

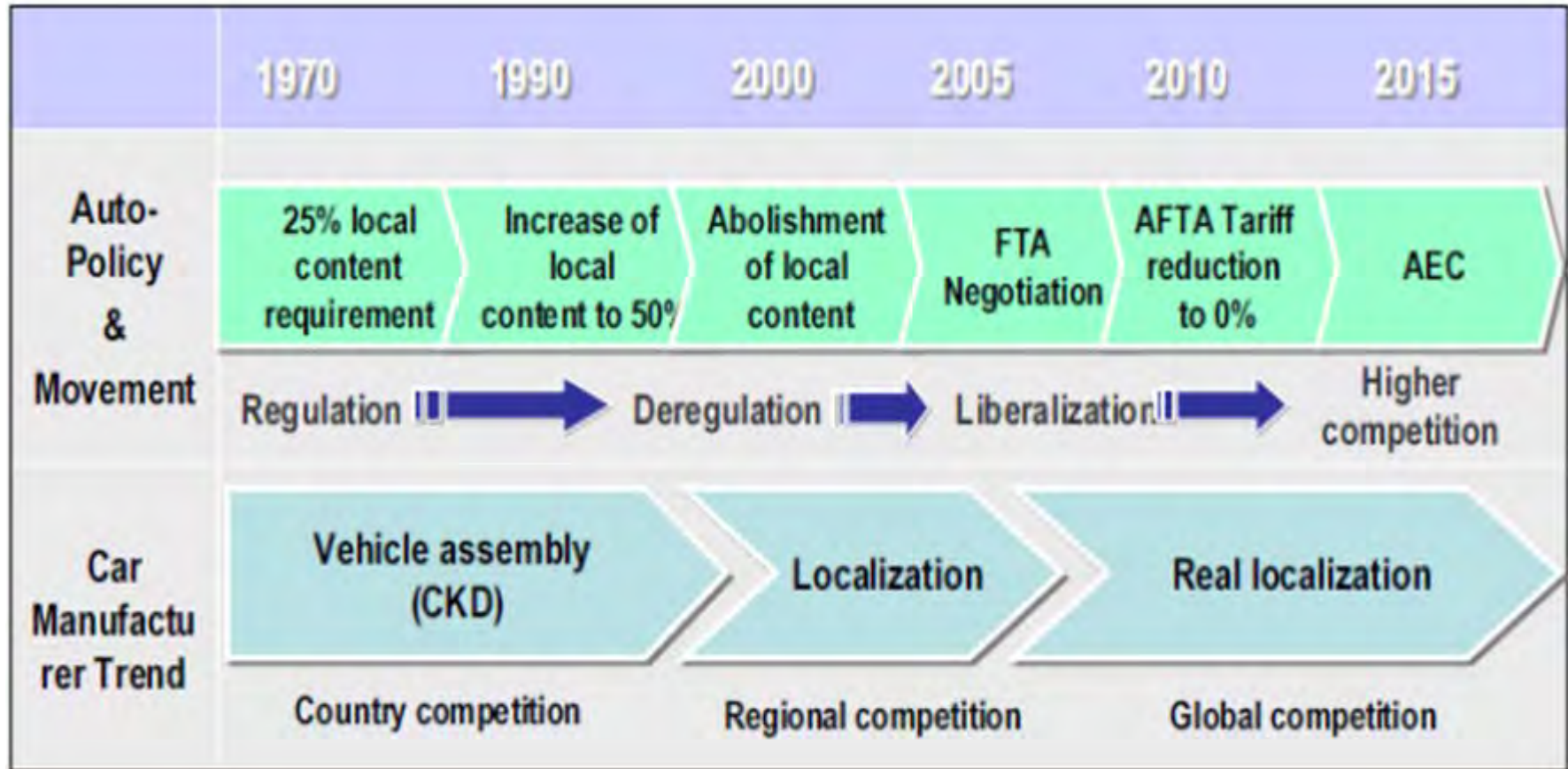
Automotive Standards and Testing Methods

Dr. Kraison Aunchaleevarapan

**Electrical and Electronic Products Testing Center
National Science and Technology Development Agency (NSTDA)**



Circumstance Change in Thai Market



Source from OICA

ความพร้อมในการเป็น AEC ?

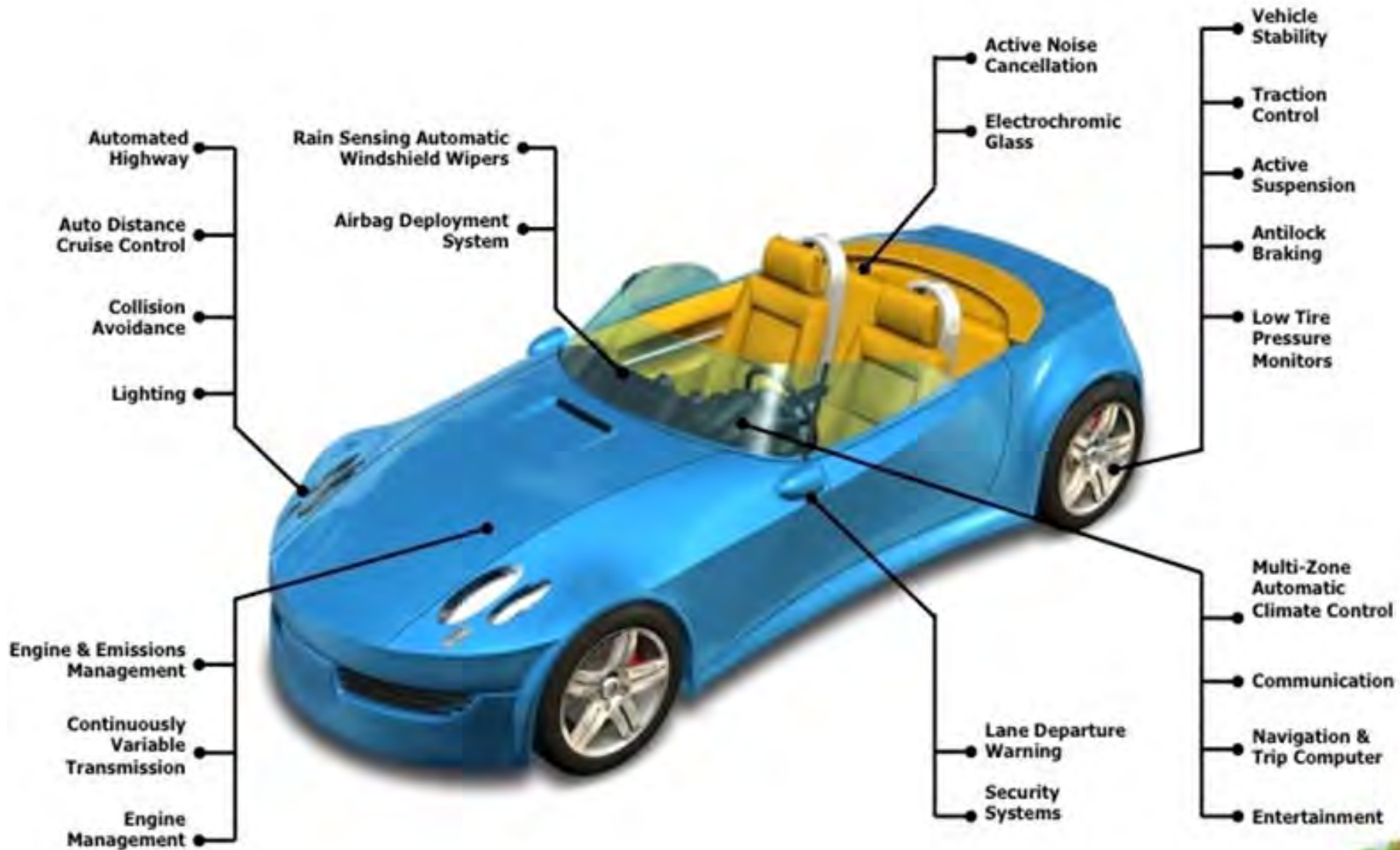
Production Network in ASEAN and ASEAN+

Auto. Production Network in ASEAN



Source from OICA

Explosion of Electronic Systems



2 big problems in automotive product in future

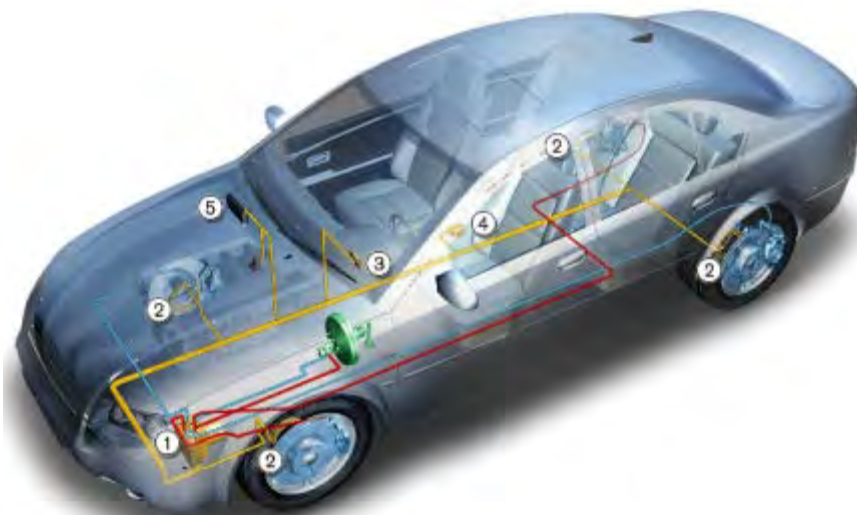
- § standards meet parts
- § repairing / spare parts



Why EMC is important?

Causes:

- Alternators, Converters, Switching Processes
- Electric Motors, Fuel Pump, Fan Motors
- Lights, Radio
- Every kind of electronic device
- Coupled on Power Lines and Wiring Harnesses
- Engine Start



Infotainment

- AM- / FM-Radio
- DVB-T Receiver “Digital Video Broadcasting-Terrestrial”
- GPS “Global Positioning system”
- DRM “Digital Radio Mondiale”
- DAB “Digital Audio Broadcasting”
- SDARS “Satellite Digital Audio Radio Service”



Unidirectional communication, Parameters as Frequency, TX-Power and coverage are regulated by Government.

Mobile Communication

- GSM
- PDC
- CDMA “Code Division Multiple Access”
- UMTS “Universal Mobile Telecommunications System”
- TETRA “Terrestrial Trunked Radio”
- Police radio services
- Taxi radio services



Bidirectional communication, Frequency and TX-Power is regulated by Government,
Coverage is provided by Network-Operators.

