



Automatic Transmission Shift System Specification

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 standard provides the specifications and requirements for a mechanical linkage Automatic Transmission Shift Control (ATSC). It applies to the components of that subsystem, including the shifter assembly, shift handle, Park, Neutral, Reverse, Drive, Low (PRNDL) indicator and bezel, shift cable or shift rod linkage, shift cable bracket, and transmission shift lever.

1.2 Applicability. This standard applies to any program with an automatic transmission and mechanical shift system.

1.3 Remarks. Gear position selection should be accomplished within the acceptable efforts and with a high level of customer satisfaction. It also provides an indication of the current position selected, contains interlocks to prevent unauthorized gear position selection, and communicates the selected position to the vehicle ignition switch to prevent unauthorized key removal. (For vehicles sold in Korea and China market, this function can be eliminated in case the key interlock function is not applied. GB 15740 and KMVSS Article 22 must be considered.)

Stipulation of the functional and durability requirements placed on gearshift mechanisms is necessary in order to ensure the quality and service lifetime of the parts supplied. The requirements contained in this specification reflect those minimum values that are necessary in order to establish a measurable level of conformity with design engineering targets. These requirements are to be looked upon as being in addition to normal testing, dimensional inspections, and in process testing.

Further, it is felt that evolutionary changes to the ATSC subsystem design are both inevitable and desirable, and this document is in no way intended to limit the supplier's creativity. Accordingly, contact engineering with requests for clarification and/or design and specifications revisions. GM Engineering alone will determine the proper interpretation should conflicts arise with these technical specifications, GM part print or technical issues.

2 References

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

2.1 External Standards/Specifications.

74/60 EEC	FMVSS 101	GB 15740	ISO 1629-2
CMVSS 101	FMVSS 102	ISO 1043-1	ISO 11469
CMVSS 102	FMVSS 114	ISO 1043-2	ISO/TS 16949
CMVSS 114	FMVSS 201	ISO 1629-1	KMVSS Article 22
ECE R21	GB 7258		

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2.2 GM Standards/Specifications.

GMW3059	GMW7294	GMW14416	GMW15118
GMW3091	GMW8518	GMW14444	GMW15272
GMW3097	GMW14011	GMW14528	GMW15560
GMW3103	GMW14082	GMW14764	GMW15571
GMW3116	GMW14155	GMW14765	GMW15750 (ID)
GMW3172	GMW14188	GMW14766	GMW16161
GMW3191	GMW14231	GMW14797	GMW16331
GMW3431	GMW14233	GMW14867	GMW17161
GMW7293	GMW14264		

(ID) = This standard is limited to internal distribution within General Motors and shall not be distributed outside this company. Contact the GM Lead Engineer for further instructions.

2.3 Additional References.

- 13501700, Base Bracket Pin Interface Drawing
- 13502714, Shift Handle Core Drawing.
- 13502715, Mounting Bracket Core Drawing
- 19153436, Connector Body and Associated Terminals
- Automatic Transmission Floor Shifter Core Mechanism Component Technical Specification (CTS)
- CG1254, Appendix C2, Automatic Transmission Shift System Subsystem Technical Specification (SSTS)
- CG3797, PRNDM(L) Module Component Technical Specification
- Global Legal Database
- GMNA Materials and Corrosion Engineering web site
- JST Supplier Drawings SPHD-001T-P0.5
- Labels and Literature web site (Socrates under L of the A to Z list)
- Noise and Vibration Integration web site, Resource Center Application
- PAP-02V-S
- PTDI-4 Automatic Transmission Shift Efforts (Best Practice)
- PTDI-23, Automatic Transmission Shift Gate Graphics (Best Practice)
- PTDI-40 Automatic Transmission Shift Linkage Geometry and Kinematics (Best Practice)
- PTDI-43 Automatic Transmission Shift Cable Routing (Best Practice)
- SOR Appendix C2
- SOR Appendix G2
- Squeak and Rattle (S&R) Noise Glossary
- SSTS Noise and Vibration Integration web site
- Stakeholders: (0D.02 Thermal Management, 15.2 Powertrain Integration)
- Statement of Requirements (SOR)

2.3.1 Electrical Best Practices

- ELEC86-5 Electrical Terminal
- ELEC86-6 Wiring Serviceability
- ELEC86-33 Prevent Wire Harness Damage at Bussed Electrical Center Connections
- ELEC86-38 Twisted and Shielded Wire
- ELEC86-39 Dynamic or Flexing Environment
- ELEC86-41 Connector Position Assurance (CPA)
- ELEC86-44 Wire Harness Assessment

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- ELEC86-46 Routing to Avoid Electromagnetic Compatibility (EMC)
- ELEC86-64 Wiring and Connector Attachment
- ELEC86-69 Routing to Avoid Water Intrusion
- ELEC86-83 Welding Circuit Splices and Terminals
- ELEC86-90 Prevent Fretting Corrosion
- ELEC86-101 Wire Protection
- ELEC86-102 Solid State Switch Usage Guidelines

3 Requirements

3.1 System/Subsystem/Component/Part Definition. The primary function of the Automatic Transmission (AT) shift system is to provide a means for the driver of a vehicle to select a transmission gear position. There is to be a shifter assembly mounted to the vehicle. Shifter movement is transmitted to the transmission by a linkage consisting of a cable, transmission manual shift lever, and reaction bracket or a rod link assembly which includes the transmission lever. Additionally, the system shall indicate to the driver the position selected and provide both park lock and brake transmission shift interlock (BTSI) functions. The design and operation of the shift control ATSC subsystem shall be in accordance with CMVSS 101 and FMVSS 101 Control Location, Identification, and Illumination; CMVSS 102 and FMVSS 102, Transmission Shift Lever Sequence; and CMVSS 114 and FMVSS 114, Theft Protection.

3.1.1 Appearance. Class A surfaces visible to the vehicle occupants shall have a uniform color, grain, and gloss, visually matching the standards specified in the Appearance Requirements Drawing maintained by the GM Appearance Engineering Group. Standards are available from the GM Appearance Engineering Group. All components specified as low gloss shall be fabricated using materials and processes which are capable of consistently matching the specified gloss standard in volume production. In addition, the chosen materials for each component shall support an overall uniform low gloss appearance within and across assemblies such that the components and assemblies appear to have been uniformly coated with a low gloss interior paint. It is recommended for the emerging market to use the polyvinyl chloride (PVC) knob and mold in color, Acrylonitrile Butadiene Styrene bezel and mold in color (jet black and ebony) and slider mold in color ink paint/pad print for indicator.

3.1.1.1 Logo. The supplier shall not affix or incorporate its name to the ATSC subsystem except as approved by the GM ATSC subsystem Product Development Team (PDT) and shown on the end item math models/drawings. Additionally, the GM logo shall be incorporated into the component and or be placed on the identifying label.

