



## **Specification for Electronic Throttle Control (ETC) Accelerator Pedal Component**

### **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.** This document provides supplier requirements for all Electronic Throttle Control (ETC) Pedals. The ETC pedal is the major interface between the Driver and the Engine Management System.

**1.2 Applicability.** This is the Component Technical Specification (CTS) for all GM applications with electronic throttle control, etc.

#### **1.3 Remarks.**

**1.3.1 Terminology.** Specialized terminology will be included in the Glossary (6.1) of this document.

**1.3.2 Change Management.** This document is the responsibility of GM Engineering, and revisions will be made by GM staff via appropriate change management processes.

**1.3.3 Contact/Owner.** Brake and Pedal Assemblies Bill of Material (BOM) Family Owner (BFO) and/or Technical Integration Engineer (TIE).

### **2 References**

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

#### **2.1 External Standards/Specifications.**

|            |             |           |           |
|------------|-------------|-----------|-----------|
| ASTM A228  | FMVSS 124   | SAE J1100 | SAE J1885 |
| ASTM A1000 | ISO 1431-1  | SAE J1395 | SAE J4004 |
| CMVSS 124  | ISO 12103-1 |           |           |

#### **2.2 GM Standards/Specifications.**

|         |          |          |          |
|---------|----------|----------|----------|
| GMW3059 | GMW3172  | GMW14551 | GMW15396 |
| GMW3091 | GMW3205  | GMW15152 | GMW15769 |
| GMW3097 | GMW7293  | GMW15272 | GMW15857 |
| GMW3103 | GMW14151 |          |          |

#### **2.3 Additional References.**

- Component Technical Specification (CTS)
- Electric Adjustable Pedal (EAP) Statement of Requirements (SOR)
- Ergonomics Engineering/Vendor Guidelines for New Products
- Five Phase Resolution (Root Cause Analysis) Form
- GM1724 located in Supply Power
- GM1738 located in Supply Power
- GM1797 located in Supply Power
- GM1829 Supplier Validation Plan
- Process Control Plan

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- Purchaser Validation Center, Product Usage Measurements and Application, Los Angeles Area Ozone Data
- Statement of Requirements (SOR) Appendix C2
- Vehicle Technical Specification (VTS)

### 3 Requirements

#### 3.1 System/Subsystem/Component/Part Definition.

##### 3.1.1 Appearance.

**3.1.1.1 Appearance by Design.** The ETC pedal shall have a visual appearance of black (reference 848 Black, although pedals may be allowed two to three times standard tolerance) and/or silver in color. Painted surfaces shall have no cracking, peeling, or runs. No supplier logo shall appear on the outside of part. Final appearance approval shall be made by GM Engineering.

**3.1.1.2 Appearance After Durability.** Portions of the ETC pedal visible from below the lower dash panel area shall not degrade in appearance, and wear on the pedal pad foot surface shall be less than 0.5 mm after exposure to SAE J1885, or any vehicle or component test referenced in this specification.

##### 3.1.2 Content.

###### 3.1.2.1 Physical Content.

**3.1.2.1.1 Housing, Lever, Lever Return Springs, Hysteresis Mechanism, Sensor, Shields/Guards.** The ETC pedal shall consist of: housing, lever, two or more return springs, hysteresis provider, two independent pedal position sensors outputs, and shields/guards to prevent contamination and/or loose interior components (screws, hoses, wires, etc.) from hindering pedal operation.

**3.1.2.1.1.1 Return Springs** At least two of the ETC pedal return springs shall have a wire diameter difference of at least 0.10 mm, each produced using completely different tooling including cutoffs. Differentiated springs shall be physically error proofed to prevent installation in the same unit. Each spring shall be designed for infinite life with a stress level that shall not exceed 65% for torsion springs or 45% for compression springs. The spring material shall be ASTM A228 (music wire), ASTM A1000 (Chromium Silicon), or of higher quality. Under no circumstances shall an acid wash process be used on the springs.

**3.1.2.1.1.2 Sensor Lube.** Sensor lube, if used, shall be certified for acceptable performance with minimum and maximum tolerance quantities applied and all environments stated in 3.1.3.1.

###### 3.1.2.1.3 Sensor Springs.

**3.1.2.1.3.1 Disconnected Sensor Return Capability.** If the pedal position sensing assembly can be removed from the ETC pedal, or secure connection to the pedal lever can be compromised, while continuing to produce potentially valid outputs, the sensor shall have a return spring that will force the position output to, or lower than, the ETC pedal output at the idle stop as specified in 3.2.1.4.

