Power Line Carrier Communications for Commercial Vehicles

RATIONALE

This document has been updated to provide a new method of dynamic MID assignments as well as other minor updates for corrections in the document. Specific changes include:

- *Section 11 - PLC Network Message Format Definitions Unique to SAE J2497 (New).* This section defines the method for dynamic MID assignments where multiple trailers and/or towed vehicles are used.
- *Update to Intellectual Property Licensing*
  Corrected references to potential intellectual property right interests.
- *Technical Updates to SAE J2497*
  Corrected text where appropriate and made minor updates to technical specifications, including:
  - Section 7.1 – Corrected waveform description.
  - Section 7.4 – Updated conducted emissions limit specification.
  - Section 8.1 – Updated superior states recognition specification.
  - Section 9.1 – Updated lamp timing tolerances.

FOREWORD

This SAE Recommended Practice has been developed by the Truck and Bus Low Speed Communications Network Subcommittee of the Truck and Bus Electrical and Electronics Committee. The objectives of the subcommittee are to develop information reports, recommended practices, and standards concerned with the requirements design and usage of devices which transmit electronic signals and control information among vehicle components.

This document is intended as a guide toward standard practice and is subject to change so as to keep pace with experience and technical advances.

TABLE OF CONTENTS

1. SCOPE

This SAE Recommended Practice defines a method for implementing a bidirectional, serial communications link over the vehicle power supply line among modules containing microcomputers. This document defines those parameters of the serial link that relate primarily to hardware and software compatibility such as interface requirements, system protocol, and message format that pertain to Power Line Communications (PLC) between Tractors and Trailers.

This document defines a method of activating the trailer ABS Indicator Lamp that is located in the tractor.

2. REFERENCES

2.1   Applicable Publications

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest version 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 J1113-41   Limits and Methods of Measurement of Radio Disturbance Characteristics of Components and Modules for the Protection of Receivers Used On-Board Vehicles

SAE J1587   Electronic Data Interchange Between Microcomputer Systems In Heavy-Duty Vehicle Applications

SAE J1708   Serial Data Communications Between Microcomputer Systems In Heavy-Duty Vehicle Applications

SAE J1939   Recommended Practice for a Serial Control and Communications Vehicle Network

3.   ABBREVIATIONS

ABS - Antilock Brake System
ASK - Amplitude Shift Key modulation
ECU - Electronic Control Unit
MID - Message Identifier
NRZ - Non Return to Zero modulation
PGN - Parameter Group Number
PL - Power Line
PLC - Power Line Communications
PRK - Phase Reversal Keying modulation
RF - Radio Frequency
Tsd - Start Delay Time

4.   INTELLECTUAL PROPERTY RIGHTS

Attention is called to the possibility that implementation of this document may require the use of subject matter covered by patent rights. By publication of this document, no position is taken with respect to the existence or validity of any patent rights in connection therewith. The SAE is not responsible for identifying patents for which a license may be required.

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5.   NETWORK DESCRIPTION

5.1   PLC Network

Figure 1 shows a typical PLC network. A typical network consists of Electronic Control Units (ECU) with, PLC transceivers, mounted on the tractor and trailer(s). These ECUs communicate to each other by sending Radio Frequency (RF) signals over the power line. These ECUs interface to the power line through a PLC transceiver.

The tractor PLC ECU must provide control for the Trailer ABS Indicator Lamp that is mounted in the tractor cab. This can be done by either a direct connection to the lamp, or by providing an appropriate control message (for example, by SAE J1587 or SAE J1939) to another ECU which then controls the lamp.
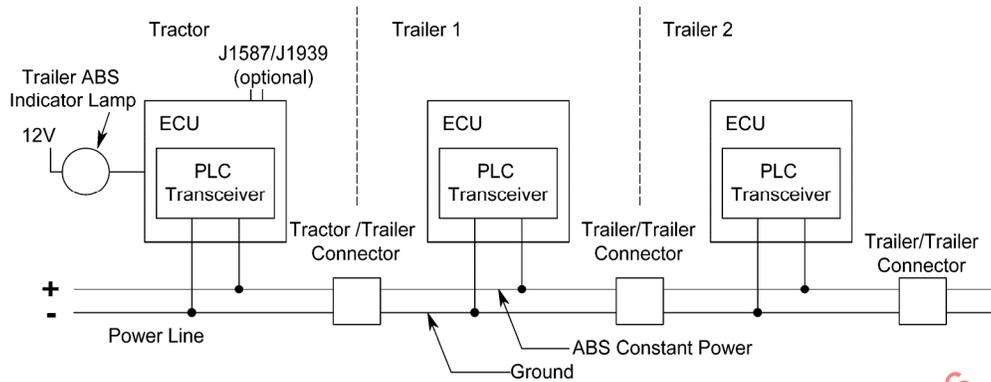
FIGURE 1 - EXAMPLE OF PLC NETWORK

5.2   PLC Transceiver

The microprocessor of an electronic module interfaces to the power line through a PLC transceiver. Refer to Figure 2. The microprocessor sends digital data (Tx) to a coding device in the PLC transceiver. This data is in the format described in SAE J1708. The coding device converts the digital data into a signal suitable for being transmitted on the power line. This signal will be described in later sections. This signal (Signal_out) is then passed through the appropriate amplifier and filters before it is coupled onto the power line. Conversely, a PLC signal (Signal_in) is taken from the power line, filtered, and decoded into digital data (Rx). This data is sent to the host microprocessor in a format defined by SAE J1708.

