

The **Rejistor** is a precision-adjustable passive resistor enabling 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 Rejst-it software. The adjustment process is typically complete within 1-2 seconds.¹

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 ±100ppm/K TCR across the adjustment range. Relative TCR between both **Rejistors** is ±10ppm/K.

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

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

ELECTRICALLY ADJUSTABLE 4.7KΩ 1:1 RESISTOR PAIR

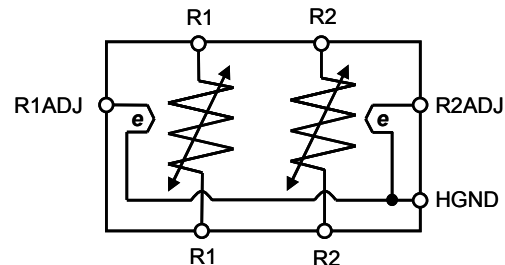


Figure 1: Functional Block Diagram

PARAMETER	SPECIFICATION
Resistance (as-manufactured)	4.7KΩ
Minimum adjustable resistance	3.3KΩ
Adjustment Precision	0.1% or 0.01% ¹
TCR (per Rejistor)	0±100ppm/K
Rated power (per Rejistor)	0.5mW

FEATURES

- 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±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

¹ 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		0.5mW
Nominal Resistance R2		4,700Ω
R2 Rated Power		0.5mW
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 and R2		+4000 ppm/mW ±20%
Relative Self-heating Coefficient of Resistance	When both <i>Rejustors</i> carry the same current	±500 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% ²	JESD22-A104, -65°C to 125°C, 1000 cycles at 2 cycles/hour
Overload	+ 0.5% ²	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% ²	JESD22-A103 150°C, 1000hrs
Humidity and Moisture Resistance	+ 0.8% ²	JESD22-A101, 85% RH, 85°C, 1000hrs
Operational Life Test	+ 0.5% ²	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

² 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

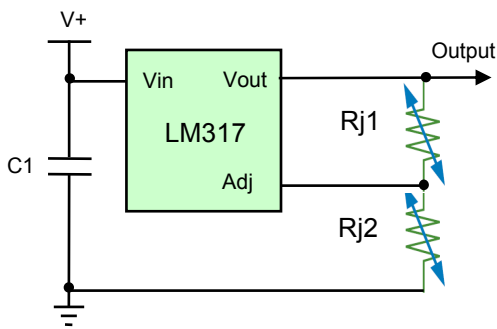


Figure 2: Voltage Regulator Application Circuit

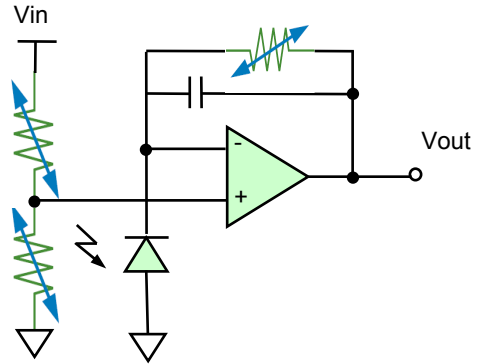


Figure 4: Adjustable Photo-Detector

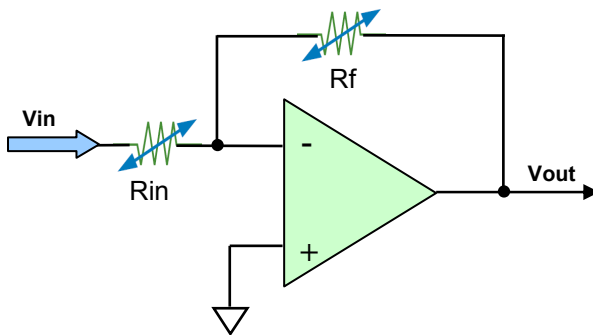


Figure 3: Basic Op Amp Application

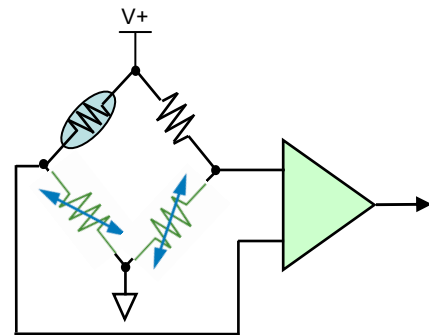


Figure 5: Sensor Offset Correction

FUNCTIONAL DESCRIPTION

Microbridge **Rejustors** represent a technology revolution in resistive adjustment for precision electronic systems. Each **Rejustor** 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.

