P09310 Automatic Shift Controls for ATV

Test Plans & Test Results

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Table of contents

MSD I: WKS 8-10 TEST PLAN 2

1.1. Introduction; Overview; Summary; Purpose; History, etc. 2
1.2. Project Description; Sub-Systems/ Critical Components Being Tested 3
1.3. Approval; Guide, Sponsor 4
1.4. Test Strategy 5
1.5. Definitions; Important Terminology; Key Words 11
1.6. References 11

2. MSD II WKS 2-4: - FINAL TEST PLAN 12

2.1. Data Collection Plan; Sampling Plan 12
2.2. Measurement Capability, Equipment 12
2.3. Test Conditions, Setup Instructions 12
2.4. Sponsor/Customer, Site Related, Requests / Considerations 13
2.5. Test Procedure, Work Breakdown Structure, Schedule 13
2.6. Assumptions 13

3. MSD II – WKS 3-10 DESIGN TEST VERIFICATION 14

3.1. Test Results 14
3.2. Logistics and Documentation 14
3.3. Definition of a Successful Test, Pass / Fail Criteria 14
3.4. Contingencies/ Mitigation for Preliminary or Insufficient Results 14
3.5. Analysis of Data – Design Summary 14
3.6. Conclusion or Design Summary 14
3.7. Function/ Performance Reviews 14
3.8. References 15
3.9. Appendices 15

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MSD I: WKS 8-10 TEST PLAN

1.1. Introduction; Overview; Summary; Purpose; History, etc.

1.1.1. Polaris Automatic Shift Controls is a project within the Systems and Controls Track.

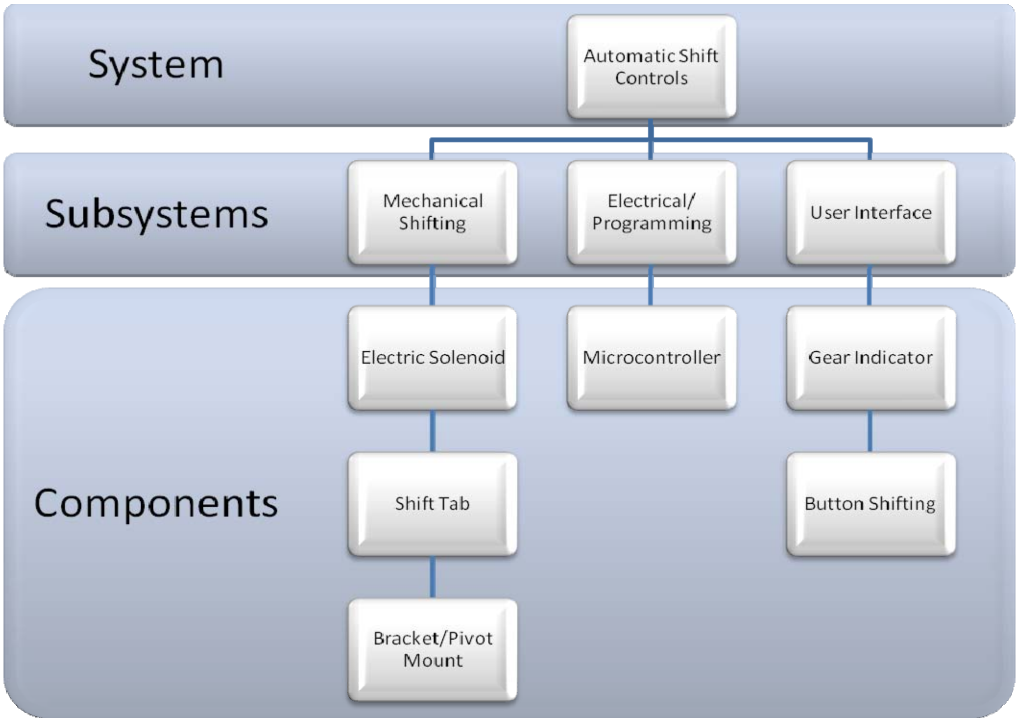
1.1.2. System is designed to automatically shift Polaris Outlaw 525 using a programmable microcontroller.

