



## Thermocouple Installation in Brake Rotors and Brake Drums

### 1 Introduction

**Note:** Nothing in this standard supercedes applicable laws and regulations.

**Note:** In the event of conflict between the English and domestic language, the English language shall take precedence.

**1.1 Purpose.** To detail the process of instrumenting brake rotors and brake drums for brake evaluation tests that require temperature monitoring or measurement.

**1.2 Applicability.** This procedure is applicable for cast iron brake rotors and drums used on passenger vehicles. This procedure is also applicable for ceramic brake rotors used on passenger cars.

**1.3 Remarks.** Thermocouples are used to provide temperature data during brake testing.

### 2 References

**Note:** Only the latest approved standards are applicable unless otherwise specified.

#### 2.1 External Standards/Specifications.

None

#### 2.2 GM Standards/Specifications.

None

### 3 Resources

**3.1 Facilities.** A lab or shop area is needed to perform this procedure.

**3.1.1 Calibration.** The test facilities and equipment shall be in good working order and shall have a valid calibration label.

**3.1.2 Alternatives.** Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

#### 3.2 Equipment.

**3.2.1** Resistance Welder.

**3.2.2** Drill Press.

**3.2.3** General Shop Tools.

**3.3 Test Vehicle/Test Piece.** Parts shall be specified on the work request. New brake parts are recommended. Used parts may be thermocoupled if remaining wear depth is sufficient.

#### 3.4 Test Time.

Calendar time: 1 d

Test time: 0.5 h

Coordination time: 0.25 h

**3.5 Test Required Information.** All safety procedures shall be followed while installing thermocouples in brake components.

**3.6 Personnel/Skills.** An experienced, trained brake technician is needed to run this procedure.

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## 4 Procedure

**4.1 Preparation.** Not applicable.

**4.2 Conditions.**

**4.2.1 Environmental Conditions.** Not applicable.

**4.2.2 Test Conditions.** Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

**4.3 Instructions.**

**4.3.1 Embedded Thermocouples For Vented Rotors.**

**4.3.1.1** Use a center punch to mark the thermocouple hole in the center of the outer cheek swept area. The thermocouple hole should be along the centerline between any two (2) of the stud holes and between two (2) ribs of the rotor.

**4.3.1.2** Use a drill press and a Number (No.) 31 drill bit (See Appendix A, Table A1) to drill a hole on the center punch mark through the rotor outer cheek. Use a de-burring tool to chamfer the hole. (See Figure A1).

**4.3.1.3** Use a No. 26 drill bit (See Appendix A, Table A1) to drill a hole through the rotor near where the ribs meet the hat section. This is the routing channel to be used for the thermocouple wire to exit the rotor. Otherwise, mill a slot, approximately 10 mm (0.4 in) wide by 2.5 mm (0.1 in) deep, into the inside rotor flange between the two (2) previously mentioned stud holes. Mill a 10 mm (0.4 in) radius into the bearing pilot hole in line with the slot for relief of the wire at the bearing flange interface. All sharp edges must be relieved using a de-burring tool.

**4.3.1.4** Push the thermocouple through the hole of the rotor cheek and out between the ribs.

**4.3.1.5** If needed, cover the thermocouple wire with fiber conduit to protect the wire from grounding on any sharp edges.

**4.3.1.6** Use a ball peen hammer and punch to set the thermocouple 1.0 mm  $\pm$  0.25 mm below the surface of the rotor cheek. Remove any burr left on the rotor surface with a file.

**4.3.1.7** Weld a strap to hold the thermocouple wire to the hat section. Any paint should be removed to ensure weld integrity.

**4.3.1.8** Trim thermocouple wires to desired length and attach a connector.

**4.3.2 Embedded Thermocouples for Solid Rotors.** The following process is used to set a thermocouple approximately at the center of the rotor swept area at approximately a depth of half the rotor cheek thickness.

**4.3.2.1** Select a drill press with enough range to accommodate the outside diameter of the rotor to be instrumented. Place the rotor in an appropriate vise. Mark a position at the center of the rotor cheek and equally spaced between two (2) stud mounting holes. Place the rotor and vise combination on the drill press table and align carefully.