Rejustors are adjusted in-circuit to meet the precision requirements of the application. For example, the **Rejustor** 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 **Rejustor** is less important than the output parameters of the circuit being adjusted. The **Rejustor** is the only pure-passive resistive element that can be adjusted at final assembly, using only electrical signals. Furthermore, unlike laser-trimmed resistors, **Rejustors** can be adjusted bi-directionally.

Rejustors are adjusted using **Rejustor** Calibration Tools, such as the MBK-408A – Low cost, high-precision **Rejustor** Calibration tool. **Rejustors** 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 **Rejustor** is connected to the **Rejustor** Calibration Tool, or equivalent hardware³. The Calibration tool provides the electrical connections to monitor the circuit output behavior and drive power into the Adjustment pins of the **Rejustor**. 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 **Rejustor** Calibration tool and the **Rejustor**. This connection to the calibration tool is only required during the adjustment step.

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

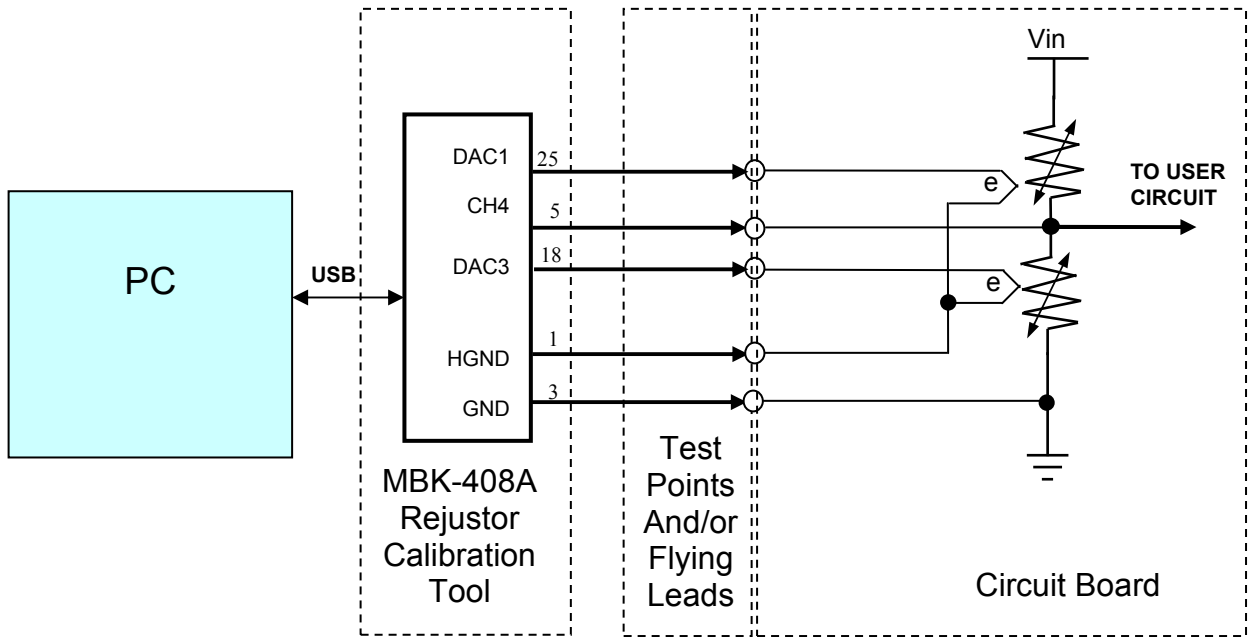


Figure 6: *Rejistor* Hardware Connection

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

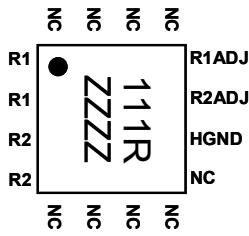


Figure 7: Pin Configuration, 16-pin QFN package (3x3mm)

PIN FUNCTIONAL DESCRIPTION

Table 8: Pin Function Descriptions

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

Note: QFN Package – Ground pad is not connected.

