SAE The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

SURFACE VEHICLE RECOMMENDED PRACTICE

An American National Standard

SAE J1843

REV. APR93

Issued 1989-06
Revised 1993-04

Superseding J1843 JUN89

(R) ACCELERATOR PEDAL POSITION SENSOR FOR USE WITH ELECTRONIC CONTROLS IN MEDIUM—AND HEAVY-DUTY VEHICLE APPLICATIONS

Foreword—Many electronic controls used in medium- and heavy-duty vehicles require an electrical indication of accelerator pedal position. A common accelerator pedal position sensor function and performance criterion is desired to minimize the number of different designs that would have to be stocked by those who service the many different types and brands of vehicles. A single universal electrical interface has not been defined. Two electrical interface types are defined in this SAE Recommended Practice. The intent of providing a choice of two signal types is to allow the industry time to prove by actual application the best selection.

While a common mechanical definition of the size, shape, etc., of the accelerator pedal and accelerator position sensor is desirable, it is realized that vehicles are not designed around the accelerator pedal. The present variations in vehicle configurations and design requirements cannot be satisfied by a single mechanical interface specification for the accelerator pedal. The intent of this specification is to limit sensor variations to one physical mounting interface and one of two electrical signal types.

The specification to outline portions of the physical interface between an accelerator pedal and the accelerator pedal position sensor should serve two purposes. First, it will minimize the number of base mechanical pedals required to mount the appropriate sensor(s) for different applications. Second, this specification would encourage the use of the sensors with the same mechanical interface for floor-mounted, suspended, and remote accelerator applications. For the remainder of this document, the term "pedal" can be construed to mean any physical means of converting operator motion into an acceleration or deceleration command.

1. Scope—The purpose of this SAE Recommended Practice is to provide a common electrical and mechanical interface specification that can be used to design electronic accelerator pedal position sensors and electronic control systems for use in medium—and heavy-duty vehicle applications.

2. References

2.1 Applicable Publication—The following publication forms a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATION—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J1455—Joint SAE/TMC Recommended Environmental Practices for Electronic Equipment Design (Heavy-Duty Trucks)

2.1.2 The APS assembly shall comply with all appropriate Federal Motor Vehicle Safety Standards.

3. *Definitions*

3.1 **Accelerator Position Sensor (APS)—**The sensor portion of the physical device used to convert the accelerator position into an electrical signal.

3.2 **Diagnostic Ranges—**The ranges of APS outputs between the maximum allowable output span during normal operation and the APS output values specified as an indication of an absolute fault condition. APS outputs in the diagnostic ranges may be used by the controller(s) as an out-of-range indication, but do not necessarily indicate an absolute fault.

3.3 **Duty Cycle—**The ratio of signal time high to signal period (see Figure 1).

3.4 **Electrical Interface—**The electrical signals to be passed from the APS to other electronic/electrical devices.

3.5 **Fault Ranges—**The ranges of the APS output values beyond the diagnostic range(s) that indicate an absolute fault condition in the accelerator pedal assembly.

3.6 **Full Scale—**The difference between the theoretical maximum and minimum signal outputs (i.e., 100% of analog supply voltage or 100% duty cycle).

3.7 **Mechanical Interface—**The physical boundaries of the APS.

3.8 **Output Hysteresis—**The maximum output signal difference for a given input pedal position due to previous history of pedal motion in either the increasing or decreasing direction.

3.9 **Output Linearity—**The maximum deviation of the actual output transfer function from a straight line defined by the best fit linear regression straight line through the actual values (see Figure 2).

3.10 **Output Smoothness—**Any spurious variation in the output not present in the input is measured as the difference between the actual output transfer function and the end points of a 2.0% of total pedal travel long line parallel to the output linearity function that passes through the actual output value for any APS position. The difference between the actual output values and the parallel line end points located ± 1.0% of total travel from the APS position should be less than the output smoothness specification (see Figure 3).

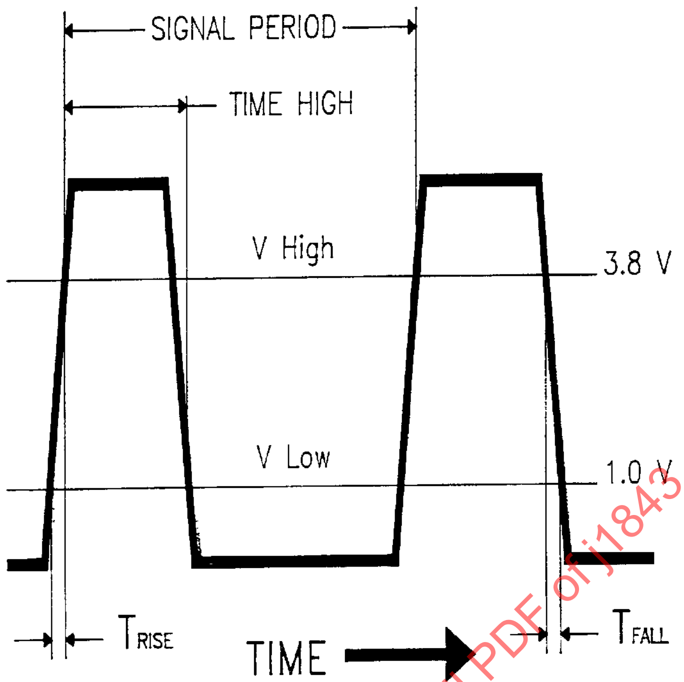
3.11 **Pulse Width Modulated (PWM)—**A system of modulation where the duty cycle of discrete pulses are varied by controlling the leading, trailing, or both edges to represent an output signal where the duty cycle of the pulse is proportional to the value represented.

