

PE07-029

Attachment 35

Response to Question 10

DATE ORIGINATED 10/08/98	RELEASE NUMBER PA2042-E6	REVISION C	REVISION DATE 02/25/03	STANDARD NO. 49-00085	PAGE 1 OF 20
------------------------------------	------------------------------------	----------------------	----------------------------------	---------------------------------	------------------------

SUBJECT: SPECIFICATION – Performance Requirements: Electrical/Electronic Modules

TABLE OF CONTENTS

1. PURPOSE2

2. ABSTRACT2

3. SCOPE2

4. RESPONSIBILITIES3

5. APPLICABLE SPECIFICATION3

5.1 GENERAL REQUIREMENTS3

6. ELECTRICAL PERFORMANCE REQUIREMENTS4

6.1 Steady State Conditions4

6.2 Transient Levels6

6.3 Electrostatic Discharge (ESD)7

6.4 Electromagnetic Interference (EMI) Susceptibility8

6.5 EMI Emissions10

6.6 EMI Whole Vehicle Requirements10

6.7 Elevated Ground Requirements10

6.8 Sneak Paths11

7. MECHANICAL PERFORMANCE REQUIREMENTS

7.1 Temperature Cycle Test11

7.2 Thermal Shock12

7.3 Humidity13

7.4 Dust Bombardment14

7.5 Mechanical Vibration14

7.6 Mechanical Shock15

7.7 Salt Spray15

7.8 Steam Cleaning And Pressure Wash15

7.9 Immersion And Splash (Chemicals and Oils)16

8. DATA COMMUNICATIONS16

8.1 J1708/158716

8.2 J193917

9. DELIVERY CONDITIONS19

DATE ORIGINATED 10/08/98	RELEASE NUMBER PA2042-E6	REVISION C	REVISION DATE 02/25/03	STANDARD NO. 49-00085	PAGE 2 OF 20
SUBJECT: SPECIFICATION – Performance Requirements: Electrical/Electronic Modules					

10. EVALUATION UNITS19

TABLE 15
Test Work Instructions

TABLE 27
Truck/Tractor 12V System Voltage Regulation Characteristics

TABLE 38
Typical 12V Vehicle Transient Voltage Characteristics

FIGURE 16
Battery and Ignition Cold Cranking Waveforms

FIGURE 212
Temperature Cycle for Cab and Chassis Equipment

FIGURE 313
Shock Cycle for Cab and Chassis Equipment

FIGURE 414
Humidity Cycle for Cab and Chassis Equipment

1 PURPOSE:

To define Freightliner LLC's (Freightliner's) criteria for the performance of electrical and electronic modules.

2 ABSTRACT:

This standard provides Freightliner's minimum requirements for the electrical and mechanical performance of electrical and electronic modules that will be installed in Freightliner vehicles.

3 SCOPE:

This document establishes minimum electrical and mechanical performance criteria for electrical/electronic components (modules) to be supplied to Freightliner LLC or any of its subsidiaries for installation on a vehicle. These requirements are defined within Society of Automotive Engineers (SAE), Technology Maintenance Council (TMC), Federal Motor Vehicle Safety Standard (FMVSS) or Military Standard (MIL-STD) specifications and the body of this

DATE ORIGINATED	RELEASE NUMBER	REVISION	REVISION DATE	STANDARD NO.	PAGE
10/08/98	PA2042-E6	C	02/25/03	49-00085	3 OF 20

SUBJECT: SPECIFICATION – Performance Requirements: Electrical/Electronic Modules

document. In case of any conflict between this document and any referenced specifications, this standard shall take precedence.

4 RESPONSIBILITIES:

Freightliner Engineering is responsible for referencing this standard on the appropriate engineering drawings. Purchasing is responsible for providing copies of the document to potential suppliers. The supplier is responsible for manufacturing and delivering electrical/electronic modules capable of meeting all performance requirements of this document; this is a contractual requirement accepted by the supplier as part of the agreement to conduct business with Freightliner LLC. In addition, documents that are significant to the design/test process, could be requested. These include design models, component schematics, specifications, and Failure Modes Effects Analysis (FMEA) data.

5 APPLICABLE SPECIFICATION

5.1 GENERAL REQUIREMENTS

Electrical/Electronic modules shall be designed such that no transients or sequence of events as described in this standard will, in any combination, cause any detrimental condition(s) to occur.

- 5.1.1 No design change (i.e. form, fit, function, appearance, labeling, or part number) shall be made to any module after it has been qualified for production without the prior written approval of the Freightliner Project and Test Engineer responsible for the module. Any change must be demonstrated to meet the quality and performance specifications of this document. Any change that affects appearance, form, function, or fit will be assigned a different part number, for Freightliner documentation purposes.
- 5.1.2 The test sequences shall be chosen to provide the worst case conditions and approved in writing by the Freightliner Test Engineer responsible for the module.
- 5.1.3 A completed product as shipped to Freightliner shall meet all requirements of the engineering standard.
- 5.1.4 A summary of the test results, for all tests performed by and for the supplier, will be sent to the Freightliner Test Engineer responsible for the project. Freightliner personnel shall have the option of observing any or all of the tests performed by or for the supplier and should be notified prior to the performance of the tests. Freightliner personnel have the option of viewing raw or detailed test data, or a complete report.

DATE ORIGINATED 10/08/98	RELEASE NUMBER PA2042-E6	REVISION C	REVISION DATE 02/25/03	STANDARD NO. 49-00085	PAGE 4 OF 20
------------------------------------	------------------------------------	----------------------	----------------------------------	---------------------------------	------------------------

SUBJECT: SPECIFICATION – Performance Requirements: Electrical/Electronic Modules

5.1.5 Specific information regarding labeling, number of samples to test, and general conditions are addressed in Section 10 of this document.

