2000-01-2611

Keeping your Sanity when using SAE J-1113

Edward T. Heck
HED (Hydro Electronic Devices, Inc.)

ABSTRACT

This paper tries to bring some semblance of sanity to the understanding and setting of test levels for testing EMI/RFI susceptibility of components used in heavy duty and Off-Road applications of Mobile Equipment Electronics. The most often used specification in the United States is the SAE J-1113 Surface Vehicle Standard for "ELECTROMAGNETIC COMPATABILITY MEASUREMENT PROCEEDURES AND LIMITS FOR VEHICLE COMPONENTS (EXCEPT AIRCRAFT) (60 HZ TO 18 GHZ)".

While some parts of the various SAE J-1113-* specification have suggested levels for acceptance, most sub parts leave the setting of the test levels to the equipment designer or customer. Once the level is agreed to, there must be agreement on the "Functional Status Classification" as well as the Region of performance required.

WHAT ARE THE PARTS OF SAE J-1113?

J-1113-1: General description and Definitions.
J-1113-2: Conducted Immunity, 30 Hz to 250 kHz, Power Leads.
J-1113-3: Conducted Immunity, 250 kHz to 500 MHz, Direct Radio Frequency (RF) Power Injection.
J-1113-4 Conducted Immunity- Bulk Current Injection (BCI) Method
J-1113-11: Immunity to Conducted Transients on Power Leads
J-1113-12: Electrical Interference by Conduction and Coupling- Coupling Clamp
J-1113-13: Immunity to Electrostatic Discharge
J-1113-21: Road Vehicles- Electrical Disturbances by Narrowband Radiated Electromagnetic Energy- Component Test Methods – Absorber Lined Chamber
J-1113-22: Immunity to Radiated Magnetic Fields from Power Lines
J-1113-23: Immunity to Radiated Electromagnetic Fields, 10 kHz to 200 MHz, Strip Line Method
J-1113-24: Immunity to Radiated Electromagnetic Fields, 10 kHz to 200 MHz, TEM Cell Method (to be released before end of 2000)
J-1113-25: Immunity to Radiated Electromagnetic Fields, 10 kHz to 500 MHz, Tri-plate Line Method
J-1113-26: Immunity to AC Power Line Electric Fields
J-1113-27: Immunity to Radiated Electromagnetic Fields- Reverberation Chamber Method
J-1113-41: Test Limits and methods of Measurement of Radio Disturbance Characteristics from Vehicle Components and Modules, Narrowband, 150 kHz to 1000 MHz
J-1113-42: Conducted Transient Emissions

WHAT OTHER SAE STANDARDS ARE INVOLVED?

J-1812: Function Performance Status Classification for EMC Immunity Testing
Other various ISO, CISPR, FCC, and other regulating body standards

OTHER STANDARDS THAT ARE SIGNIFICANT IN THE DETERMINATION OF THE LEVEL OF TESTING TO BE SPECIFIED

IEEE Std C95.1, 1999 Edition: IEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.

WHAT SOME PEOPLE IN THE FIELD ARE ASKING FOR.

Because customers who are not experienced in EMI/RFI testing have heard the "urban legend" stories of things running away or "someone" being sued because of EMI/RFI causing "something" to actuate or stop; they are "testing beyond the 'industry standards'" to avoid the possibility of a problem or a liability suit. Custom electronics manufacturers are seeing requests for every J-1113 standard and test levels to AS HIGH AS 250 V/M.

These responses to the perceived problem result in over designed components, significantly increased test costs, and longer development cycles.

WHAT IS SAE J-1812 AND HOW DOES IT AFFECT J-1113?

"This SAE Standard provides a general method for defining the function performance status classification for the functions of automotive electronic devices upon the application of the test conditions specified as described in appropriate EMC test standards (for example, the SAE J1113 series and the SAE J551 series.) Testing of devices could be performed either on or off vehicles. Appropriate test signal and methods, region of performance, and test signal severity level would have to be specified in the individual cases."

In order to use SAE J-1812, it is necessary to establish the Functional Status Classification, Region of Performance, and the Test Signal Severity Level. Functional status is fairly well defined and selecting either Class A, B, or C should be relatively straight forward. The Region of Performance is then defined in Appendix A, Figure A1. Then comes the million dollar question: the Test Signal Severity Level. The specification provides no help in establishing the value of "V" for the conducted Transient Injection test or the value of "E" for Radiated Immunity tests. It only describes the philosophy for developing the values.

