DESIGN SPECIFICATIONS

Part Number: 911-902 **Date:** 7/07/2011
Revision:
Product: Intake Manifold Runner Controller **Author:** David McClung

Fit & Function Overview

This particular IMRC (Intake Manifold Runner Controller) is electronically controlled to open or restrict the airway to the engine, depending on engine load and speed. At low speeds, restricting the airway helps prevent rough idling and generally non-precise engine function. At higher speeds, more intake air is required and this airway opens.

Design Objective:

Supplier will document performance and dimensions based on analysis of the supplied reference sample(s) and based on the included technical & material specifications given below. The supplier will submit the documentation for approval by Dorman Engineering Services. The supplier will produce the requested product based on the approved supplier documentation. The supplier will provide process information and material certification for their submitted product sample. Dorman Engineering Services will review and approve all supplier documentation prior to accepting a Production Part Approval Process (PPAP) sample(s) for inspection.

Reference Samples:

The following Approved Reference Sample is part of this specification: Original Equipment

Reference Documents:

Note: International equivalents to American standards such as SAE may be used with Dorman Products Engineering Services review and approval.

ASTM B438-08: Standard Specification for Bronze-Base Powder Metallurgy (PM) Bearings (Oil-Impregnated)
ASTM B633-07: Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
ASTM B888-08: Standard Specification for Copper Alloy Strip for Use in Manufacture of Electrical Connectors or Spring Contacts

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Materials and Finish Definition: As set forth by California State Proposition 65: The Safe Drinking Water and Toxic Enforcement Act of 1986; Material, Paint or other type of coatings are not to exceed <0.06% (600 **ppm**) **lead** by weight.

Metal

Mounting bracket:
Material: High carbon steel
Grade: SAE 1060-1070
Finish: Colored Chromate, SC 3, Type VI, per ASTM B633-07 **ALSO** black paint

Actuator Screws:
Material: Regular steel fastener (Torx)
Grade: N/A
Finish: Zinc plating

Sensor Screws:
Material: Regular steel fastener (Torx Security)
Grade: N/A
Finish: Zinc plating

Spring:
Material: Stainless spring steel
Grade: UNS S31600
Finish: none
Linear Spring Constant: 415 N/m
Angular Spring Constant: 1 mN*m/degree (milli-newton meter per degree)

All Terminals:
Material: Phosphor Bronze
Grade: UNS C51100 per ASTM B888-08
Finish: Silver or Tin plating

Solenoid magnet wire:
Material: Electrolytic Tough Pitch (ETP) Copper
Grade: UNS C11000
Conductor Diameter: .511mm
Enamel Grade: Grade 1 (8µm minimum), polyurethane, polyester, or polyamide-imide

Brush:
Material: Electrolytic Tough Pitch (ETP) Copper
Grade: UNS C11000
Finish: None

Shaft:
Material: Carbon Steel
Grade: UNS G12150

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Finish: None

Bushing 1 and 2:
Material: Powered Bronze impregnated with oil per ASTM B438-08
Grade: CT-1000
Finish: None

Ball Bearings:
Material: Steel ball bearing case

Magnet:
Material: Custom Neodymium magnet
Grade: N38
Finish: Nickel-Copper-Nickel plating.

Magnet Seat:
Material: Ferrous Powder Metal per ASTM B783-04
Grade: FY-4500
Finish: None

Winding core and coil press fit:
Material: Ferrous Powder Metal per ASTM B783-04
Grade: FY-4500
Finish: None

Coil Jumpers:
Material: Phosphor Bronze
Grade: UNS C51100 per ASTM B888-08
Finish: Silver or Tin plating

Zinc plated components are to be plated per ASTM B633, minimum plating thickness 7.5um
Chromate using trivalent chromium, thickness range 0.3um to 0.5um ***(Hexavalent Chromium not permitted)***

Rubber

O-Ring:
Material: EPDM
Color: Black
Hardness: 50 IRHD, type M

Sensor Seal:
Material: NBR
Color: Green
Hardness: 68 IRHD, type M

Plastic

All plastic:
Material: PA66+GF30, No regrind allowed

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Color: Black
Surface Finish: To match OE

Other

Resistive Strip:

Material: Kapton (polyimide) with carbon resistive paste (TU-1K-5). Refer to the Asahi TU-OO-5 series specification for details

Exception to Sample:

- Alternative material use is acceptable, but only with the approval of Dorman Products Engineering Services.
- Alternative finishes are acceptable, but only with the approval of Dorman Products Engineering Services.

Dimensions and Measurements:

This section contains information regarding significant dimensions, characteristics, or measurements that that are required to manufacture this product.

- Part or Assembly Weight: 595 g
- Unless otherwise specified, all part dimensions to match the supplied samples.
- Unless otherwise specified, dimensions specified in Bid Package are for reference only.
- Surface finishes to match supplied samples and called out on drawings.
- Coil resistance is 3.5 +/- .5Ω for all four coils at 22°C, 0.85Ω per coil.
- Each coil has 210 turns, making 840 turns total.
- The copper brush thickness was originally 0.08mm thick. Change to 0.15mm
- As shown in Figure 13, the shaft is to be press fitted with the slot oriented 20 degrees clockwise (viewed from above) from the magnet notch. Press fit clearance must be between 0.02 to 0.05mm interference.
- The "Coil Press Fit" as shown in Figure 9 must press onto a mating piece on the winding core. Press fit clearance must be between 0.02 to 0.05mm interference.
- The ball bearing opening must have a 0.02-0.05mm clearance to accept the shaft.
- The opening in bushing two should have a 0.05-0.10mm clearance to accept the shaft.
- When a voltage Vref is applied across "sns+" and "sns-" (Figure 3), "sns out" should read about 25% of Vref when the intake fins are closed (IMRC is unpowered).
- Given the same setup "sns out" should read about 70% of Vref when the intake fins are opened (IMRC is powered).

