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Class A Multiplexing Actuators

RATIONALE

This document has been reaffirmed to comply with the SAE 5-Year Review policy.

FOREWORD

This SAE Information Report is the fourth in a series of Class A Multiplexing information reports. The intent of this document is to introduce the reader to Multiplexed Class A actuators. It is not a "Recommended Practice" report. The document is intended only to inform the reader of some of the issues involved in multiplexing Class A actuators.

These actuators fall into two general categories: analog actuators and digital actuators. This document is not all-inclusive but is meant to be used as a tool for the system engineer designing and developing a Class A Multiplex network application.

There are many SAE documents that define Class B and Class C technology (e.g., SAE J1850, J1979, and J2178). This document re-examines multiplexing to define Class A terminology which has some new issues as compared with the previously defined classes of multiplexing. For example, the resistive encoded steering-wheel switch assembly is a Class A Multiplex application.

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1. SCOPE

The Class A Task Force of the Vehicle Network for Multiplex and Data Communications Committee is publishing this SAE Information Report to provide insight into Class A Multiplexing. Multiplexed actuators are generally defined as devices which accept information from the multiplexed bus. A multiplexed actuator can be an output device controlled by the operator or an intelligent controller. A Multiplex actuator can also be a display device that reports the status of a monitored vehicle function. This document is intended to help the network system engineers and is meant to stimulate the design thought process.

A list of multiplexed actuator examples is provided in Appendix A, Figure A1. Many other examples can be it identified.

1.1 Three Classes of Multiplex Networks

The Vehicle Network for Multiplex and Data Communications Committee has previously defined three classes of vehicle data communication multiplexing: Class A, Class B, and Class C. A hierarchical relationship exists between the three classes. Class A multiplexing is a subset of Class B and Class B multiplexing is a subset of Class C. Definitions of all three classes are included in this document for reader convenience.

1.1.1 A Class Multiplexing

Class A Multiplexing contains many of the direct operator controlled functions and the displays monitored by the operator. Some examples of actuator outputs would be the operator control of powered convenience features such as power windows, door locks, and windshield wiper.

1.1.2 B Class Multiplexing

Class B Multiplexing provides the data communications between different modules, internal and external to the vehicle, for the purpose of sharing common data about the vehicle. An example of this is the diagnostic information shared between an internal (on-vehicle) module and an external (hand-held) module for service repair.

1.1.3 C Class Multiplexing

Class C Multiplexing is used for real-time high-speed control, and normally requires a significant amount of data communication to function properly. An example is the hydraulic actuator for the Anti-Lock Brakes System.

1.2 Analog as Well as Digital

The physical transportation of the information in a Class A Multiplex application can use analog or digital techniques. The information can be transported by an encoded voltage, resistance, or other physical value impressed on the transportation media. The transportation media can be a wire, but is not limited to a wire.

In some cases, it is difficult to identify an actuator as digital or analog. For example, a stepper motor can be used to control a flapper position in a heat exchanger. Although the motor has digital control, the intent of the control is analog as perceived by the vehicle operator. Hence, the Class A application of the flapper is identified as an analog function. In contrast, a door lock is a digital function. This concept is discussed further in the document.

2. REFERENCES

2.1 Applicable Publications

The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J1850 Class B Data Communication Network Interface

SAE J2057/1 Class A Multiplexing Application/Definition

SAE J2057-4 Class A Multiplexing Architecture Strategies

SAE J217812 Class B Data Communication Network Messages, Data Parameter Definitions

2.2 Related Publications

The following publications are for information purposes only and are not a required part of this document.

2.2.1 SAE Publications

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J1930 Electrical/Electronic Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms

SAE J1979 E/E Diagnostic Test Modes

3. DEFINITIONS

Class A actuators mostly fall into the area of operator convenience. They are typically characterized by moderate- to slow-communication times and are nontime critical. Actuators can be identified as either analog or digital. Actuators also can be classified by their engineering units and resolution.

3.1 Analog Actuator

Class A analog actuators convert some continuously varying output characteristic such as a continuously varying output value or magnitude. Although the communicated value may or may not be digitally encoded, the action taken is intended to provide a continuous range. An example of this is the flapper position in the heat exchanger. The actuator has a continuum of positions between a maximum and minimum value.