5.1.6 Refer to Table 1 for Test Work Instructions.

TABLE 1

Test Work Instructions

TEST	SECTION	WORK INSTRUCTION	SAE J1455 ₁
Normal Operation	6.1.2	09TE-K18	4.11.1
Reverse Polarity, -24V	6.1.2	09TE-K18	4.11.1
Jump Start, +24V	6.1.2	09TE-K18	4.11.1
Cold Cranking, 0-6V	6.1.2	09TE-K18	4.11.1
Series Charging, +48V	6.1.2	09TE-K18	
Load Dump	6.2	09TE-K27	4.11.2.2
+600V Inductive Sw	6.2	09TE-K26	4.11.2.2
-600V Inductive Sw	6.2	09TE-K26	4.11.2.2
+300V Mutual Coupling	6.2	09TE-K26	4.11.2.2
-300V Mutual Coupling	6.2	09TE-K26	4.11.2.2
ESD	6.3.1	09TE-K17	5
Temperature Cycle	7.1	09TE-K16	4.1.3.1
Thermal Shock	17.2	09TE-K16	4.1.3.2
Humidity	7.3	09TE-K16	4.2.3
Dust Bombardment	7.4	09TE-K57	4.7.3
Mechanical Vibration	7.5	09TE-K47	

6 ELECTRICAL PERFORMANCE REQUIREMENTS:

6.1 STEADY STATE CONDITIONS

6.1.1 Reference the steady state electrical conditions of SAE J1455₁, "Joint SAE/TMC Recommended Environmental Practices for Electronic Equipment Design (Heavy Duty Trucks)", 4.11.1 Table 3a, for 12V systems. Operating temperatures shall range between -40°C and 85°C (-40°F and 185°F) for in-cab electronics/modules. Operating temperatures in the engine compartment and near exhaust piping will be higher, in most cases to 100°C. The specification of maximum expected

DATE ORIGINATED 10/08/98	RELEASE NUMBER PA2042-E6	REVISION C	REVISION DATE 02/25/03	STANDARD NO. 49-00085	PAGE 5 OF 20
------------------------------------	------------------------------------	----------------------	----------------------------------	---------------------------------	------------------------

SUBJECT: SPECIFICATION – Performance Requirements: Electrical/Electronic Modules

temperature will be determined by Freightliner Project and Test Engineers responsible for the module. Storage temperatures shall range between -40°C and 85°C .

- 6.1.2 The module shall operate consistently and correctly under the vehicle operating conditions specified in Table 1. Testing shall be performed at a standard room temperature environment of $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$. Fully charged Group 31 truck batteries shall be used as the power source. As defined by the Battery Council International₂, fully charged truck batteries have an open circuit value of 12.65 V. An acceptable tolerance is $\pm 0.1\text{ V}$. Direct any questions regarding this requirement to the test engineer responsible for the project.

TABLE 2
Truck/Tractor 12V System
Voltage Regulation Characteristics

Condition	Voltage ($\pm 0.1\text{V}$)	Performance Expectations <i>(communicate any deviations to the Freightliner Test Engineer responsible for the project)</i>	Notes
Normal Operating Vehicle	9V min – 16 V max	The module will operate consistently and correctly	14.2 V nominal
Reverse Polarity	-12.65 V	No damage shall occur mechanically, electrically, or logically after voltage application	Apply for 1 minute (min) then test
Reverse Polarity	-25.30 V	No damage shall occur mechanically, electrically, or logically after voltage application	Apply for 1 minute (min) then test
Jump Start	25.30 V	No damage shall occur mechanically, electrically, or logically after voltage application	Apply for 5 minutes (min) then test
Cold Cranking @ -40°C	Note 1/Figure 1	The module shall return to consistent and correct operation after being subjected to any cold cranking cycle. No adverse effects shall occur during cold cranking.	Apply waveform 2 times
Series Charging	Min +50.6 V	The module shall not fail in such a way as to create smoke, flame, or excessive heat. It is not a requirement that the module function after the test	Apply for 5 minutes (min) and note failure mode

DATE ORIGINATED 10/08/98	RELEASE NUMBER PA2042-E6	REVISION C	REVISION DATE 02/25/03	STANDARD NO. 49-00085	PAGE 6 OF 20
SUBJECT: SPECIFICATION – Performance Requirements: Electrical/Electronic Modules					

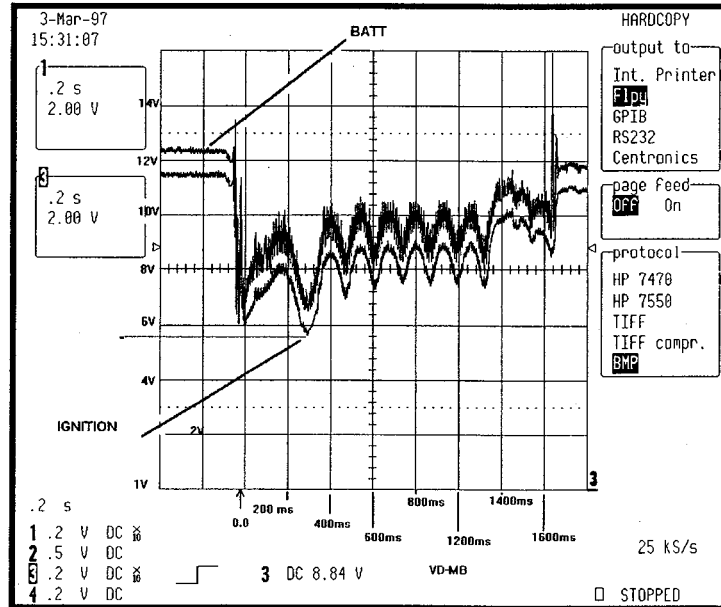


Figure 1: Battery and Ignition Cold Cranking Waveforms

Note 1: The waveform is representative of what occurs during a cold cranking cycle.