Images of Product Sample:

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Figure 1: Top View

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Figure 2: Bottom View

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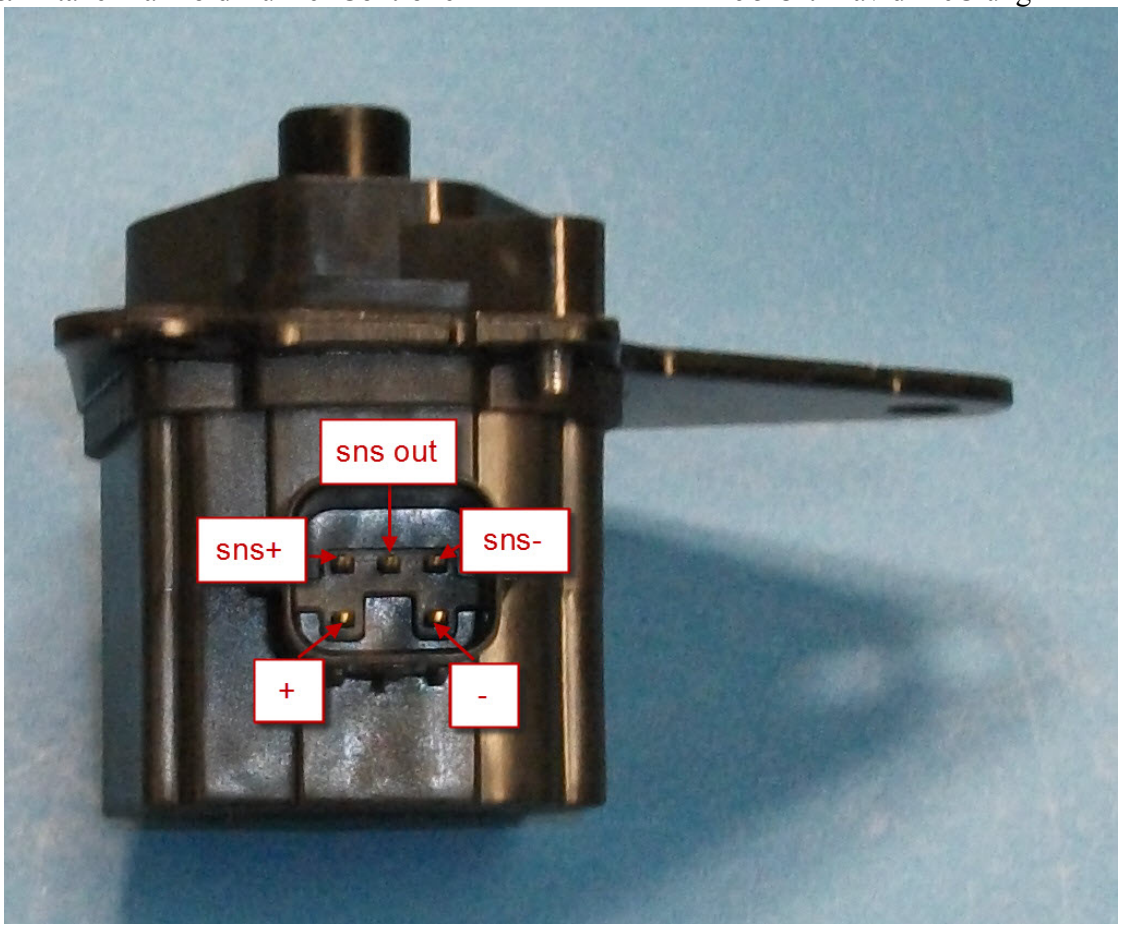

Signal Name	Description
Sns+	Sensor Reference Voltage
Sns-	Sensor Ground
Sns out	Sensor Output
+	Solenoid Power
-	Solenoid Ground