3.1.2 Content. The required physical and functional content for the ATSC subsystem is identified in 3.1.2.1 and 3.1.2.2.

3.1.2.1 Physical Content. The ATSC subsystem is comprised of two primary segments, the shifter assembly and the linkage. The linkage may be supplied as one rod and transmission lever assembly (some rear wheel drive vehicles) or it may be supplied as three separate components, the shift cable assembly, the transmission lever assembly, and the transmission cable mounting bracket (front wheel drive and some rear wheel drive vehicles). The shifter assembly is generally supplied as one assembly, but is comprised of four primary components, the core shift mechanism, the base bracket, the trim plate with PRNDL, and the shift handle. The core shift mechanism is a Corporate Common Component (CCC) and is specified by part number to the shifter assembly supplier. The base bracket may be a common design within the vehicle architecture or it may be program specific due to interior packaging. The core mechanism may be attached to the base bracket with a roll pin per Part Number 13501700. Drawing 13501700 contains pin interface requirements. The shift handle may be program specific or may be specified from a catalog of existing handles with minor Class A surface material modifications. The PRNDL is generally a program specific styled component.

Reference program specific SSTS document for component details and program content.

3.1.2.2 Functional Content.

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3.1.2.2.1 Required Functional Content. The AT subsystem shall provide these functions:

- Gear position selection
- Electronic gear/range selection
- Unauthorized gear selection prevention (BTSI, park lock)
- Accommodate mounting to the floor pan and console

3.1.2.2.2 Optional Functional Content. The AT subsystem may be required to provide these functions (see program specific document for which functions may apply):

- Gear position indication. (Optional content. See program specific SSTs document.)
- Customer access to the BTSI override device for Korean market.

3.1.3 Ambient Environment. The ATSC subsystem will be exposed to the following environmental (ENV) conditions in either customer usage or in the manufacturing, shipping, and assembly process. The ATSC subsystem shall provide satisfactory performance during and after these environmental exposures without loss of function. Appropriate laboratory tests may be used to demonstrate this performance.

3.1.3.1 Temperature Range. The ATSC subsystem and shifter assembly shall withstand the temperature ranges defined in Table 1. (These values are generic minimums and may be increased based upon specific program requirements or vehicle packaging.) Components packaged in close proximity to, or directly over, an exhaust system component may require additional heat shielding or a higher temperature material. Stakeholders: (0D.02 Thermal Management, 15.2 Powertrain Integration).

3.1.3.1.1 Minimum. The minimum temperature at which a component will be expected to operate. Assisted vehicle starting shall be permitted. Temporary degradation of component function shall be permitted, but permanent loss of function shall not be permitted. After a vehicle has been started, temporary degradation of component function shall not result in a walk home situation.

3.1.3.1.2 Continuous. The maximum temperature a component will experience on a continuous basis and maintain design functional life. The vehicle shall be able to experience 1400 h/12 000 cycles per 160 900 km (100 000 mi) of operation during continuous vehicle conditions. Occupant safety shall not be compromised during continuous thermal conditions.

3.1.3.1.3 Excursion. The maximum temperature a component will experience on an infrequent basis and maintain design functional life (reference Table 1). The vehicle shall be able to experience 60 h/400 cycles per 160 900 km (100 000 mi) of operation during Excursion vehicle conditions. Occupant safety shall not be compromised during Excursion thermal conditions.

Table 1: Temperature Ranges

Temperature	Temperature Range
Minimum Temperature (interior and engine compartment)	-40 °C (-40 °F)
Minimum Shipping Temperature (if shipped via air)	-50 °C (-60 °F)
Maximum Excursion Temperature (interior)	93 °C (200 °F)
Maximum Continuous Temperature (interior)	80 °C (176 °F)
Maximum Continuous Temperature (exterior/underhood)	120 °C (250 °F)
Maximum Excursion Temperature (localized exterior/underhood)	Reference SOR Appendix C2 for application specific temperature range.

3.1.3.2 Relative Humidity. The ATSC subsystem shall withstand exposure to 0% Relative Humidity (RH) to 100% RH.

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3.1.3.3 Atmospheric Pressure. The ATSC subsystem shall withstand the atmospheric pressure range 330 mmHg to 864 mmHg (0.44 bar to 1.15 bar) (all components). The minimum atmospheric pressure is 127 mmHg if the ATSC subsystems are shipped (via intended dunnage) by air.

3.1.3.4 Ozone. The ATSC subsystem shall withstand exposure to ozone (O₃) concentration levels up to a maximum of 0.4 ppm.

3.1.3.5 Contamination. The portion of the ATSC subsystem inside the vehicle passenger compartment will be exposed to and should withstand prolonged exposure to the following contaminants during its life:

Dust/dirt, ash, coffee, cola and other soft drinks, water, salt fog, human skin oils, skin lotion, sunscreen, dirt, grit, sand, dust, O₃.

The portion of the ATSC subsystem outside of the vehicle passenger compartment shall withstand exposure to the following contaminants, in addition to those listed above: Cleaners and protective waxes (e.g., steam cleaning, car wash chemicals and detergents, tire cleaners, engine cleaners, vinyl protector/cleaners, carpet cleaners, and brake cleaners), vehicle fluids (engine oil, AT fluid, unleaded, leaded, and diesel fuel, windshield washer fluid, ethylene glycol based coolant, power steering fluid, brake fluid, battery acid, etc.), impingement from pebbles/stones/gravel and snow/ice, mud, dirt, grit, sand, dust, road spray (including sodium chloride and calcium chloride).

3.1.4 Interfaces. The following paragraphs describe the interfaces to the AT shift system. The system shall package within available space as defined by GM engineering over full motion and tolerance ranges.

3.1.4.1 External to Vehicle to Subsystem. Not applicable.

3.1.4.2 System Interfaces. The following paragraphs describe the interface of the shift system to other systems in the vehicle.

