
NATIONAL TRANSPORTATION SAFETY BOARD

Office of Research and Engineering
Materials Laboratory Division
Washington, D.C. 20594



November 30, 2016

MATERIALS LABORATORY FACTUAL REPORT

Report No. 16-113

A. ACCIDENT INFORMATION

Place : Orlando, FL
Date : November 20, 2015
Vehicle : N7FG, Beech A36TC
NTSB No. : ERA16FA043
Investigator : Timothy Monville

B. COMPONENTS EXAMINED

Manual pitch trim switch.

C. DETAILS OF THE EXAMINATION

The autopilot trim switch was submitted to the Materials Laboratory for examination to determine its as-received electrical position and for disassembly. The switch part number (P/N) is 300-01902-0000 (obtained from Honeywell drawing and Honeywell PARTS LIST (PL) # PL200-01902-0000, dated 02/03/2016, Revision AD). The revision number of the switch is R.10 (as found on a tag on the side of the switch). The serial number (S/N) of the switch could not be determined.

The top view of the as-received switch in figure 1 indicates the respective rockers as well as the as-received position of the small rocker. The small rocker was found to be stuck or jammed down towards the 'TRIM UP' position as shown in figure 1. In addition to the small rocker position and the significant impact mark on the large rocker (see figure 1), cracks were observed and documented at several locations around the sides of the housing. A schematic of the switch assembly is shown in figure 2.

Other pre-disassembly observations include:

- The large rocker was found in what appeared to be a neutral position and when light finger pressure was applied, the rocker exhibited sloppy and loose fore and aft rotational movement without any apparent switch activation and there was no centering force that would move the rocker to the neutral position when light finger pressure was removed. No side-to-side movement was observed on either rocker.

- The three micro-switches appeared to be working properly as audible clicking sounds were heard when the rockers engaged with their respective plungers. Conductivity testing confirmed that the micro-switches were operational.

Upon disassembly, impact marks were found on the bottom outboard sides of both rockers where they meet their respective aft stop plates. The impact locations are indicated by yellow arrows in figure 3. Both stop plates were also deformed at their aft positions indicated by the white arrows in figure 4. The stop plate associated with the large rocker appeared to be bent inward while the small rocker plate sustained more damage.

Figure 5 is an upside down view of the switch prior to removing the small rocker. This image shows the small rocker-controlled actuator plate pressed against the micro-switch plunger. After removing the small rocker, the wire spring guiding the rocker was found to be positioned over and depressing the switch actuator plate as can be seen in figure 4. Figure 6 shows the bowed small rocker-controlled actuator plate while figure 7 is a closer view focused on the bent middle actuator plate. The straight lines in these two images were added as references to indicate their respective deformation.

Prior to and after disassembly, electrical conductivity was measured using a digital multimeter at each micro-switch wire connection as listed in tables 1 - 4. All micro-switch wires were firmly attached (soldered) to their respective poles as shown in figure 8. Figure 9 is a wiring schematic of the three micro-switches. The as-received switch electrical testing results are listed in table 1 while tables 2 and 3 list test results when the large rocker was rotated to the trim-up and trim-down positions respectively. With the micro-switches removed (all three as a group) from the switch assembly housing, the position of each micro-switch (S101, S102, & S103) was determined by measuring and recording the continuity between all of the wires coming out of the switch. These test results are listed in table 4.

Based on the results, the micro-switch (commanded by the small rocker) was commanding a trim-up position and both micro-switches (commanded by the large rocker) were in their "normally closed" position therefore, the switch would not be commanding either a trim-up or trim-down change.