Short Range Devices

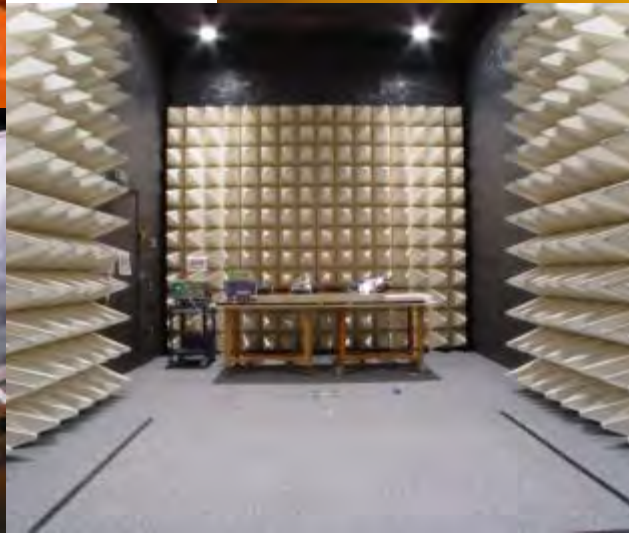
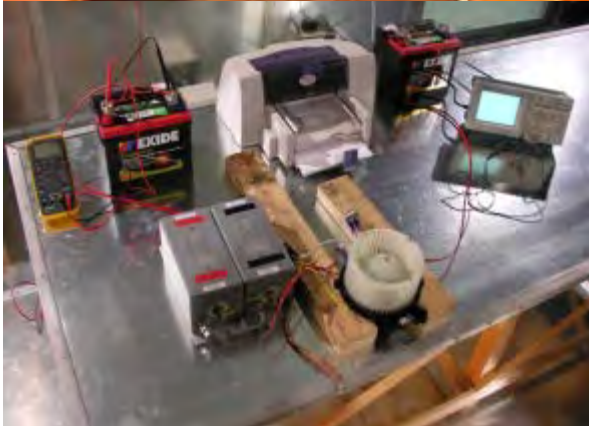
- Tire pressure control
- Keyless entry
- Remote control
- Bluetooth
- W-LAN
- ACC “Adaptive Cruise Control” (Radar)

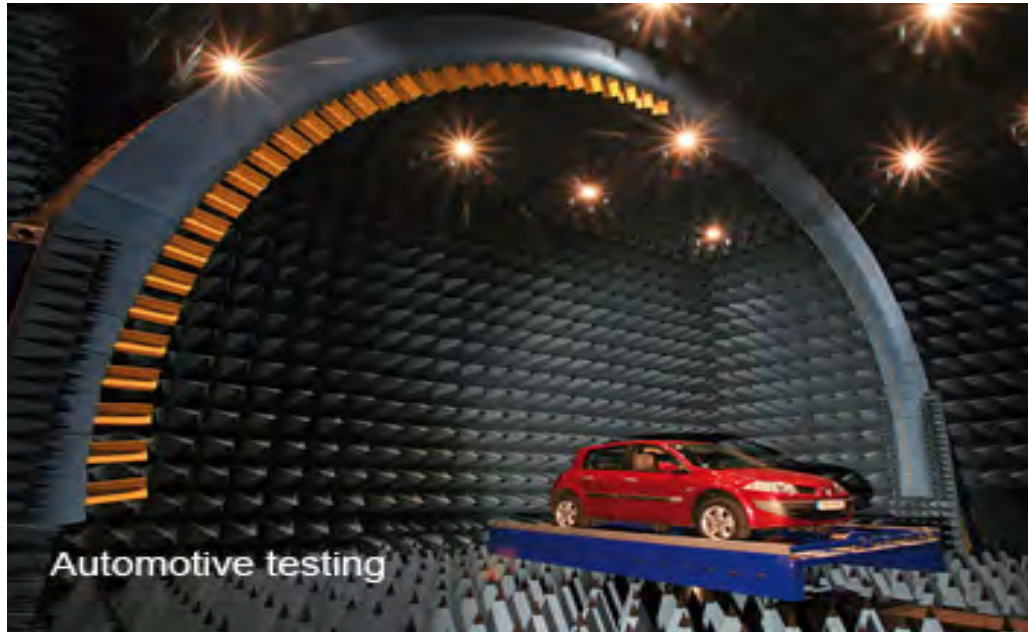


Uni- or bidirectional communication, low TX-Power is regulated by Government, former ISM-band frequencies

When devices shall be tested?

- Before production and sampling during production
- During redesigns or modifications
- During initial design phases





Product Development Cycles

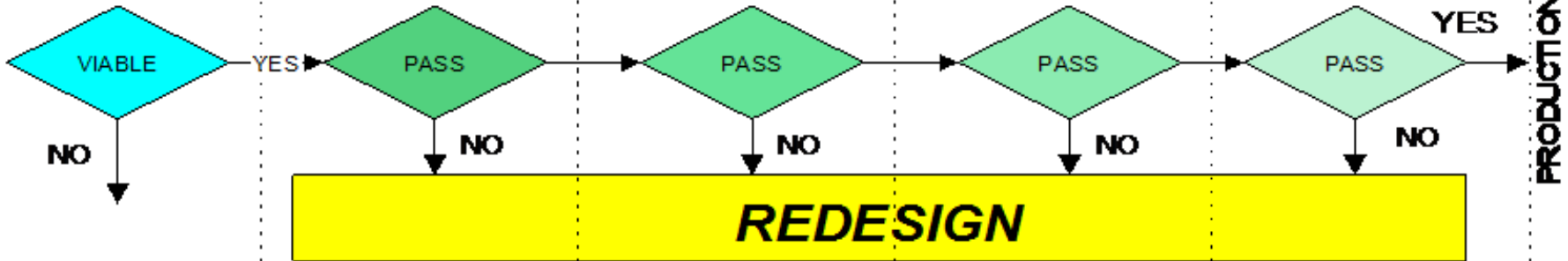
INITIAL INVESTIGATE

DESIGN BREAD BOARD

LAB PROTOTYPE

PRODUCTION PROTOTYPE

COMPLIANCE TESTING



cost

\$

\$

\$

\$

Time

T

T

T

T

Opportunity

O

O

O

O



International Bodies

ISO
IEC / CISPR



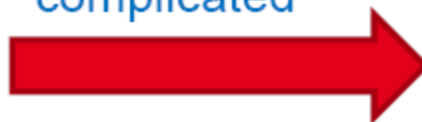
No so difficult

Regional Requirement

2004/104/EC (e-mark)
SAE (SAE J1113-11, SAE J1113-12)
JASO
GB/T



Much more complicated



Manufacturers (OEM)

BMW
Daimler Chrysler
Fiat
Ford
General Motors
Honda
Hyundai
Mazda
Peugeot
Nissan
Renault
Toyota
Volkswagen
...More!

Motivation

EMC Standards for Vehicles and ESA (Electronic Sub Assemblies)					
Car Manufacturer	Global	USA	Europe	China	Japan
MB, TL, GMW, B21, etc.	ISO, CISPR	SAE	2004/104/ EEC	GB...	JASO

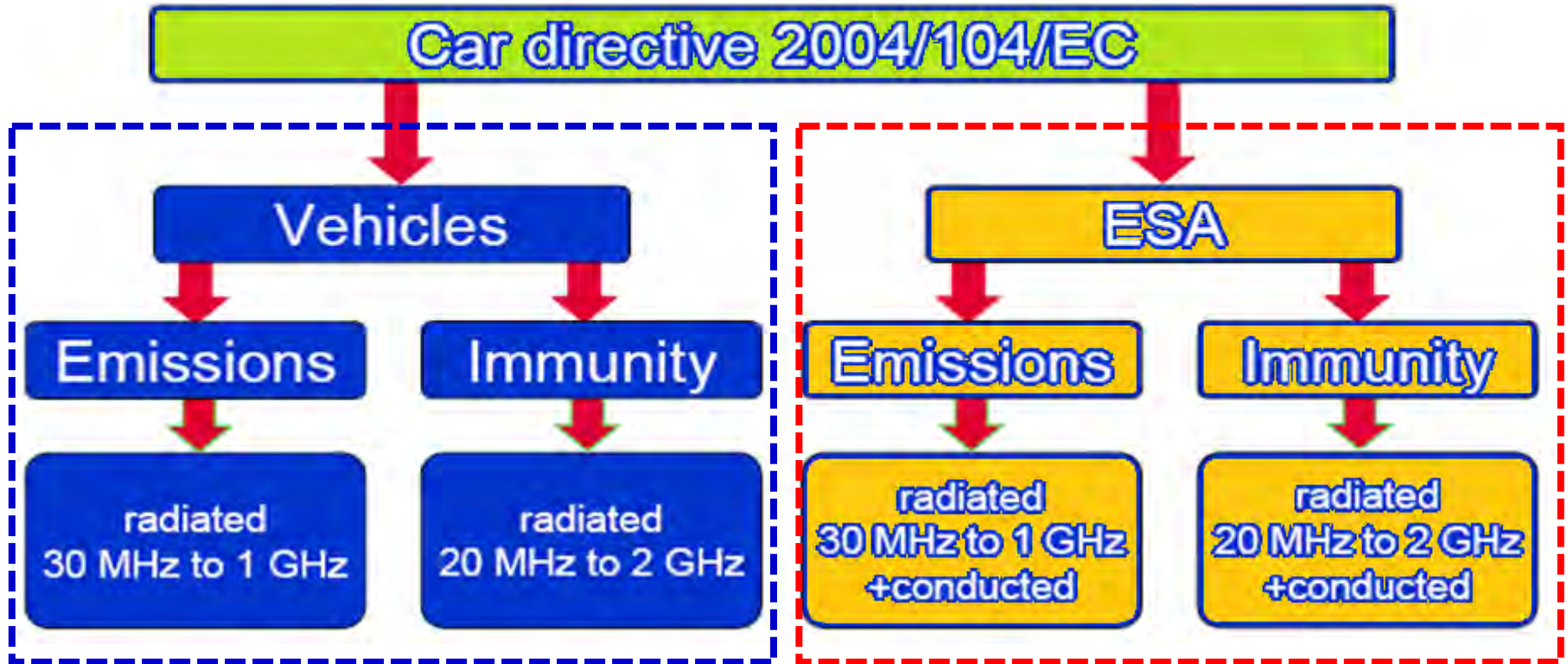
Motivation

Manufacturer	International	Europe	USA	Asia
GM 3097 Rev. 3 ESA concerns - EMC	CISPR 12 Vehicle concerns - EMI	2004/104/EEC Vehicle and ESA Concerns EMI + EMS	SAE J551 Vehicle Concerns EMI + EMS	China Vehicle and ESA Concerns - EMI
VW: TL ... ESA concerns - EMC	ISO 11451 Vehicle concerns - EMS			
PSA: B21 7090 Vehicle and ESA concerns - EMC	ISO 10605 Vehicle and ESA concerns - ESD		SAE J1113 ESA Concerns EMI + EMS	Japan Vehicle and ESA Concerns EMI + EMS
FIAT: 9.90110 Vehicle and ESA concerns - EMC	ISO 11452 ESA concerns - EMS			
⋮	CISPR 25 ESA concerns - EMI			⋮
BMW GS95002 Vehicle and ESA concerns - EMC	ISO 7637 ESA Conducted Pulses			