Figure 3: Connector pinout and pin descriptions

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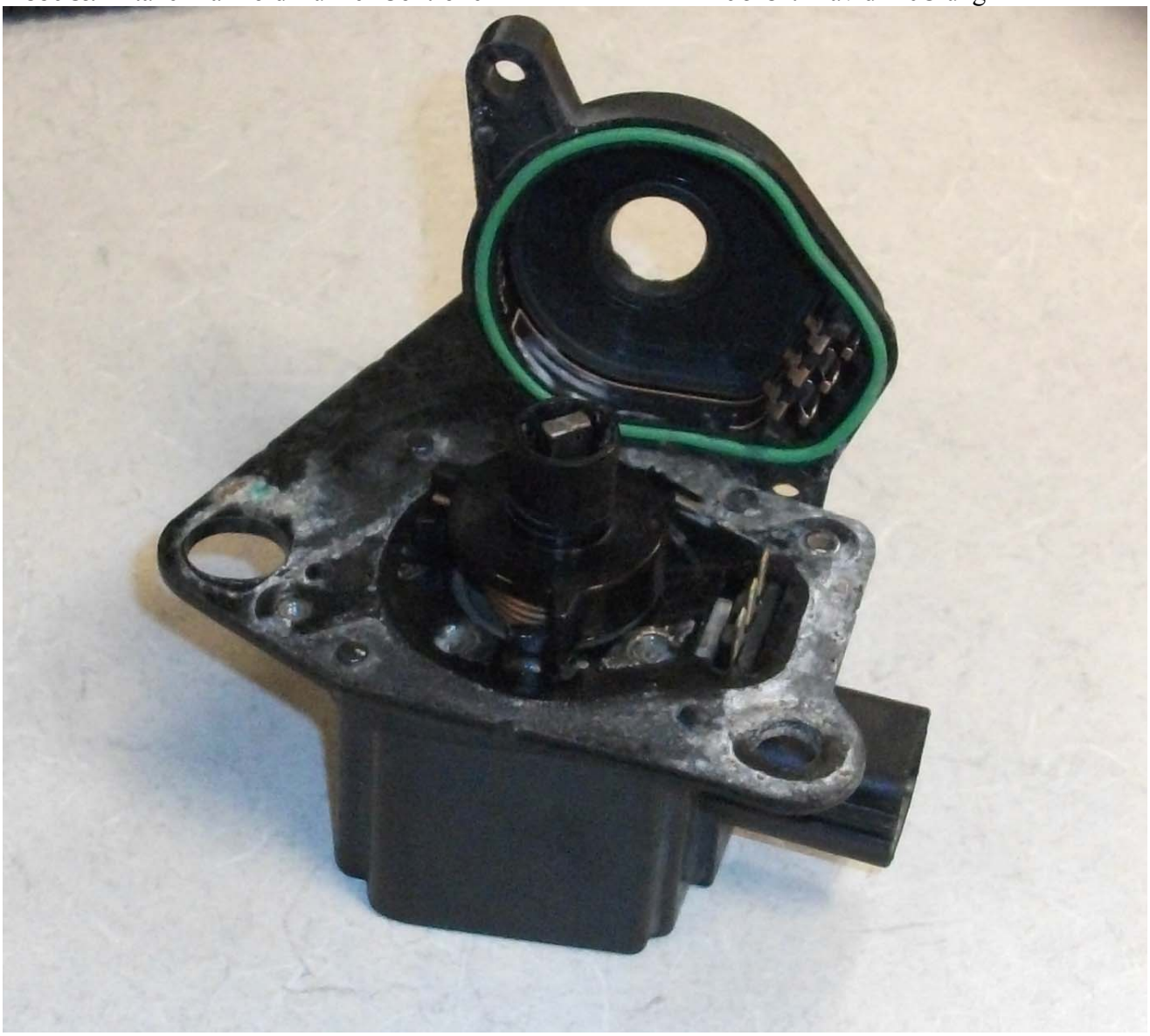

Figure 4: Inside of sensor

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Figure 5: Resistive strip fits into the sensor housing.

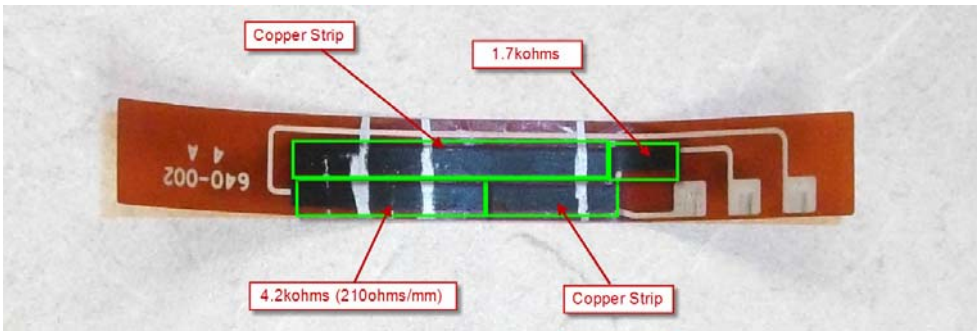

Figure 6: The green boxes depict the varying resistive zones. Some zones have copper strips that run under the contact material, making their resistance practically zero. The 4.2kohm zone is the actual potentiometer. The upper black strip is a probing arm and its resistance is irrelevant since no current flows through it.

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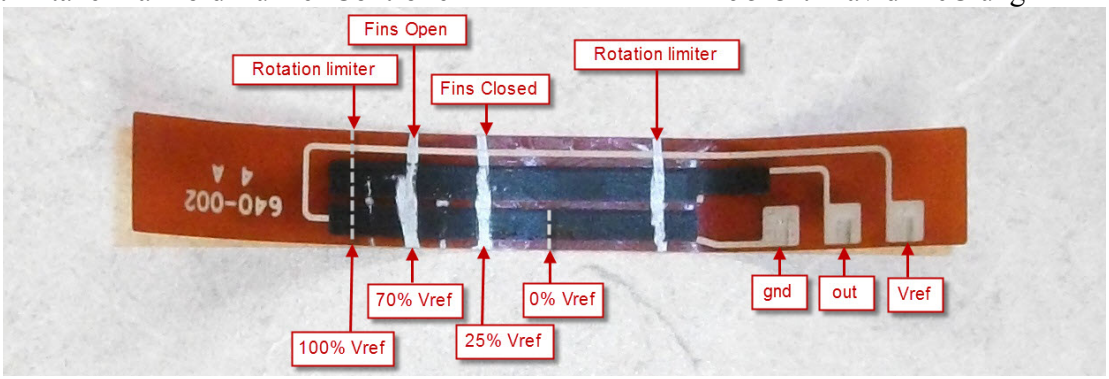

Figure 7: The silver lines represent the different positions of the brush, which connects the two black pads. The rotation limiter barriers show the range in which the brush can move.