**3.1.2.1.3.2 Number of Sensor Return Springs.** The sensor shall have two springs if worst case analysis and/or testing indicates when the first spring is severed or disconnected, mechanism lash/compliance could occur that result in requirements of 3.2.1.4 being exceeded. Reference Canadian Motor Vehicle Safety Standard (CMVSS) 124/Federal Motor Vehicle Safety Standard (FMVSS) 124 single severance or disconnection requirements.

**3.1.2.1.4 Mounting Provisions and Pedal Pad.** See program specific CTS.

**3.1.2.1.5 Sensing and Sensing Processing Technology.** See program specific CTS.

**3.1.2.1.6 Redundant Sensing** The Sensor 1 (S1) value and Sensor 2 (S2) value shall be based on a position sensing system that employs redundant elements within the angular sensing portion of the device. Shared components are permitted after a detailed review with GM Engineering to assure that overall security and integrity of the system is maintained. For example, both position sensor traces may be on the same board. The separate sensing elements may share the same physical element, i.e., two electrically independent sets of contact brushes may share the same wiper arm. Dual position sensing elements may share the same Integrated Circuit (IC). Two (2) separate, independent sets of sensor circuits may share the same chip package.

Required redundancy and robustness requirements include:

- a. For ETC pedals with electronic signal processing, each signal shall have its own independent sensing elements, signal processing, and diagnostics.

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- b. For ETC pedals with electronic signal processing, the two separate sensor circuits shall independently self-diagnose power supplies and internal functions.
- c. ETC pedal design shall ensure the sensing elements (magnet, brush carrier, inductor) and sensor drive mechanism cannot angularly disengage, or change relationship to the shaft, pedal lever, and/or idle and full travel stops such that within range incorrect output results.

See 3.2.1.5.9 for Performance of Sensors with Electronic Processing, such as non-contacting sensors.

**3.1.2.2 Functional Content.** The ETC pedal shall perform the primary function:

- Provide ETC pedal position feedback to the driver's foot, i.e., load and hysteresis
- Convert angular rotation of the pedal lever to proportional changes in electrical sensor outputs

**3.1.3 Ambient Environment.**

**3.1.3.1 Operational Environment.** The ETC pedal shall meet all operational performance requirements (see 3.2.1), without loss of function or degradation of service life, when exposed to the environments listed in 3.1.3.1.1 thru 3.1.3.4. The ETC pedal shall not exhibit any undesirable operating modes when the ETC Pedal is subjected to environments within and outside those listed in 3.1.3.1.1 thru 3.1.3.4. Undesired operating modes include incorrect driver intent output or any other deviation from performance requirements stated in 3.2.1. When constructing a program specific CTS, refer to the Vehicle Technical Specification (VTS) for program specific environments.

**3.1.3.1.1 Temperature.** The ETC pedal at any time during service life shall meet requirements when exposed to the temperatures in Table 1.

**Table 1: ETC Pedal Temperature Requirements**

| Occurrence                                                                                               | Temperature                     |
|----------------------------------------------------------------------------------------------------------|---------------------------------|
| Interior Temperature                                                                                     | -40 °C to +66 °C                |
| Extreme Temperature                                                                                      | -54 °C to +85 °C                |
| Shipping/Assembly Temperature                                                                            | -65 °C to +48 °C                |
| Durability Temperature (GMW14551)                                                                        | -40 °C to +85 °C                |
| National Highway Traffic Safety Association (NHTSA) FMVSS/CMVSS 124 Temperatures (GMW15152 and GMW15857) | -40 °C, -18 °C, Ambient, +52 °C |

**3.1.3.1.2 Pressure.** The ETC pedal at any time during service life shall meet requirements when exposed to pressures as in Table 2.

**Table 2: ETC Pedal Pressure Requirements**

| Occurrence                 | Absolute Pressure   |
|----------------------------|---------------------|
| Atmospheric                | 57 kPa to 106.3 kPa |
| Extreme Pressure 3.1.3.1.2 | 20 kPa to 106.3 kPa |
| Shipping/Assembly Pressure | 20 kPa to 106.3 kPa |

**3.1.3.1.3 Radiation.**

**3.1.3.1.3.1 Total Solar Radiation.** The ETC pedal at any time during service life shall meet requirements when exposed to 775 MJ/m<sup>2</sup> per year.