Edward Komarnicki
Engineering Technician
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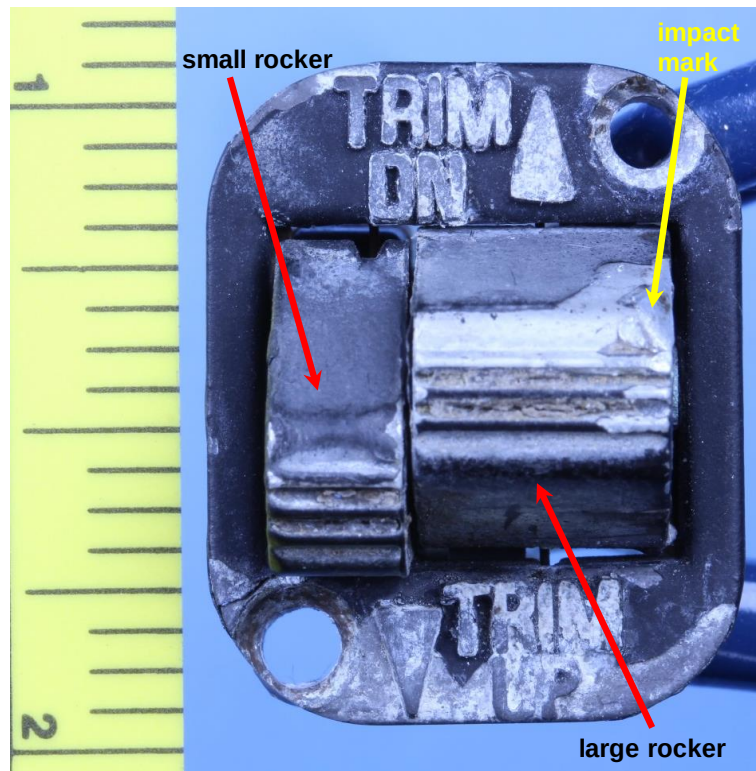


Figure 1. Top view of as-received autopilot trim switch.