1.1.3. System integrates button shift override functionality and maintains full operation of manual shifting.

1.1.4. System components include electric solenoid that actuates shifting; bracket to mount solenoid to ATV; shift tab to attach solenoid to shift lever, and microcontroller to control actuation.

1.1.5. New button shift and on board indicator interfaces were designed for ease of use, ergonomics, shift status display and system errors.

1.2. Project Description; Sub-Systems/ Critical Components Being Tested



<u>Mechanical Shifting Subsystem Components</u>

1.2.1. Electric Solenoid

1.2.1.1. Force Output

1.2.1.2. Shift Time

1.2.2. Shift Torque

1.2.2.1. Without Engine Spark Cutout

1.2.2.2. With Engine Spark Cutout

<u>Electrical/Programming Subsystem Components</u>

1.2.3. RPM vs. TPS

1.2.3.1. Shifting points

1.2.4. Battery

1.2.4.1. Total current drawn

User Interface Subsystem

1.2.5. Button Functionality

1.2.5.1. Upshift

1.2.5.2. Downshift

1.2.6. Gear Indicator Functionality

1.2.6.1. Gear Indication

1.2.6.2. Upshift/Downshift Indication

1.2.6.3. Bad Shift Indicator

1.2.6.4. System Error Indicator

1.2.6.5. All original indicators

Automatic Shift Controls System

1.2.7. Full System Functionality

1.2.7.1. Weight of all Components

1.2.7.2. Shift Time

1.2.7.3. Range RPM testing

1.2.7.4. Lab test

1.2.7.5. Field testing

1.3. Approval; Guide, Sponsor

Approved by:
Team Members:
Mechanical Subsystem: Ashley Shoum, Keith Cobb, Matt Dombovy-Johnson
Electrical Subsystem: Jon Willistein, Feng Li
User Interface: Ashley Shoum, Matt Dombovy-Johnson, Jon Willistein, Feng Li
Guide – Professor George Slack
Sponsor – Polaris, Joel Notaro

1.4. Test Strategy

1.4.1. Product Specifications, Block Diagram, and Pass/ Fail Criteria

1.4.1.1. Electric Actuator Linear Force Output:

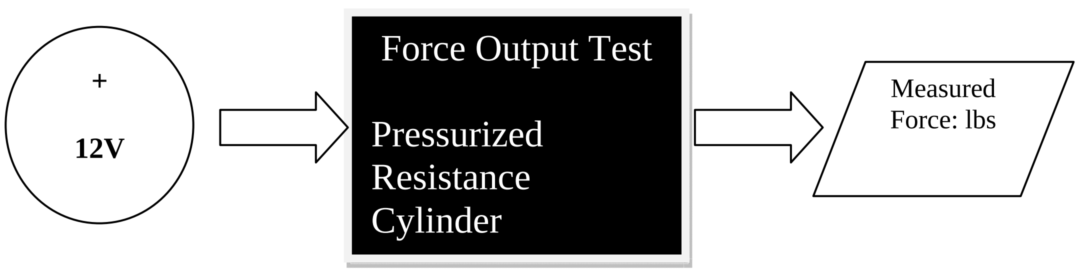
- Required: 37.5 lbs to complete a shift
- Manufacturer Specification: Actuator will provide 40 lbs

Pass/Fail Criteria:

- Pass: Cylinder provides a linear force in both directions (retraction and extraction) greater than or equal to 37.5 lbs
- Fail: Cylinder provides a linear force in either direction (retraction or extraction) less than 37.5 lbs

Block Diagram:

The test will require one input and provide a force output.



1.4.1.2. Electric Actuator Shift Time:

- Required: Complete a shift in 0.1s

Pass/Fail Criteria:

- Pass: Electric actuator is able to move from Neutral to fully extended or retracted in less than 0.1s
- Fail: Electric actuator is unable to move from Neutral to fully extended or retracted in less than 0.1s.