e1

e 1
03 0148

Requirements according to appendix 1



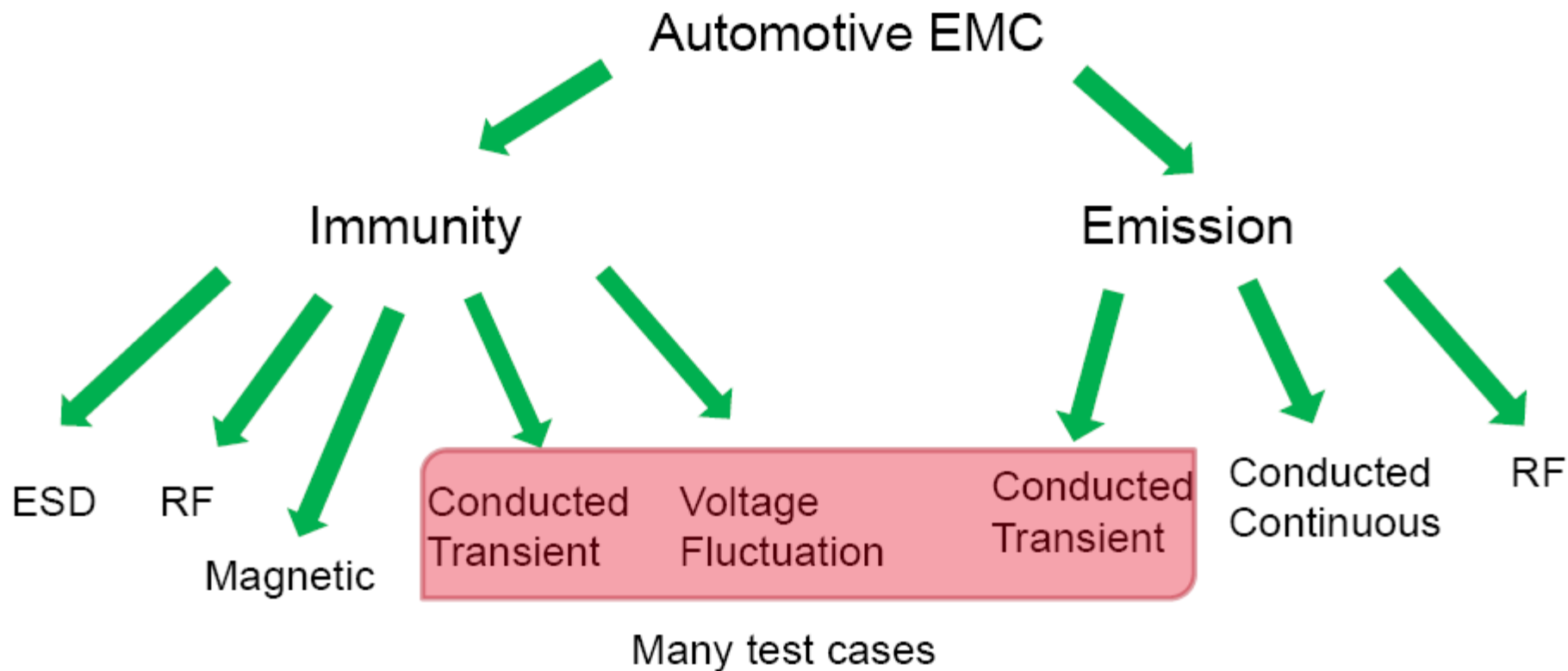
EMS Manufacturer Requirements for ESA's

Manufacturer	Specification	Requirements Antenna: 0.2 to 3.2 GHz	Requirements BCI: 0.01 to 400 MHz (**)
Audi	TL 821 66 2003-03	80 V/m	200 mA
BMW	GS9502 (2001)	100 V/m	100 mA
Daimler Chrysler	AV EMV 99	300 V/m	-/-
Daimler Chrysler	MBN 10284-2	270 V/m	35-50dBm reduced. P-fwd reduced by the transfer-loss of the clamp!
Daimler Chrysler	DC 10614	200 V/m	400 mA (CW)
FIAT	9.90110	200 V/m (CW)	10 mA – 300 mA (CW)
FORD	ES-XW7T- 1A278-AC	100V/m 400 - 800 MHz (CW AM80%) 70 V/m 0.8 - 2 GHz (pulsed) 600V/m (*) 1,2...1,4 + 2,7...3,1GHz	1,5 mA – 200 mA
GM	GM 3097 12/03	100V/m 0.4 - 1 GHz (CW AM 80%) 70 V/m 0.8 – 2 GHz (pulsed) 600V/m (*) from 1,15 to 1,45GHz	1,5 mA – 200 mA
Porsche	EMC requirements	200 V/m 0,2 to 1 GHz 150 V/m 1 to 18 GHz	-/-
PSA	B 2171 10 47/99	200 V/m	300 mA envelope
Renault	36-00-808 G	200 V/m	max. 200 mA rms
Volvo	Type specification:	up to 1000 V/m	-/-

(*) Distance (Antenna to ESA) min. 50 cm (peak V/m)

(**) with min. 3dB Attenuator to reduce the mismatch

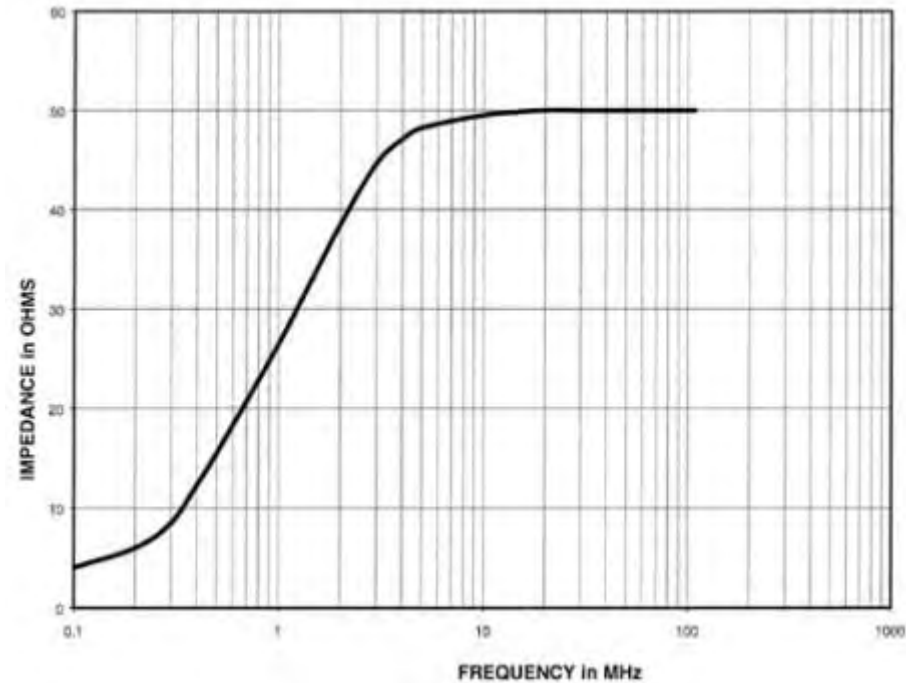
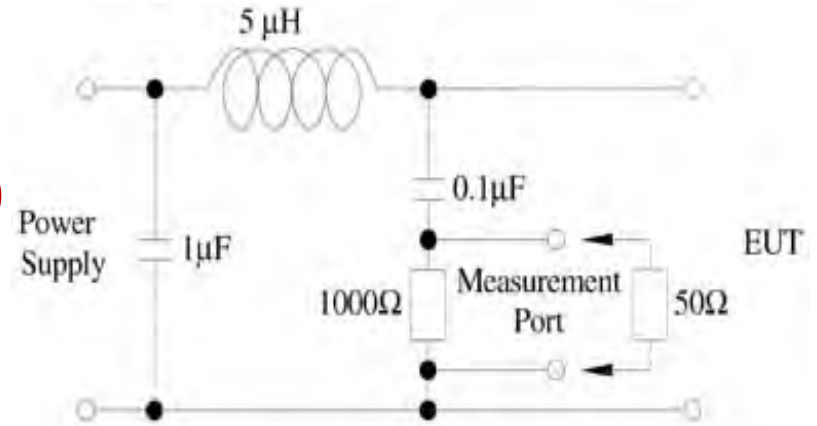
Automotive EMC



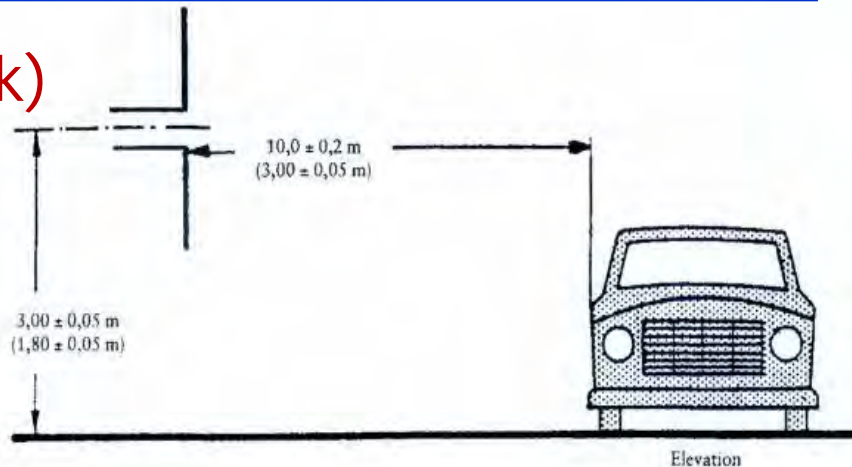
§ SAE J1113

§ CISPR 12

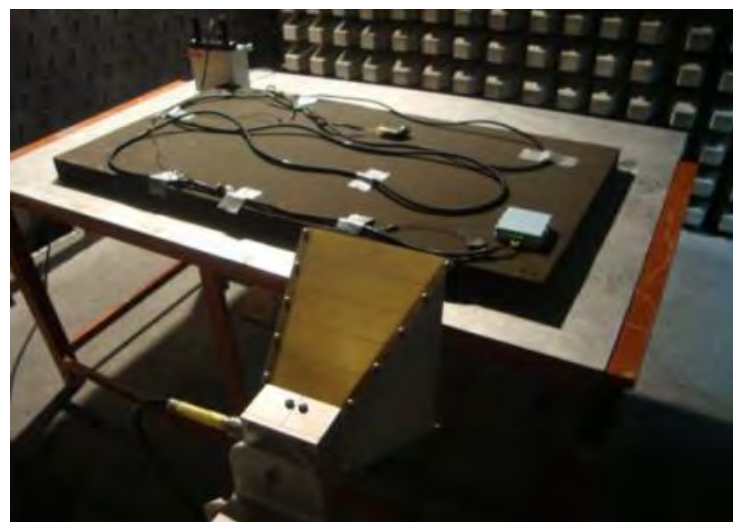
§ Car directive 2004/104/EC (e-mark)



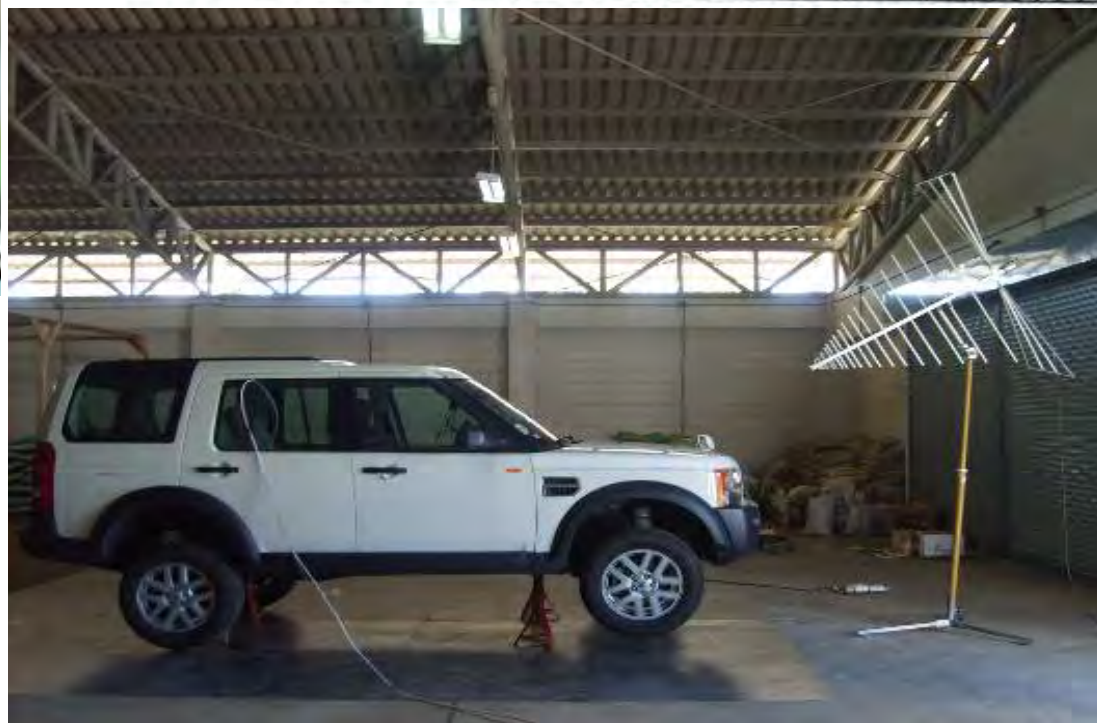
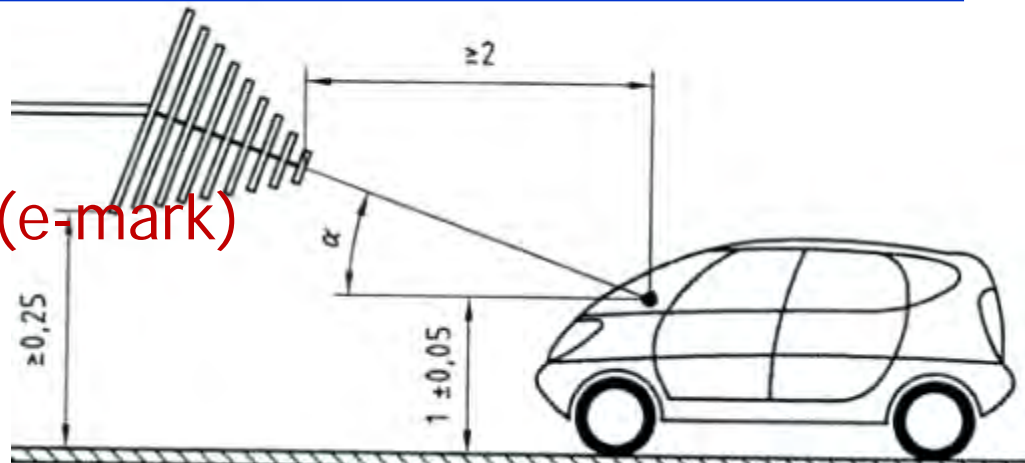
- § Car directive 2004/104/EC(e-mark)
- § SAE J551
- § CISPR12



