WP7: SYSTEM DEVELOPMENT AND EVALUATION

Leader: DM. Ton, P. Tisserand, P. Chassard – **Valeo PES**

Start: M07, 3/2014

End: M36, 10/2016

WP7: Objectives & Achievements

- **O7.1: Define an environment to evaluate the ATHENIS_3D demonstrator in terms of performance versus specification**
  - *Design of the machine, control module design, specific PCB for DC/DC converter*
- **O7.2: Demonstrate the feasibility of a BSG control module with innovative 3D ASIC structures from WP5**
  - *Design of the complete machine including control module*
- **O7.3 Evaluation of the ATHENIS_3D in BSG control module and recorded data according to VES standard validation plan (special update for new constraints)**
  - *Control module evaluation on table and on bench, evaluation of the complete machine on bench*
- **O7.4: Evaluation of the ATHENIS_3D demonstrator in BSG control module in order to demonstrate the behavior on a vehicle**
  - *Evaluation of the complete machine and system on vehicle*

WP7 planned effort and Deliverables

Updated DoW

Work package		AMS	Valeo PES	Crocus	FHG	TUW	UNIFE	AT	MASER	BESI	CEA	UNIPI	Total
WP7	Planned person.months per participant	3,0	40,0										43,0

Deliverables

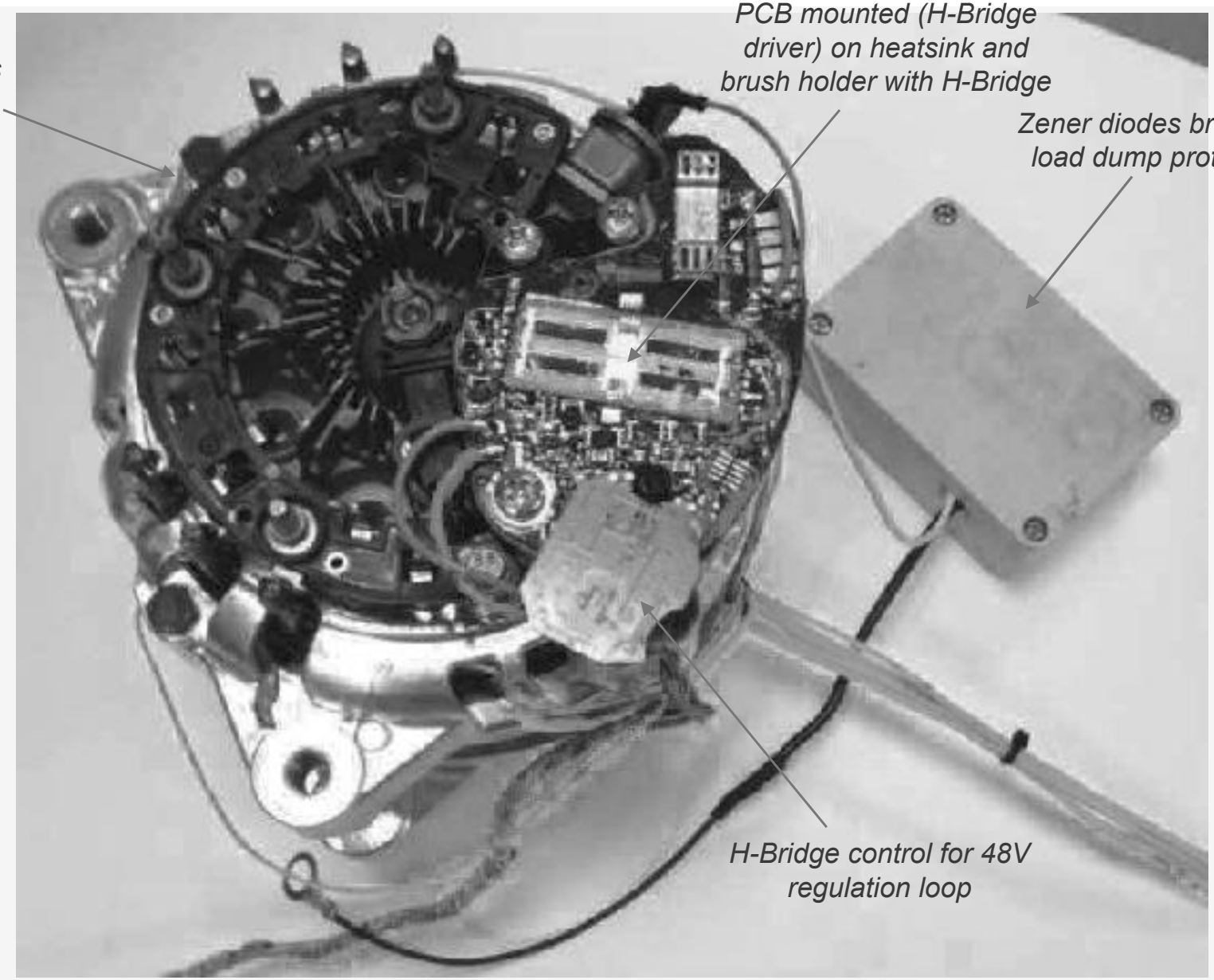
D7.1: M32 ✓ Demonstrator 1 and 2 prototypes validated at system level [Valeo PES]
D7.2: M36 ✓ Demonstrator 1 and 2* implemented in a demo car [Valeo PES]
D7.3: M36 ✓ Delivery of the demonstrator evaluation report [Valeo PES]