FIGURE 2 - PLC TRANSCEIVER
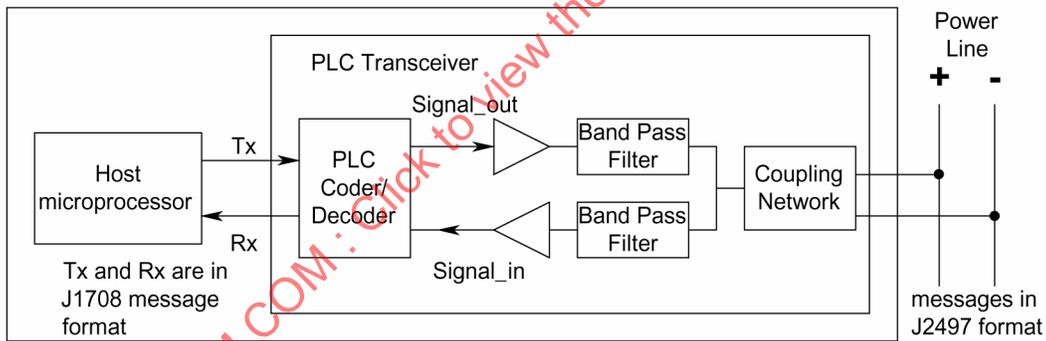
5.3   Coupling Examples

The PLC transceivers will interface to the power line, relative to the negative line, through the appropriate coupling network. Figure 3 illustrates two possible coupling networks. One provides capacitive coupling and the other provides transformer (inductive) coupling of the PLC signals onto the power line.
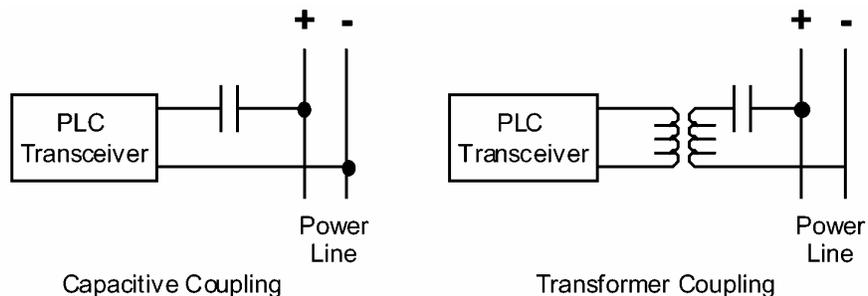

FIGURE 3 - POWER LINE COUPLING TECHNIQUES

6.   POWER LINE MESSAGE

The message sent on the power line has two major parts, the preamble and the data body. Refer to Figures C1 and C2 in Appendix C for following descriptions.

6.1   Message Format Between Host Microcontroller and PLC Transceiver

The communications between the host microcontroller and the PLC transceiver follows the SAE J1708 message format. The only exception to SAE J1708 message format is the character gap between the first and second characters. The host microcontroller must wait 2 bit times after receiving the stop bit of the first character echoed back to the microcontroller before sending the second character. Refer to Figure C1 in Appendix C.

6.2   Message Format on the Power Line

The format of the message that is placed on the power line is as follows.

Message:
    Preamble:
        Initial Symbol(s)   Less than 2 symbols
        Start bit   1   Logic low, SUPERIORθ2 symbol
        Data bits   8   Either Superior or Inferior symbol
        Stop bit   1   Logic high, Inferior symbol
Data Body:
    Sync: 5   Logic high, SUPERIORθ1 symbol
    Each data character:
        Start bit   1   Logic low, SUPERIORθ2 symbol
        Data bits   8   Either superior symbol
        Stop bit   1   Logic high, SUPERIORθ1 symbol
        Character Gap   0 – 4 symbol times
    End of message   5   Logic high, SUPERIORθ1 symbol

A symbol is the signal, encoded on the power line, that is the representation of a binary state. The symbols will be discussed in more detail in subsequent sections.

The preamble is created by the PLC transceiver and uses the first character it receives, of the message to be sent, from the host microcontroller (i.e., the MID). After the preamble, the transceiver retransmits the first data character again in the data body. The host microcontroller SHOULD NOT resend the first data character again to the PLC transceiver.

6.2.1   Preamble format

Refer to Figure C1 in Appendix C. The preamble starts with less than two complete initial SUPERIORθ2 symbols. The initial symbol(s) are followed by a start bit, 8 data bits, and 1 stop bits. The start bit is a SUPERIORθ2 symbol and the stop bit is an Inferior symbol. The data bits are either symbol.

6.2.2   Data Body Format

A sync segment follows the preamble. This sync segment consists of 5 SUPERIORθ1 symbols.

Following the sync segment is the first data character. Data characters consist of a start bit, followed by 8 data bits, and 1 stop bit. These data characters in the data body are the same characters from the SAE J1708 message sent to the PLC transceiver by the host microcontroller. The start bit is represented by a SUPERIORθ2 symbol, and a stop bit is represented by a SUPERIORθ1 symbol. The data bits can be either symbol.

The data characters are separated by character gaps of zero to four SUPERIORθ1 symbols. The character gaps are required because the bit time (symbol time) of the message on the power line is different than the bit time of the message sent between the host microprocessor and the power line transceiver.