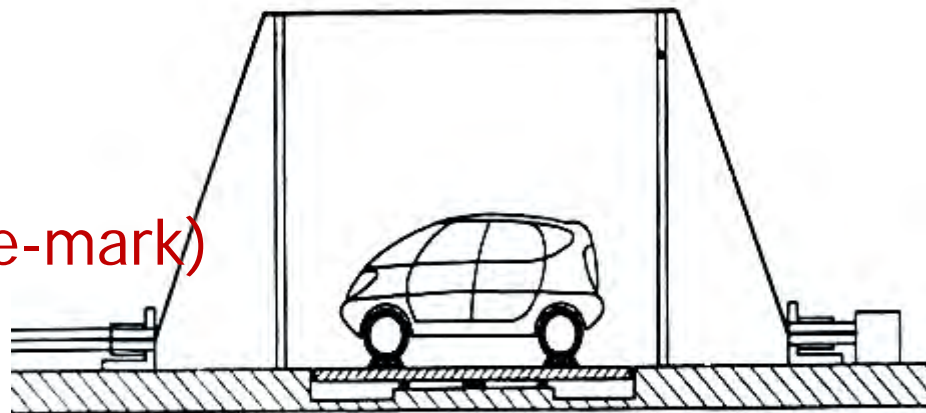
- § CISPR25
- § 2004/140/EC(e-mark)
- § ISO 11452-2
- § SAE J1113



- § CISPR25
- § ISO 11451-2
- § Car directive 2004/140/EC(e-mark)
- § SAE J551



- § CISPR25
- § ISO 11451-2
- § Car directive 2004/140/EC(e-mark)
- § SAE J551

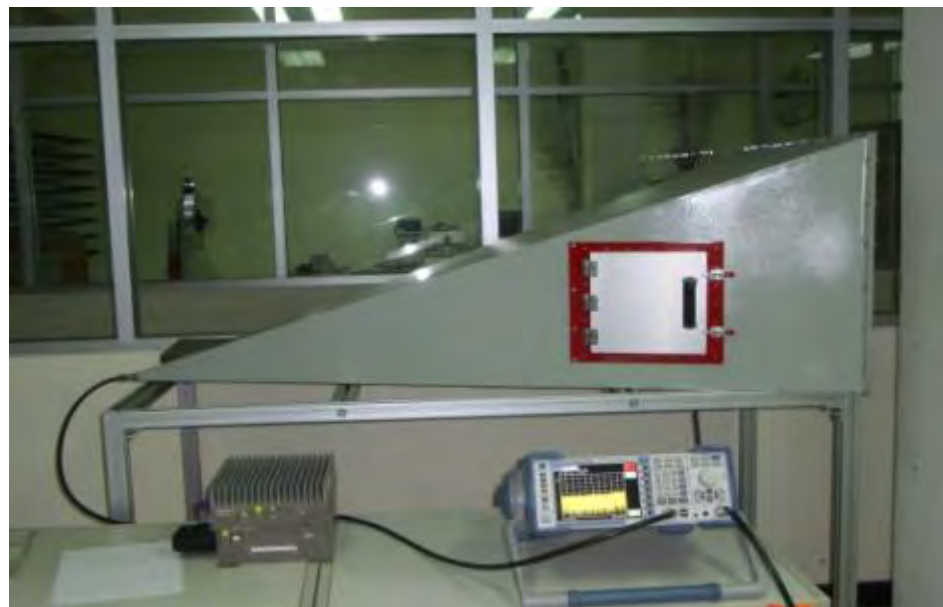


§ ISO 11452-3

§ CISPR 25

§ Car directive 2004/104/EC

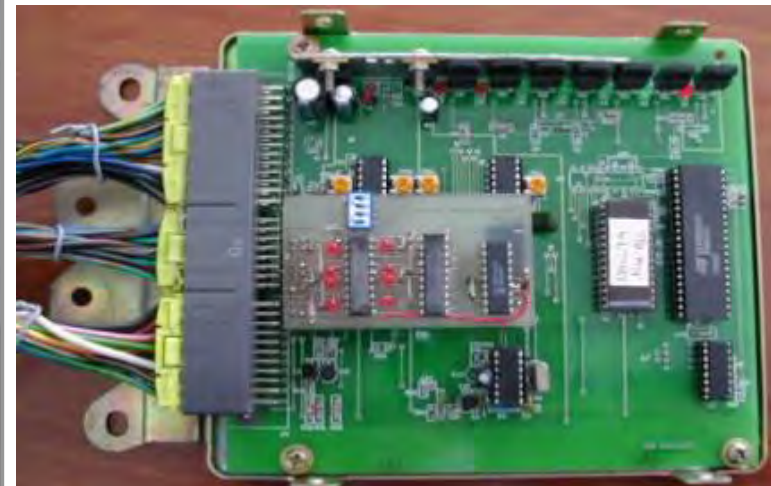
§ SAE J1113



- § ISO 11452-4
- § CISPR25
- § SAE J1113

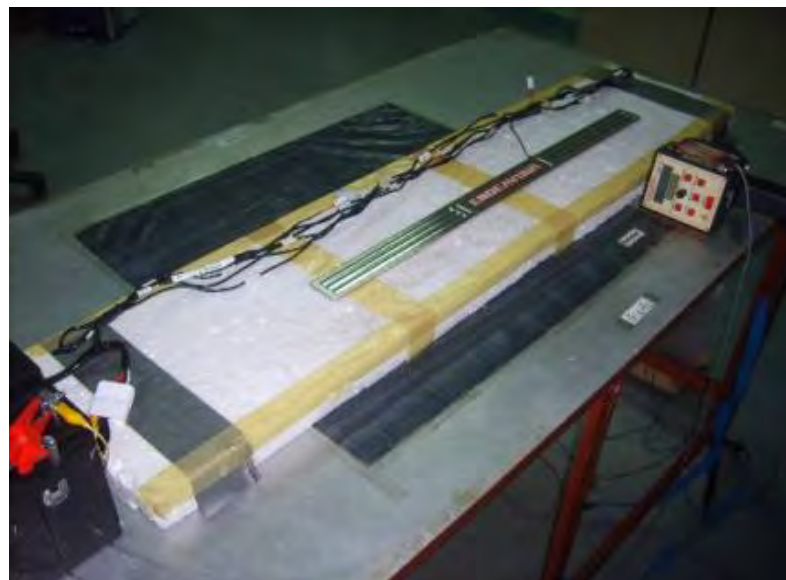


- § ISO 11452-5
- § CISPR25
- § SAE J1113



§ ISO 10605/9

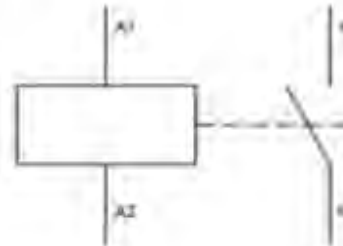
§ ISO 10605 Annex F



When to use a relay and when the electronic switch:

Relay

- Voltages over 400V
- Usually must be approved by OEM
- Poor Repeatability, Slow/Chattering
- Must be replaced
- Should be production relay from the vehicle containing the DUT



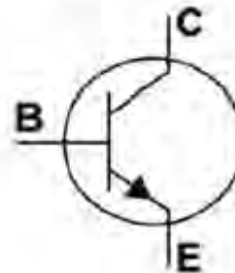
Potter & Brumfield



Bosch

Electronic Switch

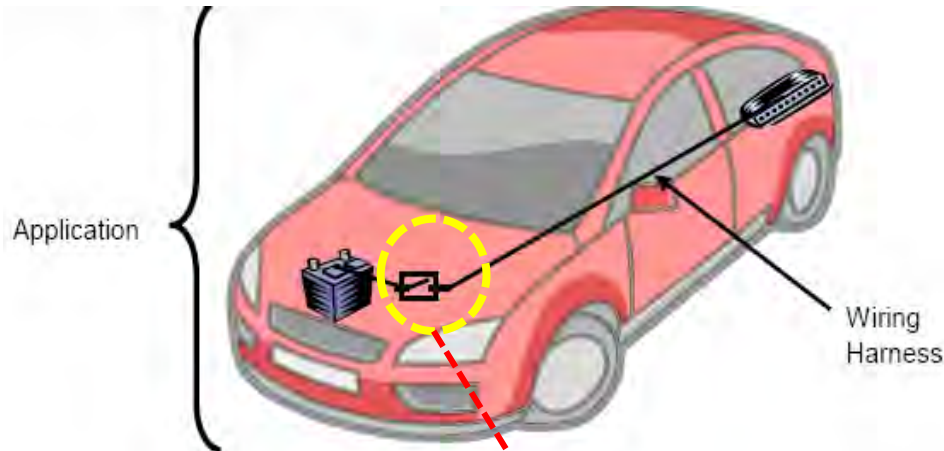
- Less than 400V
- Fast and Repeatable
- Voltage Drop Must be Accounted
For $\Delta U \leq 1V$ at 25 A