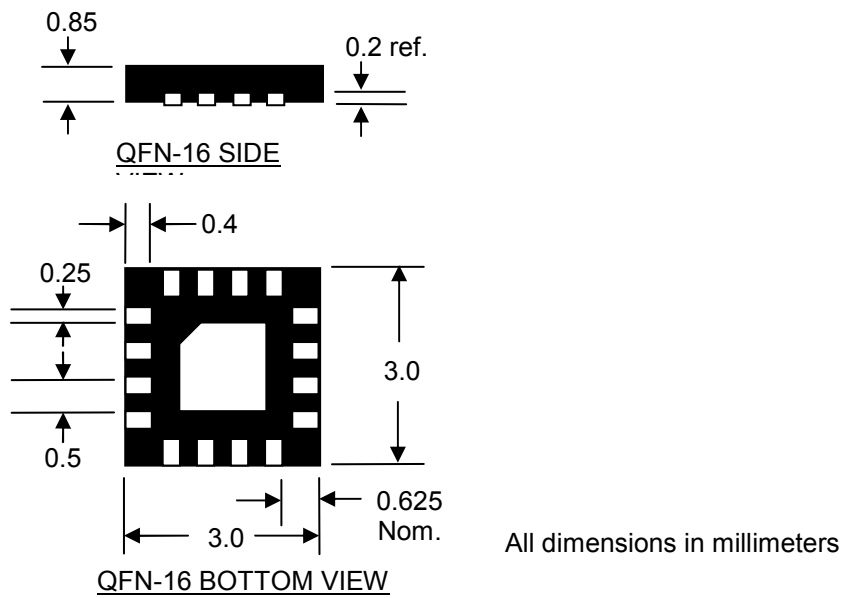


Figure 8: Package Dimensions

TAPE CARRIER PACKAGING

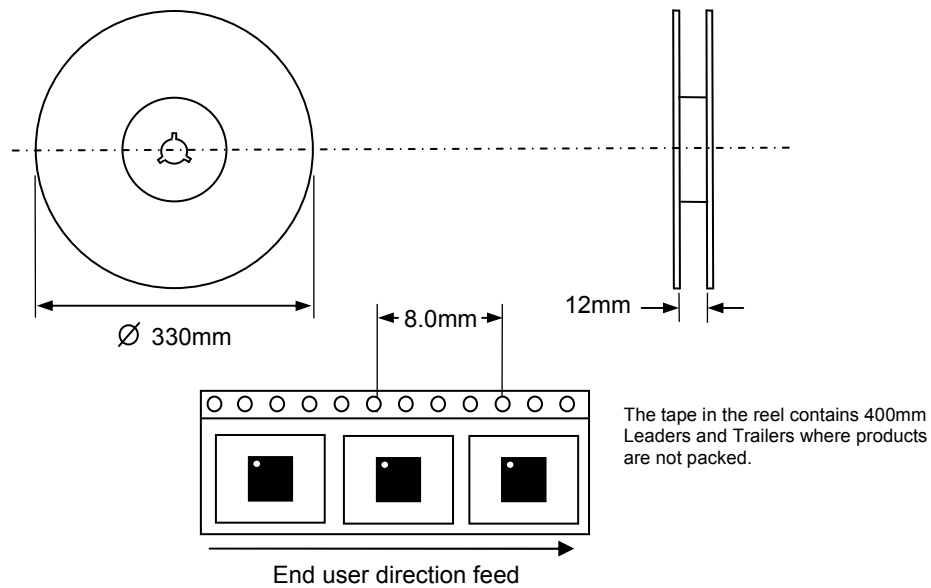


Figure 9: Tape Carrier Dimensions

Table 9: ORDERING INFORMATION

Part Number	Order Code	Package	Part Marking ⁴	Delivery	Quantity
MBD-472-AL	111R	QFN-16	111R-ZZZZ	Tape and Reel	3000 ⁵

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

⁴ Where ZZZZ represents the 4-digit date code

⁵ Smaller sample quantities available on tape