**3.1.3.1.3.2 Ultraviolet Radiation.** The ETC pedal at any time during service life shall meet requirements when exposed to 34.6 MJ/m<sup>2</sup> per year. Ultraviolet radiation is defined as wavelengths between 295 N·m and 385 N·m.

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**3.1.3.2 Extreme Operating Environment (On Vehicle).** The ETC pedal shall meet specified extreme environmental operational performance requirements listed in 3.2.1. The ETC pedal shall not exhibit any permanent failure modes or undesired operating modes when subjected to extreme environments listed in Table 3. Undesired operating modes include incorrect driver intent output.

**3.1.3.3 Manufacturing/Shipping Environment.** The ETC pedal shall not exhibit any permanent failure modes or undesirable operating modes after being subjected to manufacturing environments that include Component Shipping and Vehicle Assembly and Shipping. Undesired operating modes include incorrect driver intent output.

**3.1.3.4 Humidity.** The ETC pedal at any time during service life shall meet requirements when exposed to:

- Relative Humidity, 0% to 100%

**3.1.3.5 General and Road Contaminants.** The ETC pedal at any time during service life shall meet requirements when exposed to cleaners, fluids, general contaminants and road contaminants as specified in Table 3.

**Table 3: Contaminants** <sup>Note</sup>

| Contaminant                                                     | Content                                                                                        | Exposure Area and Time             |
|-----------------------------------------------------------------|------------------------------------------------------------------------------------------------|------------------------------------|
| Water, Snow, Ice                                                | Common                                                                                         | Entire Assembly, 168 h             |
| Coffee                                                          | Commercially available                                                                         | Foot pad and lever, 1 h            |
| Cola                                                            | Commercially available                                                                         | Foot pad and lever, 1 h            |
| Acid Rain                                                       | 62% Sulfuric, 32% Nitric, and 6% Hydrochloric acids at a pH of 3.0 and 4.0                     | Foot pad and lever, 1 h            |
| Road Salt                                                       | Sodium Chloride (NaCl), Calcium Chloride (CaCl <sub>2</sub> ), Calcium Magnesium Acetate (CMA) | Foot pad and lever, 1 h            |
| Sand, Dust                                                      | ISO 12103-1 A2 Fine Grade Dust                                                                 | See 3.1.3.4                        |
| Mud, Gravel                                                     | No test needed                                                                                 | Foot pad and lever, not applicable |
| Leaves, Mold, Fungus                                            | No test needed                                                                                 | Foot pad and lever, not applicable |
| Sap, Insects, Animal, Animal Waste                              | No test needed                                                                                 | Foot pad and lever, not applicable |
| Brake Fluid                                                     | Commercially available                                                                         | Entire Assembly, 168 h             |
| Engine Coolant                                                  | Commercially available                                                                         | Entire Assembly, 168 h             |
| Air Conditioning Refrigerant                                    | No test needed                                                                                 | Foot pad and lever, not applicable |
| Battery Fluid                                                   | Commercially available                                                                         | Foot pad and lever, 1 h            |
| Rust Proofing or Undercoating                                   | Commercially available                                                                         | Foot pad and lever, 1 h            |
| Dust Control Chemicals (CaCl <sub>2</sub> , Magnesium Chloride) | Commercially available                                                                         | Foot pad and lever, 1 h            |