Figure 8: The back side of the strip shows the copper traces.

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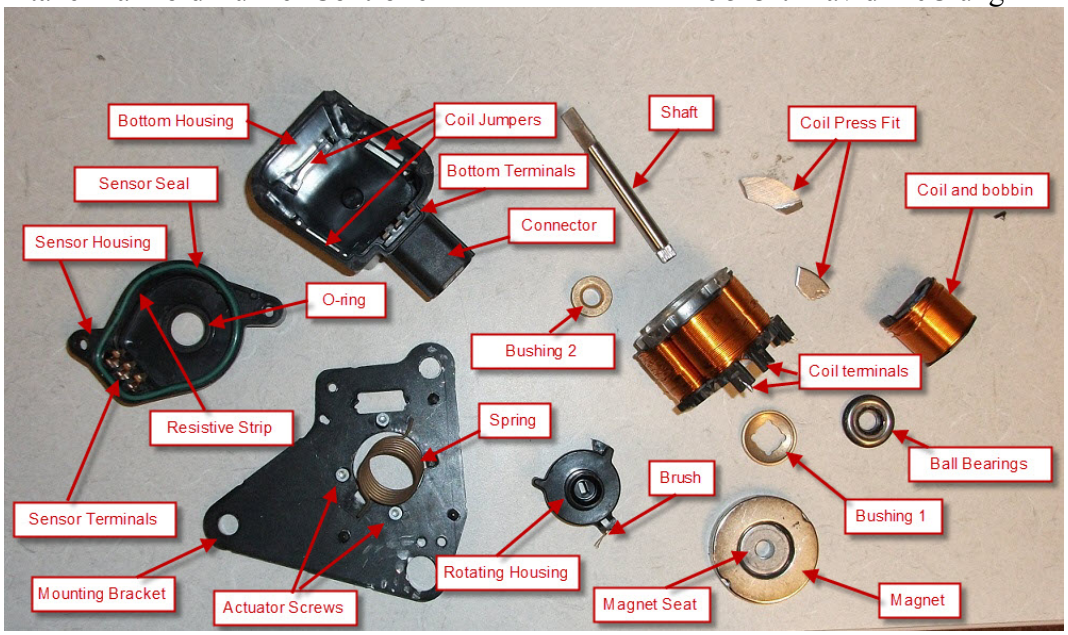

Figure 9: Parts Labels

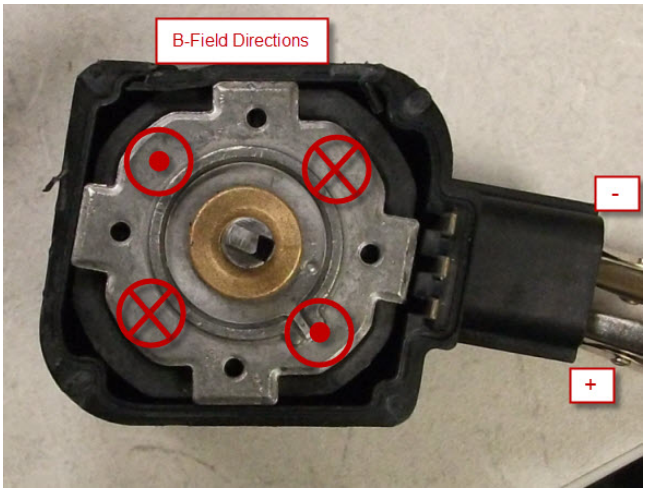

Figure 10: Rotary solenoid under the mounting bracket. If unit is powered as shown, B-Field directions will appear in the coils as shown. Dots refer to B-Fields that point up and X's refer to fields that point down. **In the coils with dots, current flows counter-clockwise when viewed from above. In the coils with X's current flows clockwise when viewed from above.**