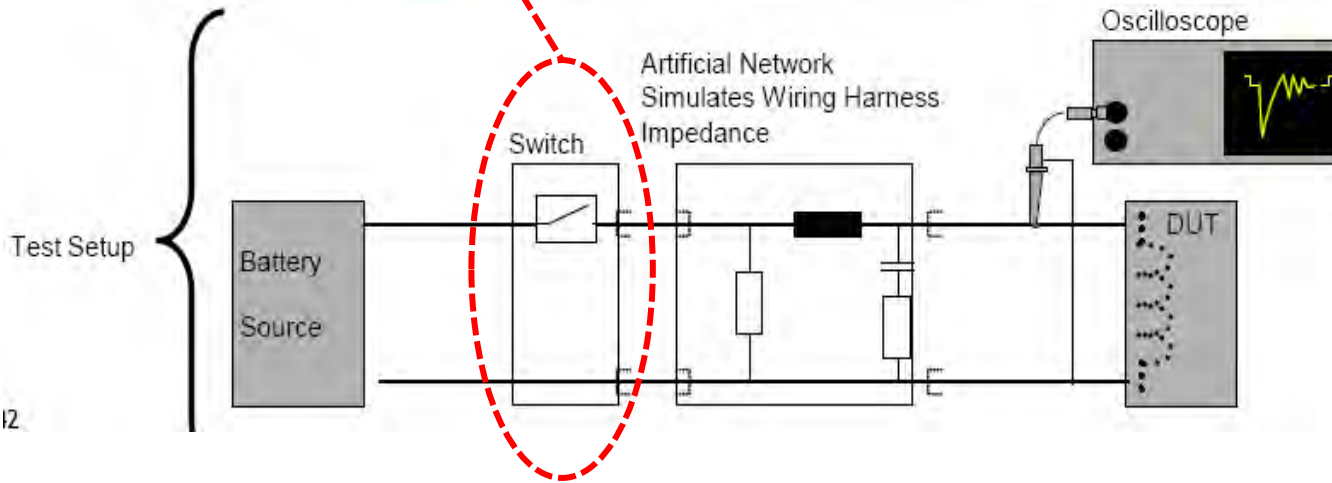


ISO 7637-2 Emissions

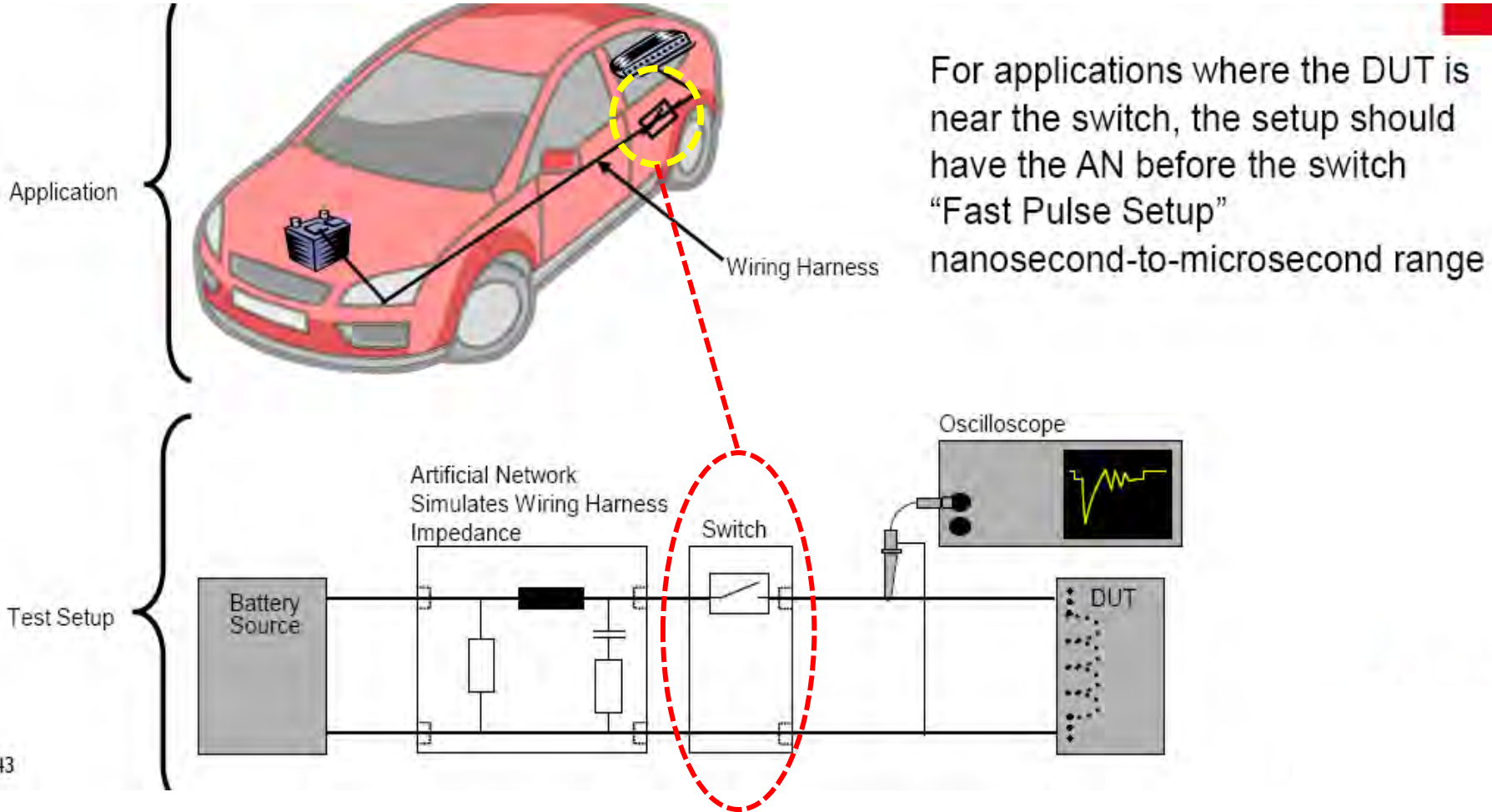
Test Layout



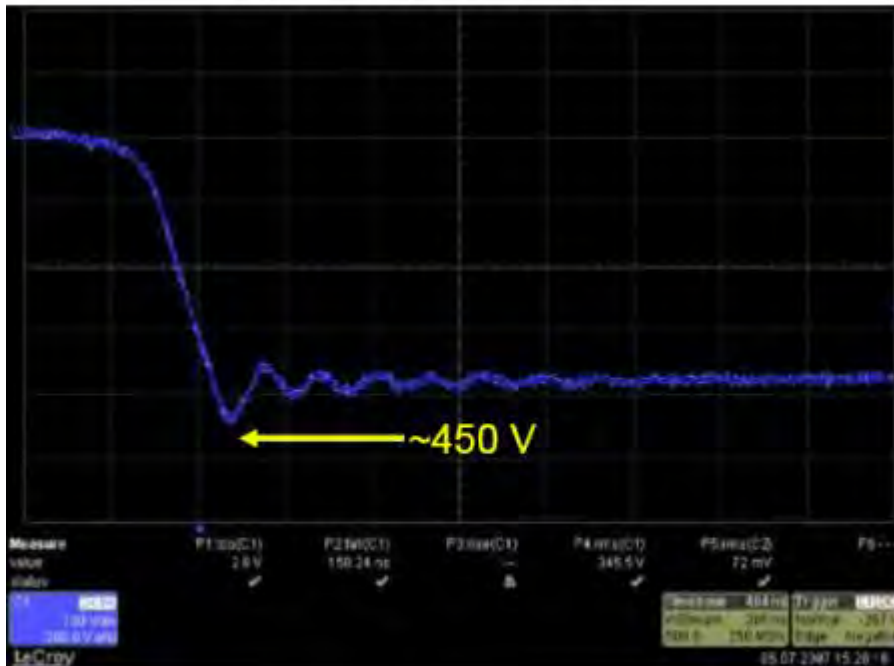
For applications where the DUT is far from the switch, the setup should have the AN between the switch (simulating the wiring harness) and the DUT.
“Slow Pulse Setup”
 Millisecond range or slower



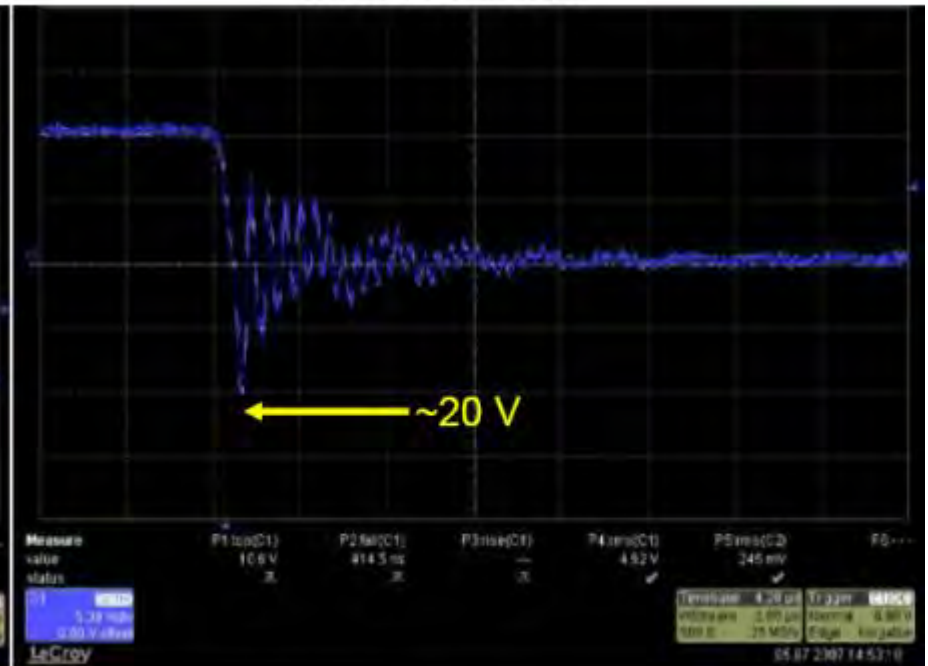
Test Layout



Very Heavily Inductive

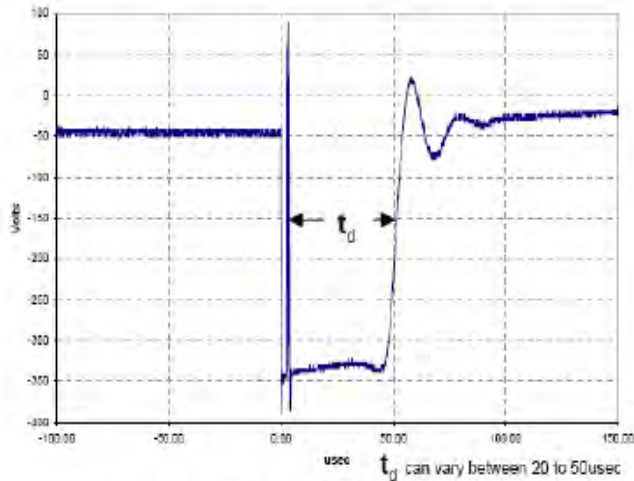


Mixed R/L Load

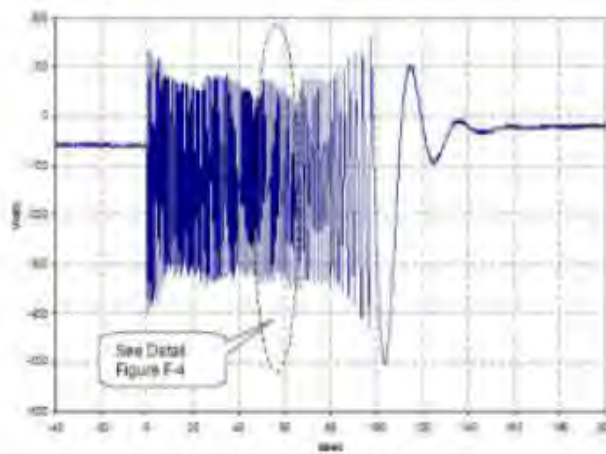


Much more severe pulses from DUTs with high inductance

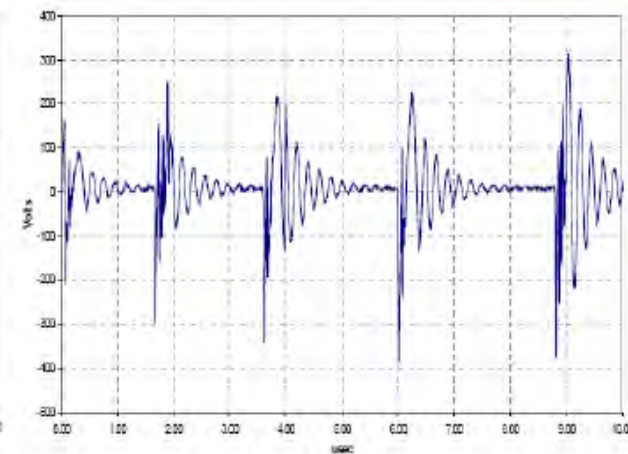
Ford ES-XW7T-1A278-AC CI220



Pulse A1



Pulse A2



Pulse C

These pulses are caused by actual mechanical relay with defined circuitry

Nissan

28401NDS02

EQ/IC 04 : Resistance to power supply micro-interruptions

Siemens VDO

Fuel Pump Transient test for IPC

- **ISO 7637-2**
- **ISO 7637-3**

Teseq Conducted Immunity System
Automotive Electronics

NSG5500



NSG5600



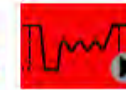
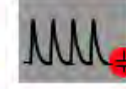
PA 5840