3.12 **Sensing Element—**The portion of, or discrete device contained within, the APS that converts physical motion into a usable electrical signal.

3.13 **Supply Voltage—**The voltage measured between the +V supply and –V supply leads with the APS device connected.

3.14 **Treadle—**The lever operated by the foot.

3.15 **Idle Validation Signal (IVS)—**A signal generated by the accelerator pedal assembly to indicate that the assembly is in the idle position.



$$\text{DUTY CYCLE (\%)} = \frac{\text{TIME HIGH}}{\text{SIGNAL PERIOD}} \times 100$$

OUTPUT FREQUENCY = 1 / SIGNAL PERIOD

$T_{RISE} \leq 5$ microseconds

$T_{FALL} \leq 5$ microseconds

FIGURE 1—PULSE WIDTH MODULATED SIGNAL WAVEFORM

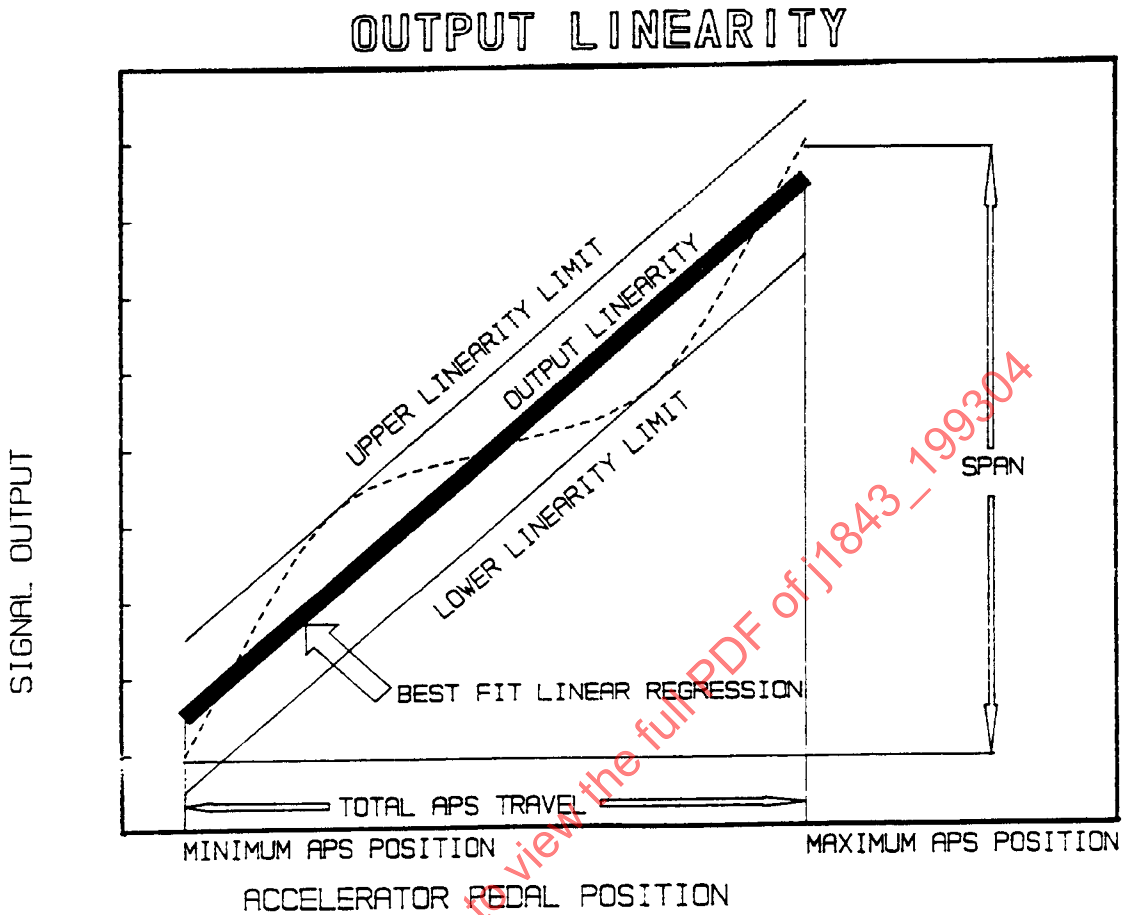


FIGURE 2—OUTPUT LINEARITY DEFINITION

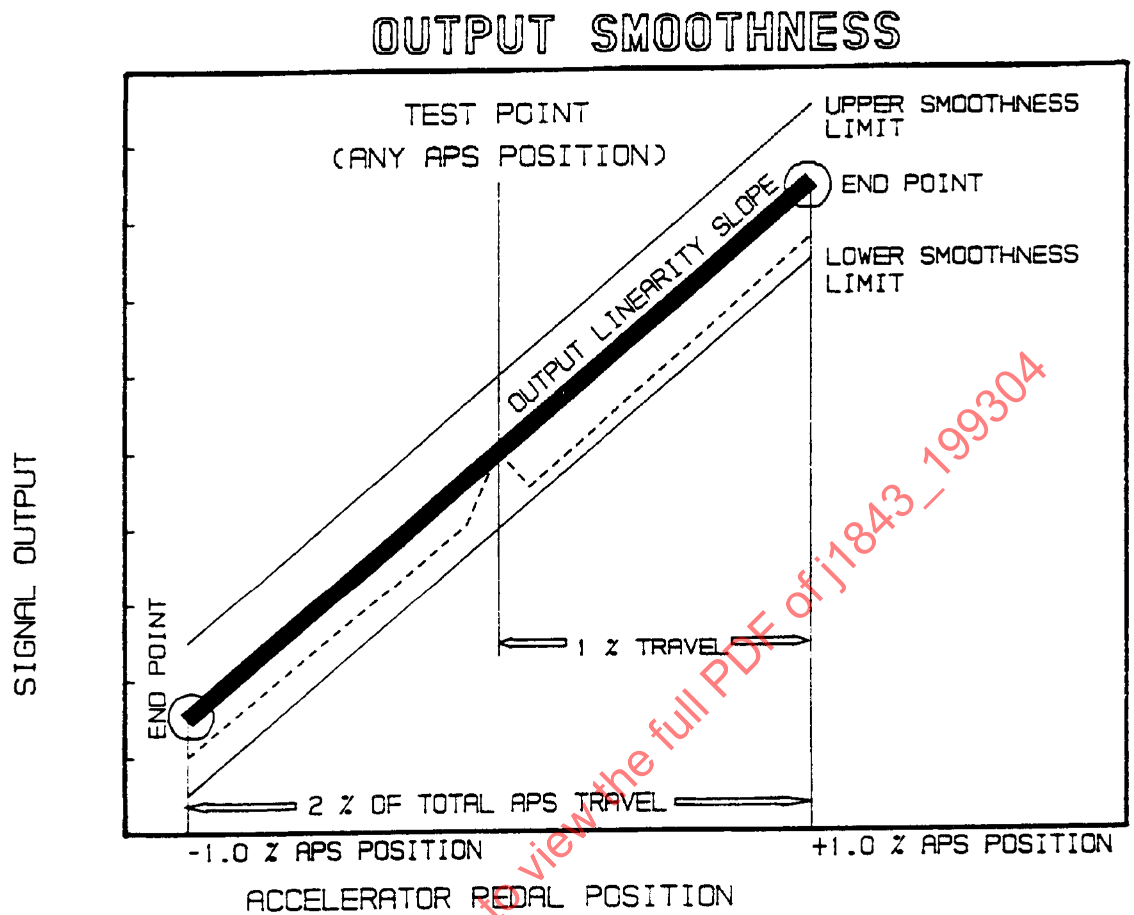


FIGURE 3—OUTPUT SMOOTHNESS DEFINITION

3.16 Transmission Shift Point Transition Signal—The electrical signal used by an automatic transmission to provide early shift points at low throttle and higher shift points at increased throttle positions.

3.17 Kick Down Signal—The electrical signal used by an automatic transmission to raise the shift points to provide maximum performance at full throttle.

4. Mechanical Interface—The following specifications are for an accelerator pedal to accelerator position sensor interface. It is intended to allow the design of sensors that are interchangeable for different electronic applications. The driveshaft configuration and APS mounting pattern are the critical areas for commonality.

Figure 4 outlines the mounting pattern and driveshaft orientation.

Figure 5 outlines the APS mechanical interface in the area around the APS driveshaft. Figure 5 is a view from section A-A of Figure 4.

Overall drift of the minimum accelerator pedal position driveshaft to be ±3 degrees over the operating life of the accelerator pedal.

Overall drift of the maximum accelerator pedal position driveshaft to be ±3 degrees over the operating life of the accelerator pedal.