*** The demonstrator 2 is not implemented in the demo car**

Milestone

MS6: M36 ATHENIS_3D demonstrators implemented and validated in the demo car

WP7 Demonstrator 1



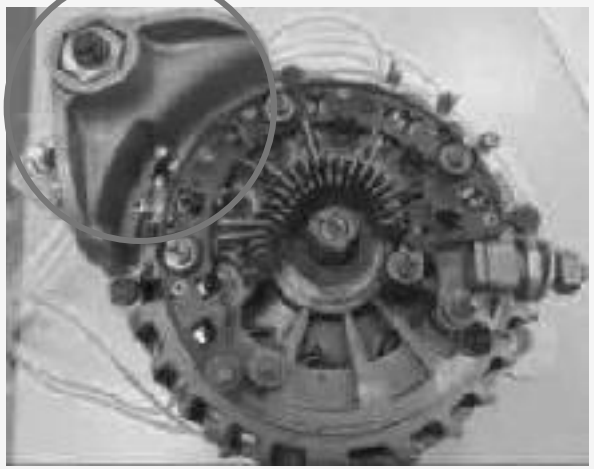
➢ Realization of the synchronous machine at 48V voltage

1) Evaluation of synchronous machine
2) Machine modification to be compatible on the democar
3) Design of interfaces between ams H-Bridge and Valeo H-Bridge control
4) 48V Voltage Regulation loop
5) Democar adaptation and tests on vehicle

➢ Brackets adaptation

- Design work to fit the new 48V machine in the cavity of 308 democar

Old Rear bracket



New Rear bracket

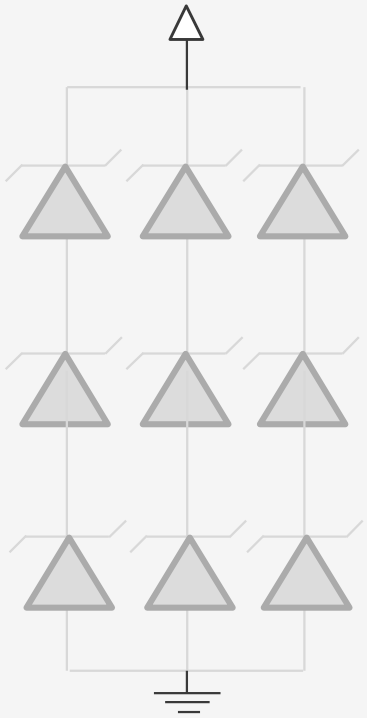
Old Front bracket

New Front bracket

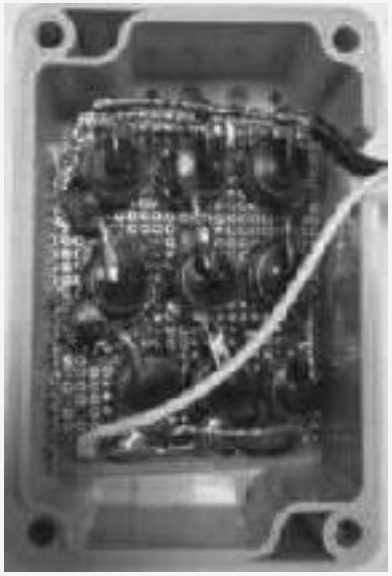
WP7 Valeo Activities - 48V machine

➢ Machine Protection

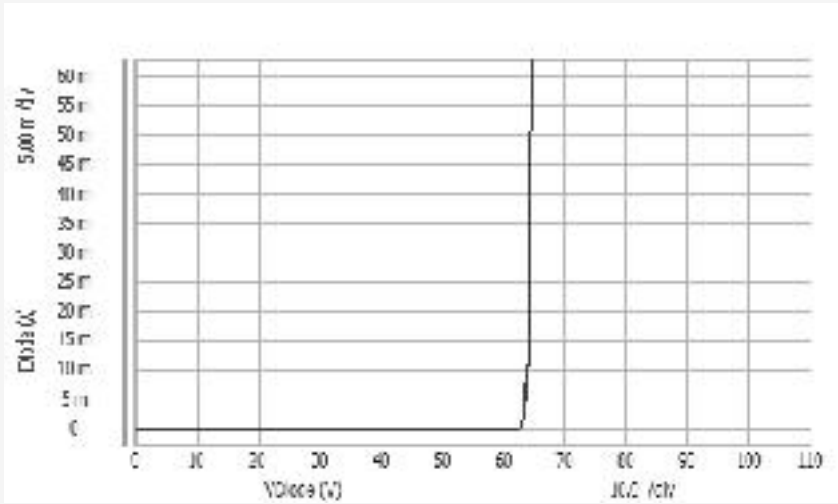
- Rectifying without over voltage protection ➔ no protection against load dump
- Conception of a protection circuit on B+A