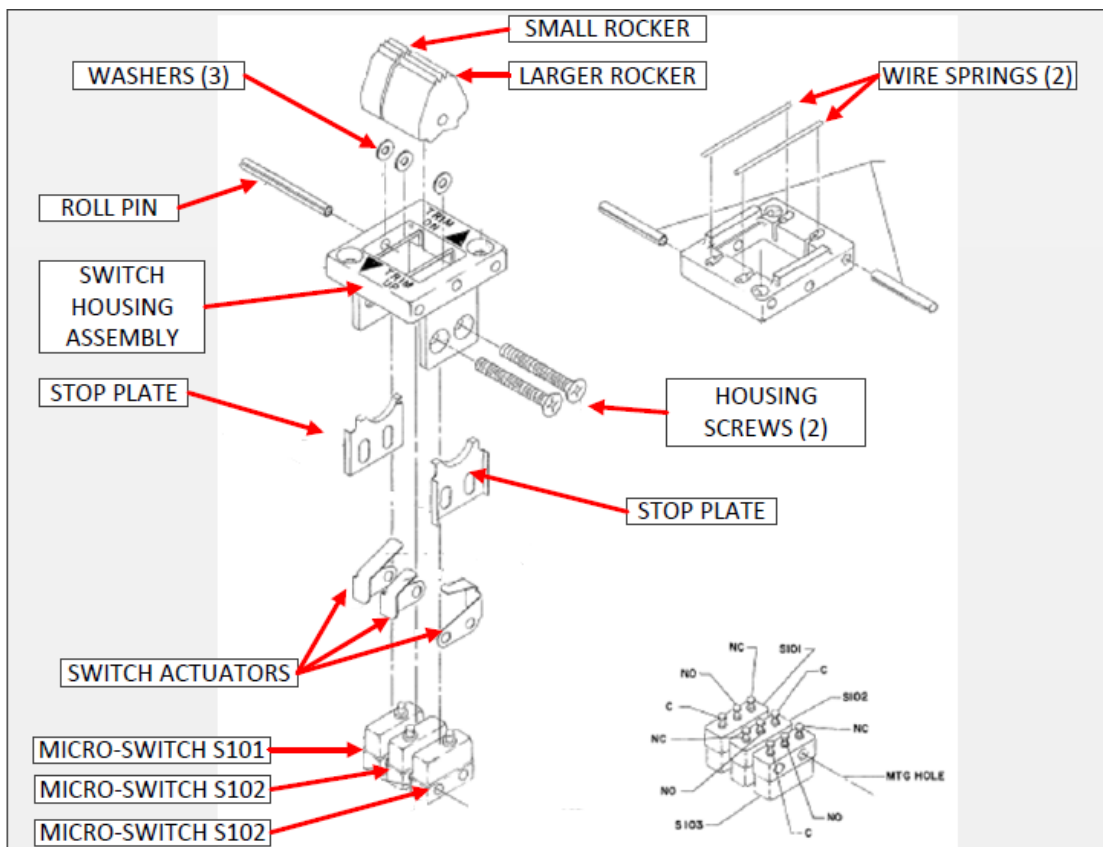


Figure 2. Schematic of switch assembly. Labels and arrows are for clarification purposes only.

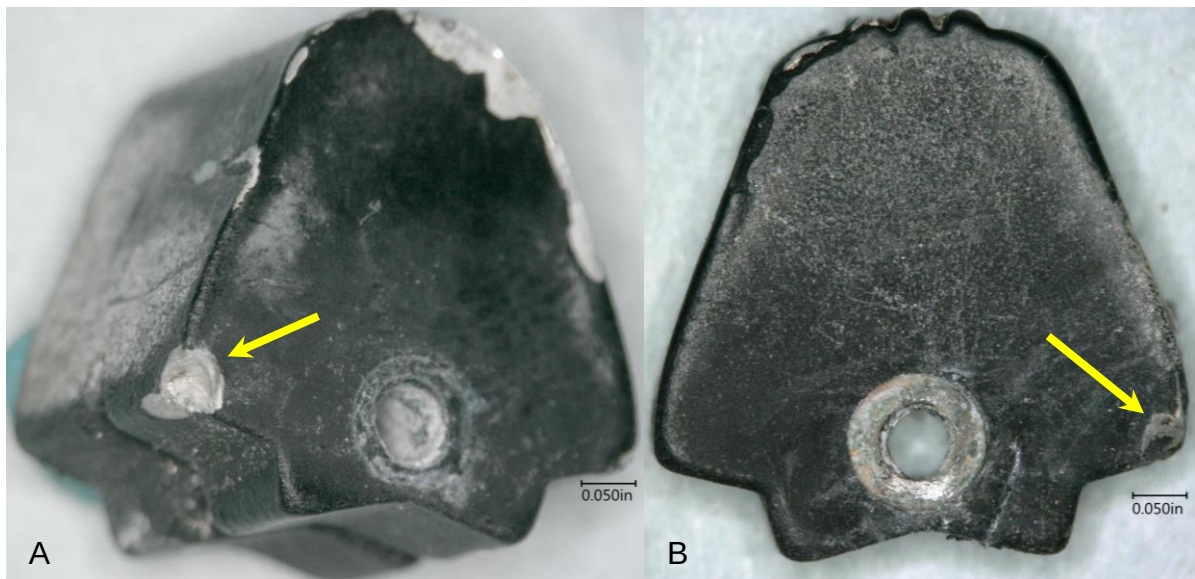


Figure 3. Images shows the outboard sides of the large (A) and small (B) rockers where the yellow arrows point to impact damage on both rockers' aft positions.