6.1.3 The component should maintain NORMAL operation even when the power to the unit is interrupted ($v=0$, $i=0$) for up to 10ms. Both ignition and battery voltage are interrupted at the same time. This test simulates battery voltage dropouts and brief interruption of power that can occur on the vehicle during normal operation. The above stated interruptions include the case of the harness vehicle power being drawn to ground ($V_{supply} = 0$) by a low impedance as well as an open circuit of the vehicle power to the component. One possible cause would be starting a high power inverter load.

6.2 Transient Levels

Reference SAE J1455, Section 4.11.2.2, Table 4a for 12 V systems. These tests shall be performed at standard room environment, $23^{\circ}C \pm 2^{\circ}C$. Test each connection singly for each condition. Any battery/ignition or power active input must withstand load dump and inductive transient as specified in Table 2. All wires must be protected against mutual coupling as specified in Table 2. Also, discuss with the Freightliner engineer which lines will be powered during transient testing. In addition, which lines were subjected to each test and whether or not they were powered, needs to be documented.

DATE ORIGINATED 10/08/98	RELEASE NUMBER PA2042-E6	REVISION C	REVISION DATE 02/25/03	STANDARD NO. 49-00085	PAGE 7 OF 20
------------------------------------	------------------------------------	----------------------	----------------------------------	---------------------------------	------------------------

SUBJECT: SPECIFICATION – Performance Requirements: Electrical/Electronic Modules

Table 3
Typical 12V Vehicle Transient
Voltage Characteristics

Lines	Type	Source Impedance (Ω)	Rise Time (μs)	Open Circuit Characteristics	Repetition	Min Approx Energy (J)	Performance Expectations
Power	Load Dump	0.4	100	$14 + 86 e^{(-t/0.4)}$	5 pulses at 10 s intervals	70	The module can deviate from expected performance but must return to normal operation once the pulse is removed.
I/O*	Inductive Switching	20	1.0	$14 \pm 600 e^{(-t/0.0001)}$	10 pulses at 1 s intervals	4.5	The module must operate properly, with no external assistance, before during and after being subjected to the test pulse
All I/O	Mutual Coupling	50	1.0	$14 \pm 300 e^{(-t/0.000015)}$	10 pulses at 1 s intervals	0.1	The module must operate properly, with no external assistance, before during and after being subjected to the test pulse

* This transient affects I/O lines that may be connected to unclamped inductive loads. Review with the Freightliner Test Engineer which lines will be tested for inductive switching.

6.3 Electrostatic Discharge (ESD)

6.3.1 Reference SAEJ1455, Section 4.11.2.2.5.1 and SAEJ1113-13. The module shall be tested for vulnerability to electrostatic discharge. For electrostatic discharge, the test procedure shall consist of discharging a 150pF capacitor that has been charged to a potential of ± 15 KV through a 150 Ω resistor (capacitor to be discharged through this resistor during test). The case of the electronic module shall be grounded, the ground pin connection to the module grounded, and each pin tested individually, 3 times with a positive pulse and 3 times with a negative pulse. The module is to be submitted to electrostatic discharge while non-functional, then tested for consistent and correct operation.

DATE ORIGINATED	RELEASE NUMBER	REVISION	REVISION DATE	STANDARD NO.	PAGE
10/08/98	PA2042-E6	C	02/25/03	49-00085	8 OF 20

SUBJECT: SPECIFICATION – Performance Requirements: Electrical/Electronic Modules

6.3.2 In-vehicle ESD evaluation will consist of discharging a 150 pF capacitor that has been charged to a potential of ± 15 KV through a 150 Ω resistor (capacitor to be discharged through this resistor during the test). Test procedures will follow SAE J551/15, "Vehicle Electromagnetic Immunity – Electrostatic Discharge (ESD)". Test points are to include all surfaces, switches, knobs and levers that may be touched by an occupant in the vehicle. The module may be tested in the key "ON" and engine idle conditions, as well as vehicle drive conditions, as specified by the Freightliner engineer. Deviations from normal operation will be recorded and reported to the Freightliner Test Engineer.

6.4 Electromagnetic Interference (EMI) Susceptibility

6.4.1 Acceptable Performance Criteria

The module shall be determined to not malfunction on any Freightliner vehicle in the presence of radiated interference from 10KHz to 1GHz. Criteria to determine acceptable performance will follow SAE J1812, "Function Performance Status Classification for EMC Susceptibility Testing of Automotive Electronic and Electrical Devices." The Freightliner Test Engineer responsible for the module shall classify functionality as A, B, or C as follows:

- Class A:** any function that provides a convenience (i.e. entertainment or comfort)
- Class B:** any function that enhances but is not essential to the operation or control of the vehicle (i.e. tachometer)
- Class C:** any function that is essential to the operation of the vehicle (i.e. brake or engine control system)

Performance will be judged based on the following region definitions and test severity levels.

Region 1: The function operates as designed during and after exposure to a disturbance.

Region 2: The function may deviate from designed performance during exposure to a disturbance and revert to a fail-safe mode of operation, but must return to normal operation, without operator assistance, after the disturbance is removed.

Region 3: The function may deviate from designed performance during exposure to a disturbance. Operator action is permitted to return the function to normal operation after the disturbance is removed.