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| Contaminant                    | Content                                                    | Exposure Area and Time       |
|--------------------------------|------------------------------------------------------------|------------------------------|
| <b>Degreasers and Cleaners</b> |                                                            |                              |
| Windshield Washer Fluid        | Commercially available                                     | Entire Assembly, 168 h       |
| Alcohol Base Cleanser          | 10% alcohol to water by volume                             | Foot pad and lever, 1 h      |
| Carpet Cleaner                 | Available at GM dealer or from Certified Service web site  | Foot pad and lever, 1 h      |
| Ammonia Base Cleanser          | Commercial (10% by volume)                                 | Foot pad and lever, 1 h      |
| Vinyl Plasticizers             | Armor All or equivalent                                    | Foot pad and lever, 1 h      |
| Hand Cleanser                  | Commercially available                                     | Foot pad and lever, 1 h      |
| Laundry Detergent              | Commercially available                                     | Foot pad and lever, 1 h      |
| Tire Cleaners                  | Commercially available                                     | Foot pad and lever, 1 h      |
| Engine Cleaners                | Commercially available                                     | Foot pad and lever, 1 h      |
| Tar Remover                    | Commercially available                                     | Foot pad and lever, 1 h      |
| <b>Fuels</b>                   |                                                            |                              |
| Unleaded Gasoline              | Commercially available                                     | Foot pad and lever, 1 minute |
| Diesel Fuel                    | Commercially available                                     | Foot pad and lever, 1 minute |
| Fuel Additives                 | Available at GM dealer, or from Certified Service web site | Foot pad and lever, 1 minute |
| <b>Lubricants</b>              |                                                            |                              |
| Engine Oil                     | Commercially available                                     | Foot pad and lever, 1 h      |
| Synthetic Motor Oil            | Commercially available 5W/30 Synthetic Motor Oil           | Foot pad and lever, 1 h      |
| Transmission Fluid             | Commercially available                                     | Foot pad and lever, 1 h      |
| Differential Fluid             | Commercially available                                     | Foot pad and lever, 1 h      |
| Wheel Bearing Lube             | Commercially available                                     | Foot pad and lever, 1 h      |
| Constant Velocity Joint Lube   | Commercially available                                     | Foot pad and lever, 1 h      |
| Power Steering Fluid           | Commercially available                                     | Foot pad and lever, 1 h      |
| Transaxle, Differential Lube   | Commercially available                                     | Foot pad and lever, 1 h      |
| Multipurpose Grease            | Commercially available                                     | Foot pad and lever, 1 h      |

**Note:** Some contaminants may come through a leaky Front of Dash or Heating, Ventilation, Air Conditioning (HVAC) unit.

**3.1.3.6 Ozone.** The ETC pedal at any time during service life shall meet requirements when exposed to ozone concentrations and durations specified in Table 4.

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Table 4: Ozone Contaminants

|                                                                                                                                   |                            |              |              |              |              |              |              |              |              |                            |
|-----------------------------------------------------------------------------------------------------------------------------------|----------------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|----------------------------|
| Time: At ambient temperature and ozone concentration                                                                              |                            |              |              |              |              |              |              |              |              |                            |
| Total Time: 10 years = 87 600 h for Passenger Cars, 12 years = 105 120 h for Trucks                                               |                            |              |              |              |              |              |              |              |              |                            |
| Total Ozone Exposure: 27 700 Parts Per Million (PPM) for Passenger Cars, 33 324 PPM for Trucks, Location: Los Angeles, California |                            |              |              |              |              |              |              |              |              |                            |
| Temperature (°C)                                                                                                                  | Ozone concentration (PPM)  |              |              |              |              |              |              |              |              |                            |
|                                                                                                                                   | 0.00                       | 0.01 to 0.05 | 0.06 to 0.10 | 0.11 to 0.15 | 0.16 to 0.20 | 0.21 to 0.25 | 0.26 to 0.30 | 0.31 to 0.35 | 0.36 to 0.40 |                            |
|                                                                                                                                   | Percent Total Vehicle Life |              |              |              |              |              |              |              |              | Percent Total Time In Band |
| 38 to 43                                                                                                                          | 0.01                       | 0.07         | 0.08         | 0.08         | 0.07         | 0.02         | 0.02         | 0.01         | 0.01         | 0.35                       |
| 32 to 38                                                                                                                          | 0.07                       | 0.72         | 0.97         | 0.74         | 0.56         | 0.29         | 0.09         | 0.02         | 0.01         | 3.46                       |
| 27 to 32                                                                                                                          | 0.92                       | 3.32         | 3.03         | 2.34         | 1.13         | 0.35         | 0.07         | 0.01         | 0            | 11.18                      |
| 21 to 27                                                                                                                          | 4.53                       | 8.97         | 4.44         | 1.23         | 0.17         | 0.01         | 0            | 0            | 0            | 19.38                      |
| 16 to 21                                                                                                                          | 10.23                      | 16.02        | 1.07         | 0.01         | 0            | 0            | 0            | 0            | 0            | 27.34                      |
| 10 to 16                                                                                                                          | 10.73                      | 14.25        | 0.03         | 0            | 0            | 0            | 0            | 0            | 0            | 25.01                      |
| 4 to 10                                                                                                                           | 4.82                       | 7.32         | 0            | 0            | 0            | 0            | 0            | 0            | 0            | 12.13                      |
| -1 to 4                                                                                                                           | 0.38                       | 0.76         | 0            | 0            | 0            | 0            | 0            | 0            | 0            | 1.14                       |
| Total                                                                                                                             | 31.70                      | 51.43        | 9.62         | 4.40         | 1.93         | 0.67         | 0.17         | 0.03         | 0.01         | 100                        |
| <b>Source:</b> Purchaser Validation Center, Product Usage Measurements and Application, Los Angeles Area Ozone Data               |                            |              |              |              |              |              |              |              |              |                            |

**3.1.3.7 Particulates.** Tables 5 and 6 list particulates and concentrations in which the ETC pedal may see repeated exposure during its service life.