Diodes bridge for 63V clamping schematic



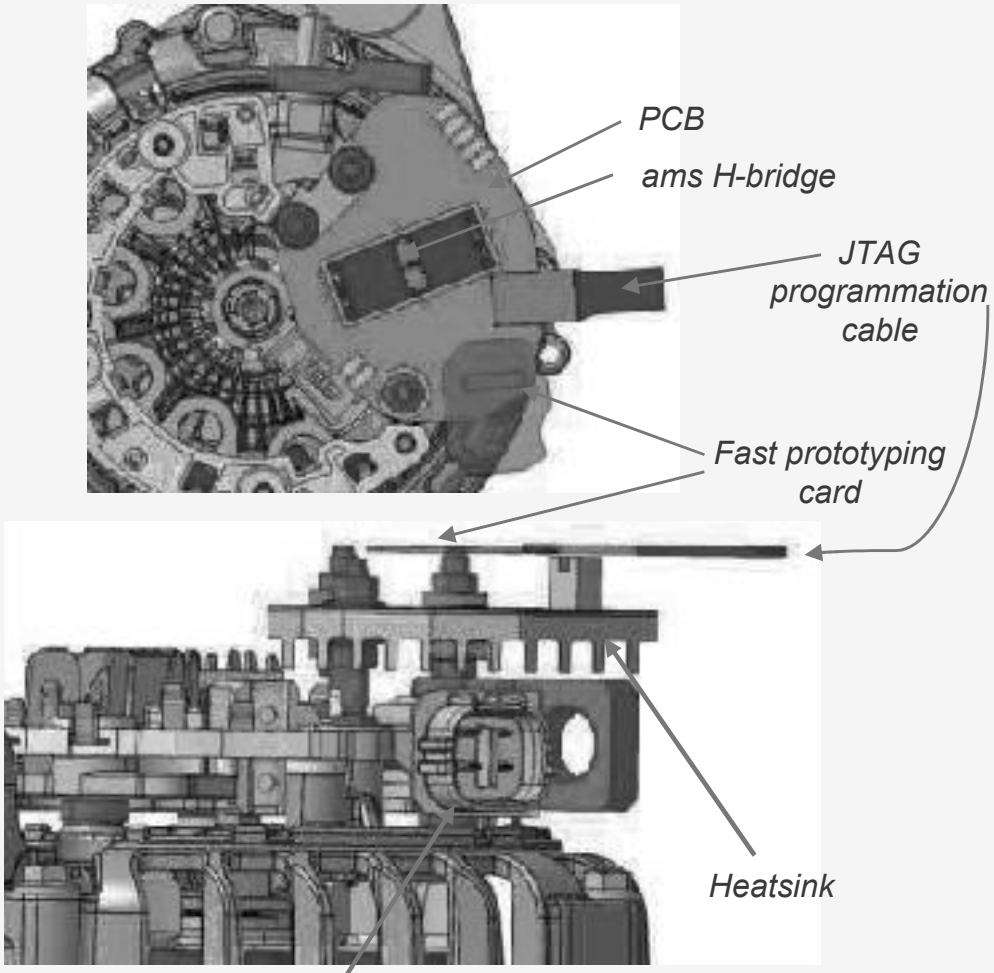
Over voltage protection Bridge



Diodes characterization in Reverse mode

Hbridge driver PCB design

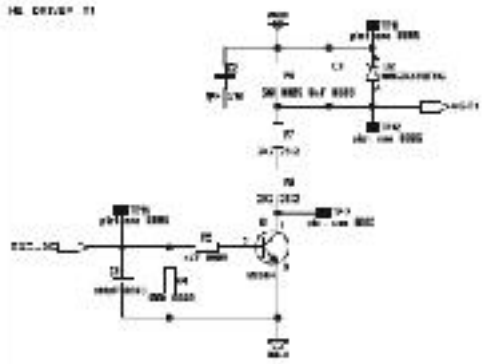
CAD Design of the assembled PCB mounted on 48V synchronous machine