DATE ORIGINATED 10/08/98	RELEASE NUMBER PA2042-E6	REVISION C	REVISION DATE 02/25/03	STANDARD NO. 49-00085	PAGE 9 OF 20
------------------------------------	------------------------------------	----------------------	----------------------------------	---------------------------------	------------------------

SUBJECT: SPECIFICATION – Performance Requirements: Electrical/Electronic Modules

Test Severity Levels:

Level 3: 100 V/m

Level 2: 80 V/m

Level 1: 50 V/m

Performance of the module must conform to the following matrix:

	Class A	Class B	Class C
Level 3 (100 V/m)	Region 3	Region 2	Region 1
Level 2 (80 V/m)	Region 2		
Level 1 (50 V/m)	Region 1	Region 1	

Interpretation of Matrix:

A class C device is an essential component and has the most stringent requirements. Performance must be acceptable during and after exposure to an electromagnetic field, without operator intervention, up to and including 100 V/m.

A class B device must have acceptable performance, without operator intervention, up to and including 50 V/m. From 50 – 100 V/m, the component may deviate from designed performance during an exposure to an electromagnetic field and revert to a fail-safe mode of operation. The component must return to normal operation after the electromagnetic field is removed, without operator intervention.

A class A device must have acceptable performance during and after exposure to an electromagnetic field, without operator intervention, up to and including 50 V/m. From 50 – 80 V/m they may deviate from designed performance during exposure to an electromagnetic field and revert to a fail safe mode of operation. The component must return to normal operation, without operator action, once the electromagnetic field is removed. Finally, from 80 –100 V/m, operator intervention is allowed to reset the device and it must function properly after the disturbance is removed.

6.4.2 Susceptibility Test Procedures

Radiated susceptibility test procedures shall meet the following SAE J1113/21, "Road Vehicles-Electrical Disturbances by Narrowband Radiated Electromagnetic Energy-Component Test Methods Part 21-Absorber Lined Chamber. Notify the

DATE ORIGINATED	RELEASE NUMBER	REVISION	REVISION DATE	STANDARD NO.	PAGE
10/08/98	PA2042-E6	C	02/25/03	49-00085	10 OF 20

SUBJECT: SPECIFICATION – Performance Requirements: Electrical/Electronic Modules

Freightliner Test Engineer of any procedural deviations. Square wave modulation of 1KHz at 100% for those frequencies greater than or equal to 200MHz and a sine wave modulation of 1KHz at 100% for those frequencies below 200MHz. A copy of the test results and data is to be sent to the Freightliner Test Engineer responsible for the module. Freightliner will be ultimately responsible for determining whether a module functions satisfactorily.

General information regarding test set-up and definitions can be found in SAE J1113/1, "Electromagnetic Compatibility Measurement Procedures and Limits for Vehicle Components (Except Aircraft) (60Hz to 18GHz)" and SAE J551/1, "Performance Levels and Methods of Measurement of Electromagnetic Compatibility of Vehicles and Devices (60Hz – 18 GHz)".

6.5 EMI Emissions

Radiated emission levels emitted by the module shall be documented for strength and distance. Results will be provided to the Freightliner Test Engineer responsible for the module. Use test procedure SAE J1113/41, "Limits and Methods of Measurements of Radio Disturbance Characteristics of Components and Modules for the Protection of Receivers Used Onboard Vehicles".

6.6 EMI Whole Vehicle Requirements

Electrical/electronic modules must be able to meet whole vehicle EMI requirements. Guidelines for whole vehicle *emissions* test follow SAE J551/4, "Test Limits and Methods of Measurement for Radio Disturbance Characteristics of Vehicles and Devices, Broadband and Narrowband, 150kHz to 1000MHz". Guidelines for whole vehicle *susceptibility* should follow SAE J551/11, "Vehicle Electromagnetic Immunity-Off-Vehicle Source", or SAE J551/14 "Vehicle Electromagnetic Immunity-Reverberation Chamber". Contact the responsible Freightliner Test Engineer for any deviation from these guidelines, such as direct illumination of the DUT during J551/14 test.

6.7 Elevated Ground Requirements

Within the vehicle wiring system there may be up to a 2V potential difference in the electrical grounds at any two points. For dedicated ground lines, a potential ground difference of 0.5 V is all that may be expected. The unit shall be designed such that these ground voltage differences have no objectionable effect on the normal operation of the vehicle. This shall include any sensors or other elements that may be connected directly to the unit. The module will be tested to determine the effects of ground potential differences. These effects are to be reported to the Freightliner Test Engineer responsible for the project who will determine if they are acceptable or not. Drastic effects such as resetting of a processor or large variances in module output will not be considered acceptable performance. Testing will concentrate on having the ground to the DUT shift in

DATE ORIGINATED 10/08/98	RELEASE NUMBER PA2042-E6	REVISION C	REVISION DATE 02/25/03	STANDARD NO. 49-00085	PAGE 11 OF 20
------------------------------------	------------------------------------	----------------------	----------------------------------	---------------------------------	-------------------------

SUBJECT: SPECIFICATION – Performance Requirements: Electrical/Electronic Modules

voltage ± 2.0 V with respect to common grounds on other ECU's, switches, or components of the system that are connected to the module under test. The capability of full operation, with ground differentials is particularly important with respect to interaction of the module with other vehicle systems on J1939 and J1708/J1587. Ground differentials within ± 1.0 V between the ground at the module and the other components should have no effect on the module or connected components.

6.8 Sneak Paths

Sneak paths are unintentional current flows or voltage potentials. Sneak paths can have unintentional results such as switched "off" devices remaining "on", or devices exhibiting incorrect behavior.

6.8.1 When IGN key is "off", there should be no voltage or current back-feed to any I/O pins from battery connections.

6.8.2 When IGN key is "off", the system/component should not respond to "small voltages" (< 5 V) that might be leaked onto the IGN or ACC buss from other systems.