3.1.4.2.1 Automatic Transmission.

3.1.4.2.1.1 Inputs to the AT Shift System From the AT.

- Detent centering torque at the manual shaft
- Vibration
- Other powertrain motion due to road inputs, engine roll, etc.
- Support for the shift cable reaction bracket

3.1.4.2.1.2 Outputs From the AT Shift System to the AT.

- Torque to rotate the transmission manual shaft to the gear positions
- Reaction force on the transmission case

3.1.4.2.2 Floor Pan (Underbody).

3.1.4.2.2.1 Inputs to the AT Shift System From the Floor Pan.

- Support for the shifter assembly
- Body/chassis vibrations and shocks

3.1.4.2.2.2 Outputs From the AT Shift System to the Floor Pan.

- Shift reaction loads

3.1.4.2.3 Electrical System.

3.1.4.2.3.1 Inputs to the AT Shift System From the Vehicle Electrical System.

- Electrical power supply for the shift inhibit solenoid and PRNDL illumination
- Electrical signal for indication of the selected gear position (if applicable)
- Electrical power supply to the tap switching mechanism (if applicable) and park position switch

3.1.4.2.3.2 Outputs From the AT Shift System to the Vehicle Electrical System.

- Location and support for other vehicle electrical harnesses which route along the shifter base may be required based on program packaging
- Electrical ground signal when shifter assembly is able to be locked in P (low side drive)

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- Variable voltage electrical signal to indicate selection of “tap up” and “tap down” (TUTD) positions, and “tap enable” when in the manual (M) position. (Parallel gate, TUTD systems only.)

3.1.4.3 Components Interfaces. The following paragraphs describe the component to component interfaces of the shift system.

3.1.4.3.1 Shifter Assembly to Shift Cable.

3.1.4.3.1.1 Inputs to the Shifter Assembly From the Shift Cable.

- Detent centering force from the transmission
- Vibrations transmitted through the cable (core and conduit) from the powertrain
- Reaction force from cable conduit

3.1.4.3.1.2 Outputs From the Shifter Assembly to the Shift Cable.

- Force and motion to rotate the transmission manual shaft to the gear positions

3.1.4.3.2 Shifter Assembly to Shift Knob.

3.1.4.3.2.1 Inputs to the Shifter Assembly From the Shift Handle.

- Lever actuation forces and assembly forces
- Pawl actuation forces
- Torque on lever tube

3.1.4.3.2.2 Outputs From the Shifter Assembly to the Shift Handle.

- Anti-rotation support
- Retention support
- Assembly reaction force
- Pawl reaction force

3.1.4.3.3 Shifter Assembly to PRNDL Indicator Trim Plate.

3.1.4.3.3.1 Inputs to the Shifter Assembly From the PRNDL Trim Plate.

- Drag force resistive to motion

3.1.4.3.3.2 Outputs From the Shifter Assembly to the PRNDL Trim Plate.

- Lever positioning for indicator sensor/flag
- Holding features for PRNDL positioning before assembly to vehicle

3.1.4.3.4 Shift Cable to Transmission Bracket and Lever.

3.1.4.3.4.1 Inputs to the Shift Cable From the Transmission Bracket and Lever.

- Detent centering force at the lever
- Vibration and other powertrain motion due to road inputs, engine roll, etc.
- Support for the shift cable

3.1.4.3.4.2 Outputs from the shift cable to the transmission bracket and lever:

- Shift forces transmitted to the lever
- Reaction force on the bracket

3.1.4.3.5 Shifter Core Mechanism to PRNDL Indicator Trim Plate.

3.1.4.3.5.1 Outputs From the Shifter Core Mechanism to the PRNDL Indicator Trim Plate.

- Positioning and alignment features and forces to help align the trim plate to the mechanism (if electrical floating type PRNDL)

3.1.5 Usage Definition. Not applicable.

3.2 Product Characteristics.

3.2.1 Performance Requirements. Paragraphs 3.2.1 thru 3.2.1.4.10 outline the performance of the ATSC subsystem and some of the individual components of the subsystem. For product performance of the shifter core mechanism, see the Automatic Transmission Floor Shifter Core Mechanism CTS.

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3.2.1.1 Shift System Performance.

3.2.1.1.1 System Kinematics. The shift system kinematics shall comply with the GM company shift system guidelines outlined in Best Practice PTDI-40. These guidelines have outlined recommended zones for placement of the critical components of the shift system. The shift system linkage travels (between park and any other gear position) at the shifter, shall have no more than 0.1 mm of nominal design mismatch when compared to the corresponding linkage travels at the transmission.

Note: The supplier shall work with the GM Design Responsible Engineer to comprehend this requirement.

When expressed as a formula:

$$|C_t - C_s| \leq 0.1 \text{ mm}$$

Where:

C_t = Design nominal cable travel at transmission

C_s = Design nominal cable travel at shifter

3.2.1.1.2 Shifter Assembly Effort. Reference the program specific SSTS document.

3.2.1.1.3 System Detent Centering. When installed in vehicle, the AT shift system shall be capable of centering itself in the adjacent detent when the system is placed in any position greater than 5 mm (measured at the handle) outside of the nominal detent positions. The test for compliance to this requirement shall be a subjective evaluation, with the Design Release Engineer (DRE), Power cube engineer (or their designee). System Bill of Material (BOM) Family Owner (BFO) (or their designee) and Safety Compliance Engineer (or their designee) is required to evaluate and approve the performance of the complete shift system at statement of requirement (SOR) hardware level and Non-Saleable Manufacturing Validation build.

3.2.1.1.4 Lateral Compliance (Vehicle Level Requirement used for Computer Aided Engineering (CAE) Analysis. Not a Physical Test). Lateral compliance testing shall be performed at room temperature (20 °C) and with the shifter assembly installed to the production intent mounting structure, including, but not limited to, any of the following: floor pan and tunnel bracket, intermediate bracket, console bracket, instrument panel (IP) structure, or other mounting hardware within 1 m of the shifter assembly. The exact amount/scope of the mounting hardware to be included in the test will be determined by the GM Validation and Design engineers. See Figure 1.

3.2.1.1.4.1 High Load Compliance. With the shifter assembly in the Reverse (R) position and a 3 N load at the Load Application Point (LAP) toward either cross car direction, measure the point of the LAP. Increase the load to 220 N and measure the change in that position. The total measured deflection between the two measurements in one lateral direction shall not exceed 15 mm at the LAP. See Figure 1.

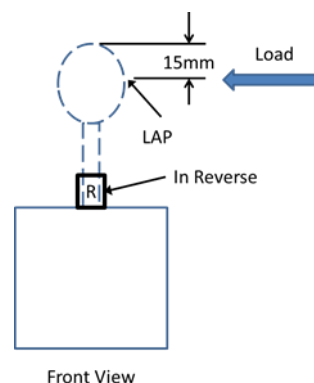


Figure 1: Lateral Compliance

3.2.1.1.5 Transmission of Vibration. The transmission of vibrations from the engine and transmission shall be evaluated to GMW14264. The ATSC subsystem shall be designed so there is no transmission of vibrations from

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the engine and transmission which causes unacceptable noise or vibrations from the ATSC subsystem. Acceptable noise level: Rating eight (8) per GMW14264.