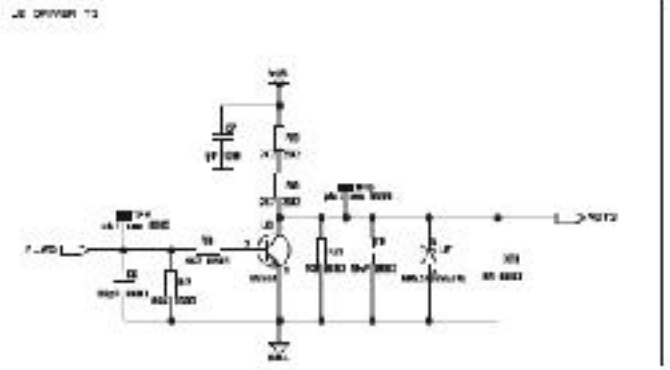
Top view of the routed PCB

Interfaces PCB design

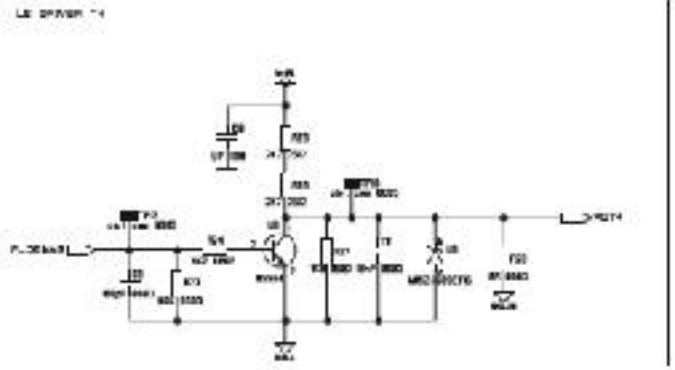
Driver High Side for PWM



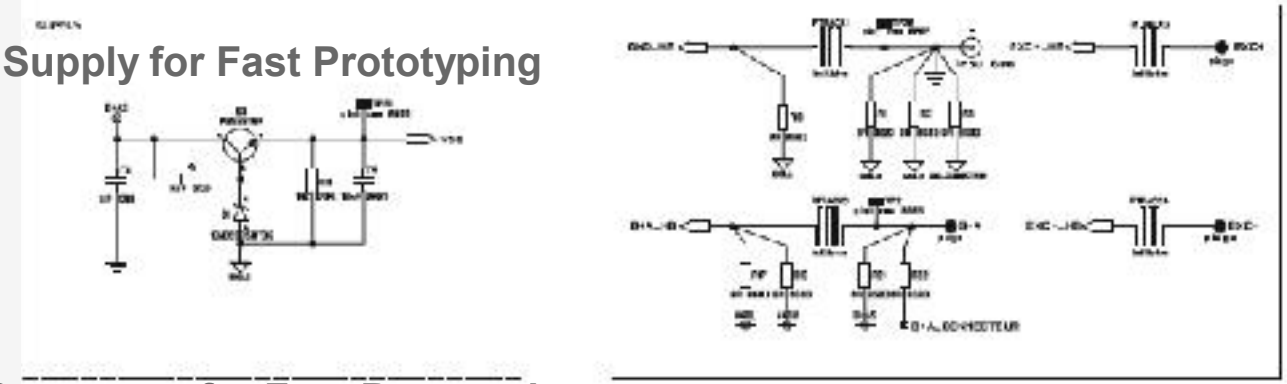
Driver for FWD Low Losses



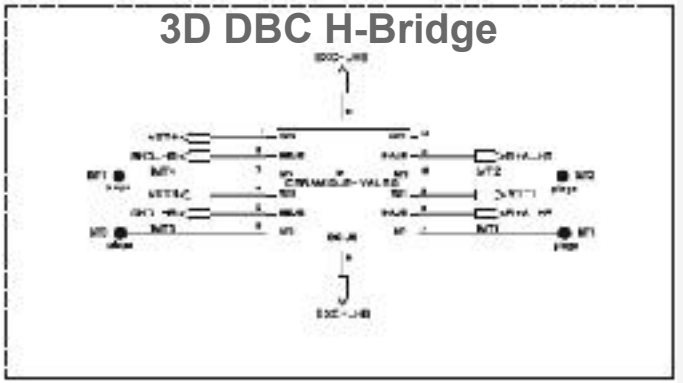
Driver for Fast Demag and Safety



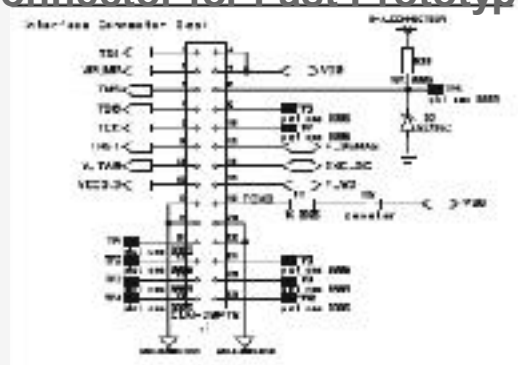