The end of the message is terminated with five consecutive SUPERIORθ1 symbols (logic highs) after the stop bit of the last (nth) character. Refer to Figure C2 of Appendix C.

6.3   Message Encoding

The preamble and data body are encoded onto the power line using different modulation techniques.

6.3.1   Preamble Encoding

The preamble is encoded onto the power line using "Amplitude Shift Key" modulation (ASK). A logic "0" is encoded using a particular waveform. This waveform is a logic symbol known as a Superior State Phase 2 or SUPERIORθ2. The characteristic of this waveform is described in a later section. The logic "1" is encoded by the absence of any signal. This logic symbol is known as an Inferior state. These symbols are illustrated in Figure 4.
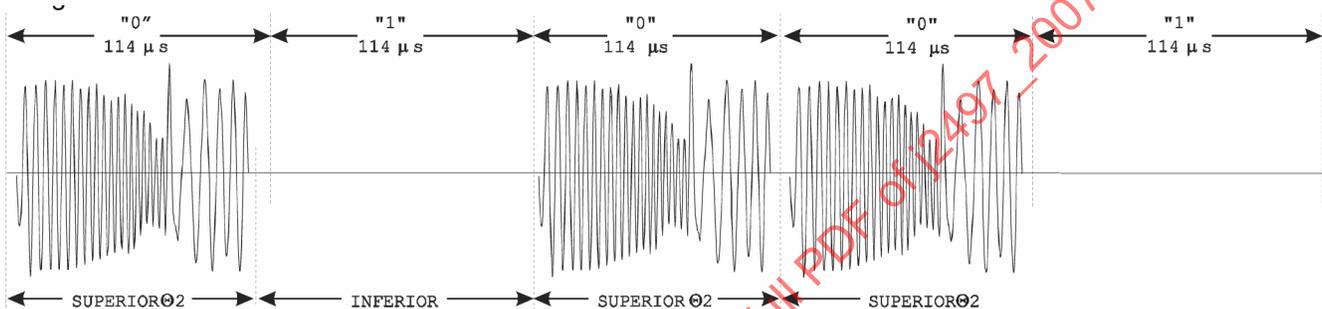

FIGURE 4 - EXAMPLE OF PREAMBLE LOGIC SYMBOL ENCODING

The bit time during the preamble is 114 µs, whereas the time of the SUPERIORθ2 symbol is 100 µs. There are 14 µs of idle time between two consecutive SUPERIORθ2 symbols. This extra idle time increases the ability to detect the preamble.

6.3.2   Data Body Encoding

The data body is encoded onto the power line using "Non Return to Zero" (NRZ) "Phase Reversal Keying" (PRK) Modulation. There are two signals used to encode binary logic symbols "1" and "0". Both are superior state. The signal for a logic "1" symbol is known as "Superior State Phase 1" or SUPERIORθ1. The signal for a logic "0" symbol is known as "Superior State Phase 2" or SUPERIORθ2. The signal for a SUPERIORθ2 has the same function as SUPERIORθ1 except it differs in phase by 180 degrees (SUPERIORθ2 = -SUPERIORθ1). Examples of these symbols are shown in Figure 5. The SUPERIORθ2 symbol is the same symbol used in the coding of the logic "0" in the preamble. The characteristics of these waveforms are described in a later section.
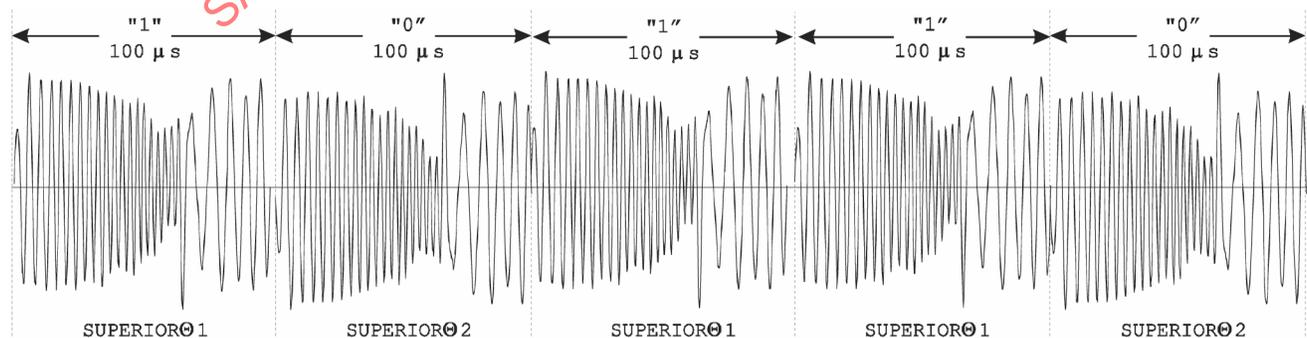

FIGURE 5 - EXAMPLE OF DATA BODY LOGIC SYMBOL ENCODING

6.4   Message Timing

Message between host microprocessor and PLC Transceiver:
     Bit time is 104 µs (9600 bits per second).
Message sent on power line:
     Bit time of preamble is 114 µs (8772 bits per second).
     Bit time of data body is 100 µs (10 000 bits per second).
     Symbol time is 100 µs.

The tolerance is ±0.5% over the operating temperature and humidity range of the PLC transceiver.

6.5   Contention Resolution

The preamble is used to resolve contention between two messages transmitted simultaneously.