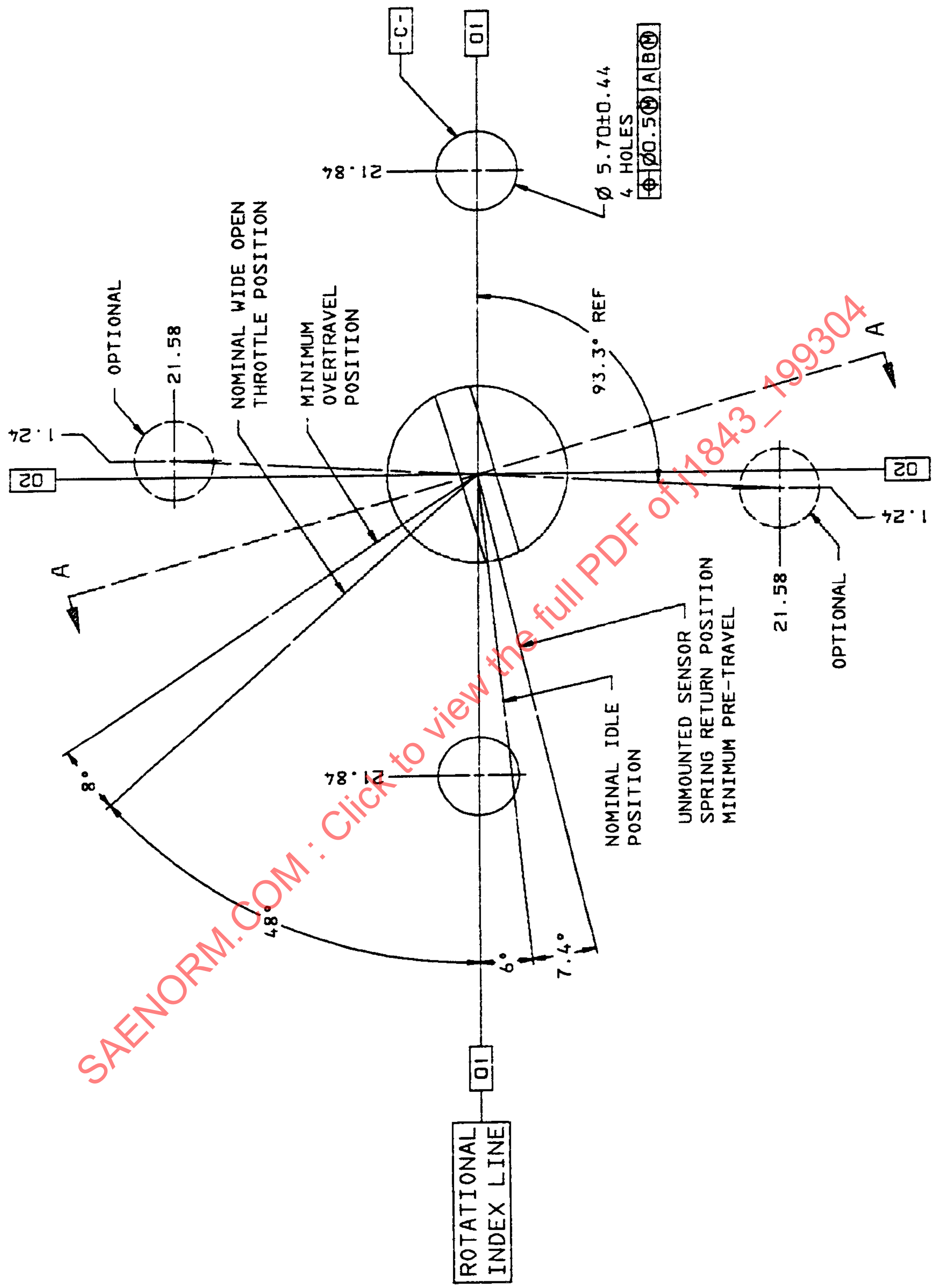


FIGURE 4—APS MOUNTING SPECIFICATIONS SENSOR MOUNTING HOLE PATTERN AND ANGULAR ROTATION REQUIREMENTS

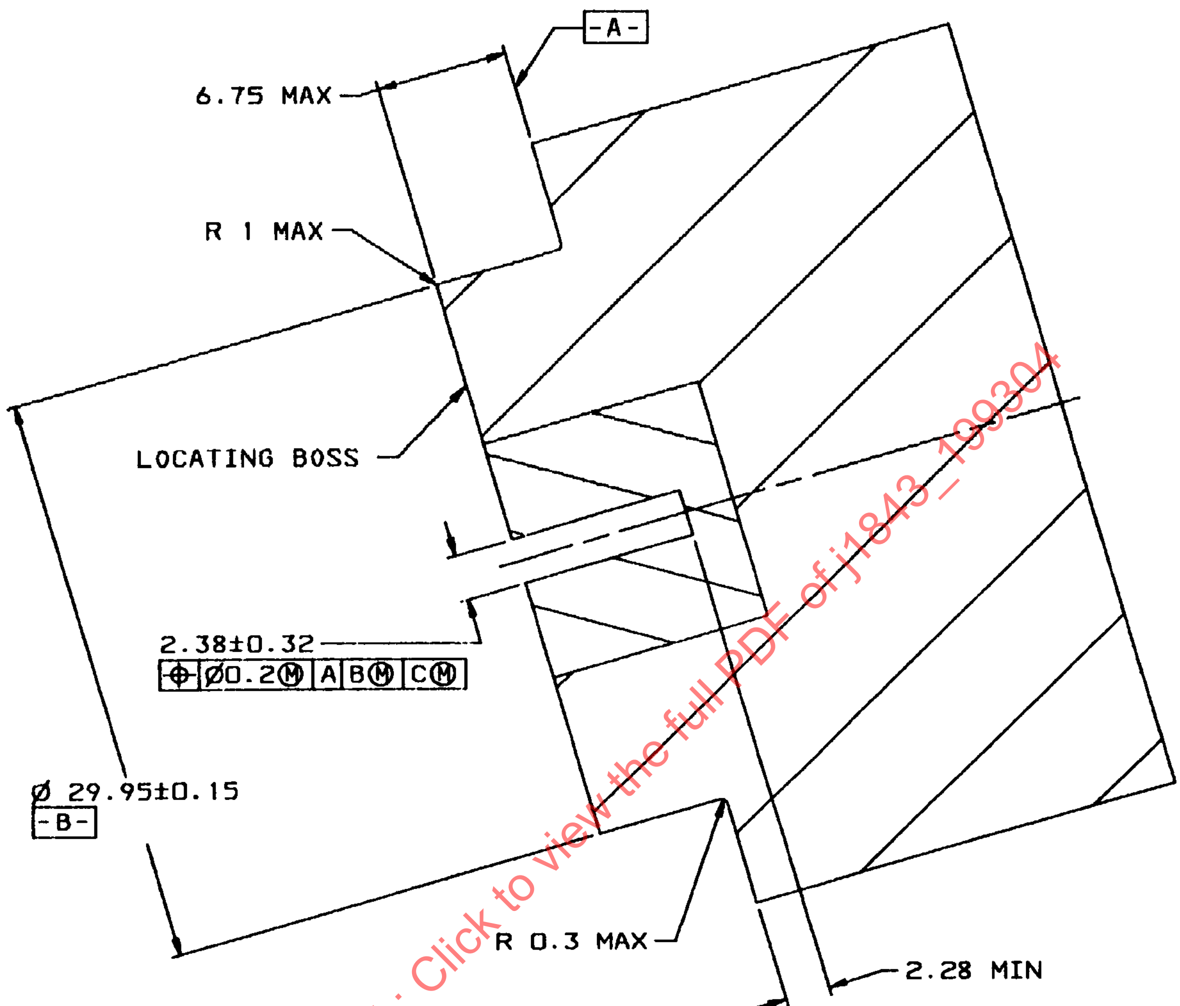


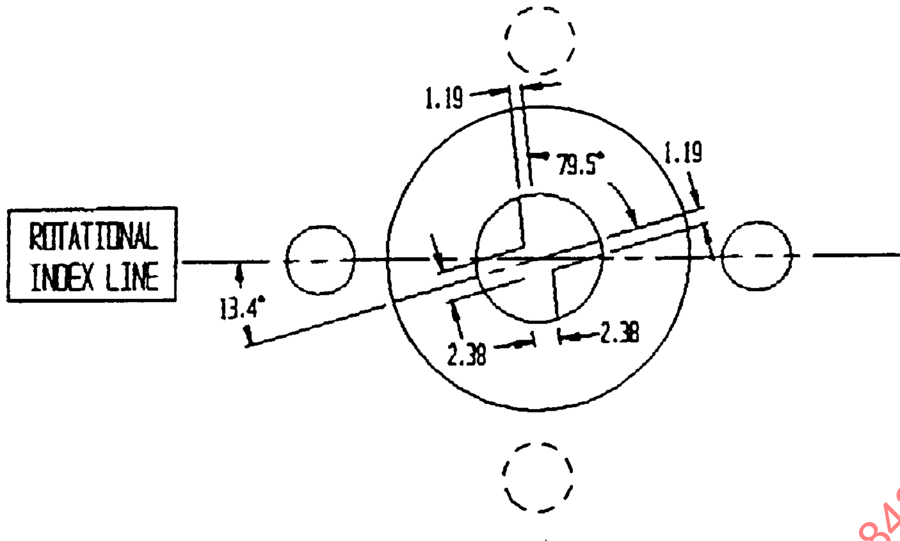
FIGURE 5—APS MOUNTING SPECIFICATIONS SECTION A-A

Due to variations in actual pedal designs and applications, sources of auxiliary signals, as defined in Section 8, may utilize, but are not required to utilize, this APS-to-pedal mechanical interface.

If the APS has an optional cutaway driveshaft receptacle as illustrated in Figure 6, then the APS must not contain an integral IVS. In this case, if the IVS is required, it must be located and operated independently of the APS.

The APS shall contain an internal source of energy capable of returning the internal portions of the APS to the end of travel nearest the idle state. It is not intended that the APS be capable of returning the entire accelerator pedal assembly to an idle condition. The accelerator pedal assembly is expected to accomplish return of the treadle through other sources of energy.