Table 5: Particulates

| Contaminant          | Content                                            | In-passenger Compartment |
|----------------------|----------------------------------------------------|--------------------------|
| Dirt, Grit, and Sand | See Table 6                                        | X                        |
| Mud                  | Various percent of water with Dirt, Grit, and Sand | X                        |
| Dust                 | Per Table 6                                        | X                        |

Table 6: Sand and Dust Exposure Times

| Concentration (milligrams per cubic meter) | Exposure Time (hours) |
|--------------------------------------------|-----------------------|
| 70                                         | 74.5                  |
| 350                                        | 25.0                  |
| 1600                                       | 5.0                   |
| 3900                                       | 1.0                   |

**3.1.3.8 Methods of Pedal Release.** The ETC pedal may see repeated exposure to the operator pedal pad release conditions during its service life:

- Gentle (very slow, < 1mm/s)
- Sidestep (instantaneous release)
- Release speeds between gentle and sidestep

**3.1.3.9 Driver Applied Forces.** The ETC pedal, as installed in vehicle, shall meet requirements when exposed to the operator applied load conditions to any point on the accelerator pedal pad during its service life, as in Table 7.

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Table 7: Drive Applied Forces

|                                                                               |
|-------------------------------------------------------------------------------|
| 668 N (150 lb) force in pedal apply direction                                 |
| 178 N (40 lb) force in reverse pedal apply direction                          |
| 178 N (40 lb) force in both lateral directions                                |
| 556 N (125 lb) force 45 degrees each side from normal in the horizontal plane |
| 334 N (75 lb) point force in pedal apply direction                            |
| 1113 N (250 lb) force in pedal apply direction                                |

**3.1.3.10 Vehicle Deceleration.** The ETC pedal at any time during service life shall meet requirements when exposed to the following vehicle decelerations:

- 1.5G vehicle decelerations

**3.1.3.11 Spray Washes.** The ETC pedal at any time during service life shall meet requirements when exposed to spray washes at warm and cold temperatures.

**3.1.3.12 Impact.** The ETC pedal at any time during service life shall meet requirements when exposed to:

- Two hundred (200) impacts with a steel vacuum cleaner nozzle to any portion of the ETC pedal which is 50 mm or more below the lower dash panel.
- Impact exposure equivalent to being dropped 1 m onto a concrete surface.

**3.1.3.13 Vibration (Figure 1).** All components in the pedal subsystem shall be designed to withstand the levels of vibration that occurs during vehicle at their respective location. Tables 8, 9 and 10 are typical direction power spectral density profiles for a dash mounted component merged from a range of vehicles. The pedal subsystem shall withstand 50 h of exposure to this environment on each axis without degradation or creating noise.

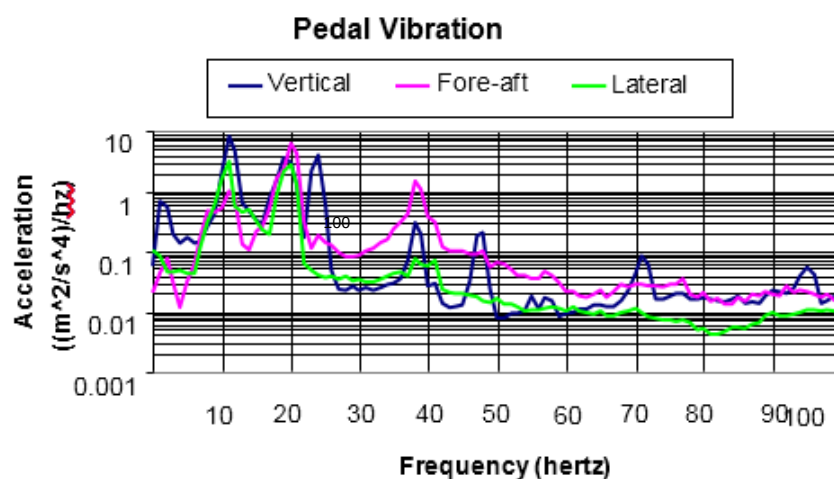


Figure 1: Pedal Vibration

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Table 8: Vertical Vibration Profile