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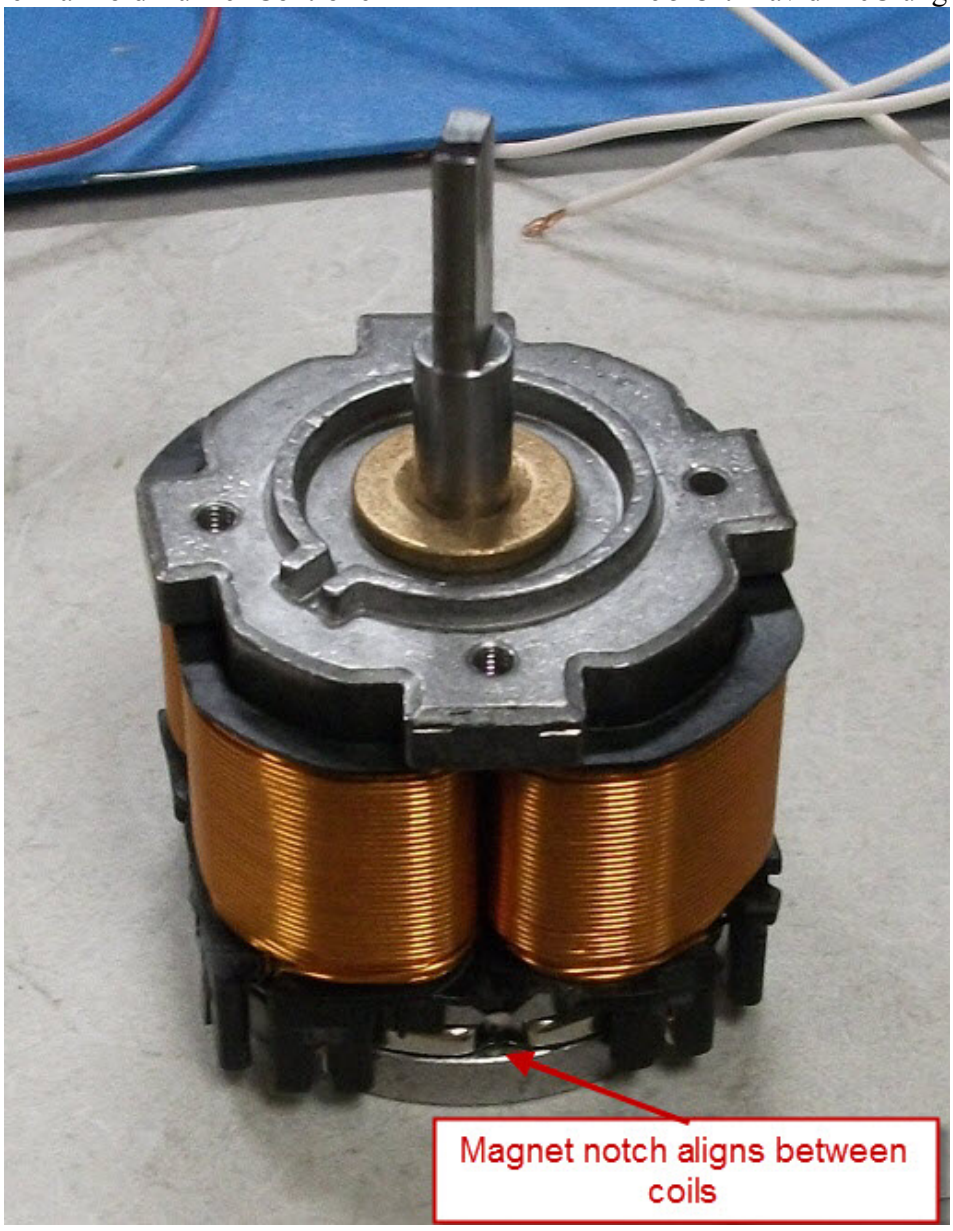

Figure 11: A closer look at the rotary solenoid. When the magnet poles align with the coils, the magnet notch is aligned between the coils.

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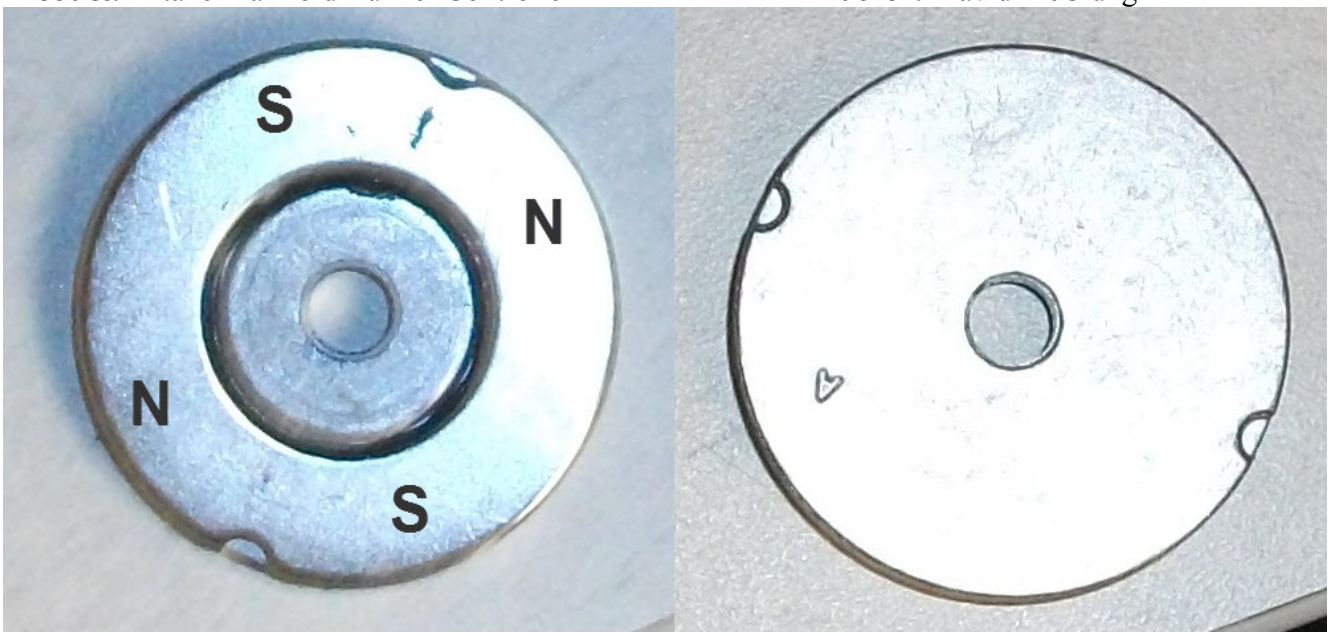