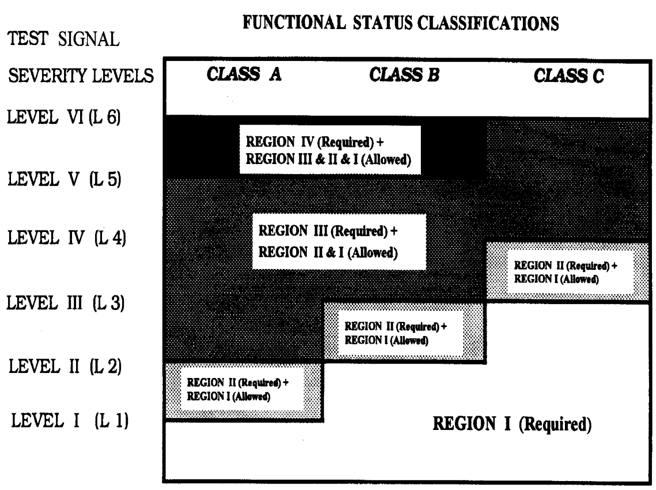

FIGURE A1—FUNCTION PERFORMANCE STATUS ON CLASSIFICATION

Fig. 1, J-1812 Function Performance Status on Classification.

The SAE J-1113 series only has suggested or "recommended" values for the test levels in the Appendices and in one case (J-1113-21) they give an example. The lone exception is SAE J-1113-13 which covers ESD testing.

THE USE OF SAE J-1113 TO DETERMINE THE PROPER TESTS FOR YOUR APPLICATION.

CONDUCTED INTERFERENCE IMMUNITY.

SAE J-1113-2, 3, 4, 11, and 12 cover conducted immunity. J-1113-2 and 3 are complimentary in that –2 covers from 30 Hz to 250 kHz and J-1113-3 covers from 250 kHz to 500 MHz. Both use direct injection methods also referred to as Direct Radio Frequency Injected (DRFI). SAE J-1113-4 is an alternative method covering 1 MHz to 400 MHz using the Bulk Current Injection (BCI) method. J-1113-4 is used to simulate the effect of the DUT (Device Under Test) and its wire harness when both are in the field of high power transmitting antennas (on or off the vehicle). While a few equipment manufacturers specify both J- 1113-3 and J-1113-4, most use only one or the other. Recently there has been a trend toward J-1113-4 as a result of its simulation of the probable source of problems coming from EMI/RFI. Most Equipment Manufacturers specify the suggested test levels in the respective Appendices. There are exceptions. We have seen requests for test levels of 800 mW for J-1113-4 (versus the suggested 500 mW in Appendix B) and 125 mA for J-1113-4 (versus the suggested 100 mA in Appendix A).

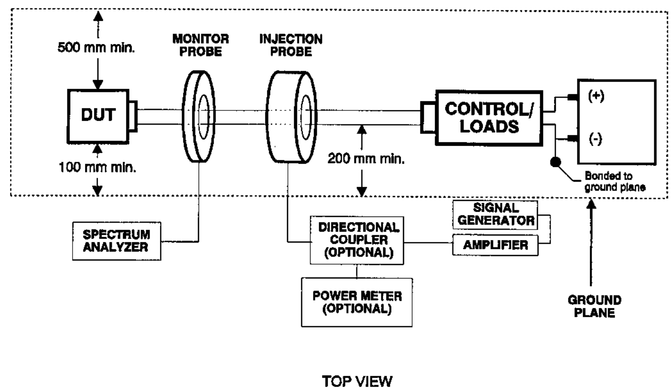

Fig. 2, J-1113-4 BCI Test Setup.

The Immunity to Conducted Transients on Power Leads test J-1113-11 is similar to the three Standards above except the test is to determine the immunity of the DUT to interference from conducted transients resulting from disturbances elsewhere on the power supply bus. The test levels are defined as: 12 Volt systems on passenger car and light-duty trucks, 12 Volt systems on heavy-duty trucks, and 24 Volt systems. Unless the system to be tested is specifically targeted for less than 24 Volt systems, the testing specified should follow the 24 Volt requirements. Please note that many of the features that machine designers are becoming accustomed to may not be available economically. This is due to the requirement to being able to withstand the specified 150 VDC open circuit voltage. This becomes troublesome if the DUT is classified as Class C (controls or affects the essential operation of the vehicle) (also sometimes identified as life threatening).

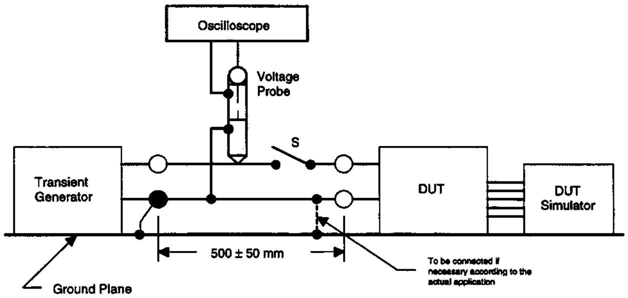

FIGURE 8—TEST SETUP FOR CONDUCTED TRANSIENT IMMUNITY

Fig. 3, J-1113-11 Test Setup for Conducted Transient Immunity.

RADIATED INTERFERENCE IMMUNITY.

