQ chassis.

During the calibration process, the **Rejutor** is connected to the **Rejutor** Calibration Tool, or equivalent hardware<sup>3</sup>. The Calibration tool provides the electrical connections to monitor the circuit output behavior and drive power into the Adjustment pins of the **Rejutor**. Power applied to the Adjustment pins controls the heating and cooling process which in-turn changes the resistance. Refer to Figure 6 for a sample connection between the MBK-408A **Rejutor** Calibration tool and the **Rejutor**. This connection to the calibration tool is only required during the adjustment step.

<sup>3</sup> Using Microbridge’s scalable production-calibration hardware (based on the NI-DAQ platform from National Instruments) and Rejist-it software, multiple units can be calibrated simultaneously during roughly the same amount of time for high-volume applications.

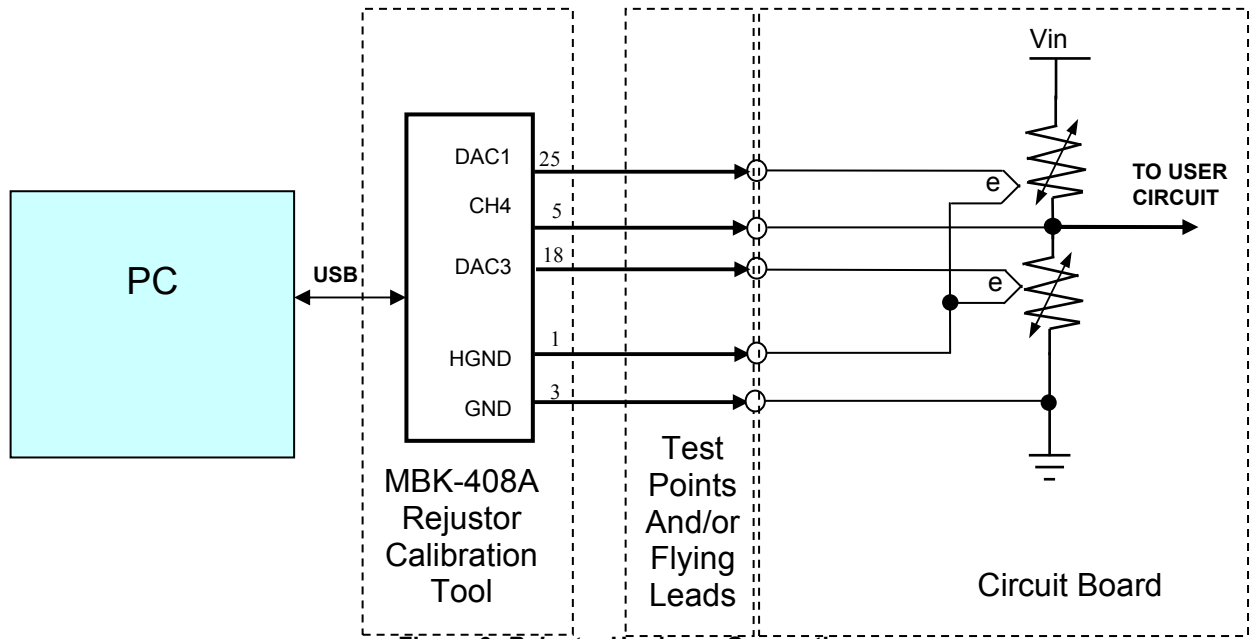


Figure 6: Rejistor Hardware Connection

Rejst-it software, provided as part of the **Rejistor** Calibration Tool is a LabVIEW-based executable that controls the adjustment process using the **Rejistor** Calibration Tool in a closed-loop feedback system. **Rejistors** are automatically adjusted to the target values, as specified in the graphical user interface. A sequence of electrical heating pulses, governed by Microbridge's proprietary algorithms, is enough to fine-tune the material properties within approximately 1 second for most applications.

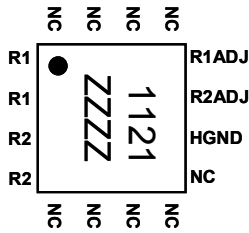
After adjustment, the circuit is disconnected from the **Rejistor** Calibration tool. The **Rejistor** does not require active power to maintain its adjusted resistance. The material properties of the **Rejistor** are altered to affect the current flow, which means the resistance is changed. **Rejistors** are intended for set-and-forget applications that involve factory calibration. The devices can be adjusted dozens-of-times, as may be required for periodic maintenance or calibration.

The resistive element of the **Rejistor** is electrically isolated from both substrate and Adjust (heater) pins and can therefore float, electrically.

Adjusted **Rejistors** are highly stable and retain their electrical and temperature performance characteristics indefinitely. **Rejistors** can be adjusted many times, bi-directionally without compromising stability or performance. **Rejistors** also feature the lowest noise and the widest bandwidth of any adjustable resistor technology.

Microbridge **Rejistors** are an electrical replacement for mechanical compensation techniques. They replace manual trim pots, digital pots and laser trimming. The Microbridge Technologies Low-TCR **Rejistor** family of electrically adjustable micro-resistors can be matched to values for precision control of sensors, voltage regulators, amplifiers and other applications.