Transients



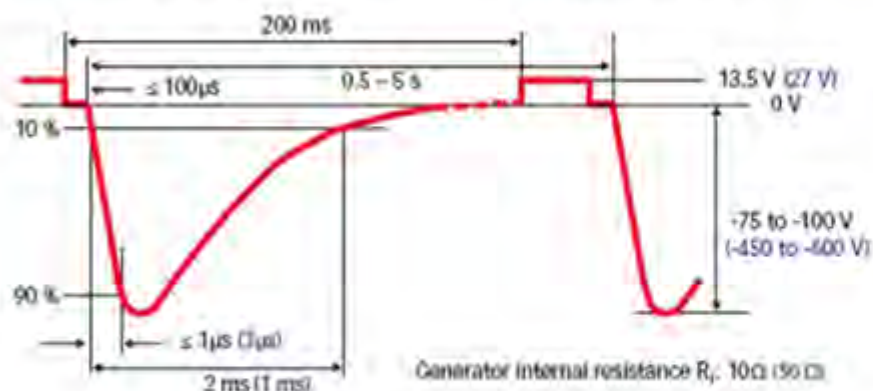
Voltage
Fluctuation



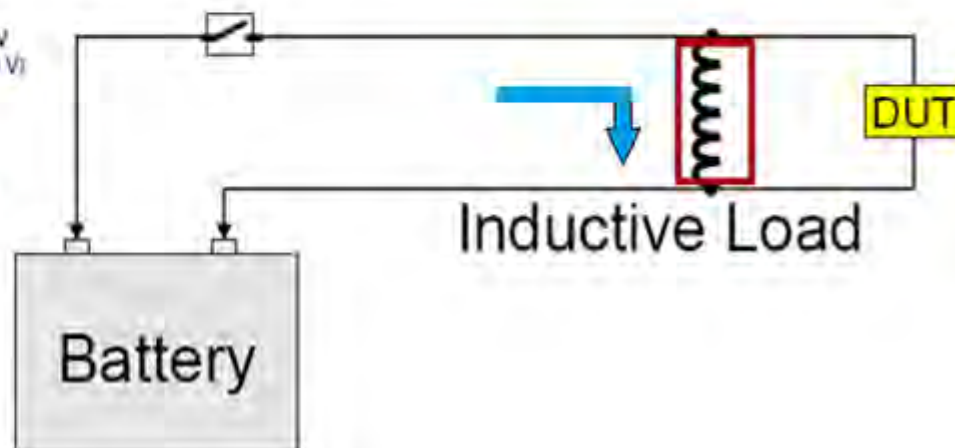
- ISO
- SAE
- JASO
- BMW
- Daimler Chrysler
- Fiat
- Ford
- General Motors
- Honda
- Hyundai
- Mazda
- Peugeot
- Nissan
- Renault
- Toyota
- Volkswagen
- Etc..

Test Pulse 1

This test is a simulation of transients due to supply disconnection from inductive loads; it applies to a DUT if as used in the vehicle, it remains connected directly in parallel with an inductive load.⁽¹⁾

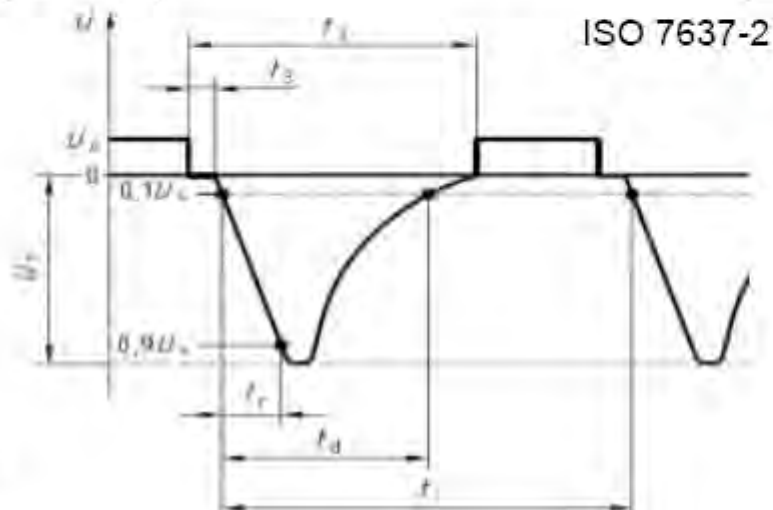


Parameter	12 V system	24 V system
U_{min}	-75 V to -100 V	-450 V to -600 V
R_g	10 Ω	50 Ω



Test Pulse 1 Variant

Parameter	12 V system	24 V system
U_s	-75 V to - 100 V	-450 V to - 600 V
R_l	10 Ω	50 Ω
t_d	2 ms	1 ms
t_r	$1_{-05}^0 \mu s$	$3_{-15}^0 \mu s$
t_1^a	0,5 s to 5 s	
t_2	200 ms	
t_3^b	= 100 μs	



Ford
ES-XW7T-1A278-AC
CI220 pulse E (12V only)



Nissan
28401NDS02
EQ/IC 01 Pulse1 (12V only)



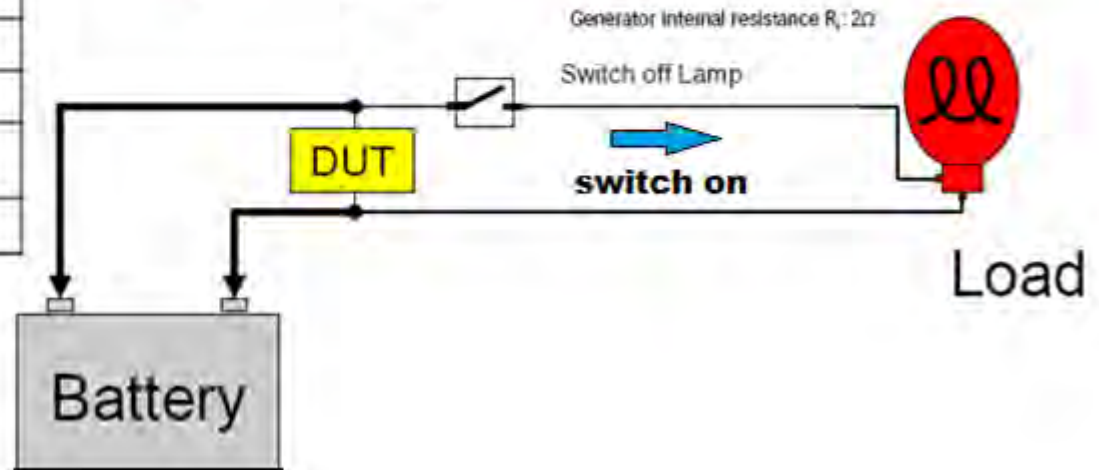
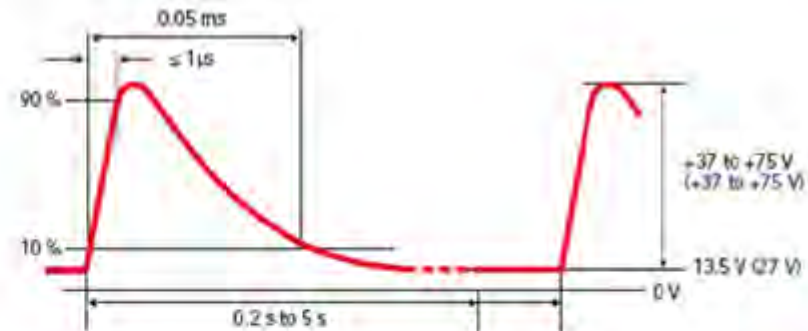
Volkswagen
TL 82066

Pulse	Number	U_r (V)	t_r (μs)	t_f (μs)	Generator R (Ω)
					12 V 42 V
Pulse 1	5,000 pulses	-100	2,000	1	4 10
					24V
Pulse 1	5,000 pulses	-150	2,000	1	10

Test Pulse 2a

Pulse 2a simulates transients due to sudden interruption of currents in a device connected in parallel with the DUT due to the inductances of the wiring harness.

Parameter	12 V system	24 V system
U_0	+37 V to +50 V	
R_0	2 Ω	
t_0	0,05 ms	
t_1	(1 -0,8) μ s	
t_2	0,2 s to 5 s	

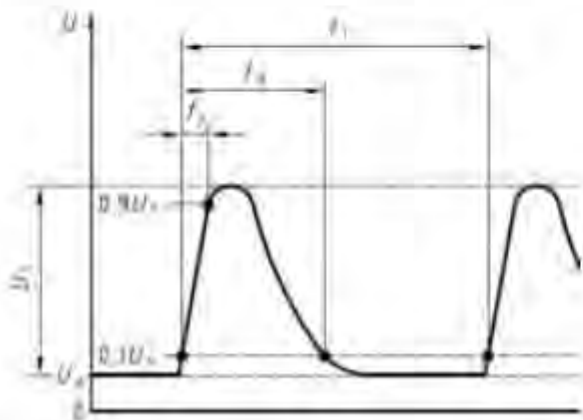


Test Purpose of ISO 7637-2 : Transients

Test Pulse 2a Variant

Parameter	12 V system	24 V system
U_s	+ 37 V to + 50 V	
R_i	2 Ω	
t_0	0,05 ms	
t_1	(1 $\begin{smallmatrix} 0 \\ -0,5 \end{smallmatrix}$) μ s	
t_1^0	0,2 s to 5 s	

ISO 7637-2



24



Ford
ES-XW7T-1A278-AC
CI220 pulse F (12V only)



Nissan
28401NDS02
EQ/IC 01 Pulse 2a (12V only)



Volkswagen
TL 82066

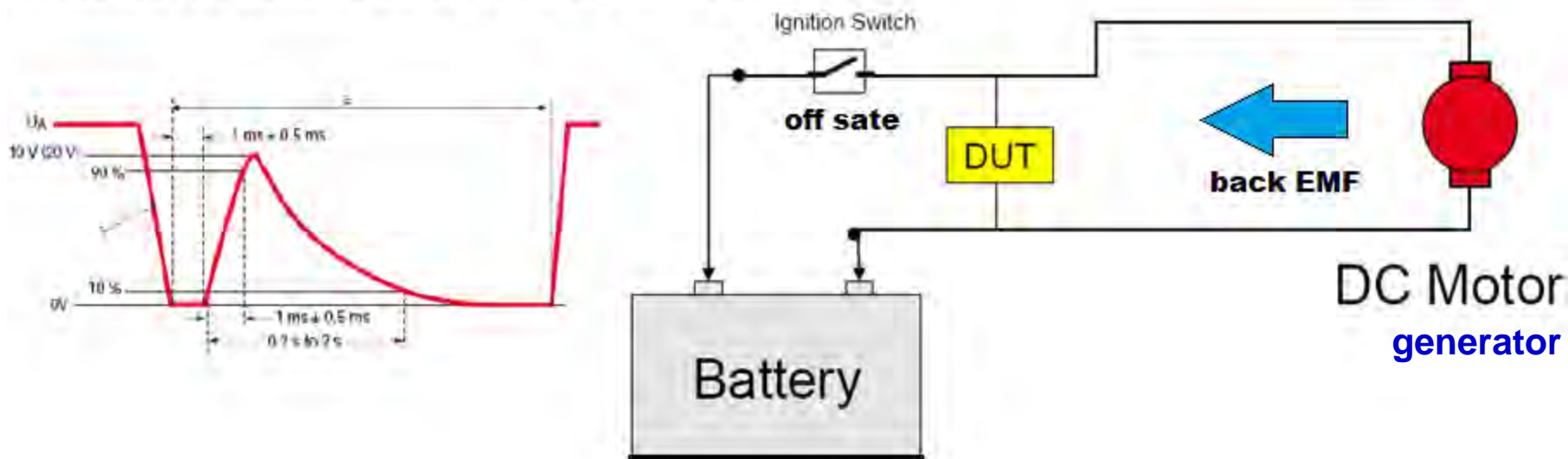
Pulse	Number	U_s (V)	t_0 (μ s)	t_1 (μ s)	Generator R (Ω)	
					12 V	42 V
Pulse 2	5,000 pulses	+50	50	1	4	10
Pulse 2	5,000 pulses	+75	200	1	24V 10	