Block Diagram:

The test will require one input and provide a distance travelled within a certain time.

1.4.1.3. ATV Shift Torque without Engine Spark Cutout

- Required: < 150 in-lbs
- Previous Specification: 150 in-lbs

Pass/Fail Criteria:

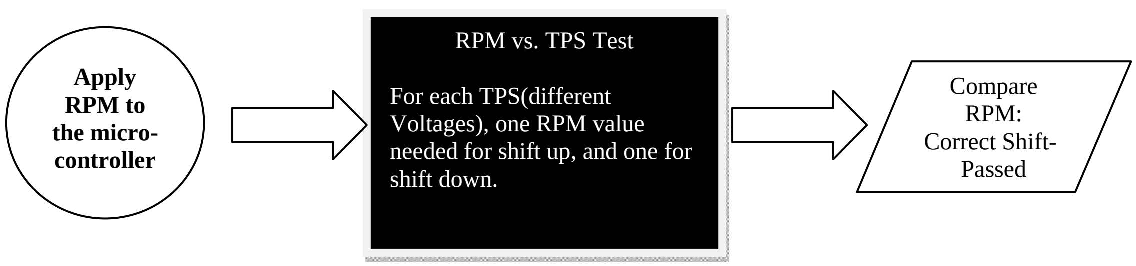
- Pass: Torque measured is less than or equal to 150 in-lbs
- Fail: Torque measured is greater than 150 in-lbs

1.4.1.4. RPM vs. TPS Shifting points

- Required: Manually drive ATV and bench test the controller for obtaining normal shifting points, Electric actuator need to shift up or down when pass shifting point

Pass/Fail Criteria:

- Pass: Electric actuator shift up or down when pass shifting point
- Fail: Electric actuator didn't shift up or down or shift to the wrong direction when pass shifting point

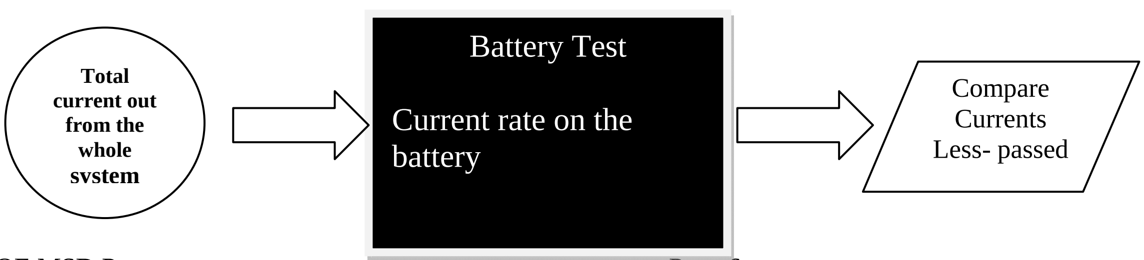


1.4.1.5. Total current drawn from battery

- Required: total current needed for the design should be less than current rate on the battery.

Pass/Fail Criteria:

- Pass: Total current drawn is less than current rate on the battery
- Fail: Total current drawn is greater than current rate on the battery



1.4.2. Functions (hardware) and Features (software, customer needs)

1.4.2.1. Mechanical:

Test Name:	Test #:	Description of Test	Specification #:	Specification Description:	System Component:
Force Output	1	Measure the force provided by the Electric Cylinder by moving a pneumatic cylinder pressurized to create a force of 40 lbs	ES6	Corresponds to our system completing a shift	Electric Actuator
Shift Time	2	Measuring the time required for the electric actuator to move from the N position to full up or down	ES2	Time required to complete a shift	Electric Actuator
Shift Torque w/o Engine Spark Cutout	3	Measure the internal spring torque or transmission without clutch simulation	ES6	Internal return torque is equivalent to force required to shift	OEM ATV component
Shift Torque with Engine Spark Cutout	4	Measure the internal spring torque of the transmission with clutch simulation	ES6	Internal return torque is equivalent to force required to shift	OEM ATV component