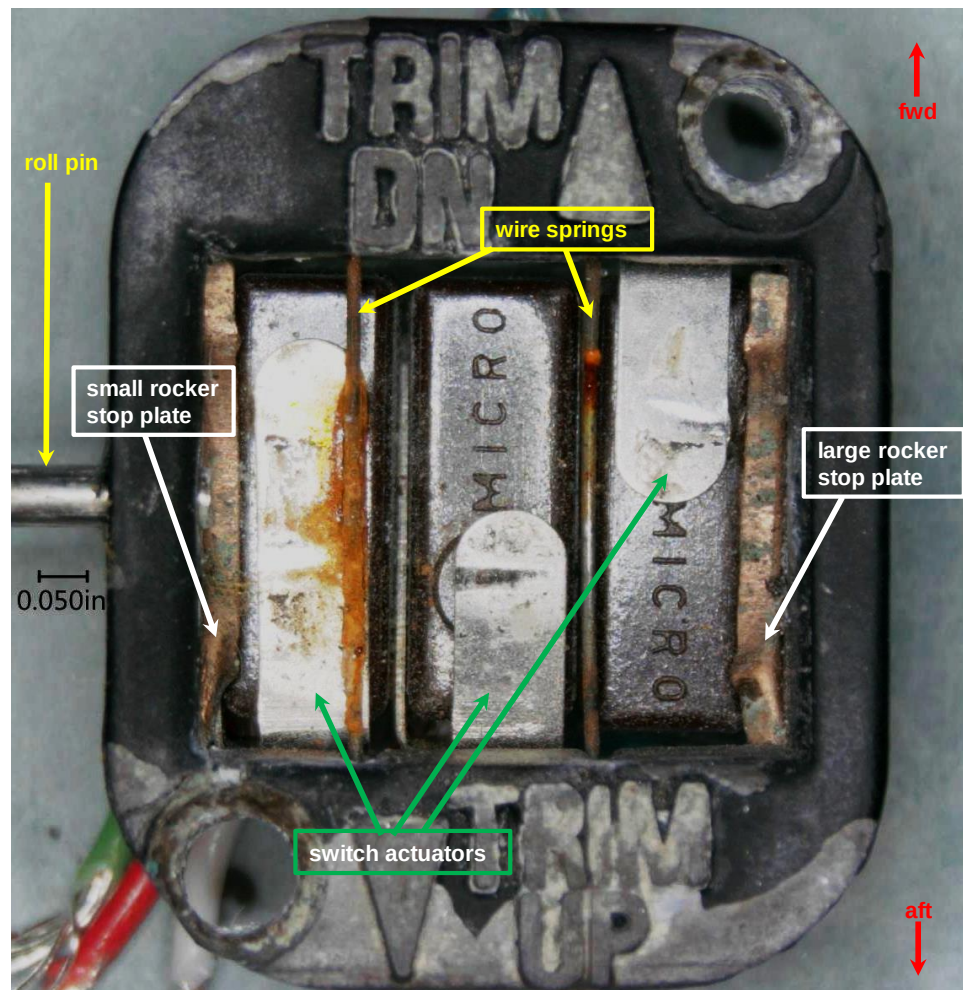


Figure 4. The partially disassembled switch with rockers removed.