6.8.3 When IGN key is "off", any I/O that is connected through a load to the BATT bus, should not allow any sneak path to any other I/O pin, IGN pin, or ACC pin.

7 MECHANICAL PERFORMANCE REQUIREMENTS

Note: Temperature readings should be within $\pm 5^{\circ}$ F ($\pm 2.8^{\circ}$ C) when conducting temperature related tests.

7.1 Temperature Cycle Test

Using the thermal cycle of SAE J1455, Section 4.1.3.1, Figure 2b, or reference figure 2 below, test the module(s) for 25 cycles of 8 hours duration with a maximum temperature of 85° C. During the entire test, modules are to be powered with 16V. Modules will be monitored and functionally exercised once a day at temperatures of -40° C, 23° C, and 85° C. Modules are to be powered and functioning throughout the test, not just when they are functionally exercised and monitored at specified temperatures. The Freightliner Test Engineer responsible for the project will specify functionality to be exercised while the test is running. It is expected that all module functions will be exercised when the module is monitored at specified temperatures. Note that modules to be located within or near the engine compartment or exhaust piping may be tested to a higher temperature, in most cases to 100° C. The maximum temperature requirement will be specified by the Freightliner Project and Test Engineers responsible for the module.

DATE ORIGINATED 10/08/98	RELEASE NUMBER PA2042-E6	REVISION C	REVISION DATE 02/25/03	STANDARD NO. 49-00085	PAGE 12 OF 20
SUBJECT: SPECIFICATION – Performance Requirements: Electrical/Electronic Modules					

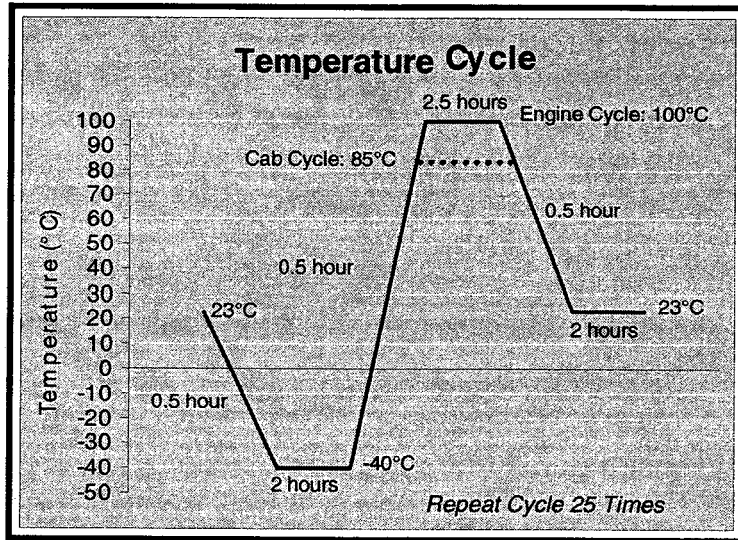


Figure 2: Temperature Cycle for Cab and Chassis Equipment

7.2 Thermal Shock

Using the thermal shock profile of SAE J1455₁, Section 4.1.3.2, Figure 2c, or reference figure 3 below, test the unit(s) for six consecutive days. Each day is to contain six 4-hour cycles as shown in Figure 2c of the SAE document, for a grand total of 36 4-hour cycles over six days. Units should be powered up with 9V for day 1, 13.8V for day 2, 16V for day 3, 9V for day 4, 13.8V for day 5, and 16V for day 6. Modules are to be functionally exercised and monitored during the 30 minutes before each temperature transition and turned off 30 minutes after each temperature transition. Note that modules that will be located within or near the engine compartment or exhaust piping may be tested to a higher temperature, in most cases to 100°C. The maximum temperature requirement will be specified by the Freightliner Project and Test Engineers responsible for the module.

DATE ORIGINATED 10/08/98	RELEASE NUMBER PA2042-E6	REVISION C	REVISION DATE 02/25/03	STANDARD NO. 49-00085	PAGE 13 OF 20
------------------------------------	------------------------------------	----------------------	----------------------------------	---------------------------------	-------------------------