1.4.2.2. Electrical:

Test Name:	Test #:	Description of Test	Spec. #:	Specification Description:	System Component:
RPM vs. TPS	1	A voltage supply will drive the TPS input, and a frequency generator will drive the RPM input with a square wave. Increasing the frequency of the function generator which acts as an rpm input until it shifts for every shifting point, same way for getting down shifting points.	ES12-ES17	Shift up or down depend on the RPM and TPS values	Electric Actuator
Battery	2	Connected a multi-meters in series with the battery and the system for	ES19	Current rate on the battery	Battery

		getting reading of current			

1.4.3. Test Equipment available

1.4.3.1. Force Output of Electric Actuator

- Pneumatic Cylinder – provides a resistive force by pressurization
- Scrap metal – machine shop metal to create a small L-bracket mount for pneumatic cylinder
- Air supply – shop air will be used to pressurize the cylinder
- 12V power supply – used to produce the input required to actuate the cylinder
- Two piece clamp – mount electric actuator

1.4.3.2. Shift Time

- Force Output test stand – integrate shift time test into the force test stand
- Cylinder position magnets – used to provide a signal to tell the position of the cylinder
- 12V Supply
- Oscilloscope
- Electric timer – measure the time to move from N to fully extended or retracted

1.4.3.3. Shift Torque w/o clutch activation

- Torque wrench – attach to the gear lever mounting bolt to determine spring torque
- ATV running – place the ATV on blocks to allow shifting through gears
- Sockets – 10 mm

1.4.3.4. Shift Torque w/clutch activation

- Torque wrench – attach to the gear lever mounting bolt to determine spring torque
- ATV running – place the ATV on blocks to allow shifting through gears
- Sockets – 10 mm

1.4.3.5. RPM vs. TPS

- Power supply – act as a battery and TPS position
- Function generator – play as RPM input

- Oscilloscope – measure how input, output and other things works as a check.

1.4.3.6. Battery

- Multimeter – measure total current of the system

1.4.4. Test Equipment needed but not available

1.4.4.1. Force Output of Electric Actuator

- Metal coupler to attach electric cylinder directly to pneumatic cylinder will need to be fabricated
- Grainger valve – will be required to set the relief valve pressure
- Air line T - to attach the grainger valve in the pressure line
- Air hose – may be able to use the left over from last year's team along with the quick disconnects
- Fittings – NPT port blocker since we will only be applying pressure to one side of the piston at a time, we will need to block the other port

1.4.4.2. Shift Time

- N/A

1.4.4.3. Shift Torque w/o clutch actuation

- Torque Wrench Calibration machine – use to calibrate torque wrench
- ATV that will run

1.4.4.4. Shift Torque w/clutch actuation

- Torque Wrench Calibration machine – use to calibrate torque wrench
- Clutch
- ATV that will run

1.4.4.5. RPM vs. TPS

- N/A

1.4.4.6. Battery

- N/A

1.4.5. Phases of Testing

1.4.5.1. Component Testing

Electric Actuator:

- Test 1: Force Output
- Test 2: Shift Time

1.4.5.2. Subsystem

Ensure all parts fit together as designed and all individual parts have passed inspection.

1.4.5.3. Integration

Shift Torque

- Test 3: Shift Torque w/o Engine Cutout
- Test 4: Shift Torque w/ Engine Cutout

1.4.5.4. Reliability

Reliability will be an on going test determined through consistent device operation through testing and exposure to the elements.

1.4.5.5. Customer Acceptance

Upon completion of Senior Design II, the specifications and requirements of the customer have been met.

1.5. Definitions; Important Terminology; Key Words

1.5.1. Grainger Valve- adjustable ball spring relief valve

1.5.2. Electric Solenoid- refers to dual action (push/pull) cylinder that is activated with 12V power supply from ATV power system

1.6. References

1.6.1. Add here or remove as applicable.

2. MSD II WKS 2-4: - FINAL TEST PLAN

Introduction: A brief description that states the purpose of the team's testing needs.