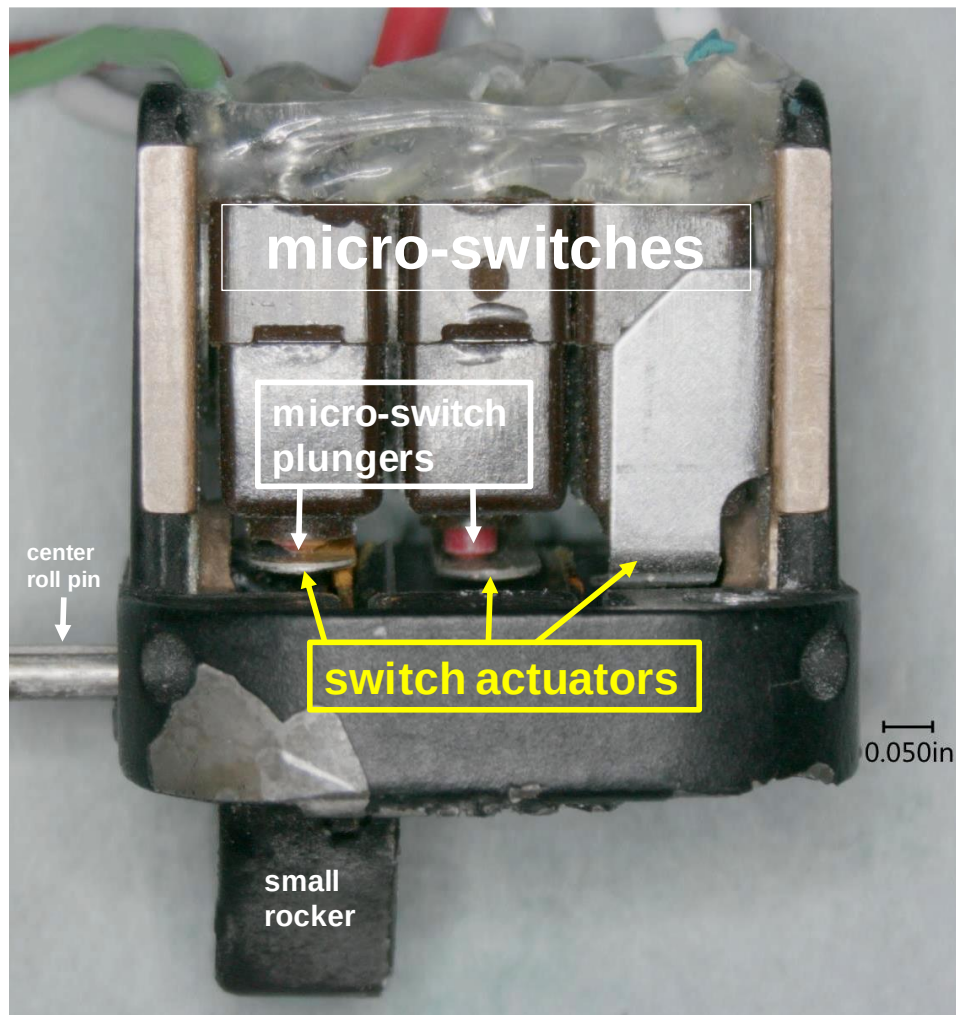


Figure 5. View showing small rocker plunger depressed.

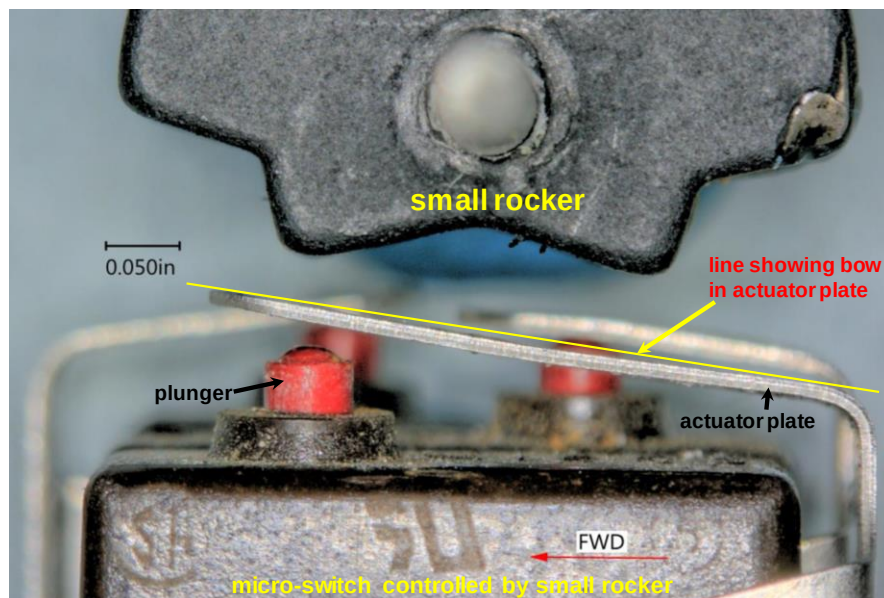


Figure 6. Showing bow in small rocker-controlled actuator plate.