SAE J-1113-21, 22, 23, 25, 26, and 27 cover Radiated Immunity to EMI/RFI. SAE J-1131-21 covers the Compatibility Measurement Procedure for 10 kHz to 18 GHz when tested in Absorber-Lined Chamber (ALC). This procedure is designed to simulate open-field testing. The test room is shielded room the has at least the four walls and the ceiling lined with EMI/RFI absorbing material that is generally some type of ferrite material to reduce the reflectivity of the room. The suggested severity level 6 is 100 V/M. A number of customers are now requesting test levels of 150, 200, or more V/M.

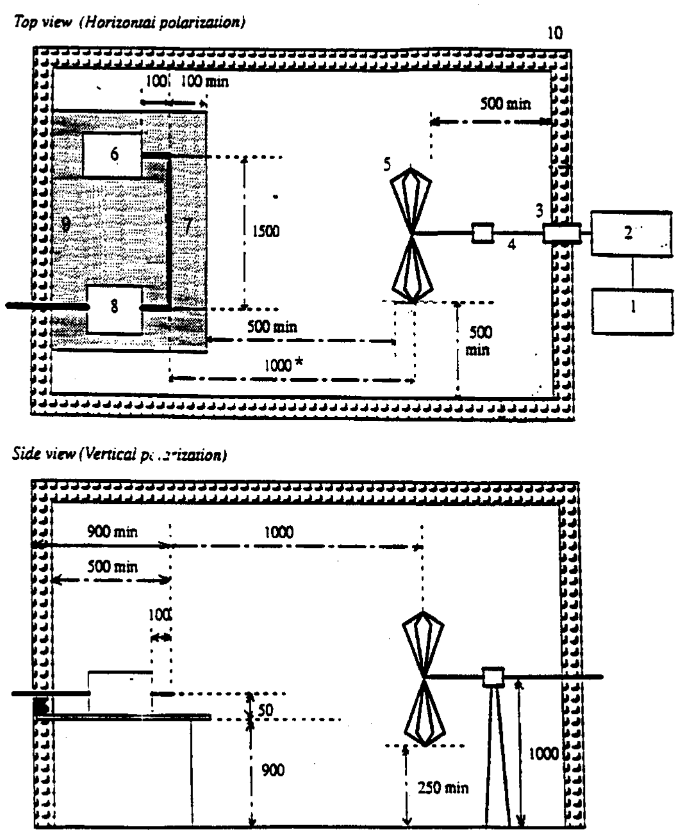

Fig. 4, J-1113-21 Test Configuration.

SAE J-1113-23 uses the Strip Line method of radiated electromagnetic fields to test the DUT and the harness by placing them on an insulated surface that is mounted on a ground plane with a strip line over the cables. The strip line is energized by a RF amplifier to the desired level. The suggested maximum power is 200 V/M.

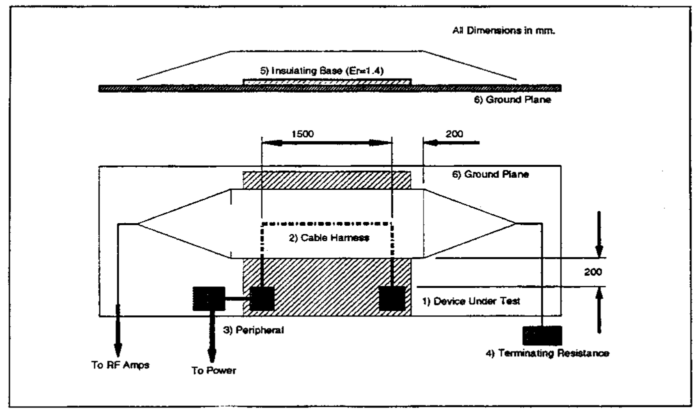

FIGURE 1—STRIP LINE TEST CONFIGURATION

Fig. 5, J-1113-23 Strip Line Test Configuration.

Per J-1113-23 dated 1995-09; "this method is being replaced by the Tri-plate Line (SAE J1113-25) which is considered to be a superior test method." The five-year grace period ends in 2000 when the Standard will be withdrawn.

The Tri-plate method contained in SAE J-1113-25 is used for 10 kHz to 500 MHz testing of the DUT and the wire harness for immunity to electromagnetic fields. The test is superior in that it places both the DUT and the cables under the direct radiation of the tri-plate. The method of construction also allows larger DUTs to be placed within the cell in an area of uniform EMI/RFI fields. The maximum power level suggested in Appendix C is 200 V/M.