| Frequency (Hertz)      | Acceleration ((m <sup>2</sup> /s <sup>4</sup> )/Hz) |
|------------------------|-----------------------------------------------------|
| 8.00                   | 0.300                                               |
| 11.00                  | 8.300                                               |
| 15.00                  | 0.320                                               |
| 19.00                  | 3.700                                               |
| 22.00                  | 0.170                                               |
| 24.00                  | 4.100                                               |
| 31.00                  | 0.025                                               |
| 38.00                  | 0.290                                               |
| 43.00                  | 0.011                                               |
| 48.00                  | 0.203                                               |
| 50.00                  | 0.010                                               |
| 67.00                  | 0.010                                               |
| 71.00                  | 0.085                                               |
| 74.00                  | 0.020                                               |
| 100.00                 | 0.020                                               |
| Root Mean Square (RMS) | 6.3                                                 |

Table 9: Fore-Aft Vibration Profile

| Frequency (Hertz) | Acceleration ((m <sup>2</sup> /s <sup>4</sup> )/Hz) |
|-------------------|-----------------------------------------------------|
| 8.00              | 0.500                                               |
| 11.00             | 1.010                                               |
| 14.00             | 0.109                                               |
| 20.00             | 6.370                                               |
| 28.00             | 0.079                                               |
| 38.00             | 1.550                                               |
| 60.00             | 0.020                                               |
| 100.00            | 0.020                                               |
| RMS               | 5.3                                                 |

Table 10: Lateral Vibration Profile

| Frequency (Hertz) | Acceleration ((m <sup>2</sup> /s <sup>4</sup> )/Hz) |
|-------------------|-----------------------------------------------------|
| 8.00              | 0.300                                               |
| 11.00             | 3.100                                               |
| 17.00             | 0.190                                               |
| 20.00             | 2.870                                               |
| 26.00             | 0.039                                               |
| 38.00             | 0.075                                               |
| 54.00             | 0.010                                               |
| 100.00            | 0.010                                               |
| RMS               | 4.2                                                 |

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**3.1.3.14 Electrical Requirements.**

**3.1.3.14.1 Voltage.** The ETC pedal shall utilize 5 V regulated reference voltages, 0 V to 5 V outputs, and 0.0 V returns.

**3.1.3.14.2 Electromagnetic Compatibility (EMC).** The ETC pedal at any time during service life shall meet requirements when exposed to EMC environments per GMW3091 and GMW3097.

**3.1.3.14.3 Electrical Environmental Durability Testing.** The ETC pedal at any time during service life shall meet requirements when exposed to the environmental conditions per GMW3172.

**3.1.3.14.4 Extreme Voltage.** The ETC pedal may be exposed to +16 V for 1 h applied to any connector pin, or housing due to electrical system shorts or servicing.

**3.1.4 Interfaces.**

**3.1.4.1 External-to-Vehicle to Subsystem.** The ETC pedal will have the driver interfaces in 3.1.4.1.1 and 3.1.4.1.2.

**3.1.4.1.1 Driver right foot to ETC pedal.**

**3.1.4.1.2 Five (5) percentile to 95 percentile male and female extremes driver foot sizes (including Big Foot),** heel point, hip point (H-Point), and reach shall be considered in the design of the ETC pedal.

**3.1.4.2 Subsystem to Subsystem.** More interface information is provided in 3.7.2.

**3.1.4.2.1 ETC Systems to Pedal.** ETC pedal shall be compatible with electrical system architecture for the given vehicle application. See CTS for specific requirements.

**3.1.4.2.2 Front of Dash (FOD) or Mod Plate or Brake/Accel/Clutch Pedal Module Assembly to ETC Pedal.**

**3.1.4.2.2.1 Mounting Provisions.** The ETC pedal shall be mounted to the vehicle as specified in program specific SOR Appendix C2, which could include floor, FOD, Mod Plate or Brake/Accel/Clutch Pedal Module Assembly.