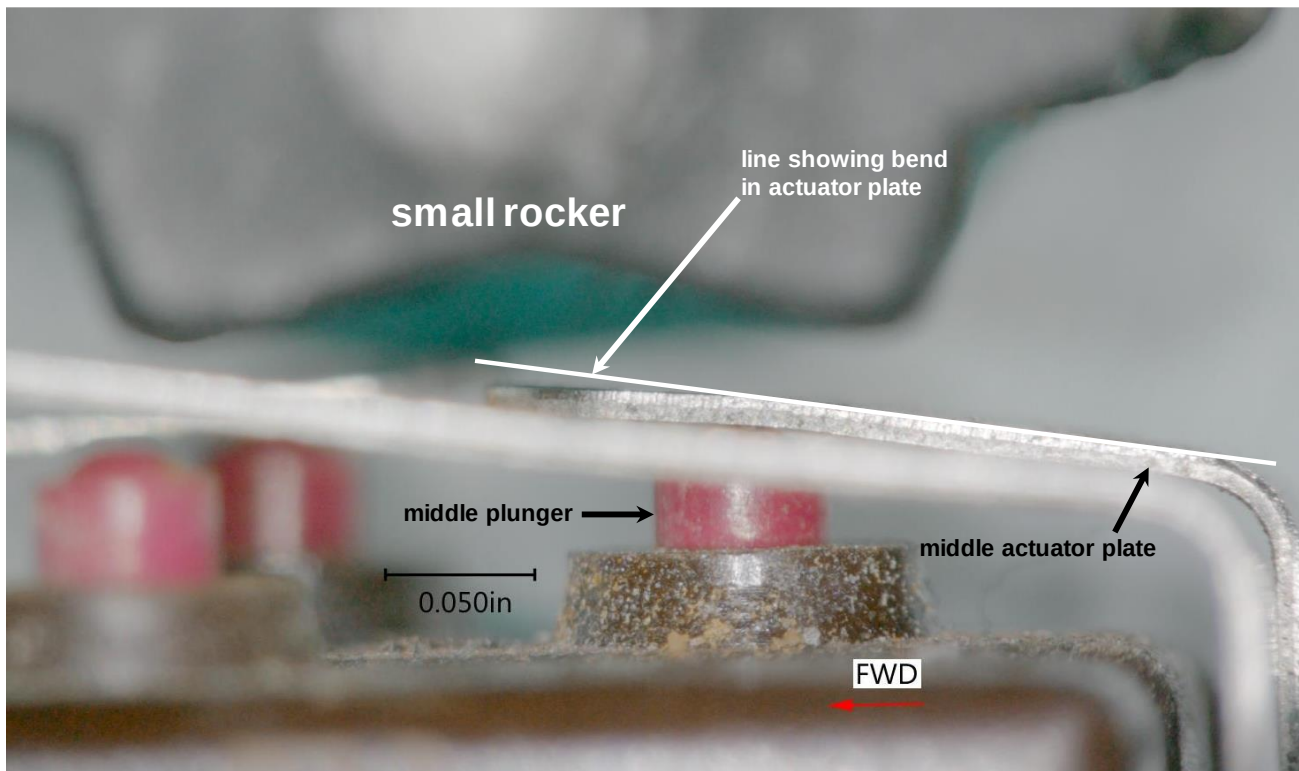


Figure 7. Showing bend at tip of middle actuator plate.