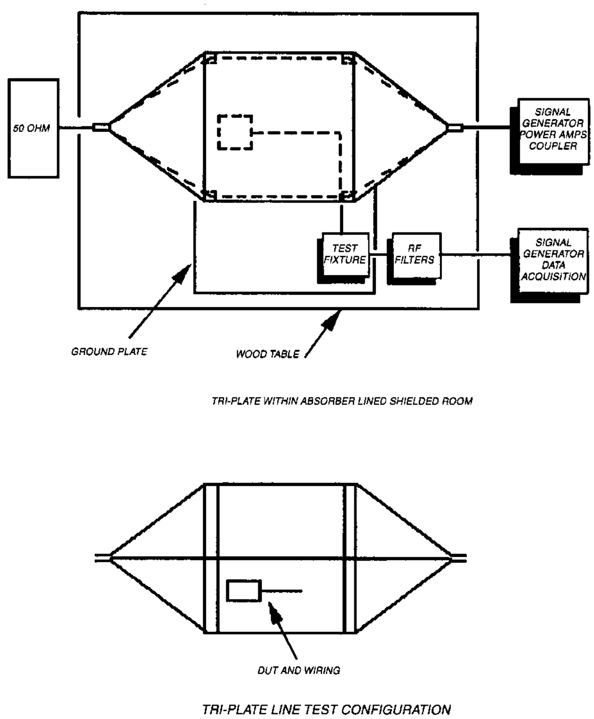

Fig. 6, J-1113-25 Tri-Plate Test Configuration

SAE J-1113-27 is for testing from 500 MHz to 2 GHz and is sometimes used over the range of 200 MHz to 10 GHz. This Standard uses a Reverberation Chamber reducing the size of the test chamber. The Reverberation Chamber can be correlated to vehicle level radiated immunity testing in an anechoic chamber. Appendix C recommends a maximum test level of 100 V/M

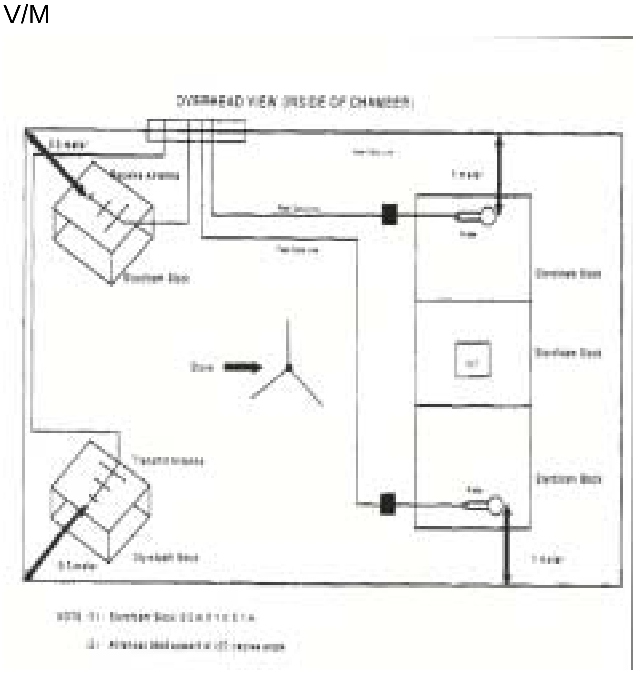

Fig. 7, J-1113-27 Reverberation Method.

POWER LINE AC FIELD INTERFERENCE IMMUNITY.

Immunity to AC Power Line Electric Fields is a unique problem that is far more prevalent with Off Road Machinery. Operation of Machinery under the extreme high-tension transmission lines can result in exposure to field levels in excess of 15,000 V/M. This problem has resulted in two SAE Standards J-1113-22 and J-1113-26. The two specifications approach the testing in different ways. J-1113-22 is designed to test to a given Magnetic Field Intensity. The recommended maximum test level is 80 µT with the field generated by the use of two Helmholtz Coils.

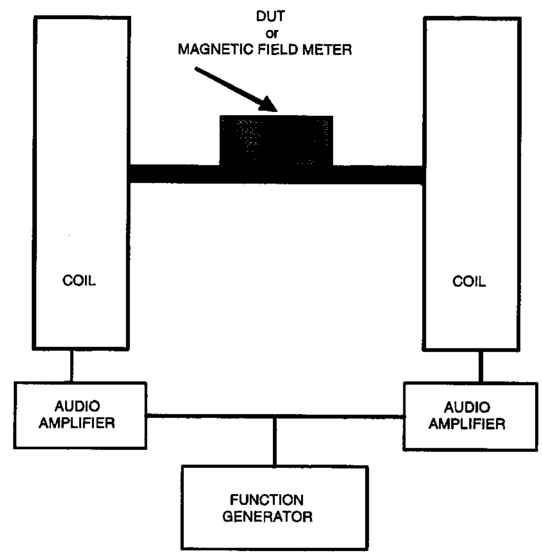

FIGURE 1—MAGNETIC FIELD TEST SETUP

Fig. 8, J-1113-22 Magnetic Field Test Setup.

J-1113-26 is designed to test to a given EMI/RFI Field level. The recommended maximum test level is 15,00 V/M with the field generated by the use of two Conductive Plates and two Field Distribution Wires. –26 is generally the test of choice for off road equipment.