5. ***Electrical Interface***—Any one electrical output signal of the accelerator pedal assembly is intended to be used by only one recipient device (i.e., electronic engine control only, or electronic transmission control only). If multiple devices require a reliable signal from the APS, then some manner of isolation and buffering of the APS signal should be provided to each device, to prevent the loss of the APS signal if a fault occurred in only one subsystem.



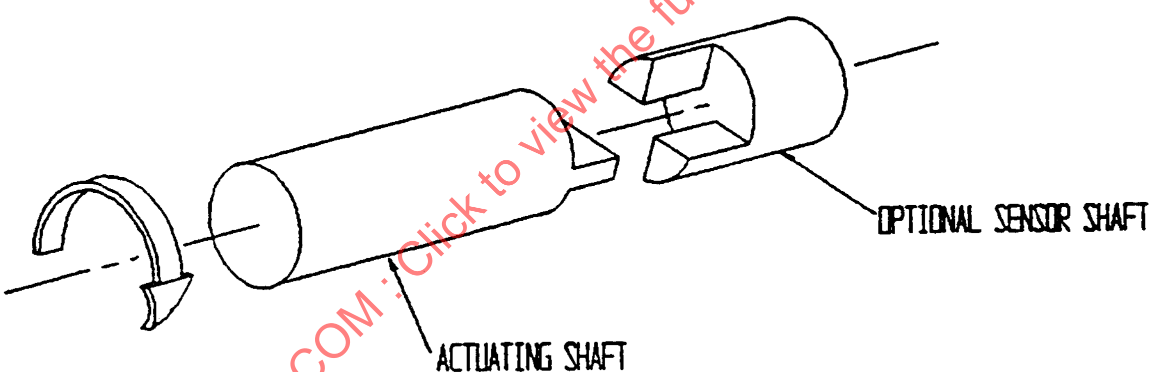


FIGURE 6—OPTIONAL SENSOR CUTOUT

Two optional electrical interfaces are defined. Either Option A, an analog ratiometric signal or Option B, a pulse width modulated (PWM) electronic interface can be used. The two options are presented and both are presently used in the industry today. An APS is not expected to provide both Option A and Option B output signals, nor is the recipient device expected to be compatible with both.

6. ***Analog Ratiometric Electronic Interface (Option A)***—The following specifications shall apply when an analog ratiometric electronic interface is used in the APS.

6.1 Supply Voltage—5.0 V DC ± 0.50 V DC

6.2 Supply Current—20 mA maximum

6.3 Output Range—See Figure 7.

a. Span = 67.5% ± 7.5% of supply voltage
b. Minimum APS Position = 15% ± 5% of supply voltage
c. Maximum APS Position = 77.5% ± 7.5% of supply voltage