SUBJECT: SPECIFICATION – Performance Requirements: Electrical/Electronic Modules

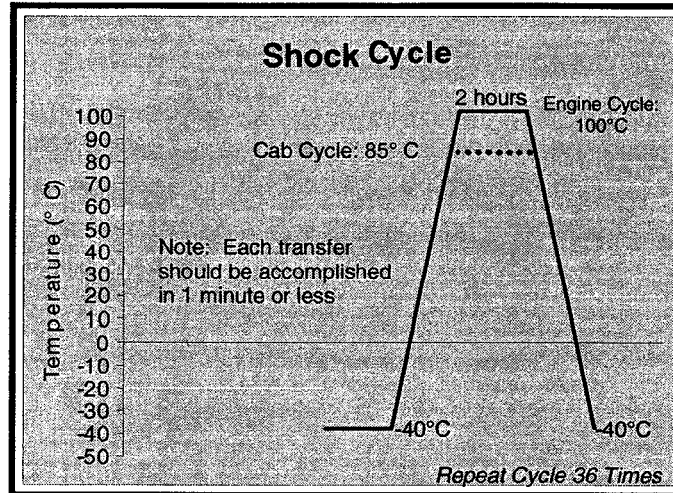


Figure 3: Shock Cycle for Cab and Chassis Equipment

7.3 Humidity

The module shall operate correctly and consistently in an environment of 95% ± 5% relative humidity at 38°C. Using SAE J1455₁ Section 4.2.3 Figure 4a, or reference figure 4 below, test the unit(s) for 30 cycles of 8 hours each with a maximum temperature of 85°C. 95% ± 3% relative humidity is to be used for all temperatures between 15°C and 38°C. Every third cycle induce frost on the modules (method to be approved by the Freightliner Test department) while at -40°C. Modules shall be powered up at 16V, functionally exercised, and monitored during the frost cycles and during the entire time the temperature is at 38°C. Modules are to be powered and functioning throughout the test, not just when they are functionally exercised and monitored at specific temperatures. The Freightliner Test Engineer responsible for the project will specify functionality to be exercised while the test is running. It is expected that all module functions will be exercised when the module is monitored at specified temperatures. Note that the maximum temperature in Figure 4a, in section 4.2.3 of SAE J1455₁ may be higher than 85°C for modules to be located in the engine compartment or near the exhaust piping. In most cases the test temperature will be 100°C. The maximum temperature requirement is to be specified by the Freightliner Project and Test Engineers responsible for the module.

DATE ORIGINATED	RELEASE NUMBER	REVISION	REVISION DATE	STANDARD NO.	PAGE
10/08/98	PA2042-E6	C	02/25/03	49-00085	14 OF 20

SUBJECT: SPECIFICATION – Performance Requirements: Electrical/Electronic Modules

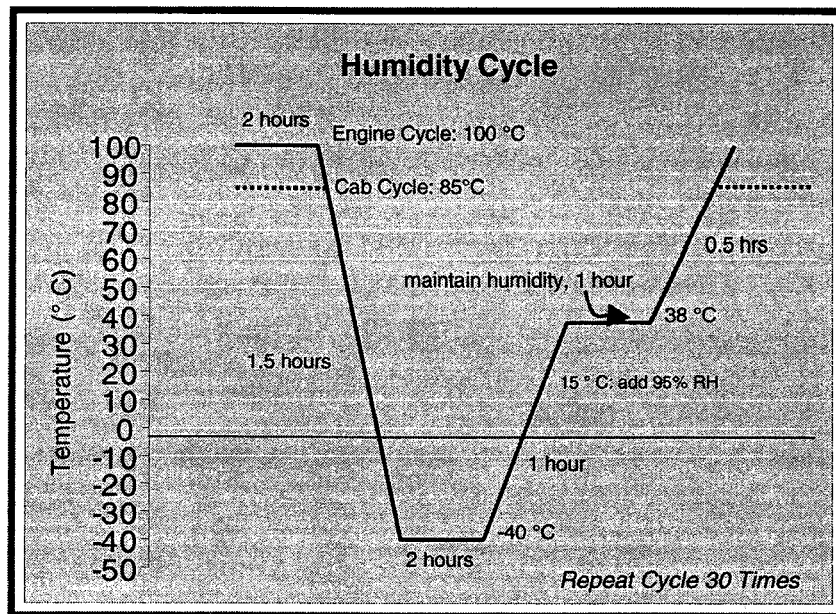


Figure 4: Humidity Cycle for Cab and Chassis Equipment

7.4 Dust Bombardment

Using SAE J1455₁ section 4.7.3, alternate method, place the module about 6 inches from one wall in a 3ft cubical box. The box should contain 10 lb. of fine powered cement in accordance with ASTM C 150-56. At intervals of 15 minutes, the dust must be agitated by compressed air or fan blower. Blasts of air for 2 sec period in a downward direction assure that the dust is completely and uniformly diffused throughout the entire cube. The dust is then allowed to settle. The cycle is repeated for 5 hours. Any collection of dust shall not inhibit the functional or mechanical operation of the module. Results from these tests shall be sent to the Freightliner Test Engineer responsible for the module.

7.5 Mechanical Vibration

The module shall function consistently and correctly after being submitted to the following random profile vibration test for 3 hours along each of three mutually perpendicular axes, as referenced in each individual electronic module design specification, for 9 hours total.

DATE ORIGINATED	RELEASE NUMBER	REVISION	REVISION DATE	STANDARD NO.	PAGE
10/08/98	PA2042-E6	C	02/25/03	49-00085	15 OF 20

SUBJECT: SPECIFICATION – Performance Requirements: Electrical/Electronic Modules**Random Profile: X, Y, and Z axis****Frequency Range: 5-500 Hz****Power Density Level: *0.0635 G²/Hz, 5-100 Hz, 3dB per octave roll-off to 500Hz****Test Level: 4.0G's**

Note: For chassis mounted equipment the test level will be 8.0G's with a corresponding Power Density Level of 0.2535 G²/Hz.

*Some test equipment is not capable of generating the recommended profile at lower frequencies. Discuss these limitations with the Freightliner Test Engineer responsible for the project.

For some applications the module should be powered and specific functions monitored. Discuss this requirement with the Freightliner Test Engineer responsible for the project.

7.6 Mechanical Shock

7.6.1 Handling Shock: Modules shall withstand a drop test of one meter onto a concrete surface, per SAE J1455₁, Section 4.10.3.1. If there is no visible damage, or only minor scratches, then the module must pass all functional tests. If there is obvious damage which would cause the plant to reject the module, then the module does not have to pass all functional tests. The module should not disintegrate into many pieces upon impact.

7.6.2 Transit Drop: Modules contained in a shipping package shall withstand a drop test onto a concrete surface, per SAE J1455₁, Section 4.10.3.2.2.

7.6.3 Operational Shock: Modules must be functional after exposure to the shock signal defined in MIL-STD 202F, "Test Methods for Electronic and Electrical Component Parts", Method 213B, Test Condition J.