3.2.1.1.6 Durability Cycling When All Best Practices Are Met. Best Practices PTDI-4, PTDI-40 and PTDI-43, (may apply to ATSC subsystem, shifter assembly or shifter assembly subcomponents). Cable supplier shall run cable durability with program specific bracket and lever. Shifter supplier shall run shifter assembly durability with program cable (routing to be agreed upon by GM engineering), and transmission or transmission load simulator.

Note: The supplier shall work with the GM Design Responsible Engineer to comprehend this requirement.

3.2.1.1.6.1 Durability Cycling When All Best Practices Are Not Met. Best Practices PTDI-4, PTDI-40 and PTDI-43 (may apply to ATSC subsystem, shifter assembly, or shifter assembly subcomponents.) If the ATSC subsystem design does not fully meet the stated best practices (green status) then the ATSC subsystem and all components shall be tested together. This includes the shifter assembly, cable assembly with program specific routing, cable bracket, transmission and transmission lever, and any other components defined as part of the ATSC subsystem.

Note: The supplier shall work with the GM Design Responsible Engineer to comprehend this requirement.

3.2.1.1.6.1.1 Durability Cycling Test Setup.

- Mount transmission or transmission simulator on bedplate
- Mount shifter assembly
- Mount shifting actuator at a 15 degree angle from the normal shift plane
- The angle will be biased toward the driver position and be established with the shifter assembly in the neutral gate position (Figure 2)
- Load at the LAP 15 mm from the top of the shifter knob

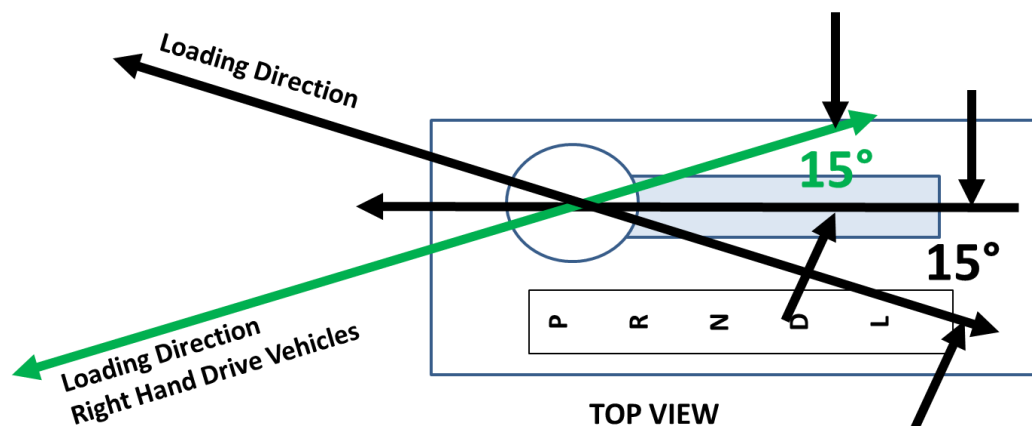


Figure 2: Durability Cycling Load Apply Angle

3.2.1.1.6.1.2 Durability Cycling of a Parallel Gate ATSC Subsystem. (May apply to ATSC subsystem, shifter assembly, or shifter assembly subcomponents.) A durability test shall be performed by moving the lever from **P** to (**M±**) and from (**M±**) back to **P**. One cycle is defined as:

- Start in **P**
- Depress button
- Shift to gate between **P** and **R**
- Release button
- Shift to **D**
- Shift to **M** gate
- Shift to **+** with 30 N load

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- Shift to - with 30 N load
- Shift to **N**
- Depress button
- Shift to **P** and release button
- End of cycle

3.2.1.1.6.1.3 Durability Cycling of a Straight Gate ATSC Subsystem. (May apply to ATSC subsystem, shifter assembly, or shifter assembly subcomponents.) A durability test shall be performed by moving the lever from **P** to **L** and back to **P**. One cycle is defined as:

- Start in **P**
- Depress button
- Shift to gate between **P** and **R**
- Release button
- Shift to **D**
- Depress button
- Shift to **L** gate
- Shift to **N**
- Depress button
- Shift to **P** and release button
- End of cycle

3.2.1.1.6.1.4 Durability Cycling Temperatures and Cycles for Parallel and Straight Gate Shifters are Defined in Appendix G, Table G1.

3.2.1.1.6.1.4.1 The solenoid shall be cycled every time the shifter is removed from the park position and continuously monitored to ensure that the solenoid returns to the lock position. If solenoid does not return to the lock position, the test shall stop at that point.

3.2.1.1.6.1.4.2 Every 10 000 cycles, the following actions shall be performed:

- A force of 350 N held for 5 s shall be applied to the LAP while the shifter is in the **P** position toward the **R** position without actuating the gate pawl and with the solenoid energized for 5 cycles
- With the gate pawl actuated and the solenoid de-energized, apply a 100 N force held for 5 s to the LAP while the lever is in the **P** position toward the **R** position for 5 cycles.

3.2.1.1.6.1.5 All tested samples shall conform to functional test requirements per Table 4, 100% Function Table.

3.2.1.1.6.2 The 95% reliability at 50% confidence (R95C50) shall be demonstrated at the Reliability Evaluation Point for the shift system, which is defined as 90 000 cycles = 1 life = 150 000 mi for 95th percentile driver.

- ATSC subsystem including shifter assembly, cables, brackets, levers and transmission or simulator = R95C50
- Shifter assembly including knob, core mechanism, and base bracket = R97C50
- Shifter assembly subcomponents including BTSI mechanism, park switch, gate pawl system, and knob assembly = R99C50
- Shifter cable assembly = R99C50

3.2.1.1.7 Vehicle Level ATSC Subsystem Durability. The ATSC subsystem will be subjected to various platform vehicle durability schedules at the GM Proving Ground. The ATSC subsystem shall be capable of maintaining function for the duration of the schedule.

3.2.1.1.8 Overall ATSC Subsystem Performance Evaluation. The ATSC subsystem will be evaluated by GM engineering regarding visual attributes as well as feel, ergonomics, function, etc. Two evaluations shall be conducted at room temperature (20 °C to 23 °C) and cold (-25 °C). The system shall achieve a minimum rating of eight (8) per GMW14264 Subjective Rating Scale. See Appendix E, Table E1 for evaluation sheet and criteria.

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3.2.1.1.9 ATSC Subsystem Linkage Adjustment. ATSC subsystem shall be adjusted with transmission and shifter assembly in park (P) position.

3.2.1.1.10 ATSC Subsystem Environmental Performance Requirements.

3.2.1.1.11 ATSC Subsystem Performance at Temperature. In the temperature ranges specified in the paragraph, the ATSC subsystem shall operate with the specified level of functionality associated with that class as defined in 3.2.1.1.11.1 thru 3.2.1.1.11.6.