Supply for Fast Prototyping



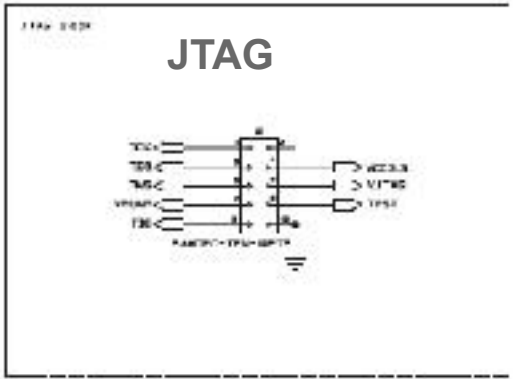
3D DBC H-Bridge



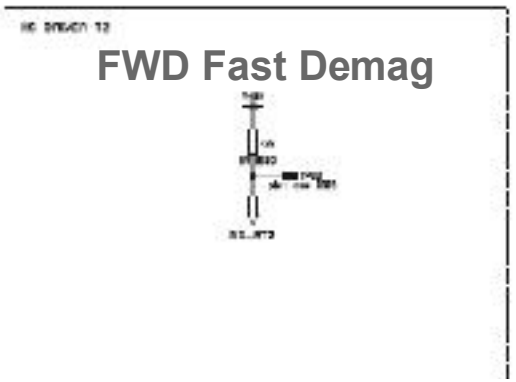
Connector for Fast Prototyping



JTAG



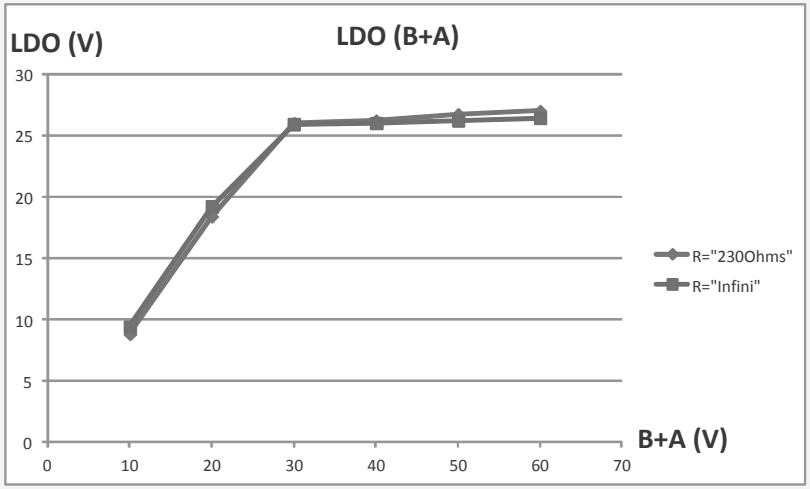
FWD Fast Demag



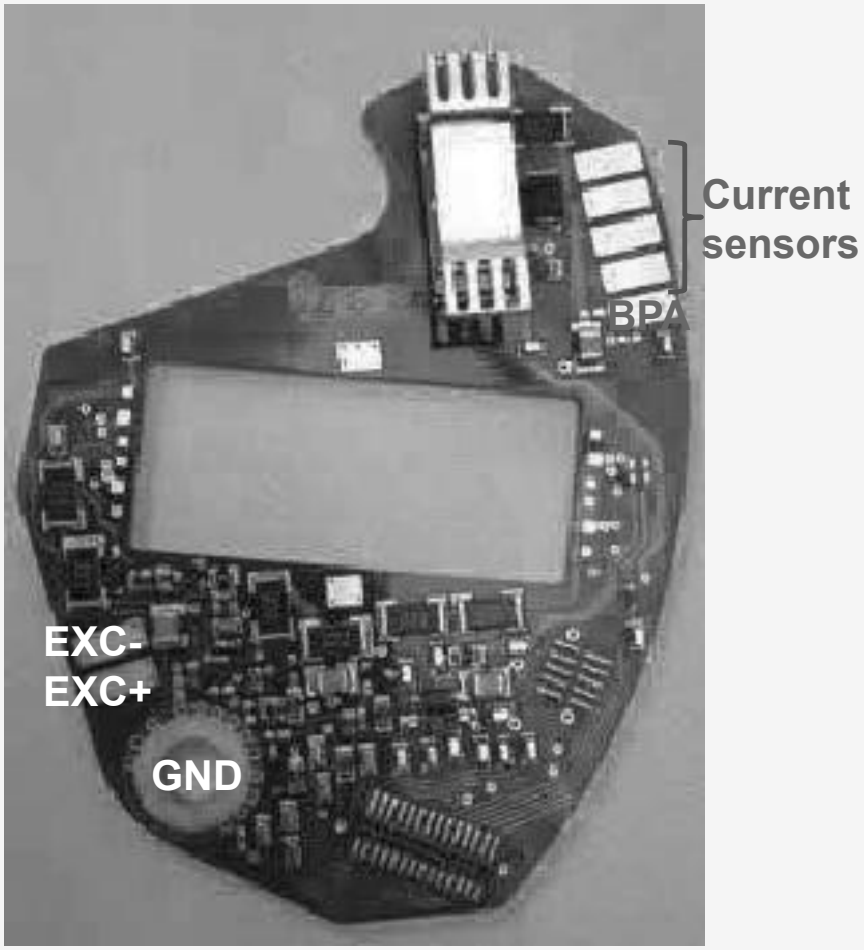
Hbridge Driver PCB in Standalone evaluation