**4.3.2.2** Using a No. 4 centering drill (See Appendix A, Table A1), start a hole at the marked location. Replace the centering drill with a No. 31 drill (See Appendix A, Table A1) that is 15.24 cm (6 in) long. Drill radially down through the rotor cheek stopping at the rotor cheek to hat section interface. Change the drill to No. 30 (See Appendix A, Table A1) and drill radially half the distance of the rotor cheek creating a relief. This relief is necessary in setting the thermocouple (see Appendix A, Figure A2).

**4.3.2.3** Remove rotor from vise. Drill a 6 mm hole at the hat section end of the radial cut through the cheek just above the hat section. Use a de-burring tool to remove all sharp edges.

**4.3.2.4** Push the thermocouple wire through the rotor cheek. The thermocouple should stop at the drilled relief. Check that the thermocouple has been pulled to approximately the center of the rotor swept area.

**4.3.2.5** Clean the hat section of the rotor to ensure a good bond for welding. Use the resistance welder and Incanel strapping to secure the thermocouple wire to the hat section of the rotor.

**4.3.2.6** If needed, cover each wire with fiberglass conduit to protect the wire from grounding. Trim thermocouple wires to desired length and attach a connector.

**4.3.2.7** The thermocouple lead can be fed through the wheel bearing pilot hole. The wheel will need a relief cut into the pilot hole to allow the thermocouple wire to be fed through the wheel and attached to a slip ring.

**4.3.3 Embedded Thermocouples For Brake Drums.**

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**4.3.3.1** Determine the centerline of the brake swept area of the brake drum. Mark the spot with a punch equally spaced between two stud holes of the drum.

**4.3.3.2** Mount the drum in a vise and mount the vice in a drill press ensuring that the drum is perpendicular.

**4.3.3.3** Using a No. 31 drill (See Appendix A, Table A1), drill through the drum. Use a de-burring tool to chamfer the hole. (See Figure A3).

**4.3.3.4** Push the thermocouple wire through the hole in the drum. Use a ball peen hammer and a punch to set the thermocouple  $1.0 \text{ mm} \pm 0.25 \text{ mm}$  below the surface of the drum.

**4.3.3.5** Clean the surface of the drum to ensure a good bond for welding. Use the resistance welder and Incanel strapping to secure the thermocouple wire.

**4.3.3.6** If needed, cover each wire with fiberglass conduit to protect the wire from grounding. Trim thermocouple wires to desired length and attach a connector.

**4.3.4** The thermocouple lead can be fed through a wheel vent hole and connected to a slip ring.

#### **4.3.5 Embedded Thermocouple Examples.**

**Note:** See Appendix A, Table A1 to cross-reference equivalent metric drill bit sizes.

##### **4.3.5.1 United States of America:**

- Temprel, Inc.
- Part No. T52OB18K513.

##### **4.3.5.2 Europe:**

- MTB Sensor- Technik GmbH, Echternacher Str. 5.
- 53 842 Troisdorf, Germany.
- Caulked thermocouples Article No. 050311-02.

##### **4.3.5.3 Approved Rubbing Thermocouples:**

- Universal Thermosensors, England.
- Model GA4089.
- [www.universal-thermosensors.co.uk](http://www.universal-thermosensors.co.uk).

**4.4 Rubbing Thermocouples for Rotors.** It is recommended that the embedded type thermocouple be used whenever possible. In the event that an embedded thermocouple is not desirable, a rubbing (sliding) thermocouple should be used. Only GM approved rubbing thermocouples should be used. See 4.3.5 for a list of GM approved rubbing thermocouples. Refer to Appendix B, Figures B1 thru Figure B3 to review data comparing GM approved thermocouples with non-approved thermocouples.

**4.4.1** The rubbing thermocouple should be mounted to a bracket to locate it in the center of the swept area of the outer cheek of the rotor and should be mounted on the trailing edge of the brake caliper (see Appendix A, Figure A4). It is important to make sure that the entire contact area of the thermocouple is touching the rotor surface and that there is sufficient loading on the thermocouple to keep it in contact with the rotor surface at all times (see Appendix A, Figure A5 for example of incorrect installation).

**4.5** Attach thermocouple wire to temperature read-out or data acquisition system. If ambient temperature is not being measured, check for grounding, damaged wire, or connector shorting. Replace thermocouple or repair connectors as necessary.

## **5 Data**

**5.1 Calculations.** Not applicable.

**5.2 Interpretation of Results.** Not applicable.

**5.3 Test Documentation.** This procedure is to be used in conjunction with other GMW procedures. Data provided from the thermocouple measurements will be described in those procedures.

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