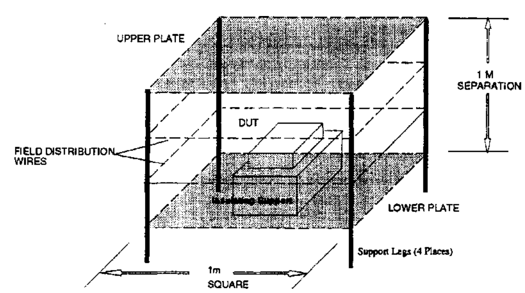

FIGURE B1—PARALLEL PLATE FIELD GENERATOR EXAMPLE

Fig. 9, J-1113-26 Parallel Plate Field Generator.

BATTERY POWER LINE EMISSIONS AND TRANSIENTS

Because of the unique problems resulting from switching or operating inductive loads, SAE has a Standard specifically to test for the transients that can be created by Mobile Equipment. SAE J-1113-42 uses a test procedure that simulates the effects of the real load by switching the supply to/from an Artificial Network (AN). The AN is a 5 µH coil that can handle a 50 A load. The equipment (and preferably the DUT) are set up over a ground plane. Proposed limits for level IV are +100 V to –150 V.

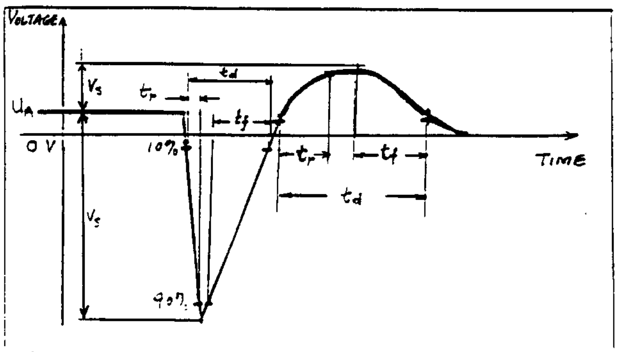

FIGURE A1—SINGLE TRANSIENT WAVEFORM

Fig. 10, J-1113-42 Single Transient Waveform.

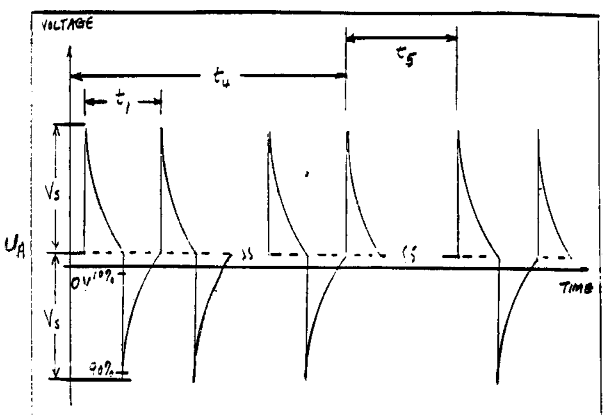

FIGURE A2—BURSTS TRANSIENT WAVEFORM

TABLE A1—TRANSIENT WAVEFORM LIMITS

	Selected Limit V[1]	Proposed Limits for Different Severity Limit IV	Proposed Limits for Different Severity Limit III	Proposed Limits for Different Severity Limit II	Proposed Limits for Different Severity Limit I
Positive amplitude (V_s)		+100 V	+75 V	+50 V	+25 V
Negative amplitude (V_s)		-150 V	-100 V	-50 V	-25 V
Duration (t_d) ≤		2 ms	2 ms	2 ms	2 ms
Rise/fall time (t_r) ≥		5 ns	5 ns	5 ns	5 ns
Burst pulse period (t_1) ≤		4 ms	4 ms	4 ms	4 ms
Burst duration (t_4) ≤		10 ms	10 ms	10 ms	10 ms
Time between bursts (t_5) ≥		90 ms	90 ms	90 ms	90 ms

[1] Values to be determined by manufacturer and supplier.

Fig. 11, J-1113-42 Bursts Transient Waveform.

NOTE: SAE J-1455 "Joint SAE/TMC Recommended Environmental Practices for Electronic Equipment Design (Heavy-Duty Trucks)" also addresses vehicle transient voltage characteristics. Tables 4A and 4B list the test requirements. It is suggested that if compliance with J-1455 is required, that the electrical transient testing be done at the same time as testing for J-1113-42.

TABLE 4A—TYPICAL 12 V VEHICLE TRANSIENT VOLTAGE CHARACTERISTICS

Lines	Type	Source (ohms)	Rise (µs)	Open Circuit	Repetition	Energy
Power	Load Dump	0.4	100	14 + 86e(–t/0.4)	5 Pulses 10 s Int.	Notes 2 and 3
I/O Note 1	Inductive Switching	20	1	14 ± 600e∧(–t/0.001)	10 Pulses at 1 s Int.	Notes 1 and 3
I/O All	Mutual	50	1	14 ± 300e∧(–t/0.000015)	10 Pulses at 1 s Int.	Note 3

NOTE 1— This transient applies to those I/O lines which may be connected to unclamped inductive loads in addition, the energy available will be 0.5LI^2 where I is the current through the inductor amps and L is the inductance in henries.