The ASK encoding method provides the means of arbitration. One preamble will have signal (SUPERIORθ2) in a bit location that the contending preamble has no signal (INFERIOR). Thus, the SUPERIORθ2 symbol will overwrite the INFERIOR symbol.

Refer to Figure C1 of Appendix C. As each transceiver sends out its preamble, it observes the preamble on the power line. When one transceiver detects a SUPERIORθ2 symbol in the bit location where there should be an INFERIOR symbol, it will immediately stop transmitting and place itself in the receiver mode so as not to corrupt the preamble of the dominant message. When in the receive mode, the output of the transceiver is placed in tri-state so as not to load the line and block the incoming signal.

The received preamble is echoed back to the host microcontroller so it will know that it has lost arbitration and not to continue sending the remainder of its message.

NOTE: The delay in the first character echoed back to the host microcontroller from the PLC transceiver is considerably larger than the delay typically found in SAE J1708 communications. This is due to the PLC preamble decoding process.

7.   TRANSMITTER CHARACTERISTICS

The transmitter shall be a differential driver capable of driving the specified carrier waveform on the PL network. The following sections detail the transmitter requirements for generating the SUPERIOR (either phase) and INFERIOR states on the power line network.

7.1   Waveform Generation

The AC output voltage generated during either SUPERIOR state shall be a swept sine wave. Figure 6 shows the waveform for a SUPERIOR state. The signal shall be impressed upon the DC power line voltage. The waveform can be approximately described as beginning at the 0° point at 203 kHz and linearly sweep in frequency versus time to a frequency of 400 kHz in 63 µs (19 full cycles), then linearly sweep to 100 kHz in 4 µs (1 full cycle), and then linearly sweep to 203 kHz in 33 µs (5 full cycles). The resultant waveform is thus 100 µs ± 100 ns ending at the 0° point after 25 cycles. The carrier may begin with either a positive or negative going phase. The shape and relative amplitude of the waveform over time is a complex function designed to reduce out-of-band radiated interference from the carrier. The exact specification for the waveform is given as a table in Appendix A.
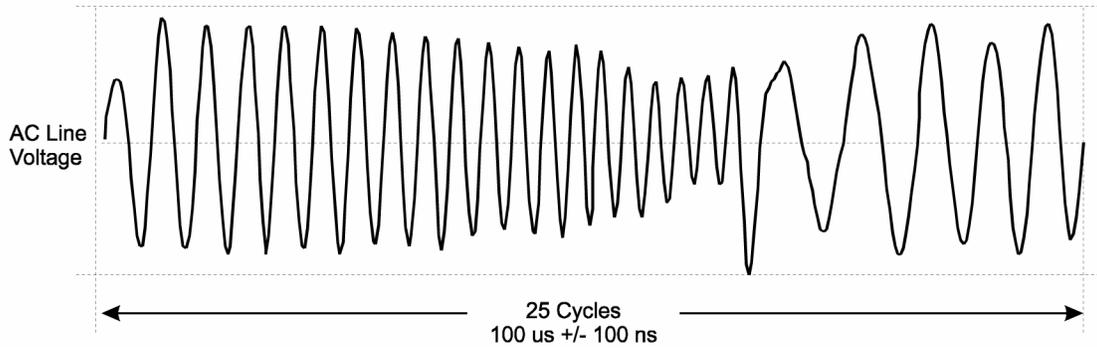
FIGURE 6 - FREQUENCY SWEPT CARRIER WAVEFORM

The only difference between the waveform of SUPERIORθ1 and SUPERIORθ2 is that they are 180 degrees out of phase (SUPERIORθ1 = - SUPERIORθ2). The phase difference depends upon the specific design and is automatically sensed by the PLC transceiver.

7.2   Amplitude

The amplitude of the carrier output voltage during either SUPERIOR state, into the test load shown in Figure 7 at the power line connector of the device, shall be between the minimum and maximum output levels given in the following table. The output voltage is measured between adjacent waveform peaks developing the highest differential amplitude. These output levels will be met over the load range represented by the switched load conditions of the test circuit. See Table 1.

TABLE 1 - OUTPUT VOLTAGE

Minimum	Maximum	Load Range
2.5 Vpp	7 Vpp	10 Ω - 2 kΩ

To ensure proper reception and minimum out of band interference, the normalized envelope shape of the transmitted swept carrier will match the envelope shape of the waveform of Table A1 in Appendix A to within ±10% measured while driving the test circuit of Figure 7, with the switch in the closed position.

Power Line Transmitter Under Test

10 mH

Vdm

C1

R1
1W

C2

R2

10 mH

+
Vpl
-

Switch closed: Minimum network impedance from 100-400 kHz
Switch open: Maximum network impedance from 100-400 kHz