**3.1.4.2.2.2 Overload Forces.** The ETC pedal shall be designed to prevent driver applied loads causing excessive stress to the FOD, Mod Plate or Brake/Accel/Clutch Pedal Module Assembly.

**3.1.4.2.3 Electrical Connector to ETC Pedal.** The ETC pedal and vehicle electrical harness shall be compatible. See 3.7.2.2.2 and 3.7.2.2.3 for specific requirements.

**3.1.5 Usage Definition.**

**3.1.5.1 Minimum Expected Service Life.** To be defined in program specific CTS.

**3.1.5.2 Minimum Typical Predicted Usage Profile.** The ETC pedal (with lever and pad in place) may be subjected to the apply and retract cycles as in 3.1.5.2.1 and 3.1.5.2.2.

**3.1.5.2.1 Instantaneous Release.** One thousand (1000) instantaneous releases from the maximum displacement position.

**3.1.5.2.2 Dithers.** Twenty five million (25 000 000) dithers or fifty million (50 000 000) sensor direction changes at ambient temperature consisting of at least 3% Vref sensor displacement from the idle position to evaluate wiper fatigue or increased sensor wear which may occur. Cycling frequency will be agreed upon per supplier equipment capability.

**3.1.5.2.3 General Durability.** A number of samples as demonstrated per Weibull analysis and agreed upon by the GM Product Development Team (PDT) shall be tested to GMW14551 ETC Accelerator Pedal Lab Durability Test. Additional requirements for cycling may be included in the program specific CTS.

**3.1.5.2.4 Regulatory Standards including FMVSS/CMVSS Compliance.** The ETC pedal shall comply with all regulatory standards as specified in the VTS for countries of sale, and also must comply with all requirements stated in 3.2.

**3.2 Product Characteristics.**

**3.2.1 Performance Requirements.** The ETC pedal shall meet all performance requirements as stated herein including Table 11 (for non-detent pedals) and Table 12 (for detent pedals) with at least  $\pm 3\sigma$  capability both before and after being subjected to Environments (3.1.3), Interfaces (3.1.4) and Usage (3.1.5) unless otherwise specified within this document. Techniques utilized to satisfy the performance requirements will be reviewed by and approved by GM.

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Table 11: Accelerator Pedal Parameters for Vehicles Without Detent (Reference Figure 2)

| Description                                              | Symbol | Units  | Requirement Values                                  |
|----------------------------------------------------------|--------|--------|-----------------------------------------------------|
| Initial Force                                            | F1     | N      | See program specific CTS                            |
| Force At Full Travel Stop                                | F2     | N      | See program specific CTS                            |
| Return Reserve Force                                     | F4     | N      | ≥ 5.0                                               |
| Force Hysteresis at Initial Apply and 50% travel         | H      | N      | See program specific CTS                            |
| Initial Displacement Force Compliance                    | D1     | mm     | See program specific CTS                            |
| Initial Displacement Sensor Output Compliance            | D2     | mm     | See program specific CTS                            |
| Travel to Full Travel Stop                               | D5     | mm     | 50.0 (nominal) ± 2.0 (tolerance)                    |
| Sensor 1 Output at Idle Stop Pedal Position              | S1 (1) | %S1ref | 20.0 (nominal)<br>Reference 3.2.1.4.1 for tolerance |
| Sensor 2 Output at Idle Stop Pedal Position              | S2 (1) | %S2ref | 10.0 (nominal)<br>Reference 3.2.1.4.1 for tolerance |
| Sensor 1 Output at Full Travel Stop Pedal Position       | S1 (2) | %S1ref | 84.0 (nominal)<br>Reference 3.2.1.4.2 for tolerance |
| Sensor 2 Output at Full Travel Stop Pedal Position       | S2 (2) | %S2ref | 42.0 (nominal)<br>Reference 3.2.1.4.2 for tolerance |
| Sensor 1 Output Delta from Idle Stop to Full Travel Stop | ΔS1    | %S1ref | 64.0 (nominal)<br>Reference 3.2.1.4.3 for tolerance |
| Sensor 2 Output Delta from Idle Stop to Full Travel Stop | ΔS2    | %S2ref | 32.0 (nominal)<br>Refer 3.2.1.4.3 for tolerance     |