Evaluation tests have been done on the PCB standalone from B+A = 30 to 60V :

- Measure of the input / output duty cycles of the drivers T1, T3 and T4
- Measure of the voltage drop for each driver
- Characterization of the interface connector
- Characterization of the LDO

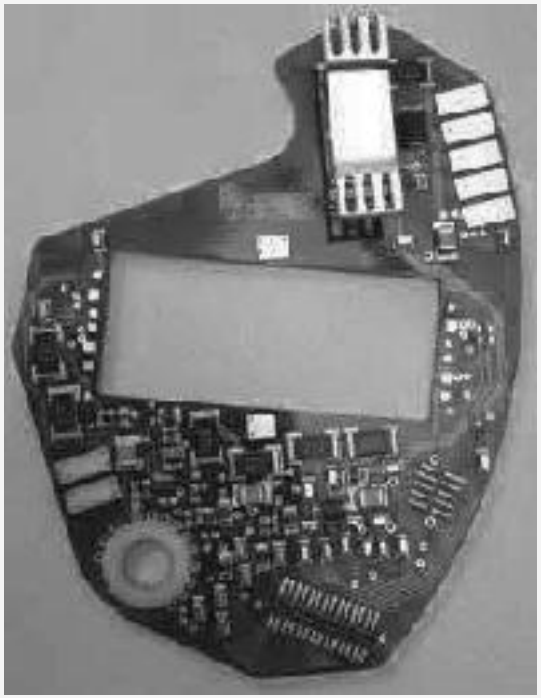


Characterization of the LDO

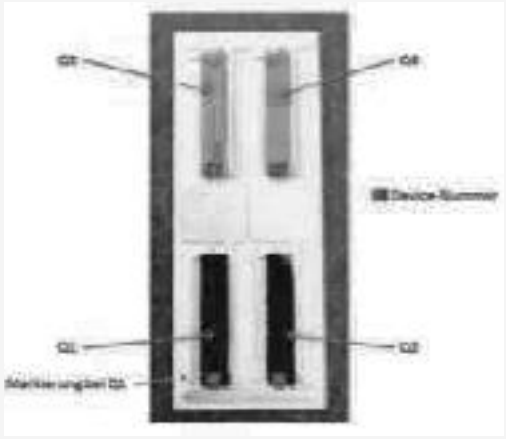


H-Bridge with Hbridge driver PCB for 48V evaluation

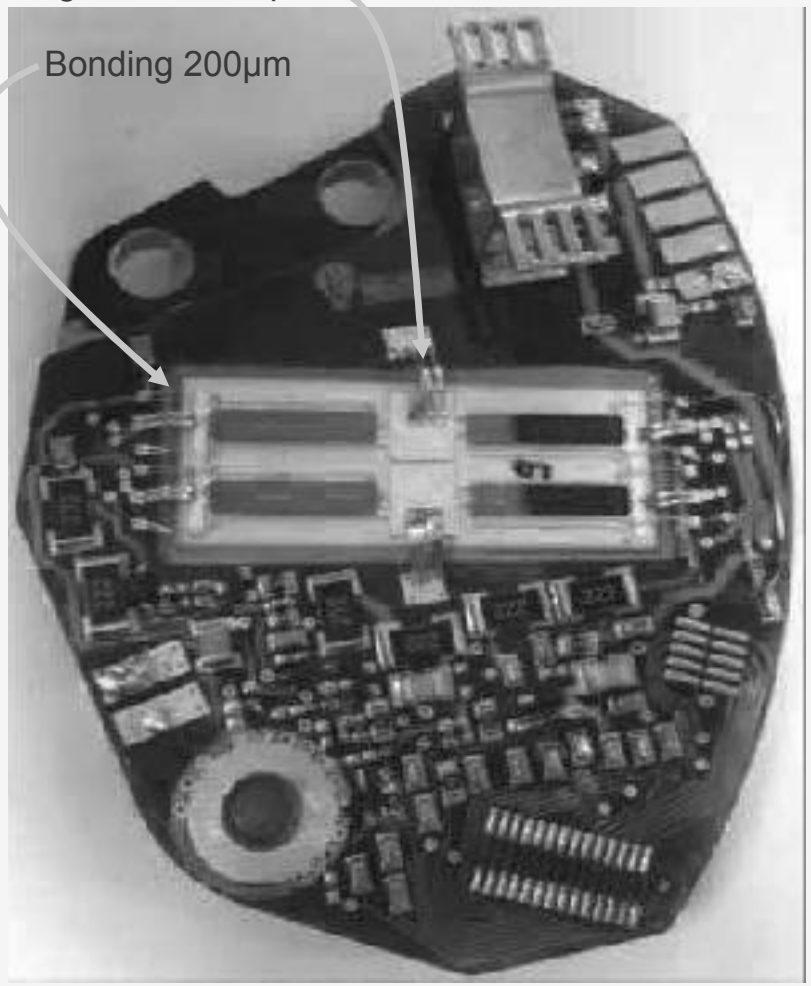
- H-Bridge evaluation
  - H-Bridge design: ams H35 technology for power MOSFETs + Smart driver (Valeo PCB)
  - Assembly of H-Bridge on Valeo PCB