**PIN CONFIGURATION**



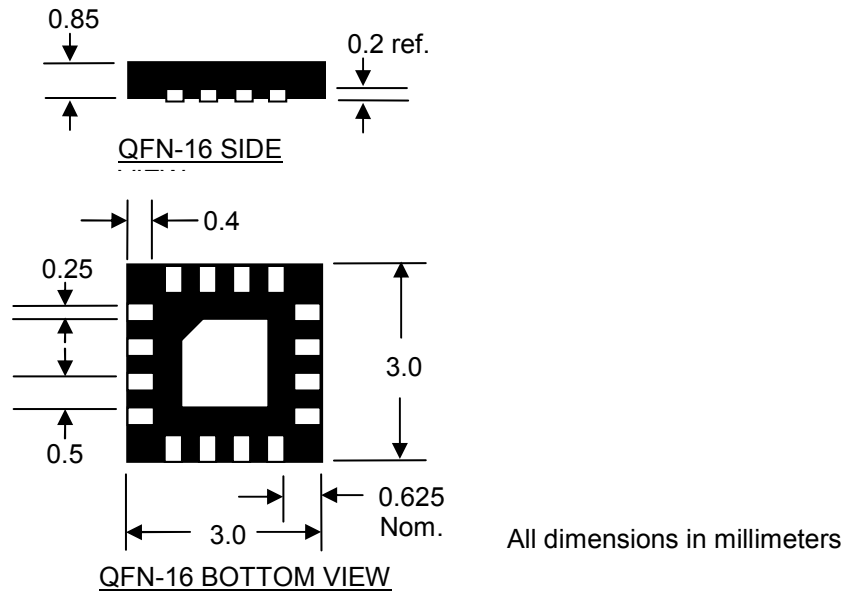
**Figure 7: Pin Configuration, 16-pin QFN package (3x3mm)**

**PIN FUNCTIONAL DESCRIPTION**

**Table 8: Pin Function Descriptions**

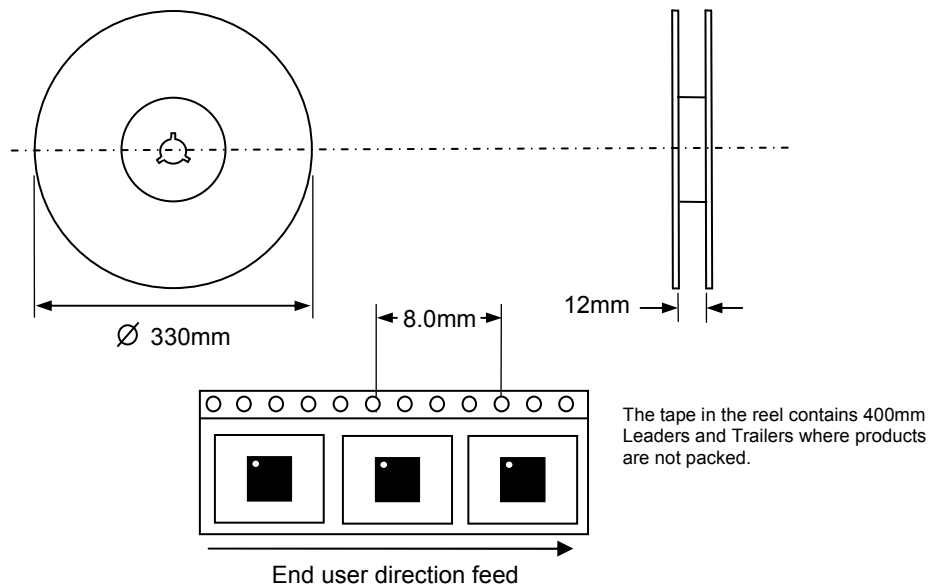
Mnemonic	Description	16-Pin QFN Pin No.
R1	Rejutor 1 Terminal	1
R1	Rejutor 1 Terminal	2
R2	Rejutor 2 Terminal	3
R2	Rejutor 2 Terminal	4
HGND	Heater Ground	10
R2ADJ	Rejutor 2 Adjust Input	11
R1ADJ	Rejutor 1 Adjust Input	12
NC	No Connect	5, 6, 7, 8, 9, 13, 14, 15, 16

**Note: QFN Package – Ground pad is not connected**



**Figure 8: Package Dimensions**

**TAPE CARRIER PACKAGING**



**Figure 9: Tape Carrier Dimensions**

**Table 9: ORDERING INFORMATION**

Part Number	Order Code	Package	Part Marking <sup>4</sup>	Delivery	Quantity
MBD-472-CL	1121	QFN-16	1121-ZZZZ	Tape and Reel	3000 <sup>5</sup>

**NOMINAL VALUES AVAILABLE**

The following additional Micro Power Dual **Rejutors** are available with similar performance specifications. Consult the individual datasheet for more information.

Part Number	Resistance R1 Value (Ω)	Resistance R2 Value (Ω)	Ratio	QFN Order Code
MBD-472-AL	4700	4700	1:1	111R
MBD-472-CL	4700	24,500	1:5	1121
MBD-902-AL	9,000	9,000	1:1	111T
MBD-902-CL	9,000	45,000	1:5	1127
MBD-902-XL	9,000	63,000	1:7	111X
MBD-153-AL	15,000	15,000	1:1	111Y
MBD-153-KL	15,000	45,000	1:3	111U
MBD-333-AL	33,000	33,000	1:1	111Z

**Please check with Microbridge Technologies Inc prior to design to ensure you have the latest revision of the datasheet for this part**

<sup>4</sup> Where ZZZZ represents the 4-digit date code

<sup>5</sup> Smaller sample quantities available on tape