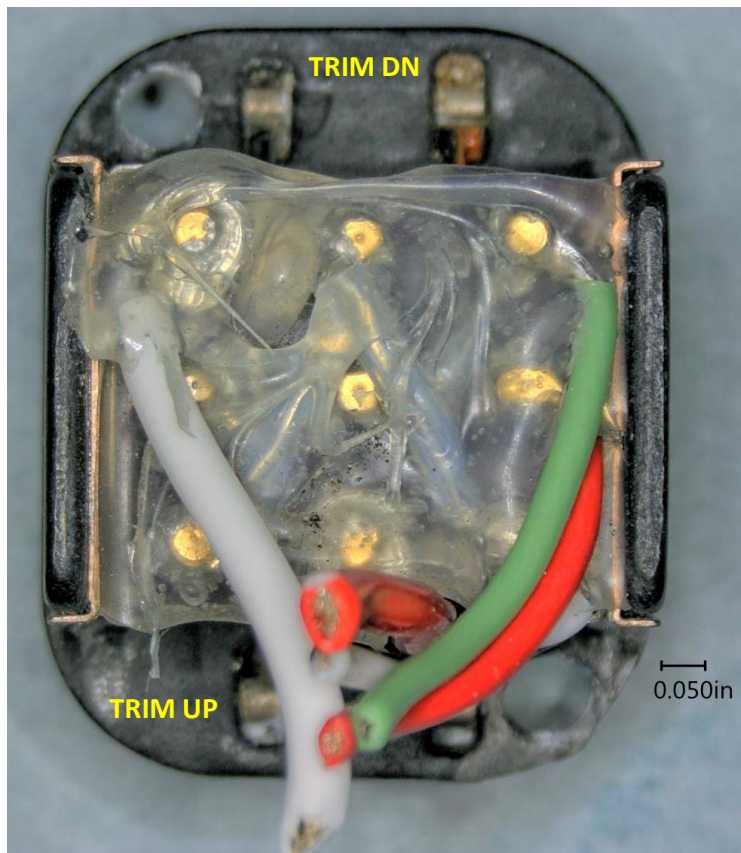


Figure 8. Bottom view showing electrical wire connections to micro-switches.

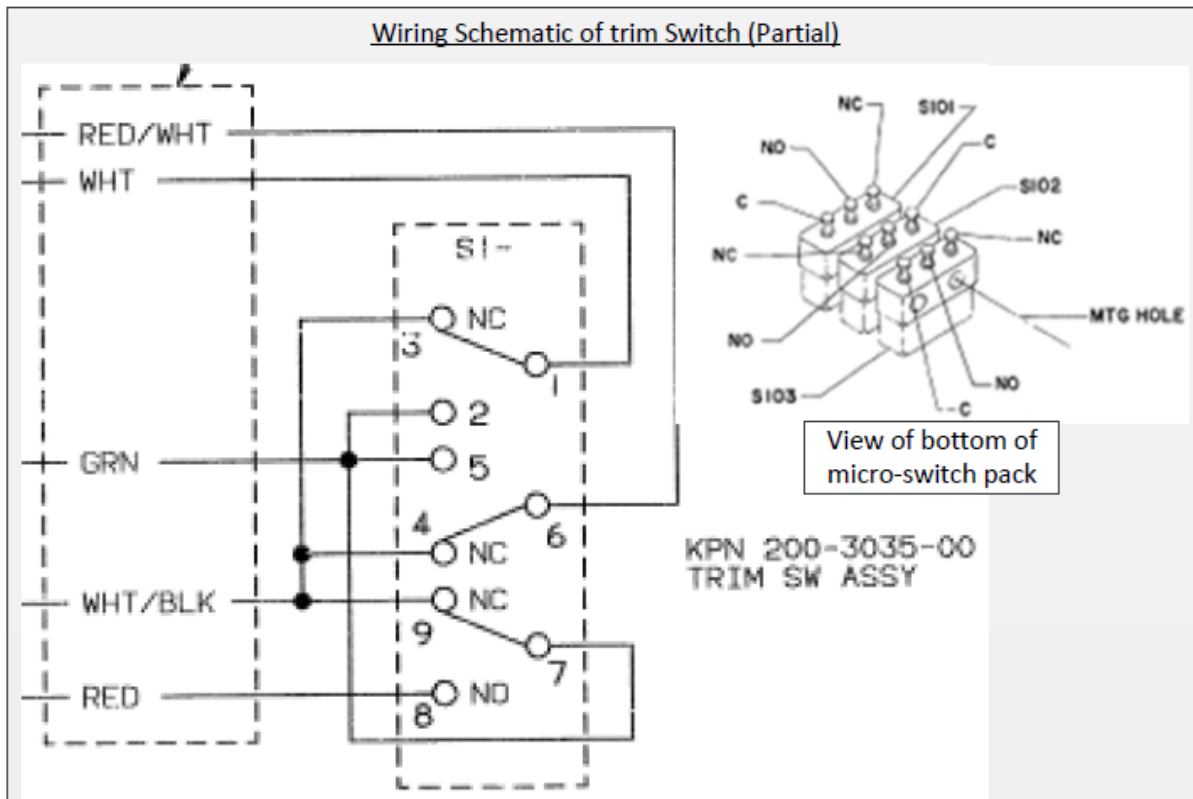


Figure 9. Switch wiring schematic.