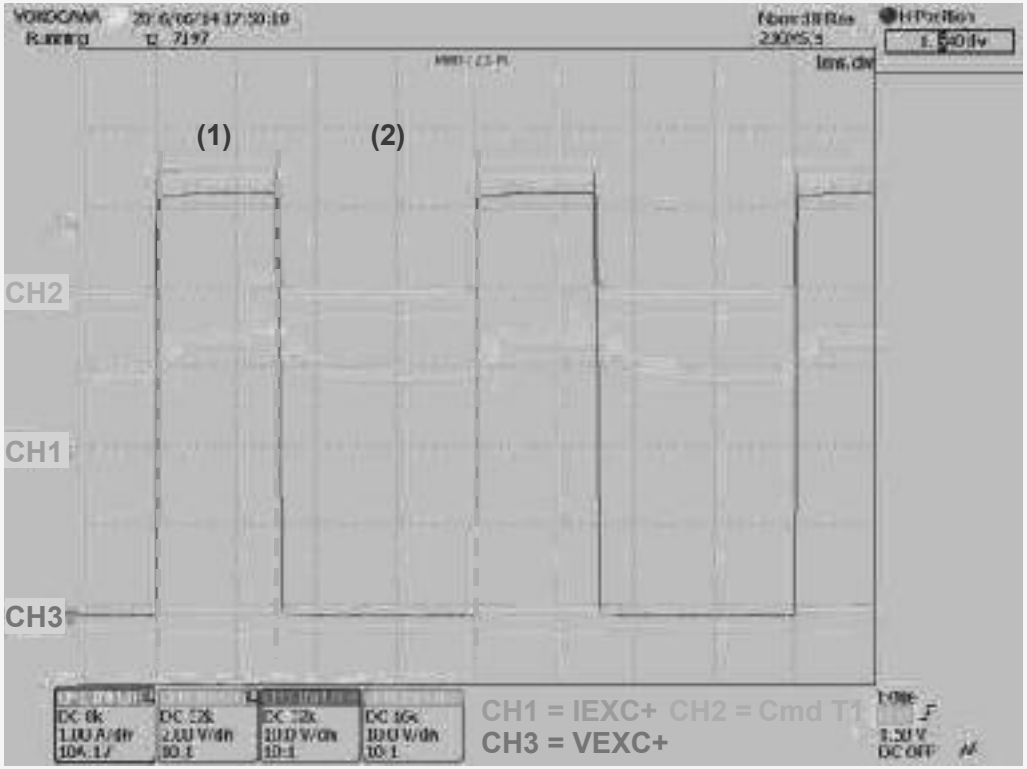
Valeo PCB

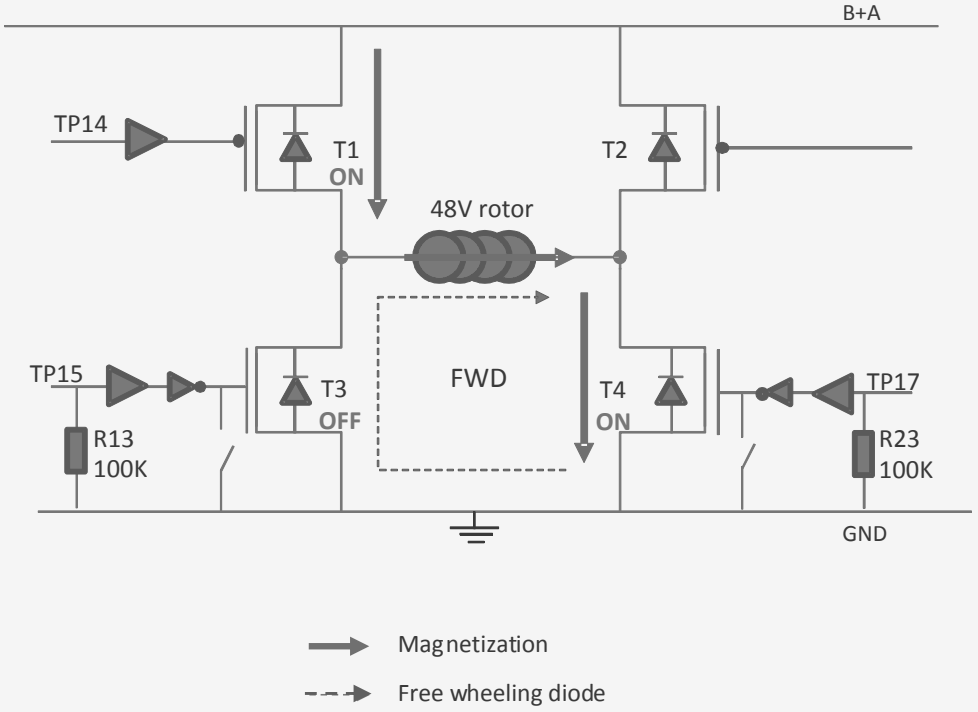