**Note:** See 3.8.5 for End of Line (EOL) Guard-Band requirements.

**Note:** S1 (1) = S1Idle = (voltage output at pin S1 with the pedal at the idle stop) ÷ S1ref × 100%  
 S1 (2) = S1Full Travel = (voltage output at pin S1 with the pedal at the Full Travel Stop) ÷ S1ref × 100%  
 S2 (1) = S2Idle = (voltage output at pin S2 with the pedal at the idle stop) ÷ S2ref × 100%  
 S2 (2) = S2Full Travel = (voltage output at pin S2 with the pedal at the Full Travel Stop) ÷ S2ref × 100%

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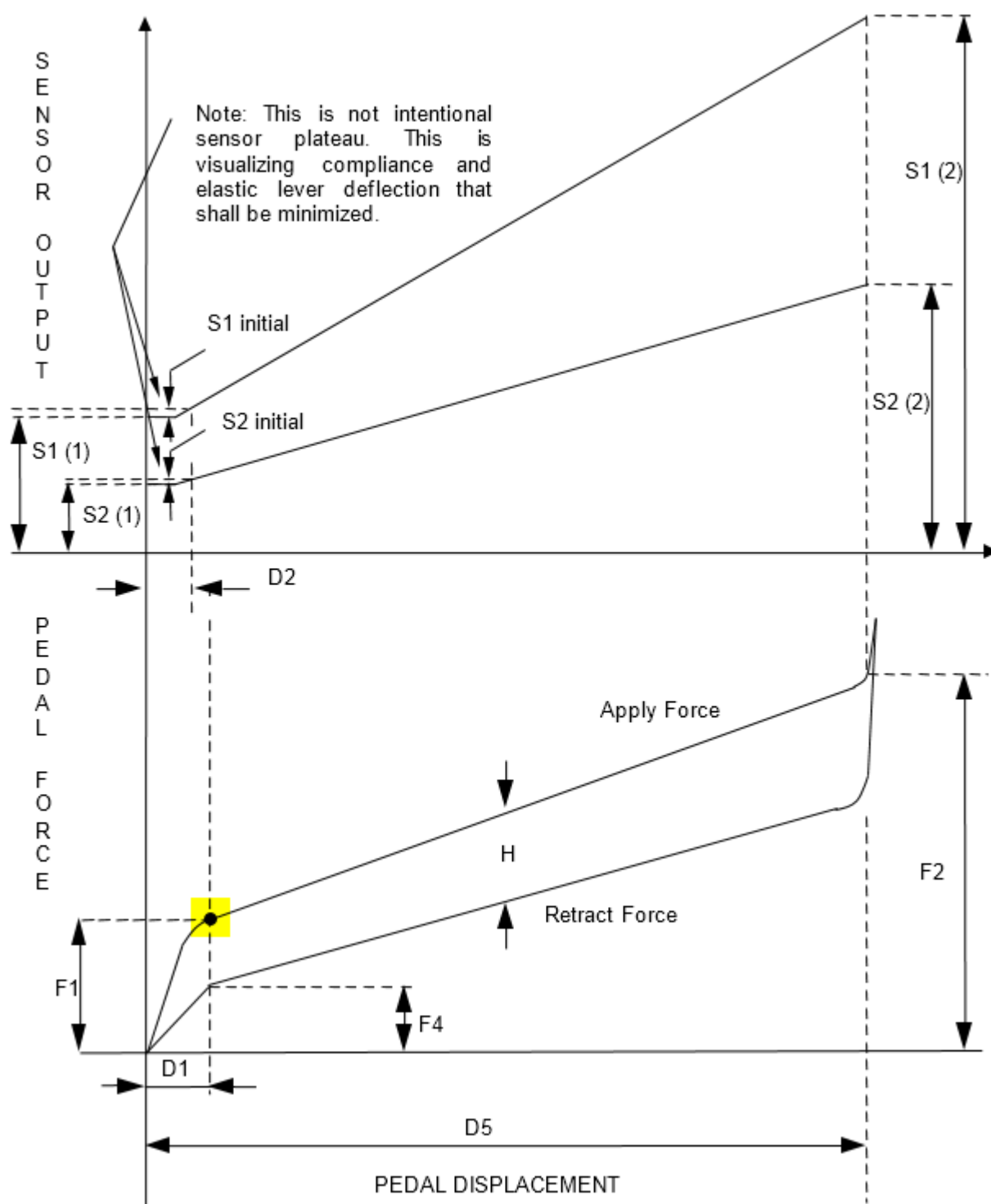


Figure 2: Plot of ETC Pedal Sensor and Force vs. Displacement without Kick-Down

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