3.2.1.1.11.1 Class 1. Minimum Subjective Rating Scale of eight (8) for comfort, noise and shift force, must operate within normal specified limits.

3.2.1.1.11.2. Class 2. Minimum Subjective Rating Scale of six (6) for comfort, noise and shift force, allowed to have minor degradation of performance.

3.2.1.1.11.3 Class 3. Must provide function, can be assisted.

3.2.1.1.11.4 Class 4. Must remain functional after exposure.

3.2.1.1.11.5 Interior Temperature Ranges.

- -50 °C to -41 °C = Class 4
- -40 °C to -30 °C = Class 3
- -29 °C to -20 °C = Class 2
- -19 °C to 70 °C = Class 1
- 71 °C to 80 °C = Class 2
- 81 °C to 93 °C = Class 3
- 94 °C to 105 °C = Class 4

3.2.1.1.11.6 Exterior Temperature Ranges.

- -50 °C to -41 °C = Class 4
- -40 °C to -30 °C = Class 3
- -29 °C to -20 °C = Class 2
- -19 °C to 120 °C = Class 1
- 120 °C to 150 °C = Class 2

Note: Higher temperature capability may be required in specific local zones pending vehicle temperature testing.

3.2.1.1.12 Squeak and Rattle (Vehicle Level Testing). No objectionable noises shall be present when the ATSC subsystem is tested using the vehicle squeak and rattle procedure GMW8518.

Minimum subjective rating under all conditions for any individual complaint and the overall rating for the subsystem determined according to GMW7294 is the subjective rating level of eight (8).

Stakeholders: OC Noise and Vibration, 15.02 Powertrain Driver Interface.

Reference: Noise and Vibration Integration web site, Resource Center Application.

3.2.1.1.13 Corrosion Resistance. The ATSC subsystem and components shall meet the requirements found in GM Specification GMW15272 Corrosion Performance Specification. For temperature ranges reference 3.1.3.1 and Table 1.

3.2.1.2 Automatic Transmission Shifter Assembly.

3.2.1.2.1 Automatic Transmission Shifter Assembly Performance.

3.2.1.2.1.1 Gates, Detents, and Travels.

3.2.1.2.1.1.1 Gear Position Selection System Kinematics and Travels. Consideration should be made in the design and tooling of the shifter assembly to accommodate the potential for other transmissions/programs and cable travels by making relatively minor tooling revisions to shifter assembly. The supplier will design for overall cable travel as given in program specific CTS.

For shifter assemblies with TUTD functionality, travel at the LAP to move from the PRNDL gate to the TUTD gate shall be between 25 mm and 45 mm for parallel gate shifter assemblies. Travel at the LAP to actuate the + and – signals shall be between 15 mm and 25 mm for parallel gate shifter assemblies.

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3.2.1.2.1.1.2 Gate Stops. The shift system shall have a gate stop device between the selector positions with a function as stated below:

Gates:

- **P to R**, drive (**D**) position to manual/low (**M/L**) position (or one position past **D**, if it exists), Neutral (**N**) to **R**, **R** to **P**
- **D** gate to **M/L** gate interlock: This shall prevent direct shifting into the **M/L** gate from **P**

The stops shall prevent movement beyond those positions unless a secondary action (operating release button) is performed. The forward stop in **P** and the rearward stop in the rearmost gear position shall be a separate feature and not load the pawl. For shifter assemblies with TUTD functionality, the lateral stop in **M** position shall not permit the lever to overload the **tap** enable switch/sensor (for parallel gate shifter assemblies). Also, the stops in the **+** and **-** directions shall not permit the lever to overload the **tap** switches/sensors (for parallel gate shifter assemblies).

The combination of gate design and pawl return spring force shall not allow the driver to harshly **slap** the shifter assembly from any forward gear position into **R**. This requirement shall be met after the completion of all durability tests.

3.2.1.2.1.1.3 Gate Over Travel. Gate position dimensions as specified are measured at the linkage attachment point:

The pawl clearance to the gate stop shall provide $0.7 \text{ mm} \pm 0.3 \text{ mm}$ of cable travel as measured at the cable pin in all gear positions except park. The pawl clearance to the rearward park gate shall provide $0.6 \text{ mm} \pm 0.2 \text{ mm}$ of cable travel as measured at the cable pin. The forward park stop shall provide $0.8 \text{ mm} \pm 0.3 \text{ mm}$ of over travel. The over travel in all positions shall be measured with just enough force applied at the LAP to create initial contact between the pawl and the gate stop plus 2 N. Sample size to be determined by **D** to zero (0) multi-varied sample selection.

3.2.1.2.1.1.4 Detents. The shifter assembly shall provide detents, which complement the transmission detents. Peaks between the detents shall be positioned at the nominal peaks between the transmission detent positions. The production tolerance on linkage travels in the shifter assembly shall be no more than $\pm 1.0 \text{ mm}$. The tolerance of the **P** gage length shall be $\pm 1.0 \text{ mm}$. The tolerance of the cable travel for each position from **P** shall be $\pm 0.2 \text{ mm}$.

3.2.1.2.1.1.5 Detents Effort at the LAP. (As defined in 3.2.2.1.1) to move the shifter core mechanism lever to any adjacent gear position shall be $9.0 \text{ N} \pm 2 \text{ N}$ (without the rest of the system connected). There shall be no truncated peaks in any gear position. The detents shall provide enough centering force to center the shifter assembly and PRNDL assembly (with a maximum 1.5 N additional load at the LAP) in each detent.

For systems with a five (5) position straight gate mechanism, the effort to shift from **D** to **M** shall be $18 \text{ N} \pm 4 \text{ N}$ when an **M** gate blocker is not present in the base design. When an **M** gate blocker is present in the base design the effort to shift from **D** to **M** shall be $9 \text{ N} \pm 2 \text{ N}$.

Effort at the top of the LAP to move the shifter assembly lever to any adjacent gear position shall be $9 \text{ N} \pm 2 \text{ N}$ (without the cable or transmission connected). The detents shall provide enough centering force to center the shifter assembly and PRNDL assembly in each detent.

For systems with a parallel gate TUTD mechanism, effort at the LAP to move the shift lever laterally into and out of the **M** position shall be $14 \text{ N} \pm 2 \text{ N}$. This peak effort shall be reached between 40% and 60% of the total travel for the four (4) position variants. For the five (5) position variant, the effort to remove the lever from the **M** position shall not exceed 18 N. Initial effort at the LAP to begin moving the lever from the **M** position to either the **+** or **-** positions, shall build to the peak force of $17.0 \text{ N} \pm 2.0 \text{ N}$ within the first 25% of travel. The profile shall then drop at least 5.0 N to a lower level and not exceed that force over the remaining travel.