Figure 12: Magnet and magnet seat. Polarities marked with respect to the notches

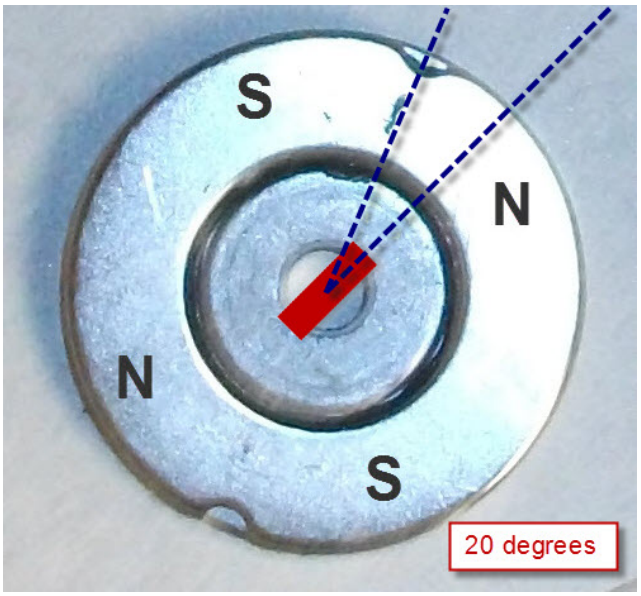

Figure 13: Shaft angle with respect to the magnet poles.

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Figure 14: Arrows showing coil jumpers

Figure 15: Bushing 1

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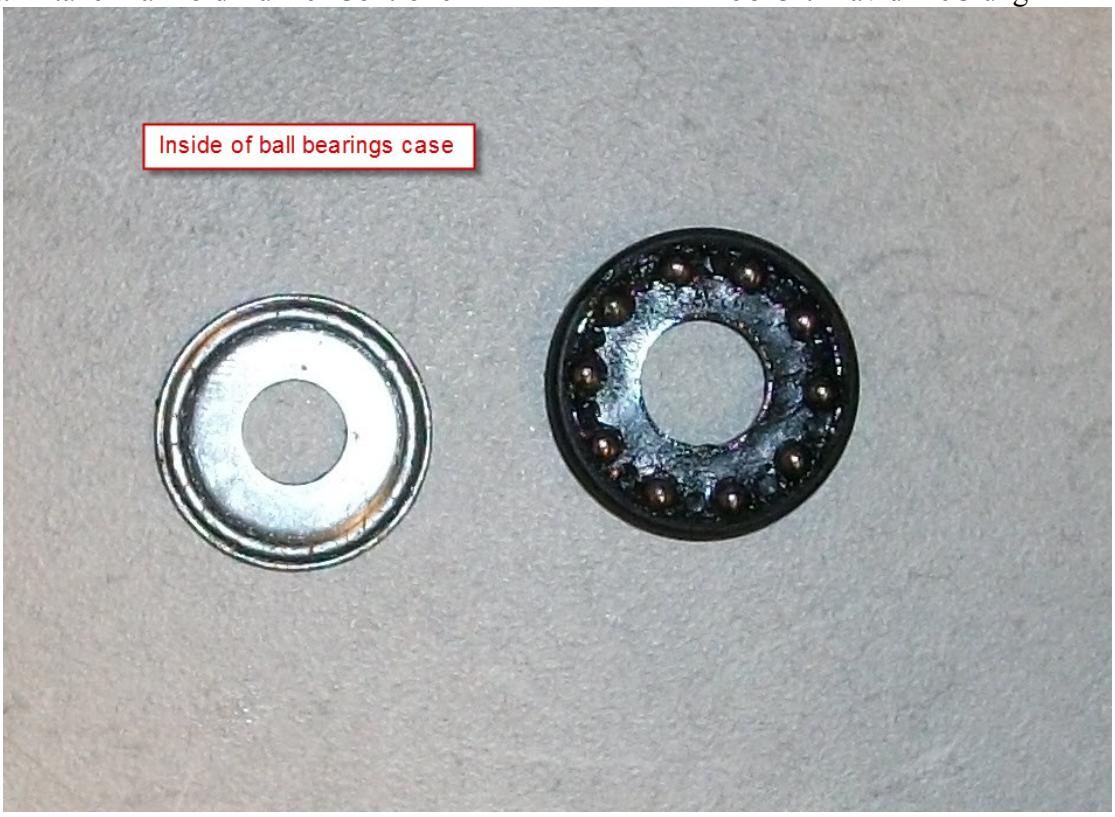

Figure 16: Ball Bearings

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Figure 17: Ball bearings fitting into bushing

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Figure 18: Bushing 1 location