*Note to Teams: The **Final Test Plan** is due in Week 5 of Senior Design 2 and details the specific methodologies to support both the overall systems specifications and detailed sub-system specifications. This portion of the test plan need to be revisited periodically to ensure your test strategy is in agreement with the team members and project mission.*

2.1. Data Collection Plan; Sampling Plan

2.1.1. Test Templates/ Tables/ File Locations

Tests (list or table): test # and name; test description

Traceability or verification matrix (table): specification # and brief description; system component embodying the spec (optional); test # (name optional if contained elsewhere); test date field (start/stop dates may be needed), pass/fail or test result field (verification); remarks or actions needed if test failed; signoff. Several specifications may utilize the same test routine, so duplicate entries should point to one entry which contains more detailed information.

EDGE team website structure (i.e. document names, file types, and header location).

2.1.2. Phases of Testing

2.1.2.1. Component

Add here or remove as applicable.

2.1.2.2. Subsystem

Add here or remove as applicable.

2.1.2.3. Integration

Add here or remove as applicable.

2.1.2.4. Reliability

Add here or remove as applicable.

2.1.2.5. Customer Acceptance

Add here or remove as applicable.

2.1.3. Sampling Techniques

2.1.4. Sample Size

2.1.5. Reporting Problems; Corrective Action

2.1.6. Add here or remove any other critical needs, as applicable.

2.2. Measurement Capability, Equipment

If there are measurement issues or techniques over and beyond RITs equipment, then either a, specific test devices test stands need to be designed for the purpose of testing or test waiver.

2.2.1. Add here.

2.3. Test Conditions, Setup Instructions

2.3.1. Add here or remove as applicable.

2.4. Sponsor/Customer, Site Related, Requests / Considerations

2.4.1. Add here or remove as applicable.

2.5. Test Procedure, Work Breakdown Structure, Schedule

Note to Team: Who is testing what? Why are you testing what you are testing? Are there interdependencies between subsystems (Block Diagram)? Can test equipment enable preliminary simulation of needed signals prior to integrating into the next level of completion?

2.5.1. Add here or remove as applicable.

2.6. Assumptions

List here including reasons why or remove as applicable.

2.6.1. Add here or remove as applicable.

3. MSD II – WKS 3-10 DESIGN TEST VERIFICATION

*Note to Teams: Populate the templates and test processes established in **Final Test Plan**.*

These elements can be integrated or rearranged to match project characteristics or personal/team preferences.

3.1. Test Results

3.1.1. Component

Add here or remove as applicable.

3.1.2. Subsystem

Add here or remove as applicable.

3.1.3. Integration

Add here or remove as applicable.

3.1.4. Reliability

Add here or remove as applicable.

3.1.5. Customer Acceptance

Add here or remove as applicable.

3.2. Logistics and Documentation

Where are the test results being performed, logged (i.e. project notebook) and documented (i.e. excel spreadsheet)? EDGE team website structure (i.e. document names, file types, and header location).

3.3. Definition of a Successful Test, Pass / Fail Criteria

3.4. Contingencies/ Mitigation for Preliminary or Insufficient Results

3.5. Analysis of Data – Design Summary

3.6. Conclusion or Design Summary

Can you explain why a particular function doesn't work? Add here or remove how the conclusions are to be reported or summarized (i.e. significance with confidence, pass/fail, etc.) as applicable.

3.7. Function/ Performance Reviews

Note: Some teams organize reviews on a weekly bases starting in week 4 or 5 and other may wish to wait until week 10 or 11. Discuss with your Guide.

3.7.1. Debriefing your Guide and Faculty Consultants

Share test results, conclusions, any follow-on recommendations, design summary.

3.7.2. Lab Demo with your Guide and Faculty Consultants

Perform each of the specifications and features.

3.7.3. Meeting with Sponsor

See Customer Acceptance above. Field Demonstration. Deliver the project. Demonstrate to the Sponsor. Customer needs met / not met.

3.8. References

Add here or remove as applicable.

3.8.1. Add here or remove as applicable.

3.9. Appendices

Add or remove as applicable.

3.9.1. Add here or remove as applicable.