3.2.1.2.1.1.6 Knob Button/Gate Pawl Travel. Total shift handle button travel of the shifter assembly, including knob, shall be between 8.0 mm and 10.0 mm. The minimum available pawl travel shall be no less than 8.5 mm. The pawl travel required to exit the park gate shall be 7.00 mm (+0.50 mm, -0.15 mm). The top of the pawl rod shall extend past the end of the lever tube $19.0 \text{ mm} \pm 0.4 \text{ mm}$ in the fully extended position and have a rounded end shape with no parting lines.

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3.2.1.2.1.1.7 Shift Knob Button Effort (Shifter Assembly).

3.2.1.2.1.1.7.1 Park Position. Total effort to depress the shift knob button fully shall be $17.0 \text{ N} \pm 3.0 \text{ N}$ with the shift knob assembled to the shifter assembly at ambient temperature. Total effort to depress the shift knob button fully with the shift knob assembled to the shifter assembly shall not exceed 35 N at -40°C .

3.2.1.2.1.1.7.2 Drive to Manual Position (With an M Gate Blocker) Total effort to depress the shift knob button shall be $20 \text{ N} \pm 4 \text{ N}$.

3.2.1.2.1.1.8 Shifter Pawl Effort.

3.2.1.2.1.1.8.1 Park Position. The shifter pawl rod effort shall have an initial effort of 5.0 N to 9.0 N at 0.5 mm of pawl travel. The peak force to travel the pawl 10 mm shall not exceed 14 N. This testing shall be performed at room temperature (20°C). The minimum return force at 0.5 mm of pawl travel shall not drop below 4 N at -40°C when measured at a return rate of 10 mm/minute.

3.2.1.2.1.1.8.2 Drive to Manual Position (with an M Gate Blocker). The shifter pawl rod effort shall have an initial effort of 5.0 N to 9.0 N at 0.5 mm of pawl travel. The peak force to travel the pawl 10 mm shall not exceed 17 N.

3.2.1.2.1.2 Lash, Compliance, and Efficiency.

3.2.1.2.1.2.1 Lash. Lash testing shall be performed at room temperature (20°C).

With the shifter assembly attached to a rigid mounting surface, the detent spring disabled, the cable attaching stud rigidly fixed to the shifter assembly base, actuation rod fully depressed, and with the lever in **R**, apply a 3.0 N load to the LAP in the forward direction and the rearward direction (x-axis). The sum of both the forward and rearward displacements shall be less than 0.7 mm in total.

With the shifter assembly attached to a rigid mounting surface and the lever in all gated positions (including TUTD gate), with the detent spring enabled, apply $\pm 3.0 \text{ N}$ in the cross car direction (y-axis) at the LAP. The sum of both cross car displacements shall be less than 0.7 mm in total.

3.2.1.2.1.2.2 Fore/Aft Gate Compliance. Compliance testing shall be performed at room temperature (20°C). Disable any detent mechanism in the core shift mechanism prior to performing this check. Hold the shifter core mechanism pawl against the neutral/reverse (**N/R**) gate with a load of 12 N applied between the cable attaching stud and the cable conduit face in the bracket, and measure the cable gage length (distance from cable pin center to cable conduit center in bracket). Increase the load to 220 N and measure the change in the gage length of the shifter assembly. Duplicate the test with the pawl against the park/reverse (**P/R**) gate in the opposite direction than the force against the **N/R** gate. The total measured deflection from both measurements shall not exceed 2.0 mm.

3.2.1.2.1.2.3 Fore/Aft Travel Loss Compliance. Compliance testing shall be performed at room temperature (20°C). With the shifter assembly attached to a rigid mounting surface, the detent spring disabled, the pawl released from the gate, the cable attaching stud rigidly fixed to the shifter assembly base at the cable conduit attaching face, and the lever in reverse position, apply $\pm 50.0 \text{ N}$ to the LAP in a direction tangential to the arc (fore/aft) defined by the lever movement. The total movement of the lever at the LAP shall be $< 8.0 \text{ mm} +$ the fore/aft lash measurement (from 3.2.1.2.1.2.1).

3.2.1.2.1.2.4 Lateral Compliance. Lateral compliance testing shall be performed at room temperature (20°C) with the shifter assembly mounted to a rigid surface.

3.2.1.2.1.2.4.1 Low Load Compliance. With the shifter assembly in the **R** position add a 3 N load at the LAP to remove lash from the system, toward either cross car direction and measure the initial deflection. Increase the load to 30 N and measure the change in the deflection.

Deflection (millimeters) at 30 N – Deflection (millimeters) at 3 N = Total Measured Deflection (millimeters).

The total measured deflection between the two measurements in one lateral direction shall not exceed 4 mm (straight gate) and 5 mm (parallel gate) at the LAP. See Figure 3.

3.2.1.2.1.2.4.2 High Load Compliance. With the shifter assembly in the **R** position add a 3 N load at the LAP to remove lash from the system, toward either cross car direction and measure the initial deflection. Increase the load to 220 N and measure the change in the deflection.

**Deflection (millimeters) at 220 N – Deflection (millimeters) at 3 N =
Total Measured Deflection (millimeters)**

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The total measured deflection between the two measurements in one lateral direction shall not exceed 6 mm (straight gate), 8 mm (parallel gate), 8 mm (70 mm and less pivot pin shifter assemblies), and 6 mm (70 mm and greater pivot pin assemblies) at the LAP. See Figure 3.

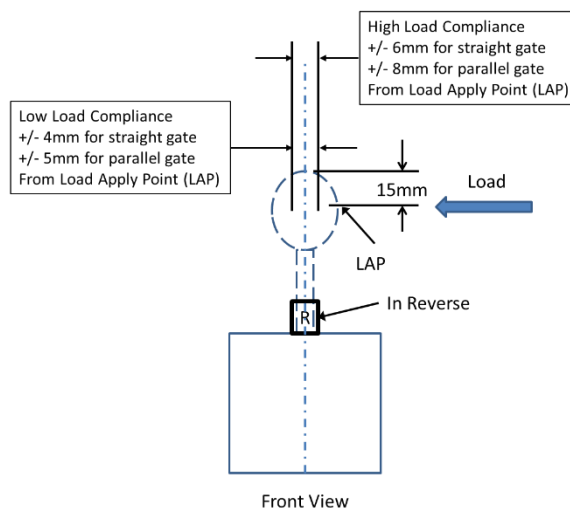


Figure 3: Compliance

3.2.1.2.1.2.5 Shifter Assembly Efficiency and Free State Effort. Efficiency of the shifter assembly (without the PRNDL) shall be a minimum of 90% as measured by GMW14765. See Figure 4.