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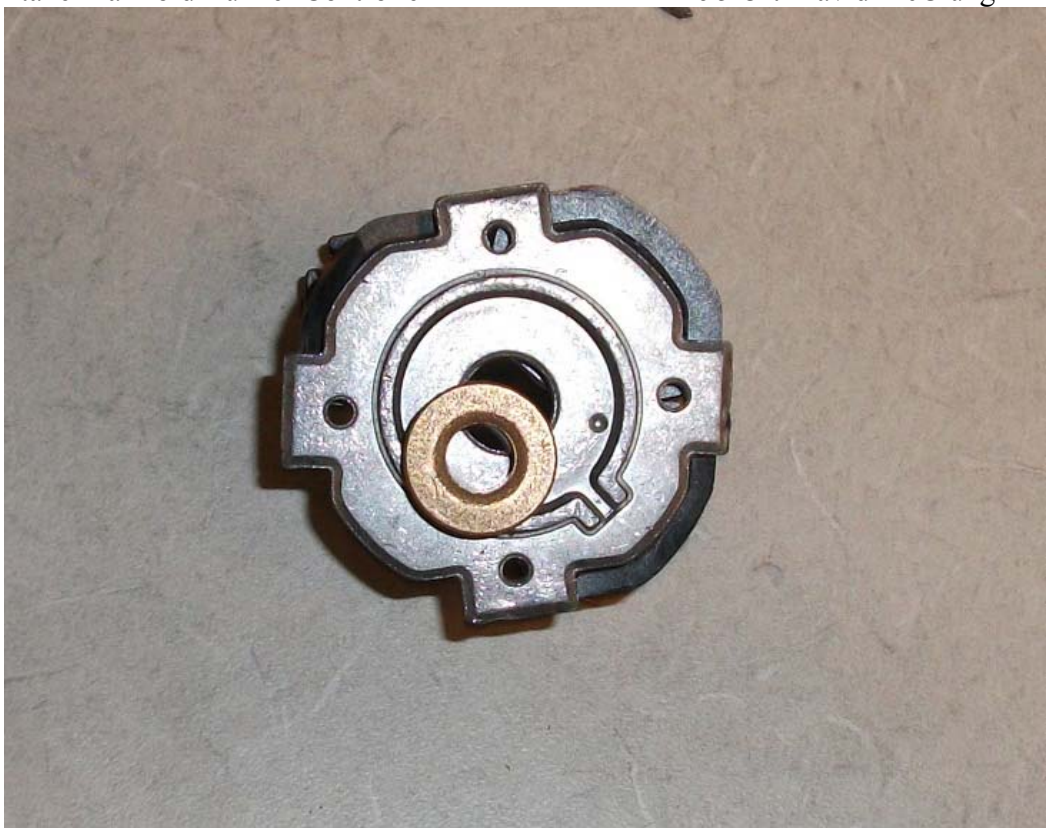

Figure 19: Bushing 2 location

Process & Performance Information:

This section contains information regarding significant performance requirements and / or manufacturing processes that are required to manufacture this product.

- Note: For more detailed performance information, view document "Supplemental Information."
- The solenoid itself produces about 0.63N-m of torque in the counterclockwise direction when the poles are 45 degrees out of alignment (max torque).
- The spring provides torque in the clockwise direction. The initial torque of the spring when the axle is completely clockwise is about 0.25Nm (when not installed on the manifold).
- The angular spring constant is 1mN-m/degree.
- When installed in the manifold, the spring torque is initially 0.25 + 0.001*45 = 0.295 N-m (Axle is rotated 45 degrees counterclockwise).

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- When actuating the manifold fully open, the spring torque climbs to 0.295 + 0.001*18 = 0.313 N-m (Axle is rotated an additional 18 degrees clockwise).
- Power consumption is about 41W at 12V and 50W at 13.8V
- The manifold should be able to fully open in 26ms and fully close in 33ms when powered by 13.8V.
- *All Graded / Class hardware are to be manufactured and in compliance with the United States Fastener Quality Act.*
  (http://ts.nist.gov/WeightsAndMeasures/fqa.cfm)
- Zinc plated parts to be tested in accordance with ASTM B117.
  Minimum corrosion resistance:
  96 hours: no white corrosion
  240 hours: no red corrosion of base metal
- ***(Under-hood part)*** Part must withstand exposure to -40 to 120 C without loss in performance or construction

Critical Characteristics:

This section contains information significant to the proper function and durability of the product.

Functional ◇

- When 13.8V is applied across pins "sns+" and "sns-" (Figure 3), "sns out" should read 3-4V when the intake fins are closed (IMRC is unpowered).
- Given the same setup "sns out" should read 9-10.5V when the intake fins are opened (IMRC is powered).
- As shown in Figure 13, the shaft is to be press fitted with the slot oriented 20 degrees clockwise (viewed from above) from the magnet notch. Press fit clearance must be between 0.02 to 0.05mm interference.
- The "Coil Press Fit" as shown in Figure 9 must press onto a mating piece on the winding core. Press fit clearance must be between 0.02 to 0.05mm interference.
- The ball bearing opening must have a .02-.05 clearance to accept the shaft.
- The ball bearing opening must have a 0.02-0.05mm clearance to accept the shaft.
- The opening in bushing two should have a 0.05-0.10mm clearance to accept the shaft.
- The copper brush thickness was originally 0.08mm thick. Change to 0.15mm

Safety Identification:

The National Highway Traffic Safety Administration (NHTSA) has legislative mandate of United States Code of Federal Regulations Title 49: Chapter V to issue Federal Motor Vehicle Safety Standards (FMVSS) and Regulations to which manufacturers of motor vehicles and items of motor vehicle equipment must conform and certify compliance.