Test Purpose of ISO 7637-2 :Transients

Test Pulse 2b

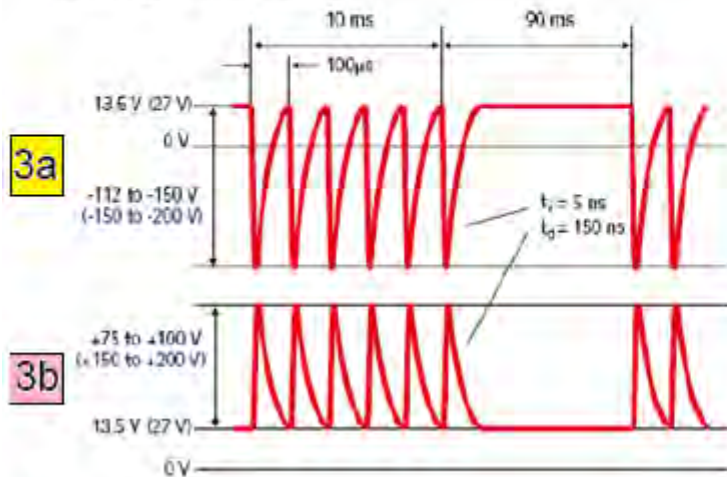
Pulse 2b simulates transients from dc motors acting as generators after the ignition is switched off

It is more like a voltage fluctuation test. Most car manufacturers had withdrawn this because it is covered by other voltage fluctuation tests



Test Pulse 3a/3b

Pulse 3 occurs as the result of switching processes. The characteristics of this pulse are influenced by distributed capacitance and inductance of the wiring harness.



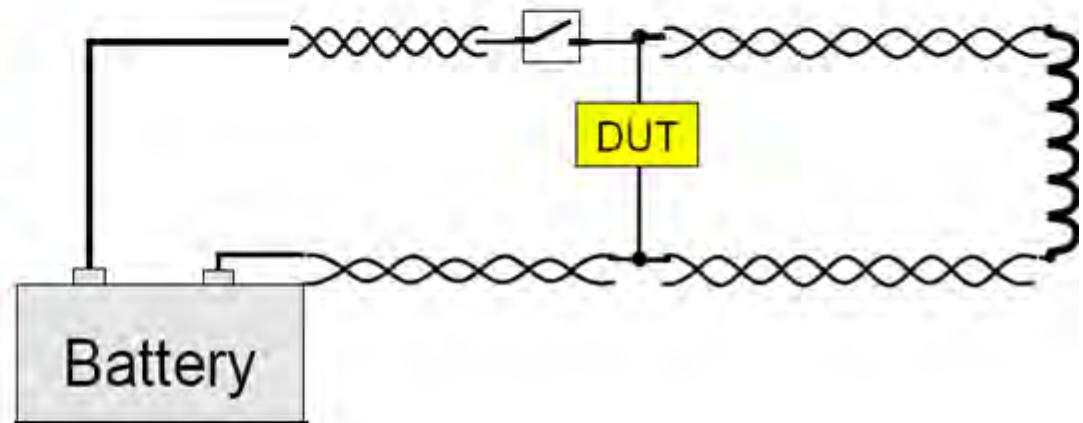
26

Parameters for test pulse 3a

Parameter	12 V system	24 V system
U_1	-112 V to -150 V	-150 V to -200 V

Parameters for test pulse 3b

Parameter	12 V system	24 V system
U_2	-75 V to +100 V	-150 V to -200 V

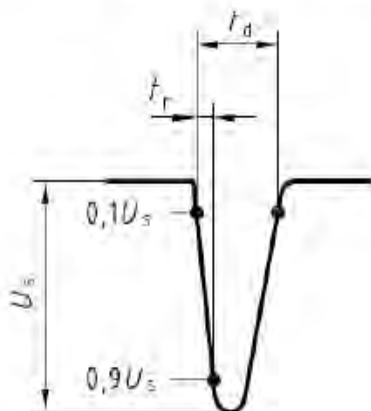


Test Purpose of ISO 7637-2 : Transients

Test Pulse 3a/3b Variant

Most manufacturers bring these tests into their own EMC standards except Ford

Test pulse 3a	U_s	t_r	t_d
No load	$-200\text{ V} \pm 20\text{ V}$	$5\text{ ns} \pm 1,5\text{ ns}$	$150\text{ ns} \pm 45\text{ ns}$
Test pulse 3b	U_s	t_r	t_d
No load	$-200\text{ V} \pm 20\text{ V}$	$5\text{ ns} \pm 1,5\text{ ns}$	$150\text{ ns} \pm 45\text{ ns}$



General Motor
GMW3097



Nissan
28401NDS02
EQ/IC 02 Pulse 3a/3b



Volkswagen
TL 82066 Pulse 3a/3b

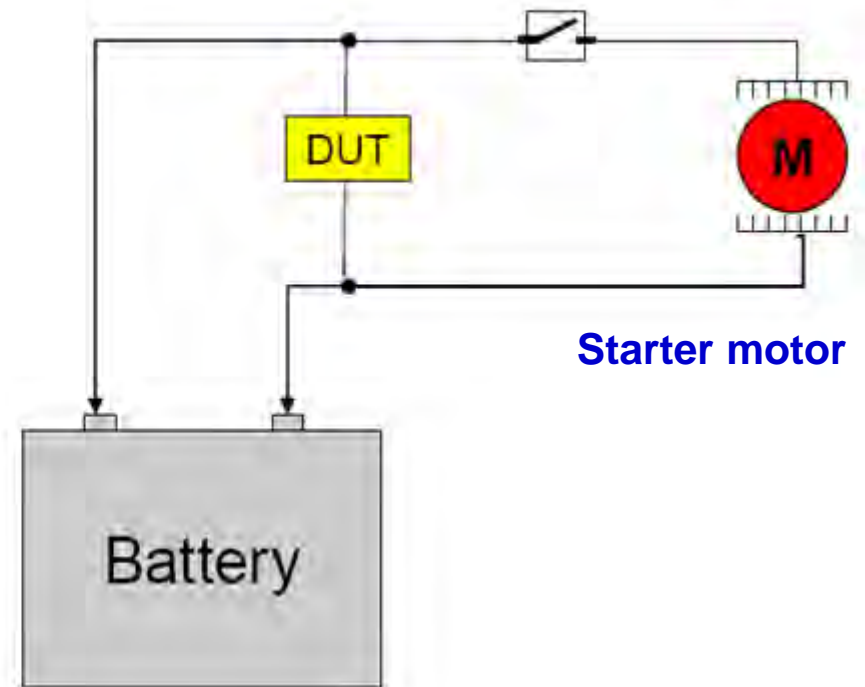
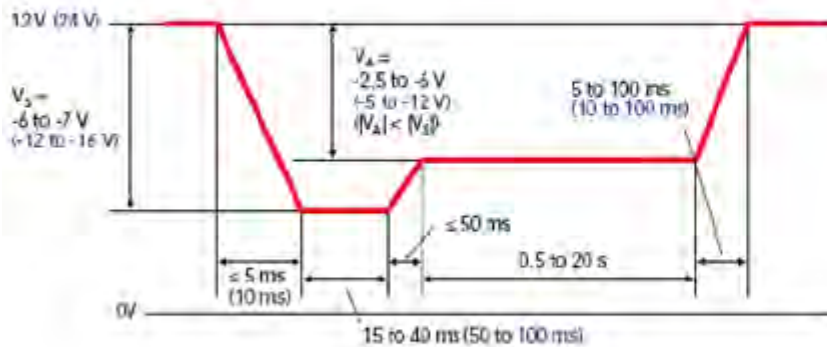


Pulse width
 $t_d = 100\text{ ns}$

Test Purpose of ISO 7637-2 : Transients

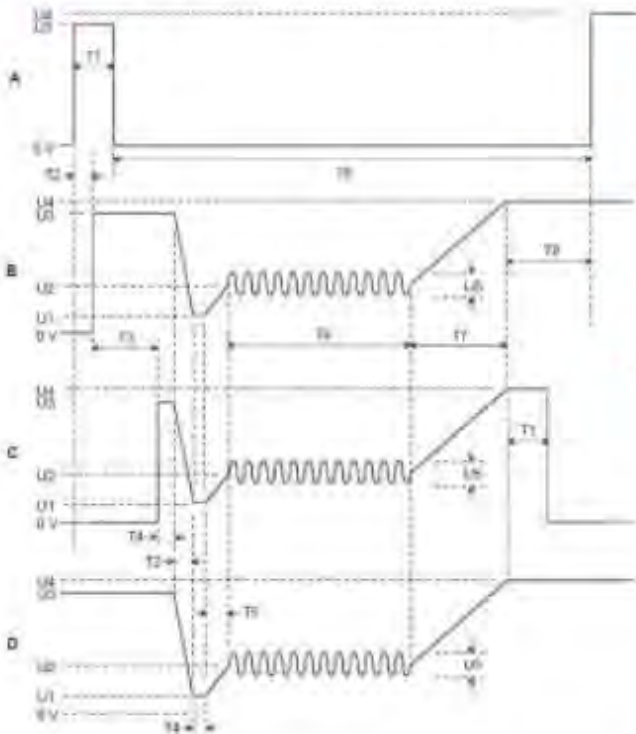
Test Pulse 4

Pulse 4 is the voltage reduction caused by energizing the starter motor circuits of the internal combustion engines