Switch Description	Position Measured	Test Results (Ohms)
As received switch with large rocker in neutral position and small rocker stuck in 'TRIM-UP' position.	red to (black & white)	open
	red to (red & white)	open
	red to white	open
	red to green	closed (continuity)
	green to red	closed (continuity)
	green to (black & white)	open
	green to (red & white)	open
	green to white	open
	(black & white) to green	open
	(black & white) to red	open
	(black & white) to (red & white)	closed (continuity)
	(black & white) to white	closed (continuity)
	(red & white) to green	open
	(red & white) to red	open
	(red & white) to (black & white)	closed (continuity)
	(red & white) to white	closed (continuity)
	white to green	open
	white to red	open
	white to (black & white)	closed (continuity)
	white to (red & white)	closed (continuity)

Table 1. As-received electrical continuity testing.

Switch Description	Position Measured	Test Results (Ohms)
With light finger pressure, the large rocker was moved downward to its 'TRIM UP' position.	red to (black & white)	open
	red to (red & white)	closed (continuity)
	red to white	open
	red to green	closed (continuity)
	green to red	closed (continuity)
	green to (black & white)	open
	green to (red & white)	closed (continuity)
	green to white	open
	(black & white) to green	open
	(black & white) to red	open
	(black & white) to (red & white)	open
	(black & white) to white	closed (continuity)
	(red & white) to green	closed (continuity)
	(red & white) to red	closed (continuity)
	(red & white) to (black & white)	open
	(red & white) to white	open
	white to green	open
	white to red	open
	white to (black & white)	closed (continuity)
	white to (red & white)	open

Table 2. Large Rocker in trim-up position electrical continuity testing.

Switch Description	Position Measured	Test Results (Ohms)
With light finger pressure, the large rocker was moved upward to its 'TRIM DN' position.	red to (black white)	open
	red to (red & white)	open
	red to white	closed (continuity)
	red to green	closed (continuity)
	green to red	closed (continuity)
	green to (black white)	open
	green to (red & white)	open
	green to white	closed (continuity)
	(black &white) to green	open
	(black &white) to red	open
	(black &white) to (red & white)	closed (continuity)
	(black &white) to white	open
	(red & white) to green	open
	(red & white) to red	open
	(red & white) to (black & white)	closed (continuity)
	(red & white) to white	open
	white to green	closed (continuity)
	white to red	closed (continuity)
	white to (black & white)	open
	white to (red & white)	open

Table 3. Large Rocker in trim-down position electrical continuity testing.

Switch Description	Position Measured	Test Results (Ohms)
Micro-switch assembly removed from housing.	red to (black & white)	open
	red to (red & white)	open
	red to (white)	open
	red to (green)	open
	green to (red)	open
	green to (black & white)	closed (continuity)
	green to (red & white)	closed (continuity)
	green to white	closed (continuity)
	(black & white) to green	closed (continuity)
	(black & white) to red	open
	(black & white) to (red & white)	closed (continuity)
	(black & white) to white	closed (continuity)
	(red & white) to green	closed (continuity)
	(red & white) to red	open
	(red & white) to (black & white)	closed (continuity)
	(red & white) to white	closed (continuity)
	white to green	closed (continuity)
	white to red	open
	white to (black & white)	closed (continuity)
	white to (red & white)	closed (continuity)

Table 4. Electrical continuity testing with micro-switch assembly removed from housing.