C1	R1	C2	R2	V_{PI}
5µF	10Ω	15nF	2kΩ	12 Vdc
ESR ≤ 1 Ω				
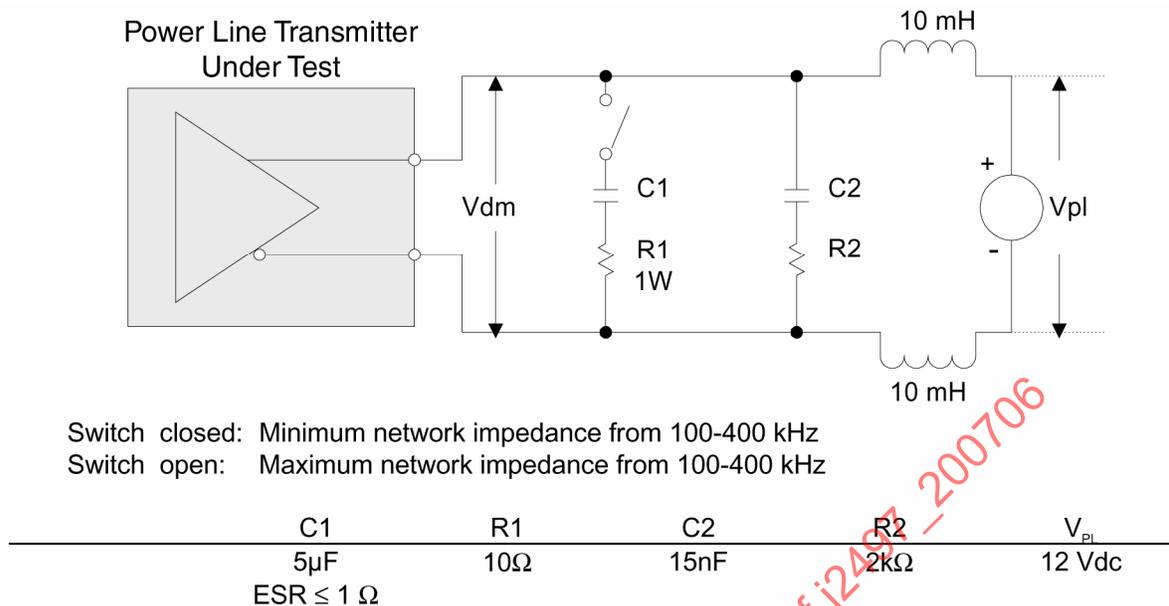
C1 should have equivalent series resistance less than 1 ohm.

Note: The intent is to present a nearly real load to the PLC transceiver. C1 and C2 are for AC coupling of R1 and R2 respectively. Their impedance and ESR must be much less than R1 and R2 respectively within reasonable component characteristics.

FIGURE 7 - OUTPUT DRIVER TEST CIRCUIT

The 10 mH inductors must have a self resonance much greater than the PLC band (> 400 kHz) and saturation and maximum current limits above DC current levels used by the PLC Transceiver or devices connected in parallel with the PLC Transceiver.

7.3   SUPERIORθ1 to SUPERIORθ2 Transition

During the output transition from the end of one SUPERIOR state to the beginning of another SUPERIOR state of the opposite phase, the waveform amplitude ±2 intervals (Table A1 in Appendix A) about the transition point may assume any value necessary to implement the phase reversal (less than the maximum waveform amplitude allowed during this interval) provided the out-of-band signal level requirements of 7.4 are met.

7.4   Conducted Emissions Limit

The PLC signal must be considered when testing for the Electro-Magnetic Compatibility. The emissions from the PLC transmitters will exceed recommended limits in the PLC frequency range. Therefore, exceptions to the limits must be made for the PLC frequency range.

The appropriate test to consider for measuring electromagnetic emissions is defined in SAE J1113-41 (July 1995) Section 5, "Conducted Emissions Component/Module" using the voltage measurement (J1113-41, Section 5.2.1).

NOTE: (Informative):
        The output signal within the 100 to 400 kHz frequency range, when measured at the Artificial Network port, can exceed +105 dBuV (typically less than 120 dBuV ($1V_{RMS}$)). The out-of-band limits for emissions described in J1113-41 are in the range of +20 to +80 dBuV. Thus, if the analyzer reference level is set to a value of 80 dBuV (or less) to obtain good measurement accuracy, the 105 dBuV SSC signals will create intermodulation products in the front end of the spectrum analyzer. These intermodulation products will adversely affect the readings in the band of interest, although they might be outside the sweep range of the analyzer. High pass filters should be used at the analyzer input as follows:

- To observe the PLC signal spectrum, the spectrum analyzer reference level should be set to 120 dBuV and a 10 kHz hgh pass filter should be used at the analyzer input.
- To measure out-of-band signals in higher frequency ranges, the analyzer reference level should be set to 80 dBuV and a 450 kHz, 7 to 10 pole high pass filter should be used to avoid spectrum analyzer input overload protection.

Do not rely on the spectrum analyzer's overload indicator. Intermodulation products are produced in most analyzers well before this indicator becomes active.

7.5   ECU Isolation

The PLC transceiver essentially connects in parallel to the power supply of the ECU into which the transceiver is integrated. Some component configurations in the power supply may cause attenuation and distortion, which may lead to conducted emissions exceeding the recommended limits. Examples of ECU and PLC isolation are shown in Appendix B.

8.   RECEIVER CHARACTERISTICS

The PLC receiver must detect the two valid swept frequency carrier unit symbol state waveforms of SUPERIORθ1 and SUPERIORθ2. Detection is assumed to occur, for specification description purposes, by correlating the received waveform with an internal model of the waveform. This process requires that reporting of a valid medium state occur only after the complete state (100 µs) has been received.

8.1   SUPERIOR States Recognition

Unit SUPERIOR state symbol recognition (of either phase) will occur when the received swept frequency carrier signal level is ≥5.0 mV p-p and <7.0 V p-p, at the power line connector of the device, in the band from 100 kHz to 400 kHz and the transmitted swept carrier waveform meets the relative amplitude and waveform timing requirements given in Section 7.