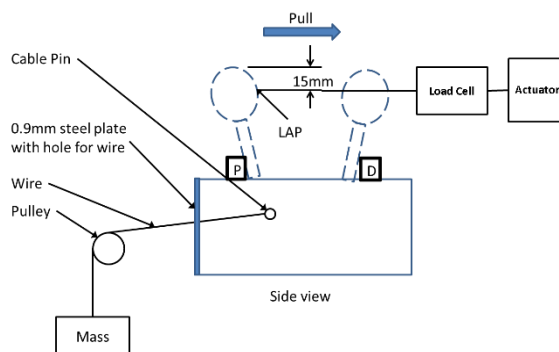


Figure 4: Efficiency

3.2.1.2.1.3 Unauthorized Gear Selection Prevention. These paragraphs outline the requirements for the unauthorized gear selection prevention devices to be included in the shifter assembly. This ATSC subsystem shall meet the requirements of FMVSS 102 and CMVSS 102 for the brake interlock and FMVSS 114 and CMVSS 114 for the ignition key interlock.

The shifter assembly shall be equipped with an electronic solenoid driven system that will lock the lever in **P** unless the solenoid is energized (by placing the ignition in the Run position/mode and applying the service brake pedal). The BTSI mechanism shall not work against the pawl to lock the lever in **P**. The vehicle shift interlock system shall also have a key lock function that makes it impossible to remove the ignition key unless the lever of the shifter assembly is locked in **P**. Therefore, the shifter assembly shall provide a signal to the vehicle when it is locked in **P** to allow the vehicle to comply with these requirements. The BTSI interlock mechanism shall prevent lever motion when de-energized.

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3.2.1.2.1.3.1 Park Switch Actuation Point. If the method to indicate the shifter assembly locked in park is a switch acting on the pawl rod travel, that switch shall close 2.0 mm to 3.5 mm below the point where the pawl rod is at rest (fully released into the park gate).

If the method to indicate the shifter assembly locked in park is a switch acting on the BTSI subsystem, that switch shall close only when the lock mechanism is engaged 50% or greater.

3.2.1.2.1.3.2 Unauthorized Gear Selection Prevention – Override. When the shifter assembly has locking capability, an override device may be required. The force required to operate the override shall be $10\text{ N} \pm 4\text{ N}$. The override device shall be capable of withstanding a single force of 150 N and maintain function. Reference CG1254 program specific and SSTs document for more details around the override device.

3.2.1.2.1.3.3 Unauthorized Gear Selection Prevention Durability – P Position. A durability test of shift lock device shall be performed with the lever in the **P** position and locking device in lock position (if applicable). The shifter gate release device shall be fully depressed and the lever loaded with a force of 100 N at the LAP towards **R** position and release for 10 000 cycles, followed by a single static force of 350 N held for 5 s, and shall conform to functional test requirements per 100% function. See 3.2.1.2.1.9.1.

3.2.1.2.1.3.4 Unauthorized Gear Selection Prevention High Load Cycling. With the ignition in the off/lock position (park lock engaged), the shift system shall be capable of withstanding a 350 N load held for 5 s at the LAP with the gate release device fully released for fifteen (15) cycles. The entire system shall be soaked at 50 °C for 8 h immediately prior to performing this check. During the test (only with the 1st and 15th cycle) the shift cable pin travel must be measured. Shift cable pin travel is determined by measuring the distance between the cable pin in park (no load applied at the lever LAP) and cable pin when 350 N is being applied and held for 5 s. The cable pin travel shall not exceed 3.2 mm. At the conclusion of the test, the system shall conform to functional test requirements per 100% function. See 3.2.1.2.1.9.1.

3.2.1.2.1.3.5 Unauthorized Gear Selection Prevention For High Load Premature Lock-Up. With the ignition in the off/lock position (park lock engaged) and shifter assembly in park, the BTSI system must operate freely when 100 N is applied to the lever at the LAP pulling towards reverse against the rear of park gate without depressing the gate release device. With the 100 N load applied, power the BTSI solenoid and check for full travel of the solenoid.

3.2.1.2.1.4 Control Durability Requirements.

3.2.1.2.1.4.1 Durability Test of Pawl. A durability test of the gate pawl shall be performed with the lever in the **P** position and with the BTSI energized. With a force on the LAP of 20 N toward **R**, actuate the pin until it **jumps** over **P/R** segment, repeat for 90 000 cycles for one life. Shall conform to functional test requirements per 100% function. See 3.2.1.2.1.9.1.

3.2.1.2.1.4.2 Gate Durability Tests.

3.2.1.2.1.4.2.1 Gate Durability P to R. A durability test shall be performed with the lever in **P** moving toward **R** without actuating the release button. Apply a force of 225 N to the LAP for 1000 cycles. Shall conform to functional test requirements per 100% function. See 3.2.1.2.1.9.1.

3.2.1.2.1.4.2.2 Gate Durability N to R. A durability test shall be performed with the lever in **N** position moving toward **R** without actuating the release button. The test shall be performed with a force of 225 N to the LAP for 1000 cycles. Shall conform to functional test requirements per 100% function. See 3.2.1.2.1.9.1.

3.2.1.2.1.4.2.3 Gate Durability D Rearward. A durability test shall be performed with the lever in **D** position moving rearward in vehicle (x+) without actuating the release button until it contacts a stop. The test shall be performed with a force of 225 N to the LAP for 1000 cycles. The test shall conform to functional test requirements per 100% function. See 3.2.1.2.1.9.1.

3.2.1.2.1.4.2.4 Gate Durability Drive/Manual (D/M) Position in Cross Car Direction. A durability test shall be performed with the lever in **D** moving in +y direction against stop and subsequently from position **M** moving in -y direction against stop without actuating the release button. Apply a force of 225 N to the LAP in both directions for 1000 cycles. This shall conform to functional test requirements per 100% function. See 3.2.1.2.1.9.1. This paragraph applies only to parallel gate shifter assemblies.

3.2.1.2.1.4.2.5 Gate Durability M Gate in + Direction. A durability test shall be performed with the lever in **M** moving in the + direction without actuating the release button. Apply a force of 225 N to the LAP for 1000 cycles. This shall conform to functional test requirements per 100% function. See 3.2.1.2.1.9.1. This paragraph applies only to parallel gate shifter assemblies.

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3.2.1.2.1.4.2.6 Gate Durability M Gate in – Direction. A durability test shall be performed with the lever in **M** moving in the – direction without actuating the release button. Apply a force of 225 N to the LAP for 1000 cycles. This shall conform to functional test requirements per 100% function. See 3.2.1.2.1.9.1. This paragraph applies only to parallel gate shifter assemblies.