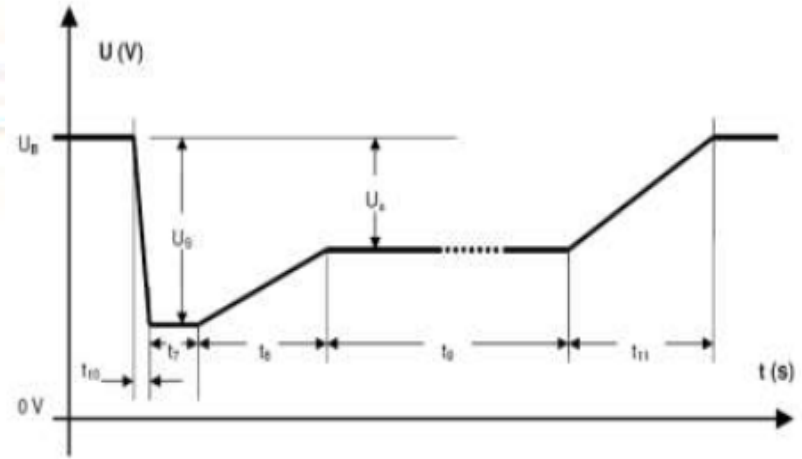


Test Pulse 4 Variant

Very Complicated Starting Profile tests



This test is to be done at -40°C or below



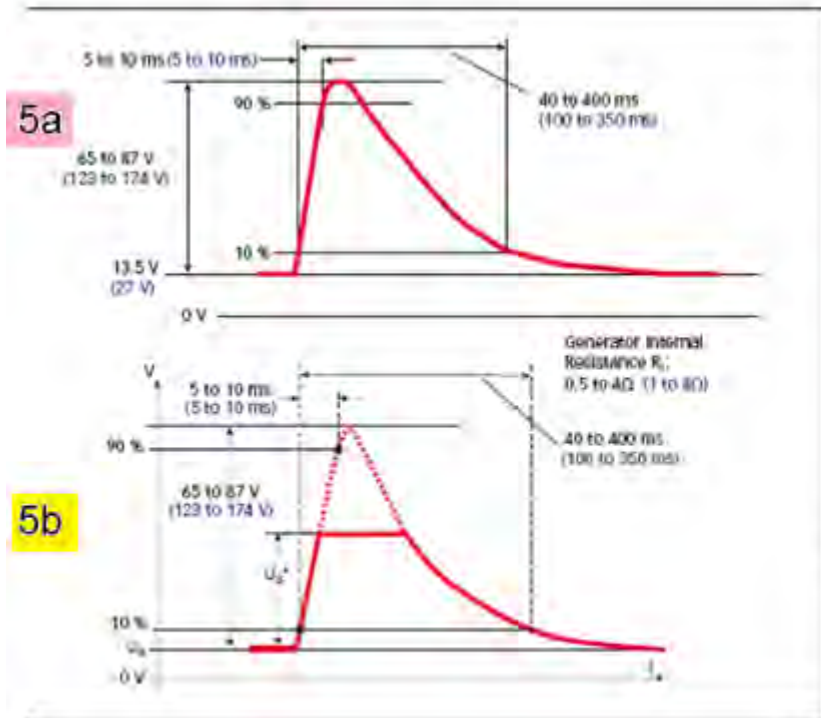
Pulse	Number	U_B (V)	U_S (V)	U_5 (V)	t_{10} (ms)	t_5 (ms)	
4	12 V	10	12	7	5,5	≤ 5	2,000
4b	12 V	10	12	9	7	≤ 5	1,000
4	24 V	10	24	18	12	≤ 10	3,000
4	42 V	10	36	18	15	≤ 10	2,000

The following applies to the pulses: $t_7 = 15$ ms, $t_5 = 50$ ms, $t_{11} = 100$ ms, $R_i = 0$ to 0.02Ω

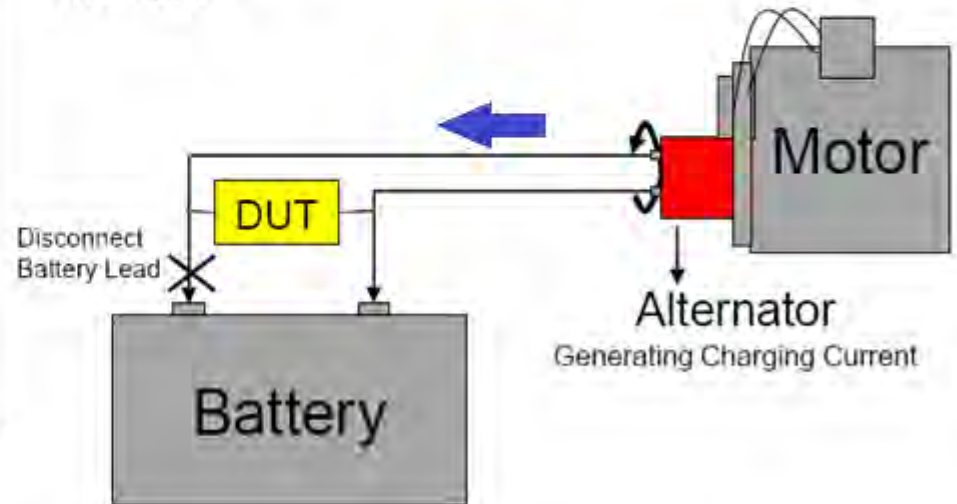
Ford
ES-XW7T-1A278-AC CI230
Power Cycling

Volkswagen
TL 82066 Pulse 4/4b

Test Pulse 5a/5b



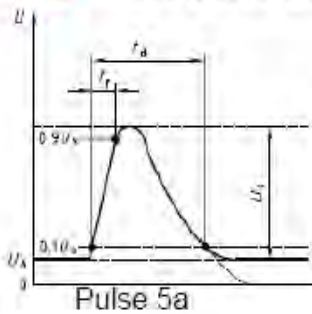
Pulse 5 is a simulation of a load dump transient occurring in the event of a discharged battery being disconnected while the alternator is generating charging current with other loads remaining on the alternator circuit at this moment




Test Purpose of ISO 7637-2 : Transients

Test Pulse 5a/5b variant

- All manufacturers requires Load Dump test but almost all of them are specified in different ways
- This pulse generate high energy and often destructive




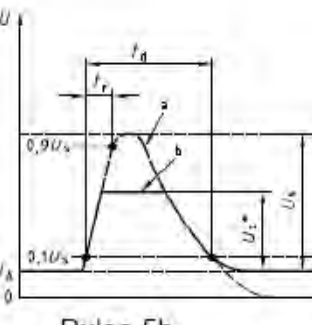
Parameter	12 V system	24 V system
U_s	65 V to 87 V	123 V to 174 V
R_i	0.6 Ω to 4 Ω	1 Ω to 8 Ω
t_d	40 ms to 400 ms	100 ms to 350 ms
t_f	$(10 \frac{0}{8})$ ms	

Ford

 ES-XW7T-1A278-AC
 CI220 pulse G


Test pulse G - Parameters

Open Circuit Conditions	
U_b	13.5 V
U_s	79.5 V
t_r	1 - 10 ms
t_d	300 ms \pm 20%
t_f	30 s
R_i	0.5

Nissan

 28401NDS02
 EQ/IC 03 Pulse 5a/5b

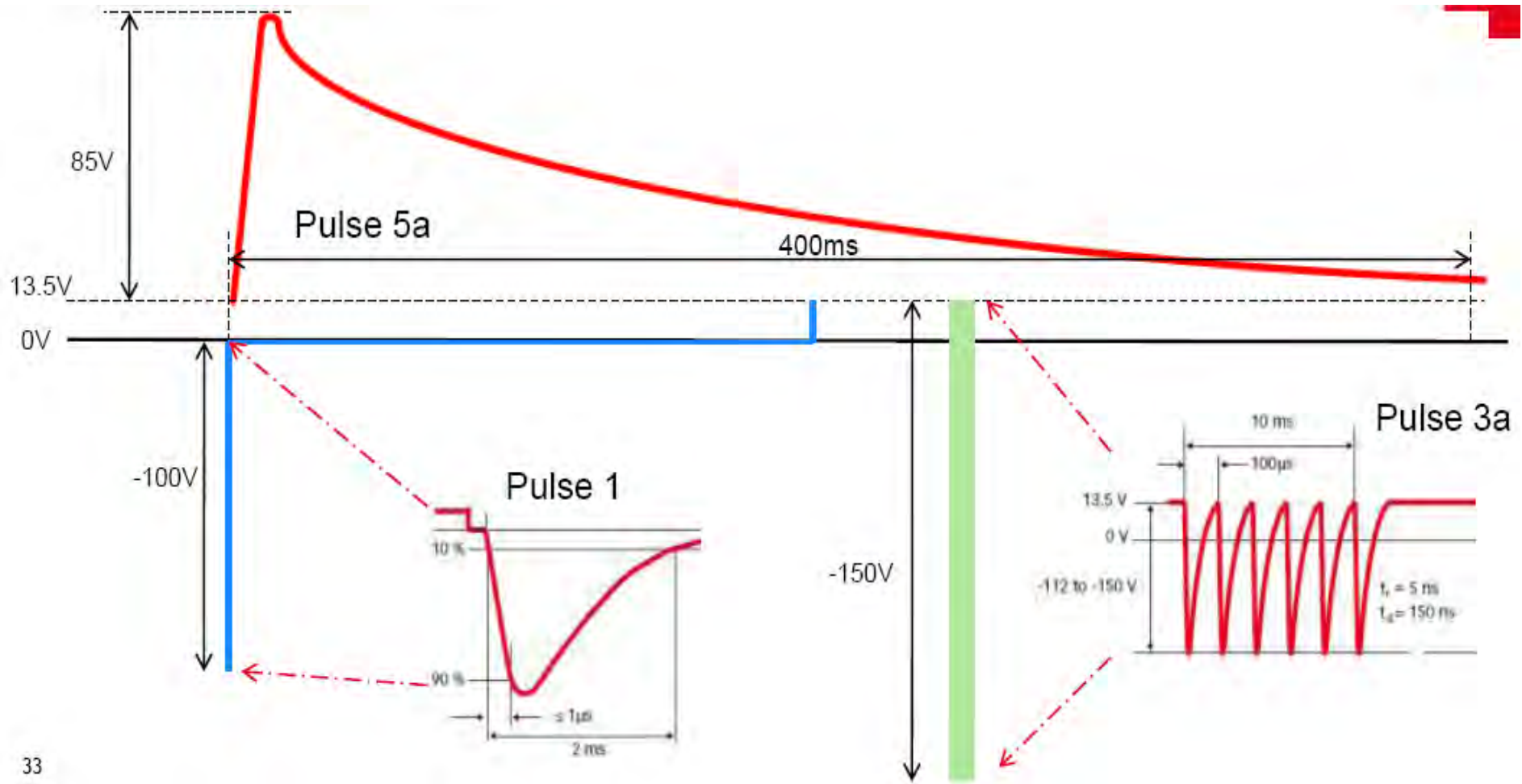


Parameter	12 V system	24 V system
U_s	65 V to 87 V	123 V to 174 V
U_s^*	As specified by customer	
t_d	Same as unsuppressed value	

Volkswagen

 TL 82066 Pulse 5p
 Only applicable to 42V system
 $R_i = 3\Omega$

Test Purpose of ISO 7637-2 : Transients

Test Pulse 5a/5b



Conducted Immunity Tests Summary

ISO7637-2	Ford ES-XW7T-1A278-AC	Nissan 28401NDS02	Volkswagen TL 82066
Pulse 1	CI 210	EQ/TE 01	Pulse 1
Pulse 2a	CI 220	EQ/TE 02	Pulse 2
Pulse 3a	Pulse A1	EQ/TE 03	Pulse 3
Pulse 3b	Pulse A2	EQ/TE 04	Pulse 4
Pulse 4	Pulse B1	EQ/TE 05	Pulse 4b
Pulse 5a	Pulse B2	EQ/IC 01	Pulse 5b
Pulse 5b	Pulse C	pulse 1	Pulse 6
	Pulse D	pulse 2	
	Pulse E	EQ/IC 02	
	Pulse F	pulse 3a	
	Pulse G	pulse 3b	
	CI 230	EQ/IC 03	
	CI 250	EQ/IC 04	
	CI 260	EQ/IC 05	
	Waveform A	EQ/IC 06	
	Waveform B		
	Waveform C		
	Waveform D		
	Waveform E		
	CI 270		



Website: WWW.ptec.or.th

Tel: 0-273 92195-98 Ext: 111

Fax:0-273 92199

Email: sales@ptec.or.th

For Further information

-please refer to:

§EMC Testing :[Brochure](#)

§Products Safety Testing :[Brochure](#)

§Calibration :[Brochure](#)

§Solar Cell Testing :[Brochure](#)

§Site Survey :[Brochure](#)

§RFID Testing :[Brochure](#)

§Telecom Testing :[Brochure](#)

§Training / R&D :[Brochure](#)

§Consultancy :[Brochure](#)

•Energy Saving/ Efficiency Testing

Thank You Very Much