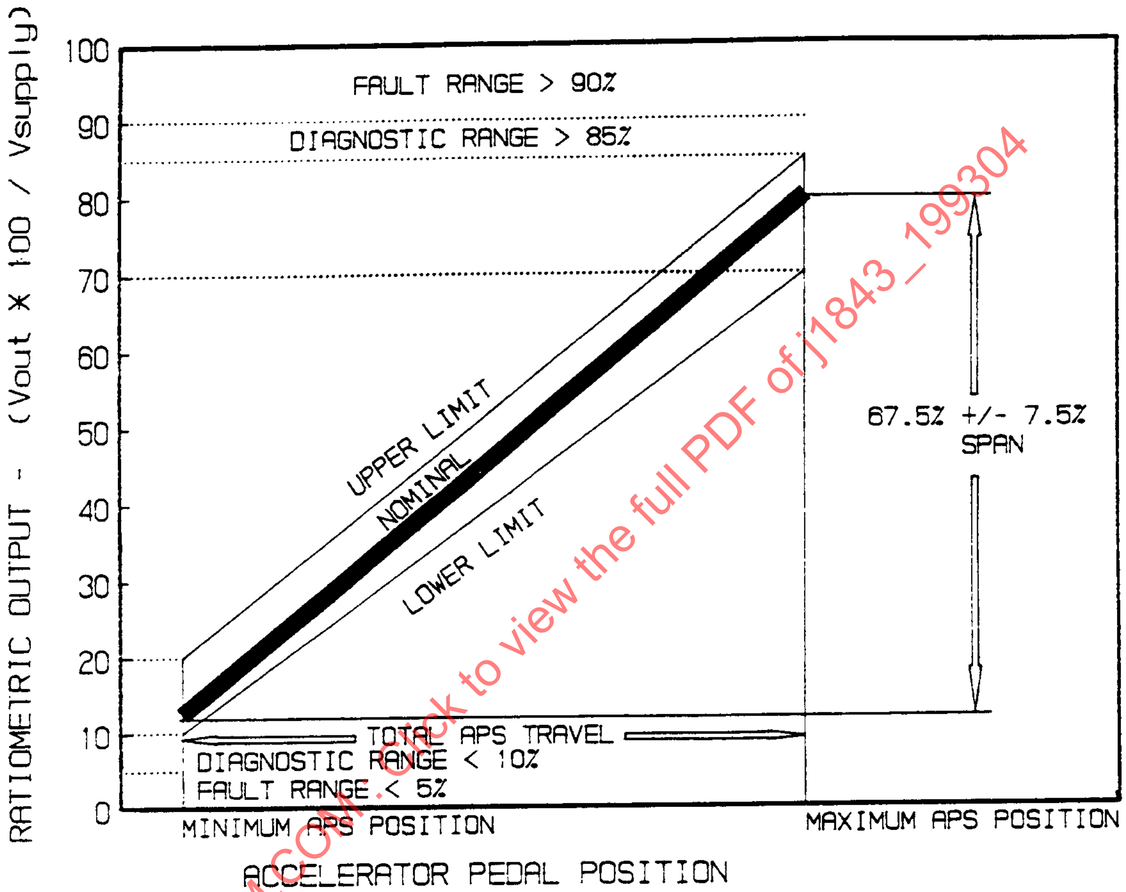


FIGURE 7—ANALOG RATIOMETRIC OUTPUT TRANSFER FUNCTION

6.4 Diagnostic Range—See Figure 7.

a. Lower Range = Less than 10% of supply voltage
b. Upper Range = Greater than 85% of supply voltage

6.5 Fault Range—See Figure 7.

a. Lower Range = Less than 5% of supply voltage
b. Upper Range = Greater than 90% of supply voltage

6.6 Output Smoothness—0.5% of full scale output for any 2% interval of total travel over the output range (See Figure 3).

6.7 Output Linearity—±5% of full scale output over the output range.

6.8 Output Current—The output transfer function defined in Figure 7 is to be valid under an electrical test load of 47 kΩ ± 5%. (See Figure 8).

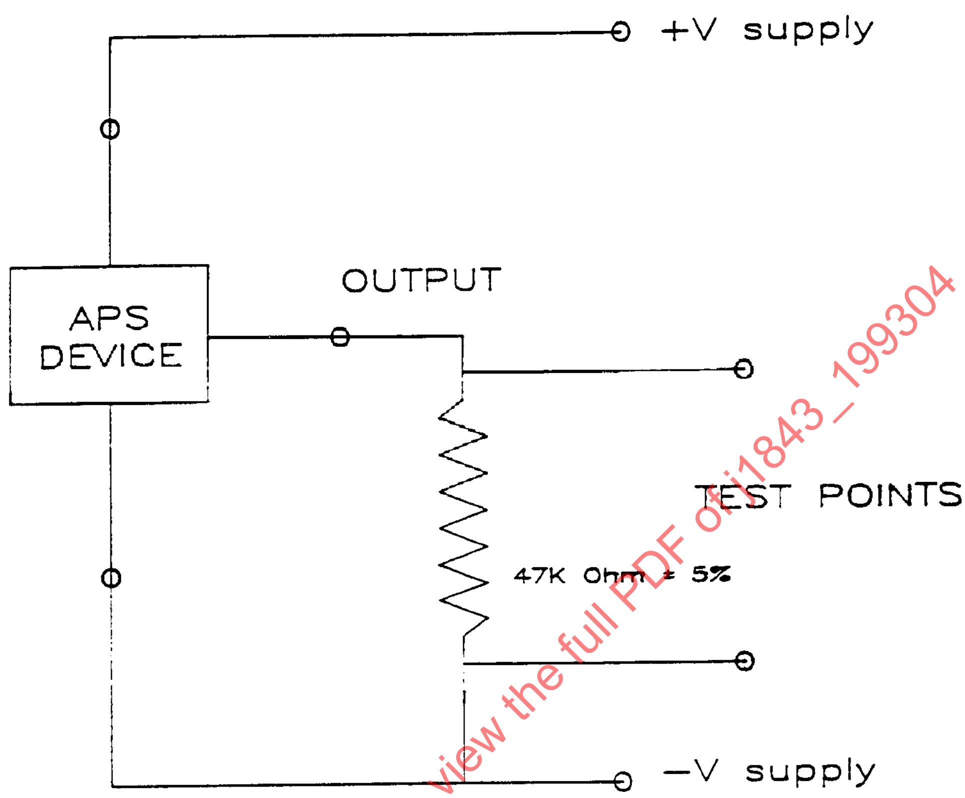


FIGURE 8—RATIOMETRIC APS OUTPUT TEST CIRCUIT

6.9 Output Hysteresis—The sensing device must not exhibit output hysteresis greater than 2% of full scale output when measured at mid-travel. Output hysteresis is measured at the direct mechanical input to the accelerator pedal position sensing element. Hysteresis of the linkages between the treadle and the sensing element of the APS is not included.