7.7 Salt Spray

Components installed on the chassis, exterior, and under-hood are exposed to a salt spray environment. A recommended test method is identified in SAE J1455₁, Section 4.3

7.8 Steam Cleaning And Pressure Wash

Components installed on the chassis, exterior, and under-hood are exposed to steam-cleaning and pressure washing. A recommended test method is identified in SAE J1455₁, Section 4.5

DATE ORIGINATED	RELEASE NUMBER	REVISION	REVISION DATE	STANDARD NO.	PAGE
10/08/98	PA2042-E6	C	02/25/03	49-00085	16 OF 20

SUBJECT: SPECIFICATION – Performance Requirements: Electrical/Electronic Modules

7.9 Immersion And Splash (CHEMICALS AND OILS)

Electronic components are exposed to varying amounts of chemicals and oils. A list of potential chemicals and a recommended test method are included in SAE J1455, section 4.4. A list of chemicals and/or oils should be discussed with the Freightliner test engineer responsible for the project.

8 Data Communications

It is the responsibility of the supplier to be familiar with SAE standards, in particular J1939, J1708, and J1587. The supplier shall also be responsible for petitioning the appropriate SAE subcommittee/task force for any new message, identifier, or other necessary items for these data links in connection with the functions of the module.

The module or system may use ServiceLink with message interaction as described below if external programming or support in the field is required. Please refer to the product specification and/or the test engineer responsible for the project to determine if this will be applicable.

8.1 J1708/J1587

- 8.1.1 Unless specified otherwise in the Freightliner product specification, any data communications shall meet applicable recommended practices of SAE and Freightliner communications specifications. Hardware is to comply with standard node definitions; serial communications are to comply with bit rate and standard data formatting requirements.
- 8.1.2 Each data bus shall be loaded to approach 100 percent bus utilization with data typical to what occurs on a Freightliner vehicle. Any deviations in module performance shall be noted along with the percentage of bus utilization at which the deviation occurred. This information shall be communicated to the Freightliner Test Engineer responsible for the module.
- 8.1.3 The module shall be able to extract data required for its operation from J1587 PID 192 multi-section messages, and shall be able to correctly format oversized outgoing messages into PID 192 sections when necessary.
- 8.1.4 Unless specified by the responsible Freightliner Project Engineer, the module shall filter data first on MID, then PID. This requirement is to ensure that the module does not respond to conflicting data from two sources MID's on the vehicle network.

DATE ORIGINATED	RELEASE NUMBER	REVISION	REVISION DATE	STANDARD NO.	PAGE
10/08/98	PA2042-E6	C	02/25/03	49-00085	17 OF 20

SUBJECT: SPECIFICATION – Performance Requirements: Electrical/Electronic Modules

- 8.1.5 Under no circumstances shall SAE J1587/J1708 bus overloading cause the module to do resets, nor cause it to lose its basic controls functionality.
- 8.1.6 Physical layer feature (short circuit, open circuit) of the SAE J1587/1708 data bus shall not cause the module to reset or cause it to lose its basic controls functionality.
- 8.1.7 Repeated requests for data by off-board service equipment on the vehicle network (source MID 172, using component specific or global requests) shall not cause the module to deviate from its specified functionality. Requests for data will be at a 10 per second rate.
- 8.1.8 The module shall respond to both global request PID 0 and component specific request parameters as described in SAE J1587.
- 8.1.9 The module is to ignore valid messages with MIDs below 128 and unassigned MIDs currently held in reserve by the SAE J1587 subcommittee.
- 8.1.10 The module will correctly handle transmitter diagnostic PID 194 with close attention to the correct usage of byte count, SID/PID code byte, diagnostic code byte and occurrence code byte. This PID is to be transmitted once whenever a module fault goes active and once again whenever a module fault goes inactive, but never more than once a second (see PID 194 definition in SAE J1587).
- 8.1.11 The module will be verified for correct processing of Extension PID 255 and Data Link Escape PID 254.
- 8.1.12 Support for the following PIDs are required for all modules: 243, 234, 168, 0, 128, and 194 for active fault reports. It is desirable to have the component support PID 194 stored fault reporting. If either of these fault lists have the potential of being large, or the device requires long transmissions, PID 192 must be used. Single bit collision detection is recommended.

8.2 J1939

Potential failures modes are listed below and acceptable performance criteria is provided in SAE J1939/11 Oct 97. The supplier is responsible for documenting and communicating any performance issues with the Freightliner Test and Design Engineers responsible for the project.

- 8.2.1 If a node is disconnected from the network, communication should not be disrupted between other nodes.
- 8.2.2 Loss of power or ground connection to the device

DATE ORIGINATED	RELEASE NUMBER	REVISION	REVISION DATE	STANDARD NO.	PAGE
10/08/98	PA2042-E6	C	02/25/03	49-00085	18 OF 20

SUBJECT: SPECIFICATION – Performance Requirements: Electrical/Electronic Modules

8.2.2.1 If a node loses power, or if it is in a low voltage condition, and the network is not loaded down, the remaining nodes shall continue to communicate.

8.2.2.2 If a node loses ground, the network shall not be biased up. The remaining nodes shall continue to communicate.

8.2.3 Open and short failures: In principle, failures are detectable if there is a significant message destruction rate, as interpreted by the electronic control units.

8.2.3.1 CAN_H Open Circuit: Data communication between nodes on opposite sides of an interruption is not possible. Data communication between nodes on the same side of an interruption may be possible, but with reduced signal-to-noise ratio.

8.2.3.2 CAN_L Open Circuit: Data communication between nodes on opposite sides of an interruption is not possible. Data communication between nodes on the same side of an interruption may be possible, but with reduced signal-to-noise ratio.

8.2.3.3 CAN_H Shorted to VBat: Data communication is not possible if VBat is greater than the maximum allowed common mode bus voltage.