NOTE 2— The alternator is capable of outputting much more energy than can be absorbed by used electronic clamping devices. Therefore, when clamping devices are used in electronic modules, caution must be used in the design of the vehicle electrical system to insure the energy limitations of each clamping device are observed (see Appendix B).

NOTE 3— The transient waveforms described previously in mathematical form may actually be implemented by diode O-ring a DC and transient voltage.

TABLE 4B—TYPICAL 24 V VEHICLE TRANSIENT VOLTAGE CHARACTERISTICS

Lines	Type	Source (ohms)	Rise (µs)	Open Circuit	Repetition	Energy
Power	Load Dump	0.8	100	28 + 122e∧(–t/0.4)	5 Pulses 10 s Int.	Notes 2 and 3
I/O Note 1	Inductive Switching	20	1	28 ± 600e∧(–t/0.001)	10 Pulses at 1 s Int.	Notes 1 and 3
I/O All	Mutual	50	1	28 ± 300e∧(–t/0.000015)	10 Pulses at 1 s Int.	Note 3

NOTE 1— This transient applies to those I/O lines which may be connected to unclamped inductive loads. In addition, the energy available will be 0.5LI^2 where I is the current through the inductor and amps and L is the inductance in henries.

NOTE 2— The alternator is capable of outputting much more energy than can be absorbed by commonly used electronic clamping devices. Therefore, when clamping devices are used in electronic modules, caution must be used in the design of the vehicle electrical system to insure the energy imitations of each clamping device are observed (see Appendix B).

NOTE 3— The transient waveforms described previously in mathematical form may actually be implemented by diode O-ring a DC and transient voltage.

Fig. 12, J-1455 Transient Voltage Characteristics.

WHAT! ME CAUSE INTERFERENCE?

SAE J-1113-41 Standard for Limits and Methods of Measurement of Radio Disturbance Characteristics of Components and Modules for the Protection of Receivers used On Board Vehicles covers testing to determine the level of emissions from the DUT that may interfere with onboard receivers. The Standard is useable for Mobile equipment and is equivalent to IEC CISPR 25 (1^{st} edition).

Most equipment builders building for the North American market prefer to use the FCC Part 15 Class A test. While there is considerable discussion about the need for this test (does the DUT need to meet the FCC requirements), the general feeling is "if it has a microprocessor, I might have to certify it in the future." Test houses generally consider the J-1113-42 to be a better test. The cost of obtaining a test report for Part 15 using the test data from J-1113-42 done by an independent test house is insignificant. If the equipment will need to be certified later for a CE mark, the J-1113-42 report should also be prepared for meeting CISPR 25 format.

WHAT ARE OTHERS USING FOR TEST STANDARDS AND WHAT LIMITS ARE THEY SPECIFYING

What to specify if you do not use the suggested or recommended values in the J-1113-* Standards is one of the hottest topics in Mobile Equipment manufacturing today. The component manufacturers are even more in a quandary. Do they do what the machine manufacturers say and possibly waste their customer's money? Or, do they argue with the customer and possibly lose the order? With some customers sometimes doubling the severity of the test parameters, it is tough to keep quiet.

To quickly review each of the major use standards and compare the standard versus the range being requested in the market might help. The market ranges are those levels being requested by customers and levels being used as researched by the author. Unfortunately, because almost everyone has requested anonymity, I cannot list those companies that contributed to the summary below.

CONDUCTED IMMUNITY- DRFI: J1113-3. This test is seeing less and less use. Those companies still using J1113-3 tend to use the Suggested Test Severity Levels contained in Appendix B. A few limit this test to 200 MHz max.
CONDUCTED IMMUNITY- BCI: J1113-4. Almost without exception, companies using this test use the recommended performance levels in Appendix A and over the frequency range of 1 to 400 MHz. The only exceptions are the companies that also use J1113-3 up to 200 MHz use –4 for 200 MHz to 400 MHz. The other exception is in rare instances, a company may specify this test to 500 MHz. The rarest of all exceptions is the one company that specified Region I to 100 mA (-4 recommends 60 mA for Class C) and 125 mA for Region II (-4 recommends 80 mA for Class C). Needless to say the testing, component, and design costs are significantly higher.
RADIATED IMMUNITY- ALC: J-1113-21. With very few exceptions, manufacturers list 100 V/M as Region II. (The function may deviate from design but will return to normal after the disturbance is removed.) This is what is finally tested. There have been discussions and some bid specifications with the power at 150 V/M and in one case 200 V/M. The only case that I am aware of that the final order was 200 V/M, the Acceptance Criteria was Region III. (The function may deviate from design during exposure but simple operator action may be required to return the function to normal, after the disturbance is removed.) They also specified Region II up to 150 V/M. The extra cost of the design and testing must be considered when creating a specification this severe.