The received message error rate (one or more errors occurring within the message) will not exceed 0.1% (with no retries) when the swept carrier waveform is received with a signal level in the range of ≥5.0 mV p-p and <7.0 V p-p without any interfering signals or signal impairments, measured using a minimum of 1000 messages of data with a message length of five bytes. In addition, the received packet error rate will not exceed:

2% when the swept carrier waveform is received in the presence of a constant carrier interfering signal occupying any single frequency from 20 kHz to 1 MHz producing a signal-to-interfering noise ratio of 3.0 dB at the receiver terminals.

2% when the swept carrier waveform is received in the presence of broadband noise producing a signal-to-interfering noise ratio of 3.0 dB at the receiver terminal.

NOTE: (Informative):
The PLC for trucks technology is more sensitive to constant carrier interference than to broadband interference at a similar signal to noise ratio, so it is likely that designs meeting the former requirements will comply with the later. Testing with both types of interfering signals will be needed to ensure that interference will not degrade communication in the vehicle.

2% when the swept carrier waveform is received at the minimum level of 5 mV p-p, where not impaired, in the presence of a band stop filter impairment between the signal source and the receiver with a 10.0 db attenuation in the stop band, having a Q of 5, with center frequency placed at any point between 100 kHz and 400 kHz.

9.   SOFTWARE FUNCTIONS

The protocol of the messages communicated on the PLC network is that which is described in the SAE J1708.

9.1   Cab Mounted Trailer ABS Malfunction Indicator Lamp Control

The physical control of the cab mounted Trailer ABS Indicator Lamp is made by a device within the towing vehicle. An example of this device is the Tractor ABS ECU. The logical control of the cab mounted Trailer ABS Indicator Lamp is made by a device mounted on the Trailer. An example of this device is the Trailer ABS ECU.

9.1.1   Trailer Device Control Functions

The trailer mounted device performs the logical control of the cab mounted trailer ABS Indicator Lamp by sending the appropriate control message over the power line to the tractor mounted control device. The trailer device shall send either of these messages every 500 ms.

9.1.1.1   Lamp On Command

The message to command the lamp "ON" starts with message identifier (MID) 10. This message is defined in Section 10.

9.1.1.2   Lamp Off Command

The message to command the lamp "OFF" starts with message identifier (MID) 11. This message is defined in Section 10.

9.1.1.3   Power up (Bulb Check)

When power is applied and the trailer ABS device becomes active, if the lamp is not to be turned on (no faults), the trailer device has the option to send one or more initial "ON" command(s) for a bulb check. Otherwise, it shall send the "OFF" commands (Example 2.8 in Figure 8).

9.1.2   Tractor Device Control Functions

The device in the tractor, that physically controls the cab mounted Trailer ABS Indicator Lamp, shall activate the lamp as indicated in the following.

9.1.2.1   Lamp On Function

When the tractor device receives an "ON" message, from the power line, it shall turn on the Lamp for 2.5 +0.5/-0 s (Example 2.1 in Figure 8). In the event of multiple trailers sending conflicting control messages, the "ON" message has priority (Example 2.2 in Figure 8).

9.1.2.2   Lamp Off Function

When the tractor device receives an "OFF" message, over the power line, it shall turn the lamp off 2.5 +0.5/-0 s after the receipt of the last "ON" message (Examples 2.3 through 2.5 in Figure 8).

When the tractor device no longer receives "ON" or "OFF" messages, from the power line, it shall turn off the lamp 10 seconds after the receipt of the last "ON" message (Example 2.6 in Figure 8).

9.1.2.3   Power on (Bulb Check)

When the ignition becomes active and the first control message that the tractor device receives within 3 s is an "OFF", then the tractor device will turn on the lamp for 2.5 +0.5/-0 s or longer if an "ON" message is received (Examples 2.7 and 2.8 in Figure 8). If an "ON" message is received during this time, the tractor device will then control according to the preceding sections.

If no lamp control messages are received, then the tractor device will not perform a bulb check (Example 2.9 in Figure 8).

Example		Comments
2.1	lamp on ...11 11 11 10 10 10 10...____ lamp off ____|___ →‖0.5s‖←					Lamp on when ON message received (MID 10)
2.2	lamp on ...11¹¹11¹¹11¹¹10¹¹10¹¹10¹¹ 10¹¹... ____ lamp off ___ →‖0.5s‖←					Lamp on with multiple trailers (dollies) and ON message received
2.3	lamp on ...10 10 11 11 11 11 11 11... lamp off	→‖0.5s‖←			___	Lamp off 2.5 seconds after last ON message sent. OFF messages sent.
2.4	lamp on ...10¹¹10¹¹11¹¹11¹¹11¹¹11¹¹11¹¹11 11 lamp off	→‖0.5s‖←			___	Lamp off, multiple trailers
2.5	lamp on ...10¹¹10¹¹ 11 11 11 11 11 lamp off	→‖0.5s‖←			___	Lamp off with multiple trailers and ON message from one trailer no longer received.
2.6	lamp on ...10 10 _____ lamp off →‖0.5s‖←			____ t t + 10 sec	Lamp off 10 seconds after loss of messages
2.7	lamp on 11 11 11 11 11 11 11... lamp off	___	___ →‖0.5s‖←		___ ign on t < 3sec t + 2.5 sec	Bulb check performed when OFF messages detected within 3 seconds of ignition activation.
2.8	lamp on 11 11... lamp off |___ →‖0.5s‖←				 ign on t > 3sec	Bulb check **NOT** performed when OFF messages are detected after 3 seconds of ignition activation.
2.9	lamp on lamp off ___|___ →‖0.5s‖←					Lamp not to be activated with no control messages available.