6.10 Open Circuit Response—An open circuit of any lead to the APS shall result in a signal as measured across the test points (47 kΩ ± 5% test lead as per Figure 8) within a specified fault range as shown in Figure 7 and within a maximum time of 1.0 s. The signal shall transit from a specified fault range signal to the correct reading at any APS position in less than 0.1 s (signal slew rate only) upon return to a normal operation.

6.11 Short Circuit Response—A short circuit between any two leads of the APS shall result in a signal as measured across the test points (47 kΩ ± 5% load as per Figure 8) within a specified fault range as shown in Figure 7 and within a maximum time of 1.0 s. The signal shall transit from a specified fault range signal to the correct reading at any APS position in less than 0.1 s (signal slew rate only) upon return to a normal operation.

7. Pulse Width Modulated (PWM) Electronic Interface (Option B)—The following specifications shall apply when a pulse width modulated electronic interface, Figure 1, is used in the APS.

7.1 Supply Voltage—Positive battery voltage, 12 V DC or 24 V DC nominal, regulated 8 V DC ± 0.4 V DC, or regulated 5 V DC ± 0.25 V DC.

7.2 Supply Current—100 V DC maximum.

7.3 Output Range—See Figure 9.

a. Minimum APS Position = 6% duty cycle
b. Maximum APS Position = 94% duty cycle
c. Minimum Accelerator Assembly Position = 16% ± 6% duty cycle
d. Maximum Accelerator Assembly Position = 82.5% ± 7.5% duty cycle

7.4 Fault Range—See Figure 9.

a. Lower Range = Less than 5% duty cycle
b. Upper Range = Greater than 95% duty cycle

7.5 Output Smoothness—0.5% of full scale output for any 2% interval of total travel over the output range (See Figure 3).

7.6 Output Linearity—±5% of full scale output over the output range.

7.7 Output Frequency

a. Minimum = 200 Hz
b. Maximum = 1100 Hz

7.8 Output Current—The output transfer function as defined in Figure 9 is to be valid under an electrical test load impedance of 47 kΩ ± 5% and 0.001 µF capacitance. Figure 10 for test schematic. The output voltage across the test points high shall be greater than 3.8 V while sourcing a minimum 8.0 mA current. The output voltage low shall be less than 1.0 V while sinking a maximum 10 mA current.

7.9 Output Waveform—The pulse width modulated signal shall have the wave shape shown in Figure 1 while connected to the electrical test load impedance as shown in Figure 10.

7.10 Output Hysteresis—The sensing device must not exhibit output hysteresis greater than 2% of full scale output when measured at mid-travel. Output hysteresis is measured at the direct mechanical input to the accelerator pedal position sensing element. Hysteresis of the linkages between the treadle and the sensing element of the APS are not included.

7.11 Open Circuit Response—An open circuit of any lead to the APS shall result in a signal as measured across the test points (47 kΩ ± 5% and 0.001 µF test load per Figure 10) within a specified fault range as shown in Figure 9 and within a maximum time of 1.0 s. The signal shall transit from a specified fault range signal to the correct reading at any APS position in less than 0.1 s (signal slew rate only) upon return to a normal operation.

7.12 Short Circuit Response—A short circuit between any two leads to the APS shall result in a signal as measured across the test points (47 kΩ ± 5% and 0.001 µF test load per Figure 10) within a specified fault range as shown in Figure 9 and within a maximum time of 1.0 s. The signal shall transit from a specified fault range signal to the correct reading at any APS position in less than 0.1 s (signal slew rate only) upon return to a normal operation.

***8. Auxiliary Signals*—**Some applications may require auxiliary "low idle," "shift point transition," and/or "kickdown" accelerator pedal position signal functions. If an auxiliary digital state change device is used, it shall comply to the appropriate section(s) as follows:

8.1 Signal Source—The auxiliary signal(s) shall be electrically independent of the APS output signal such that the auxiliary signal(s) are not derived from the APS output signal. The auxiliary signal source(s) and APS may be housed in a single mechanical package, or a separate package as required by the application.

8.2 Idle Validation Signal

8.2.1 LOW IDLE STATE—The Idle Validation Signal (IVS) shall be calibrated to change state at a point between 3 and 10% of the APS output span above the minimum APS position output. The IVS shall remain in the low idle state below this transition point.

8.2.2 VOLTAGE DROP—The conducting state voltage drop shall be less than 1.2 V when conducting between 1.0 and 25.0 mA.

8.2.3 CURRENT LEAKAGE—Nonconducting state current leakage shall be less than 100.0 µA with an applied potential of battery voltage.

8.2.4 SIGNAL OUTPUTS—The IVS shall have complimentary outputs as illustrated in Figure 11, or any functional equivalent.

8.2.5 STATE CHANGE—The device shall establish a stable state in less than 50 ms after the indication of a state change for an individual signal output.

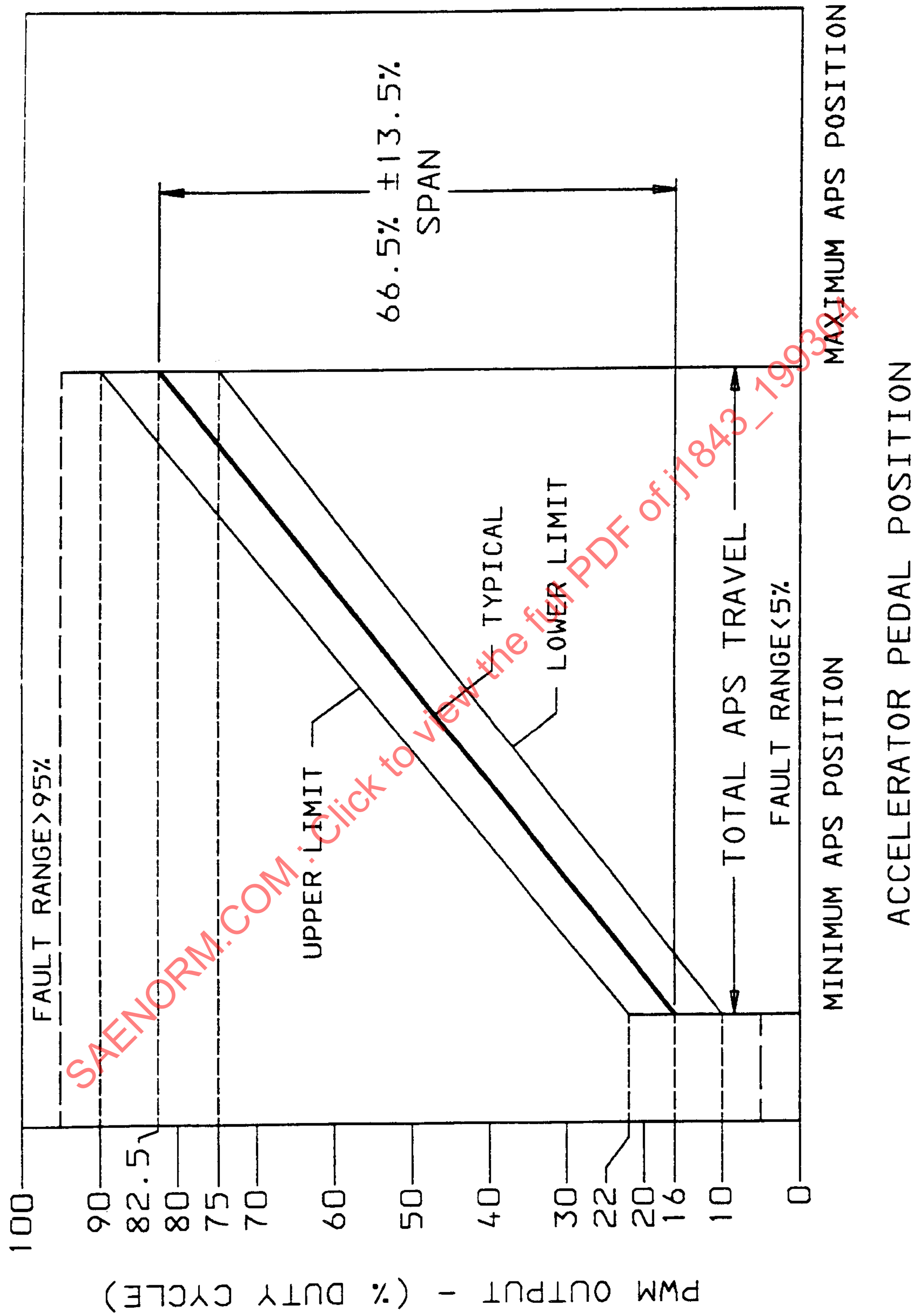


FIGURE 9—PULSE WIDTH MODULATED OUTPUT TRANSFER FUNCTION

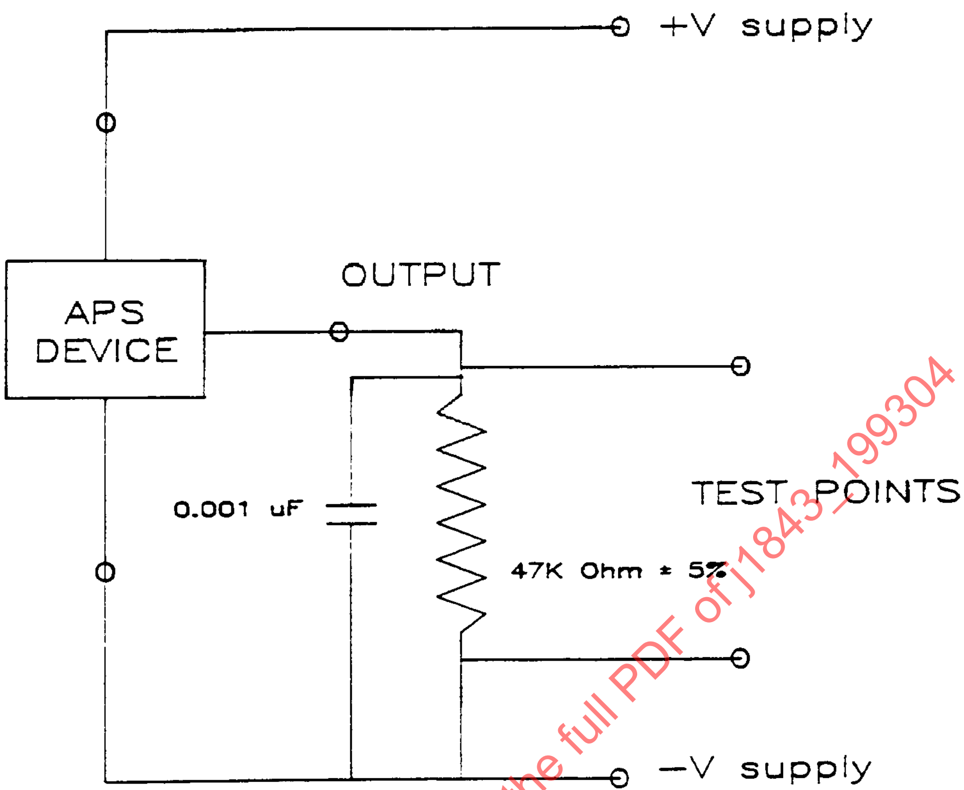


FIGURE 10—PWM APS OUTPUT TEST CIRCUIT