3.2 Digital Actuator

Class A digital actuators convert some output characteristic to discrete output states. The actuator has a maximum and minimum measurable range that corresponds to a fixed number of discrete output states. Examples of outputs that can have two states are the interior lights and parking lights. An output can have more than two states. For example, the blower fan is a digital actuator with possibly four or more states: off, low, medium, and high.

3.3 Engineering Units

Engineering units are the units of measure detected by and processed by the measuring system. Engineering units are a measure of Volume, Voltage, Displacement, Time, and other similar quantities. The engineering unit can be measured as an absolute value (i.e., volts), as a ratio (i.e., decibel), or as a percentage (i.e., gas tank gauge).

3.4 Binary Resolution

Binary resolution is the number of bits, in base 2, required to represent the full scale value. A bit is a single unit of binary information which has only two states: On/Off, 1/0, HI/LO, or True/False. Binary bits may be combined into groups of bits, representing values above two.

3.5 Analog Resolution Requirement

Analog resolution requirement is the largest level change that cannot be perceived by an occupant or operator. The analog resolution of the system should not allow the occupant to perceive discrete change. For example, “Opera Dimming” is an analog function. It can be achieved with discrete drive level changes that appear to the occupant as continuous dimming. The discrete drive resolution of this actuator should resolve to a level that is finer than required by the analog resolution of the function.

4. TYPICAL APPLICATION

Typical applications can be divided into analog and digital systems. A system is an analog system if the intent of the control is continuous. The system is considered digital if the intent of the control has discrete steps, locations, or values.

4.1 Analog Actuators

Analog actuators are used where continuously varying data is required for display or actuation. For analog data to be communicated on the Class A network, it is usually, but not always, first converted to a digital format. Analog actuators provide continuous quantities as perceived by the occupant such as voltages, resistances, and pressures. For example, the location of a flapper can control temperature. The location of the flapper is controlled by an electric voltage, current output, or stepper motor. The temperature output signal is solely dependent upon the actuator's transfer function to obtain a value or magnitude. A second example of an analog actuator is a seat motor, since the location of the seat is not in discrete steps, this actuator is classified as an Analog Actuator.

4.2 Digital Actuators

Digital actuators are used where discrete actuation is required. The information is represented by coded pulses or states based on discrete techniques. The information can be represented by two, three, or many states. The number of states are fixed and finite. For example, a door can be unlocked, locked, or bolted.

5. REQUIREMENTS

The following is a general list of requirements and is not meant to be specific for any one application. The requirements in this report are for informational purposes only. The actual requirements for each specific actuator would be determined by the application and by the manufacturer.

5.1 Network Requirements

The actuator will be capable of interfacing to the Class A network through integral interface circuitry or through a stand alone interface module. Reference SAE J2057/1 for specific requirements.

5.2 Electrical Requirements

The actuator must operate at all standard automotive voltages and survive the abnormal conditions, such as reverse voltage and load dump, as required by each user.

5.3 Environmental Requirements

The environmental requirements vary depending on the application. Some of the requirements that should be identified are: temperature range, dust, humidity, shock, vibration, power dissipation, conducted transients (load dump, etc.), double battery transients, low-voltage electrostatic discharge, and high-voltage electrostatic discharge.

5.4 Latency

Refer to Table 2.2, Typical Class A Application, included in SAE J2057/1.

5.5 EMC Susceptibility and Radiation

The EMC (Electro-Magnetic Compatibility) of actuators must meet the Requirements of the manufacturer and should meet the requirements of SAE J2057/1, paragraph 7.4.

5.6 Reliability

The reliability of the actuator and its Class A network interface should not degrade the performance of the function or the network as compared to nonmultiplexed vehicles. The actual actuator reliability requirement will be determined by the application and by the manufacturer.

5.7 Actuator Failure

The failure of the actuator must not affect operation of the Class A Bus and should return to a known default value when appropriate. Reference SAE J2057/1, paragraph 6.3.

5.8 Bus Failure

The actuator should monitor bus activity to determine if there is active communication. During bus failures, this activity may be lost and can be used as an indication of a bus failure. If the actuator has the ability to initiate communication, the actuator can test the bus by sending a status message. If the actuator detects a bus failure, it should move to a safe state as appropriate for the specific system affected.

5.9 Diagnostics

The actuator should have the ability to be interrogated by a system to determine if failures are present in the actuator and transmit this information for appropriate action. In some actuators degraded performance could also be reported.