FIGURE 8 - CONTROL OF CAB MOUNTED TRAILER ABS INDICATOR LAMP BY TRACTOR DEVICE

9.1.3   SAE J1587 Indicator Lamp Control

The tractor PLC unit will send a message onto the SAE J1587 bus to indicate the control status of the Trailer ABS Indicator Lamp. This message is to facilitate control of a Trailer ABS Indicator lamp that is mounted in an electronic instrument panel with no dedicated control input. The Parameter Identifier (PID) for the control of this lamp is defined in SAE J1587.

9.1.4   SAE J1939 Indicator Lamp Control

The tractor PLC unit will send a message onto the SAE J1939 bus to indicate the control status of the Trailer ABS Indicator Lamp. This message is to facilitate control of Trailer ABS Indicator lamp that is mounted in an electronic instrument panel with no dedicated control input. The Parameter Group Number (PGN) for the control of this lamp is defined in SAE J1939.

10. PLC NETWORK MESSAGE FORMAT DEFINITIONS

The definitions of the PLC network messages, which are not described in the SAE J1708 and SAE J1587, are described in this section.

10.1   Trailer ABS Indicator Lamp ON (MID10)

Message Identifier (MID) 10d
- DATA = 00d
- Update rate = 500ms

The purpose of the message identifier is to command tractor mounted Trailer ABS Indicator Lamp to be ON.

10.2   Trailer ABS Indicator Lamp OFF (MID 11)

Message Identifier (MID) 11d

- DATA = 255d
- Update rate = 500ms

The purpose of the message identifier is to command tractor mounted Trailer ABS Indicator Lamp to be OFF.

10.3   Trailer ABS Active (MID 87)

Message Identifier (MID) 87d

Format: MID / data / checksum
- Data = 255d
- Update rate = 500 ms and when ABS is first active.

State signal which indicates that the ABS in the trailer is actively controlling an ABS event. This information is used in the tractor vehicle dynamic control system for calculating trailer dynamics.

This message is to be sent on change to ABS active state and continued to be broadcast with an update rate of 500 ms while in the active state. To indicate that this message is supported by the trailer ECU, this message is transmitted, with an update rate of 500 ms, during the first 2.5 s following the application of power and vehicle motion is not detected.

11. PLC NETWORK MESSAGE FORMAT DEFINITIONS UNIQUE TO SAE J2497

Historically, communication message assignments were assumed to be identical for SAE J1587 and SAE J2497. Due to industry needs, there are reasons to apply a separate MID level for SAE J2497 as MIDs are nearly used up in SAE J1587 and there is a need for additional MIDs to support dynamic addressing in SAE J2497.

11.1   Dynamic Claim to a Unique SAE J2497 MID

11.1.1   Background

This method assumes that there is no current industry need for dynamic MID addressing for similar devices on a single SAE J1708/SAE J1587 network. It is only needed for same devices on the SAE J2497 network, resident on multiple trailers. Also, it assumes the ECU has the ability to choose from a set of pre-defined MID numbers.

For proper bus access, devices communicating on the same data bus are required to have unique message identifiers (MID) (Refer to SAE J1708, Section 6.3.3.1). Because of power line communications (PLC – SAE J2497), trailer devices of the same type (e.g., ABS ECUs) can now communicate on the same data bus (The power line). Even though SAE J1587 defines different MIDs for devices of the same type (example: Brakes MID 137, 138, 139, 246, and 247), there is no standard way of dynamically assigning these MIDs to their devices when communicating on the same power line. Manually configuring MIDs is not a reliable method because trailers are often swapped in tractor / trailer combinations.

NOTE: Today in many cases, diagnostic devices have the issue of trying to communicate with multiple MID 137 devices on the same power line when communicating with multiple trailers connected. In the future, diagnostic devices will have the option to communicate to a single ABS unit using the primary MID 137 or the newly defined set of dynamic MID addresses. SAE recommends that trailer devices communicating on the power line evolve to exclusively using the new dynamic MID assignments as soon as possible.

11.1.2   Priority of MIDs 10, 11 and 87

If the trailer device (ECU) is responsible for sending MID 10, 11 or 87, it should not attempt the dynamic MID function until after it has broadcast these higher priority MIDs at least one time.

11.1.3   Method

11.1.3.1   Power-Up MID Claim

A device powers up and waits the Tsd before sending PID 4 – Dynamic MID Claim for SAE J2497 Gateway Devices using the last claimed MID during the previous power cycle unless it has already detected another ECU using this same MID.

If the ECU does detect another ECU that starts broadcasting using the same MID, the ECU will claim the next unused (not detected) MID of the device set, reset Tsd, and then send PID 4 – Dynamic MID Claim for SAE J2497 Gateway Devices using the new MID. A "Device Set" is defined as a group of MIDs intended to allow multiple devices of the same type to operate on the same data bus (e.g., Brakes, Trailer #1, Brakes Trailer #2, etc.).