8.2.3.4 CAN_L Shorted to VBat: Data communication is not possible.

8.2.3.5 CAN_L is Shorted to GND: Data communication is possible, because the bus voltages are within the common mode voltage range. Signal-to-noise ratio is reduced and radiation is increased. The electromagnetic immunity is decreased.

8.2.3.6 CAN_H is Shorted to GND: Data communication is not possible.

8.2.3.7 CAN_H is Shorted to CAN_L: Data communication is not possible.

8.2.3.8 Both Bus Lines are Interrupted at the Same Location: Data communication between nodes on opposite sides of an interruption is not possible. Data communication between nodes on the same side of the interruption may be possible, but with reduced signal-to-noise ratio.

8.2.3.9 Loss of Termination Resistor: Data communication via the bus may be possible, but with reduced signal-to-noise ratio.

8.2.3.10 Topology Parameter Violations (i.e. bus length, cable stud length, node distribution): Data communication via the bus may be possible, but with reduced signal-to-noise ratio.

DATE ORIGINATED	RELEASE NUMBER	REVISION	REVISION DATE	STANDARD NO.	PAGE
10/08/98	PA2042-E6	C	02/25/03	49-00085	19 OF 20

SUBJECT: SPECIFICATION – Performance Requirements: Electrical/Electronic Modules

8.2.4 If a shielded cable is used, test for the condition of an unconnected shield. Communication is possible but the electromagnetic interference increases.

9 DELIVERY CONDITIONS

- 9.1 As explained in the Freightliner supplier quality requirements manual, suppliers must complete all applicable elements of Production Part Approval Process (PPAP) published by AIAG. The default submission level is based on supplier's current rating with Freightliner.
- 9.2 All production and pre-production units shall complete a single 8 hour temperature cycle as described in Section 3.1.1 of this document. After burn-in, the units shall be functionally tested and only units that operate consistently and correctly during and after burn-in may be shipped to Freightliner. With each production lot shipped, documentation of the percentage of that lot passing the requirements shall be supplied. This requirement may be waived once the supplier has shown with documentation that 500 consecutive modules have been produced without any flaws or functional problems being induced by this burn-in.

10 EVALUATION UNITS

- 10.1 All evaluation units sent to Freightliner shall be accompanied by documentation as to the circuit and software design levels. Evaluation units shall be clearly marked with the revision level so it may be distinguished from earlier and later revision levels of the design.
- 10.2 Freightliner requires the supplier to provide prototype units for Freightliner's evaluation at agreed upon design levels. The quantity will be a minimum of six units of each major revision level up to and including fully functional units. These units are classified as Engineering "E" status parts by Freightliner. These units do not have to meet all of the specified performance requirements, but must be operational to an agreed upon level. Level of operation is to be documented by the supplier. This documentation is to accompany the part when it is delivered to Freightliner and shall be clearly identified with the rev level of the part it describes (reference 6.1). Within the category of "E" status parts, Freightliner, used the following terminology to classify development sample levels:

DATE ORIGINATED	RELEASE NUMBER	REVISION	REVISION DATE	STANDARD NO.	PAGE
10/08/98	PA2042-E6	C	02/25/03	49-00085	20 OF 20

SUBJECT: SPECIFICATION – Performance Requirements: Electrical/Electronic ModulesClassification of “E” status parts (engineering samples)

“A” Development Samples:-- prototypes are expected to function

- some rework of pc board permissible
- some rework of mechanical parts permissible
- non-production housing permissible
- production intent electrical circuits
- production intent software

“B” Development Samples:-- correct housing and connector required

- few, if any, pc board reworks
- hardware is EMI/EMC “testable”
- pinouts/circuit definitions “frozen”
- samples ok for early field tests

“C” Development Samples:-- pre-production units

- 100 % production intent
- incorporates changes from B sample testing
- not necessarily built with production processes

Series Production: -- Obvious definition

10.3 Freightliner requires that the supplier also provide pre-production units for Freightliner’s evaluation. The intent is that each unit shall meet all of the specified performance requirements. These units are classified as “A” status parts by Freightliner (not to be confused with “A” development samples as described in section 6.2). The pre-production unit(s) will be connected into a fully functional Freightliner vehicle and tested. Upon passing the tests, the unit(s) can then be approved for production.

Footnotes:

¹ SAE J1455, Version AUG94

² Battery Council International, Nov 1995

Note: Unless specified, use the most current revision available for the documents referenced in this specification.



R&D Work Request

A Subsidiary of **FREIGHTLINER**
CORPORATION

WORK ORDER NUMBER:	97269
REF. NUMBER:	NONE
HOURS TO DATE:	0
REQUEST TYPE:	RDWR

REQUESTER	REQUESTER EXTENSION	FIXTURE NUMBER ID:
Steve Javonovich		NO

ASSIGNED DATE:	ESTIMATED START DATE:	DESIRED COMPLETION DATE:	ASSIGNED TO:
7/5/2007	7/5/2007	7/30/2007	M.MACIAS

DESCRIPTION:

ER-HDX BODY ELECTRICAL CIRCUIT BOARD FIRE INVESTIGATION:

TEST ITEM

ER-HDX Body Electrical Circuit Board Field Investigation

TEST PURPOSE

Determine mode of failure of circuit boards catching fire on customer field units

COMMENTS

IN-HOUSE

ESTIMATED HOURS:	ESTIMATED COMPLETION DATE:
40	8/16/2007

RESPONSE / COMPLETION SUMMARY:

REVISED ESTIMATED HOURS:	REVISED ESTIMATED COMPLETION DATE:	ACTUAL COMPLETION DATE: