

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 Rejst-it software. The adjustment process is typically complete within 1-2 second.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 ± 100 ppm/K TCR across the adjustment range. Relative TCR between both **Rejistors** is ± 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

ELECTRICALLY ADJUSTABLE 15K Ω 1:3 RESISTOR PAIR

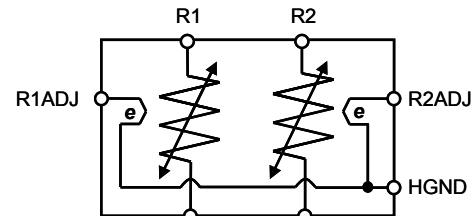


Figure 1: Functional Block Diagram

| PARAMETER | SPECIFICATION |
|----------------------------------|----------------------------|
| R1 Resistance (as-manufactured) | 15K Ω |
| R1 Minimum adjustable resistance | 10.5K Ω |
| R2 Resistance (as-manufactured) | 45K Ω |
| R2 Minimum adjustable resistance | 31.5K Ω |
| Adjustment Precision | 0.1% or 0.01% ¹ |
| TCR | 0 \pm 100ppm/K |
| R1 Rated Power | 0.25mW |
| R2 Rated Power | 0.75mW |

FEATURES

- Electrically adjustable 15K Ω , 1:3 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

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 – Rejutors $0^{\circ}\text{C} < T_A < +70^{\circ}\text{C}$ and rated power; unless otherwise noted.

| Item | Conditions | Typical Specifications |
|---|--|---|
| Maximum power | | 5 times rated power |
| Nominal Resistance R1 | | 15,000Ω |
| R1 Rated Power | | 0.25mW |
| Nominal Resistance R2 | | 45,000Ω |
| R2 Rated Power | | 0.75mW |
| Operating Temperature | As specified in this datasheet | 0°C to +70°C |
| | As specified in Application Note “ <i>Rejutor</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>Rejutor</i> Self-heating Coefficient of Resistance, R1 | | +8000 ppm/mW ±20% |
| <i>Rejutor</i> Self-heating Coefficient of Resistance, R2 | | +3000 ppm/mW ±20% |
| Relative Self-heating Coefficient of Resistance | When both <i>Rejutors</i> carry the same current | ±500ppm/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 – Rejutors $0^{\circ}\text{C} < T_A < +70^{\circ}\text{C}$ 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

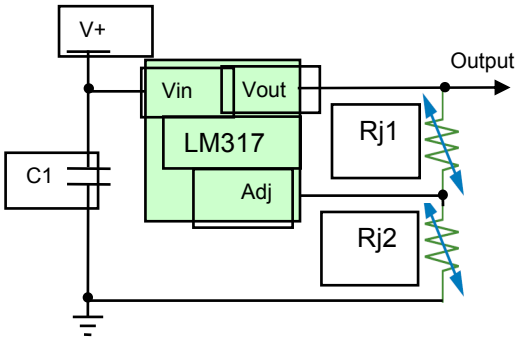


Figure 2: Voltage Regulator Application Circuit

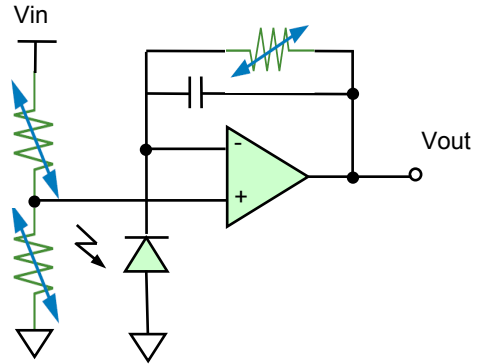


Figure 4: Adjustable Photo-Detector

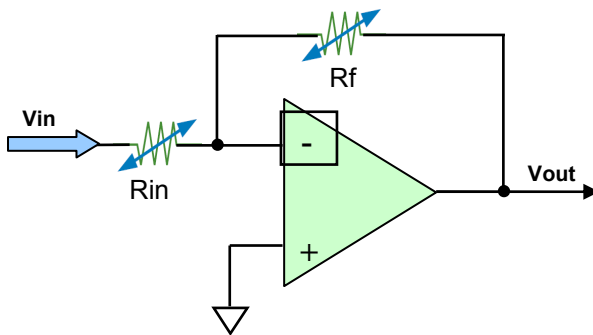


Figure 3: Basic Op Amp Application

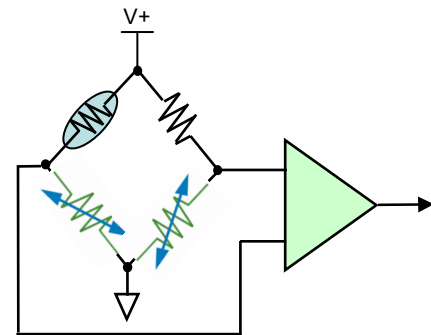


Figure 5: Sensor Offset Correction

FUNCTIONAL DESCRIPTION

Microbridge **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 parameters 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 hardware³. 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.

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

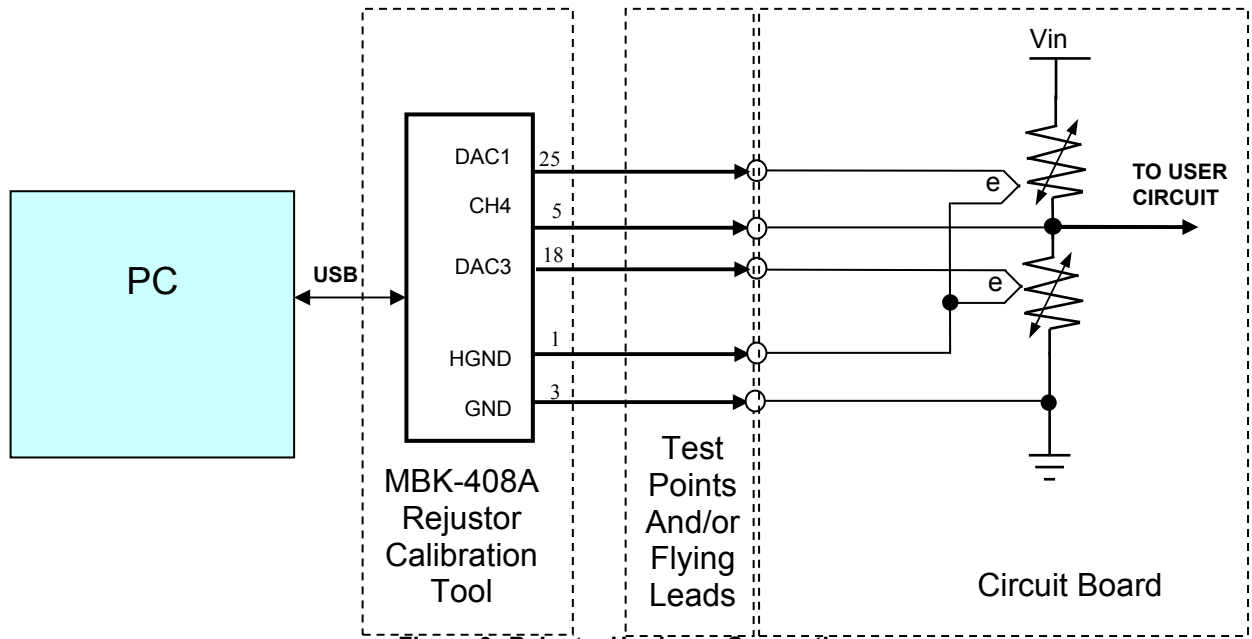


Figure 6: Rejistor Hardware Connection

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

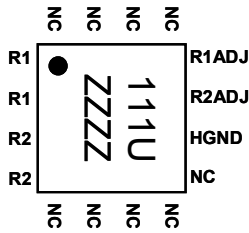


Figure 7: Pin Configuration, 16-pin QFN package (3x3mm)

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.

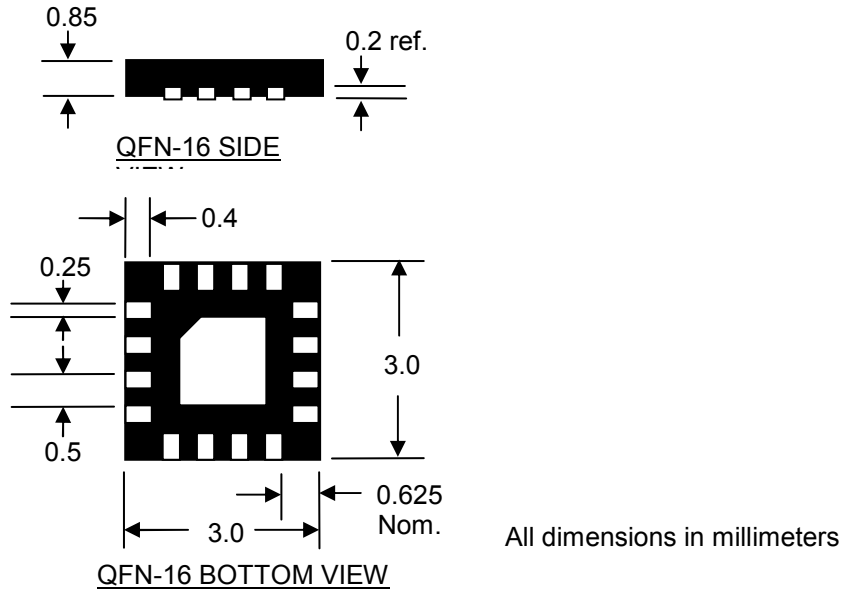


Figure 8: Package Dimensions

TAPE CARRIER PACKAGING

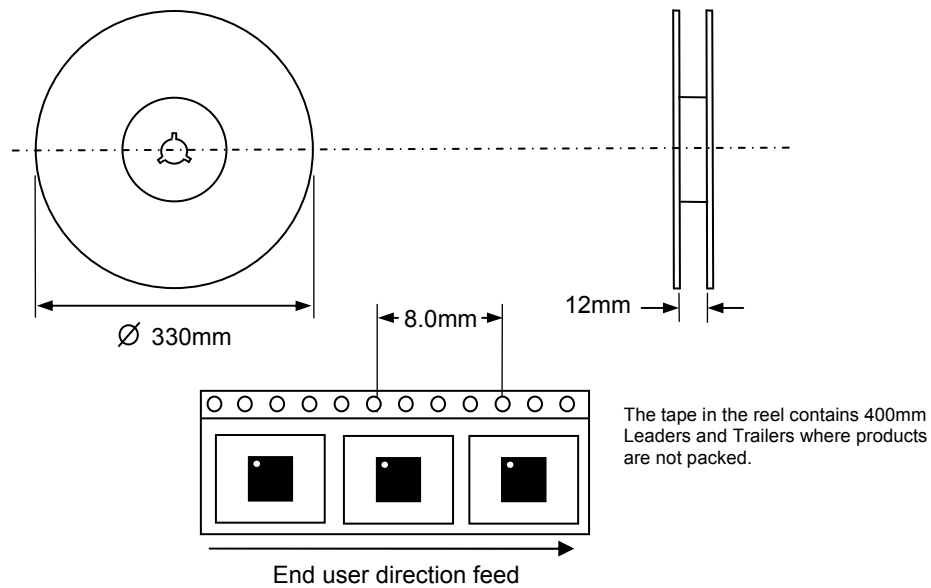


Figure 9: Tape Carrier Dimensions

Table 9: ORDERING INFORMATION

| Part Number | Order Code | Package | Part Marking ⁴ | Delivery | Quantity |
|-------------|------------|---------|---------------------------|---------------|-------------------|
| MBD-153-KL | 111U | QFN-16 | 111U-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