RADIATED IMMUNITY- TEM: J-1113-24. (Not yet released by SAE) While companies that use this future Standard all have slightly different specifications pending release of –24, all of the ones that I am aware of specify 100 V/M for Region II. They generally use 100 kHz to 200 MHz.
RADIATED IMMUNITY- STRIP LINE METHOD: J-1113-23. This Standard has not enjoyed widespread acceptance. This is because the test places most of the emphasis on energizing the wiring harness not the DUT.
RADIATED IMMUNITY- TRI-PLATE METHOD: J-1113-25. This is another Standard where a few manufacturers are asking for test levels higher than the suggested test levels. One in particular has stretched the frequency range from 500 MHz to 1 GHz with Region II at 200 V/M and Region I at 100 V/m for the extended frequency range. Same problem as before- it costs money and time.

The other Standards did not have enough responses to comment on anything except that the few that replied all were using the suggested or recommended test procedures and levels.

WHY THE "APPROVED COMPONENTS" FAIL ON YOUR MACHINE.

One of the biggest frustrations to machine builders is where they have conscientiously had all of the various components in a system tested prior to complete machine testing and watched the machine fail miserably. They then start looking at all of the test reports on the components and try to determine who did not pass the component test. They all did. What now?

The problem can come from several areas. The most common cause is that the wiring harness as installed has become a tuned antenna and is injecting significantly more EMI/RFI into one or more of the components. The second most common is; one of the sensors attached to the system is acting as a receiver and sending erroneous signals to the system. Ground loops that create current/voltage paths that cause inductive transfer to the sensor wiring, bad ground connections acting as detector diodes and changing the EMI/RFI into low frequency signals that the system assumes are commands, and inductive cross talk between power cables and signal cables are also common. The serial data transmitted between modules may be corrupted by interference pulses or bad wiring. (This is why CAN such as SAE J-1939 is used in place of sensitive data communication methods such as RS-232.)

Good installation techniques along with testing using the intended wiring harnesses will reduce the incidences of failure when testing the complete system. *Nothing* will guarantee passage on the first test of the complete system. Through testing at the component level just significantly improves your odds.

PRACTICAL LIMITATIONS ON THE OPERATION OF OFF HIGHWAY EQUIPMENT BASED ON LIMITATIONS OF IEEE C95.1, 1999

Making the test levels higher than the suggested or recommended levels contained in the Standards is somewhat ridiculous when considered in relation with IEEE C95.1, 1999. The maximum permissible exposure levels for an uncontrolled environment is significantly less than many of the test levels in the SAE Standards. (Uncontrolled environment is defined as the exposure of individuals who have no knowledge or control of their exposure.) The maximum for 30 to 300 MHz is 27.5 V/M averaged over 30 minutes. For controlled environments, the level is only 51.4 V/M for 6 minutes.

With the high test levels being specified by some equipment manufacturers, the equipment will run; but, the operator has received a dangerous and illegal EMI/RFI exposure. While there should be some margin between dangerous exposure level and the point of failure of machine safety items, common sense should be employed in selecting the test criteria.

RADIO FREQUENCY ELECTROMAGNETIC FIELDS, 3 kHz TO 300 GHz — IEEE Std C95.1, 1999 Edition

Table 2—Maximum permissible exposure for uncontrolled environments*

Part A: Electromagnetic Fields†					
Frequency range (MHz) 1	Electric field strength (E) (V/m) 2	Magnetic field strength (*H*) (A/m) 3	Power density (*S*) E-field, H-field (mW/cm²) 4	Averaging time $\|E\|^2$, *S* or $\|H\|^2$ (min) 5	
0.003–0.1	614	163	(100, 1 000 000)‡	6	6
0.1–1.34	614	$16.3/f$	$(100, 10\,000/f^2)$‡	6	6
1.34–3.0	$823.8/f$	$16.3/f$	$(180/f^2, 10\,000/f^2)$	$f^2/0.3$	6
3.0–30	$823.8/f$	$16.3/f$	$(180/f^2, 10\,000/f^2)$	30	6
30–100	27.5	$158.3/f^{1.668}$	$(0.2, 940\,000/f^{3.336}$	30	$0.0636f^{1.337}$
100–300	27.5	0.0729	0.2	30	30
300–3000	—	—	$f/1500$	30	
3000–15 000	—	—	$f/1500$	$90\,000/f$	
15 000–300 000			10	$616\,000/f^{1.2}$	
NOTE—*f* is the frequency in MHz.					

*See Figure E.1 and Figure E.4 for graphical depictions of MPEs.

†The exposure values in terms of electric and magnetic field strengths are the mean values obtained by spatially averaging the squares of the fields over an area equivalent to the vertical cross section of the human body (projected area).