The link to United States Code of Federal Regulations Title 49: Chapter V
http://www.nhtsa.gov/cars/rules/standards/FMVSS-Regs/pages/Part571.htm

Link to full versions of all FMVSS Standards
http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=b2be4ada7f14072ab2769203a2b45678&tpl=/ecfrbrowse/Title49/49cfr571_main_02.tpl

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Items listed below have been identified as being included in or part of a vehicle system under United States Code of Federal Regulations Title 49: Chapter V, Parts 571.101 through 571.500

Marking and Identification:

- Unless otherwise specified, part is to be marked in accordance to *Dorman Products Inc. Marking Requirements.*
- Unless otherwise specified; part numbers, logos, recycling marks, date codes or other marking found on the approved product samples are not to be copied.
- Part to be marked with the Dorman Wings Logo, Country of Origin, date code, and part number on locations shown below.

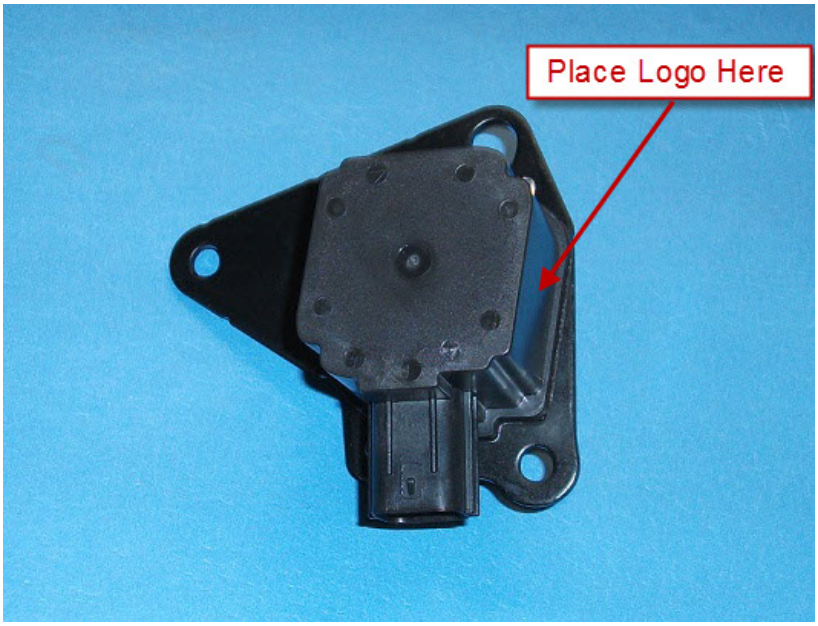

Figure 20: Place Logo Here

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Ozone Depleting Chemicals (ODC) Compliance:

- The following Ozone Depleting Chemicals are not to be used in the cleaning or manufacturing of printed circuit boards or products with soldering:

Common Name	Chemical Nomenclature
CFC-11	Trichlorofluoromethane
CFC-12	Dichlorodifluoromethane
CFC-113	Trichlorotrifluoroethane
CFC-114	1,2 dichloro 1,1,2,2 tetrafluoroethane
CFC-115	Chloropentafluoroethane
Halon 1211	Bromochlorodifluoromethane
Halon 1301	Bromotrifluoromethane
Halon 2402	Dibromotetrafluoroethane
Carbon tetrachloride	Tetrachloromethane
Methyl chloroform	1,1,1 trichloroethane
CFC 13	CF3C1
CFC 111	C2FC15
CFC 112	C2F2C14
CFC 211	C3FC17
CFC 212	C3F2C16
CFC 213	C3F3C15
CFC 214	C3F4C14
CFC 215	C3F5C13
CFC 216	C3F6C12
CFC 217	C3F7C1

- Certification letter is required and is to describe in detail, the new alternative product or the replacement technology used instead of the ODC process. The description is to include the type of equipment involved, the month and year the new technology was placed in service, and the name and address of the firm from whom the new technology was purchased.
    - Additional requirements of the Supplier Letter:
        - Be from the supplier on the supplier's company letterhead, which includes the address and phone number of the foreign manufacturer.
        - Addressed to Dorman Products Inc.
        - Signed by an officer or an authorized representative of the company.

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Restriction of Hazardous Substances Directive (RoHS) Compliance:

- All solder and components used in the manufacturing of printed circuit boards are to be RoHS compliant.
- The RoHS controlled materials are to be within the allowable amount listed below.

Material	Allowable Amount
Lead (Pb)	0.1% by weight at raw homogeneous materials level
Cadmium (Cd)	< 0.01% by weight at raw homogeneous materials level
Mercury (Hg)	100 ppm or less; Not intentionally added
Hexavalent chromium (Hex-Cr)	< 0.01% by weight at raw homogeneous materials level
Polybrominated biphenyls (PBB – fire retardant)	0.1% by weight at raw homogeneous materials
Polybrominated diphenyl ethers (PBDE – fire retardant)	0.1% by weight at raw homogeneous materials

- Certification letter is required showing RoHS compliant components.