11.1.3.2   MID Infringement and Reclaim

At any time during the power cycle, if an ECU that has already claimed a MID detects another ECU that starts broadcasting using the same MID, the first unit will claim the next unused (not detected) MID of the device set, reset Tsd, and then resend PID 4 – Dynamic MID Claim for SAE J2497 Gateway Devices using the new MID. A "Device Set" is defined as a group of MIDs intended to allow multiple devices of the same type to operate on the same data bus; e.g., Brakes, Trailer #1, Brakes Trailer #2, etc.
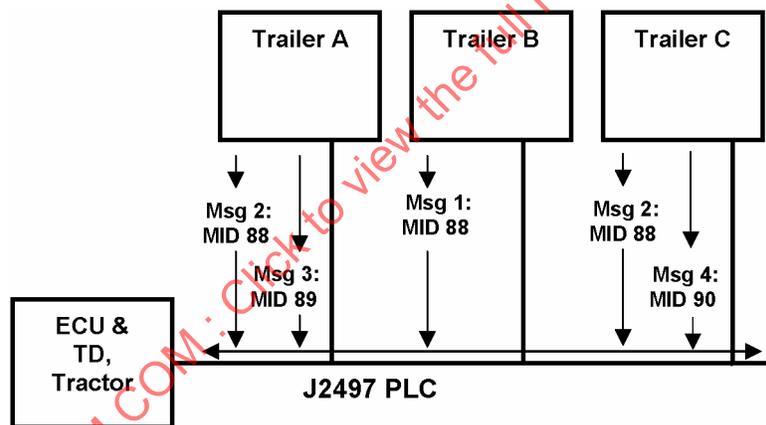
11.1.3.3   MID Claim Examples

FIGURE 9 - EXAMPLE OF TRAILER DEVICE SET SUPPORTING DYNAMIC ADDRESSING

Sequence of MID Claim messages:

All three trailer ECUs are defaulted for MID 88 and receive power at the same time.

1.   Trailer B initiates first and sends PID 4 using MID 88.

2.   Trailers A and C see an ECU using MID88 and both units will claim the next unused (not detected) MID of the device set and reset Tsd.

3.   Trailer A initiates before Trailer C and sends PID 4 using MID 89.

4.   Trailers C sees an ECU using MID89 and then claims the next unused (not detected) MID of the device set, reset Tsd.

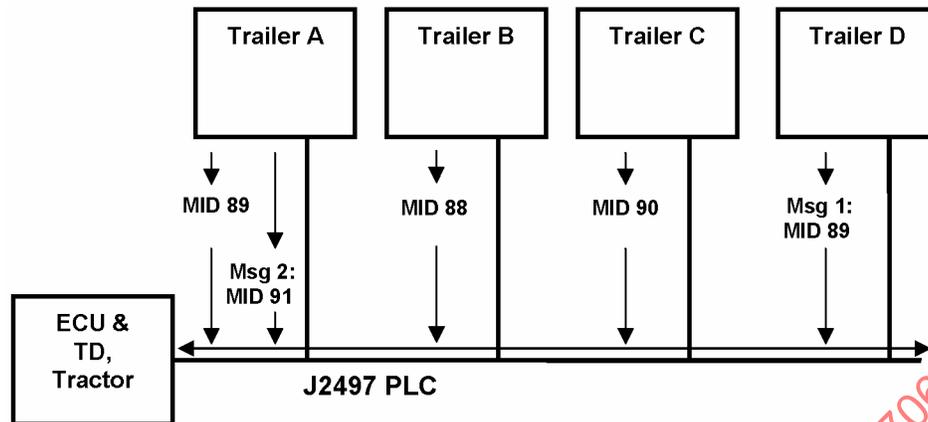5.   Trailer C initiates and sends PID 4 using MID 90.

FIGURE 10 - EXAMPLE OF ADDING ECU TO TRAILER DEVICE SET SUPPORTING DYNAMIC ADDRESSING

Sequence of MID Claim messages:

1. Trailer D initiates and sends PID 4 using MID 89. (Last MID claimed during last power cycle.)

2. Trailer A sees an ECU using MID89 claims the next unused (not detected) MID of the device set, resets Tsd, then sends PID 4 using MID 91.

11.1.3.4   Trailer Device Sets without Dynamic Addressing Support

Older devices will not be using MIDs in this range and will not affect the dynamic addressing function.

11.1.4   Start Delay Time

The start delay time (Tsd) is randomly chosen to minimize the probability that two devices try to claim the same MID at power-up or after a new device is introduced to the system. This will allow the bus to stabilize as quickly as possible.

Devices powering up late may be the result of a trailer being connected to an already powered train of trailers, or due to a device intermittently loosing power.

11.1.5   Physical Position

MID number does not indicate physical position in a multiple trailer configurations. Using the MID to indicate physical position is not currently possible because there is no standard method to determine position. Note: it is possible for a device to claim the first dynamic MID value when it is actually not in the first trailer position due to variable conditions in the wiring systems between trailers. Devices that associate functions to MIDs need to be aware that the MID can change during power cycles.

11.1.6   MID Retention

The MID used during last power cycle should be retained in device memory. At power up, devices should begin communicating using the claimed MID from the previous power cycle and used throughout the power cycle unless another device is detected using the MID. This will reduce the resulting MID claiming actions between power cycles or during intermittent power-loss.

11.2   SAE J2497 MID Assignments

The SAE J2497 Task Force recommends that MIDs in the range of 88 to 110 be used for dynamic MID assignments. Table 2 summarizes how all MIDs should be assigned in SAE J2497.