‡These plane-wave equivalent power density values, although not appropriate for near-field conditions, are commonly used as a convenient comparison with MPEs at higher frequencies and are displayed on some instruments in use.

Part B: Induced and contact radio frequency currents*			
Frequency range (MHz)	Maximum current (mA)		Contact
	Through both feet	Through each foot	
0.003–0.1	$900f$	$450f$	$450f$
0.1–100	90	45	45
NOTE—*f* is the frequency in MHz.			

*It should be noted that the current limits given above may not adequately protect against startle reactions and burns caused by transient discharges when contacting an energized object. (See text for additional comment and see Figure E.5 for a graphical depiction.)

WHERE CAN YOU GET HELP FOR CURRENT PRODUCTS AND NEW DESIGNS?

One of the best sources of information on using SAE J-1113-* Standards is the standards themselves. They are generally clear and readable to non-electronic engineers. Your electronic component supplier should be able to answer any questions you may have with the Standards. (Your supplier should have experience with Heavy Duty Mobile Equipment. You do not want to be the Guinea Pig for his learning experiences.) The independent test labs are generally very willing to help you to learn the basics of the testing and what is normal for your type of equipment. Last, but not least, are a number of experienced consultants in EMI/RFI that are available for hire. For specific segments of the testing and application of Electronics to Mobile equipment, there are the industry association educational seminars sponsored by SAE, CIMA, EMI, NFPA, etc. These seminars are the most effective training available. Dollar for dollar and hour for hour, you receive more this way than any other way.

Involving your electronic supplier(s) early will result in more robust designs with higher cost effectiveness than what will result if you call them in after you have completed the machine design and tell them that they need to make a component to "fit this spot"

I have been asked a number of times about the suitability of using a person from academia. I would leave you with the caveat: *Their usefulness is directly proportional to the amount of experience they have in the field. Those that tend to live almost totally in the hallowed walls of an educational institution, generally do not know how to translate theoretical works into working hardware that will be purchased by real customers and survive in operation*.

WHERE IS THE INDUSTRY GOING IN THE FUTURE

- All indications are that the use of electronics is going to only increase.
- The sophistication of the electronics will increase.
- The complexity of operation will decrease.
- Significant effort will be invested in having electronic controls that are so durable and so simple to operate that they are transparent to the operator.
- Economically, the cost of individual features will decrease while the number of features will increase.
- The dollar amount of electronics on a machine will increase substantially.
- Because of the use of higher frequency processors in the components, emission prevention design and testing will need to be improved.
- Overseas business will require electrically quieter units.
- For components using digital communication with sensors and other components such as CAN, proper treatment of the digital waveform will be required to prevent excessive emissions.
- Susceptibility will become more of an issue with the increasingly crowed frequencies.
- The use of personal RF devices will mean that there is a higher likelihood that a transmitter will be place on top of a component and act like a 10,000 watt transmitter that is 100 meters away. This will result in more stringent susceptibility testing (but, not necessarily higher power).
- Because of the robustness of CAN communications, they will be the communication method of choice to increase immunity to interference.

CONCLUSION

The use of electronics will grow geometrically.

The use of Standards such as SAE J-1113-* and others will increase. Conflicts between Standards of different groups will increase unless cooperation exists during the creation of the standards.

Because of the litigious society of today, machinery associations will create testing levels and in some cases methods. If manufacturers fail to cooperate, the legal ramifications will drive the "top" standard (severity) to uneconomical and possibly technically unreachable levels.

CONTACTS

Edward T. Heck- Business Development Manager
HED (Hydro Electronic Devices, Inc.
P.O. Box 270218
Hartford, WI 53027
Phone 262-673-9450
FAX 262-673-9455
E-mail eheck@hedonline.com
info@hedonline.com
Engr@hedonline.com

International Electrical & Electronic Engineers
Phone 800-678-IEEE
E-mail www.standards.ieee.org

DEFINITIONS, ACRONYMS, ABBREVIATIONS

ALC- Absorber Lined Chamber
AN- Artificial Network
BCI- Bulk Current Injection
CAN- Controller Area Network
CE- Approval mark used in the European Common Market
CIMA- Const4ruction Industry Manufacturers Association
DRFI- Direct Radio Frequency Injected
DUT- Device Under Test
ESD- Electro Static Discharge
EMF- Electro Motive Force
EMI- Equipment Manufacturers Institute

EMI/RFI- Electro Magnetic Interference/ Radio Frequency Interference
FCC- Federal Communications Commission
Functional Status Classification- see SAE Standard J-1812
GHz- giga-hertz
kHz- kilo hertz
MHz- mega hertz
mA- milli-amphere
mW- milli-watt
NFPA- National Fluid Power Association
Region of Performance- see SAE Standard J-1812
RF- Radio Frequency
RS-232- Serial communication used between two points
SAE- Society of Automotive Engineers
Test Signal Severity Level- see SAE Standard J-1812
μH- micro-Henry
μT- micro-Tesla
V/M- Volts per Meter