3.2.1.2.1.4.2.7 Shifter Assembly Wiring Durability. (Console integrated shifters: Design validation level with shifter component only. Production validation level shifter assembly with console testing.) If the ATSC subsystem includes moving electrical wiring, perform the following durability test. At the conclusion of the test, the wiring and connections to the shift mechanism shall not exhibit any chafing on the insulation and shall maintain electrical continuity. Circuit continuity shall be monitored continuously throughout testing.

3.2.1.2.1.4.2.7.1 Mount the shifter assembly with knob and wiring attached in a console per production intent design. All trim and closeouts (boot or slider tape) shall be attached and in position. Use a fixture or other means to hold the button and gate pawl and any shift interlock mechanism in a released state, that is, such that the shift lever can be freely moved through its travel.

3.2.1.2.1.4.2.7.2 Cycle from Park to Low (most rearward position) and back to Park for 50 000 cycles at a maximum rate of 30 cycles/minute.

3.2.1.2.1.4.2.7.3 All cycling shall be completed at a temperature of -40 °C.

3.2.1.2.1.5 Static and Dynamic Loading Conditions.

3.2.1.2.1.5.1 Static Loading Conditions/Tests.

3.2.1.2.1.5.1.1 Ultimate Strength/High Load Cyclic Durability Test. All conditions contained in GMW14764 shall be tested with the shifter assembly installed to the production intent mounting structure, including, but not limited to, any of the following: floor pan and tunnel bracket, intermediate bracket, console bracket, IP structure or other mounting hardware within 1 m of the shifter assembly. The exact amount/scope of the mounting hardware to be included in the test will be determined by the GM validation and design engineers. This mounting hardware shall also be monitored for signs of fatigue or other structural abnormalities during the test and those results supplied to the appropriate responsible GM engineer.

3.2.1.2.1.5.1.1.1 Ultimate Strength – Forward Loading. The shifter assembly shall be capable of achieving 578 N for ultimate strength when tested per GMW14764. See Figure 5.

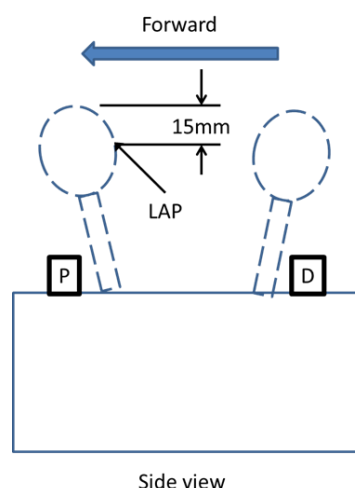


Figure 5: Ultimate Strength

3.2.1.2.1.5.1.1.2 High Load Cycling – Forward Loading. The shifter assembly shall be capable of achieving 2000 cycles for high load cycling when tested per GMW14764.

3.2.1.2.1.5.1.1.3 High Load Cycling – Fore/Aft Loading. The shifter assembly shall be capable of withstanding fifteen (15) applications of 350 N applied forward or rearward to LAP when tested per GMW14764.

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3.2.1.2.1.5.1.1.4 High Load Cycling – Lateral Loading. The shifter assembly shall be capable of withstanding 15 applications of ± 500 N applied laterally to the LAP when tested per GMW14764. Park switch state shall be monitored during testing and shall not show an open circuit at any time when testing in the Park position.

3.2.1.2.1.5.1.1.5 High Load Cycling – Vertical Loading. The shifter assembly shall be capable of withstanding a single application of a 1000 N force in the axial direction down the lever tube when tested per GMW14764.

3.2.1.2.1.5.1.2 Ultimate Strength Data. The supplier shall load the shifter assembly to the point of initial deformation/fracture and record those loads and the failure mode for the following conditions:

3.2.1.2.1.5.1.2.1 With BTSI/park lock mechanism locked in park and the button fully depressed load the lever towards Reverse position.

3.2.1.2.1.5.1.2.2 While in the park gate with the BTSI mechanism unlocked and the button not depressed, load the shifter lever toward reverse.

3.2.1.2.1.5.1.2.3 While in the reverse gate and button not depressed load the shifter lever toward park.

3.2.1.2.1.5.1.2.4 While in the neutral gate and button not depressed load the shifter lever toward the driver (-y direction).

3.2.1.2.1.5.1.2.5 While in the neutral gate and button not depressed load the shifter lever toward the passenger (+y direction).

3.2.1.2.1.5.1.2.6 While in the neutral gate with the BTSI mechanism unlocked and the button not depressed, load the shifter lever toward reverse position.

3.2.1.2.1.5.1.2.7 While in the neutral gate with the BTSI mechanism locked and the button fully depressed, load the shifter lever toward reverse position.

3.2.1.2.1.5.1.2.8 While in the M ($\pm$) gate and button not depressed load the shifter lever toward the driver (-y direction). This paragraph applies only to parallel gate shifter assembly.

Note: These tests will be required in the development phase of the program to understand the point at which the component will fail and the failure mode. The components must be evaluated to determine the specific failure mode and then used to determine if it is necessary to modify the design to change the failure mode.

3.2.1.2.1.5.1.3 Linkage Attachment Point Ultimate Strength. The shifter assembly shall be capable of withstanding 890 N, applied at the linkage attachment point along the linkage line of action, without separation of the connection or pin or yielding of the lever.

The above loading conditions shall be conducted with the linkage in the installed position, after a 1 h soak at 80 °C, with each load being held for a minimum of 5 s.

3.2.1.2.1.5.1.4 Torque at Knob. After five (5) applications of a 20 N·m torque on the shift handle (in one direction), the shifter assembly shall maintain function including all electrical requirements, which shall be monitored during testing. Total deformation of the shifter assembly shall be less than 5 degrees and deformation at the interface between the handle and lever shall not allow more than 1 degree of rotational free play between the handle and lever with the application of a ± 1.0 N·m torque. Shall conform to functional test requirements per 100% function. See 3.2.1.2.1.9.1.

3.2.1.2.1.5.2 Dynamic Loading Conditions. The paragraphs in this section define the types of dynamic loading conditions that the shifter assembly shall be required to comply with. For the tests (3.2.1.2.5.2.1 thru 3.2.1.2.5.2.8) the shifter assembly shall be rigidly mounted through the interface features. The tests shall be performed by attaching a cable to end of the knob which interfaces to the lever tube at a point that would be equal to the LAP of the shifter assembly (see 3.2.2.1.1 for LAP definition) and a mass to the other end of the cable with a weight specified in 3.2.1.2.5.2.1 thru 3.2.1.2.5.2.8. The cable is routed from the shift lever tube through a pulley to allow the mass to hang by gravity and pull the lever when released as shown in Figure 6. See Figure 7 for example of charted impact data. The tests are then performed by starting with the lever in the defined position and releasing the mass, which will accelerate the lever to impact the gate that is defined in the individual paragraph.

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