ams H-Bridge



Magnetization test

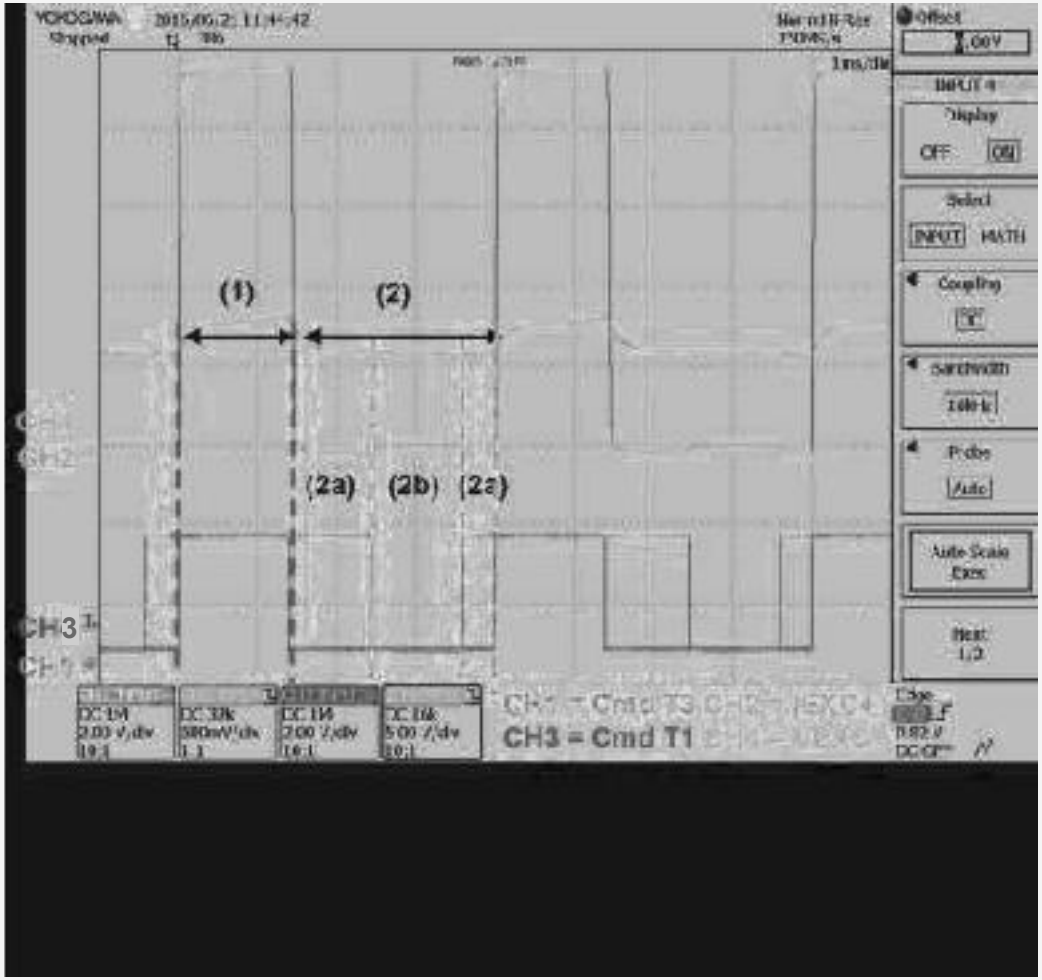


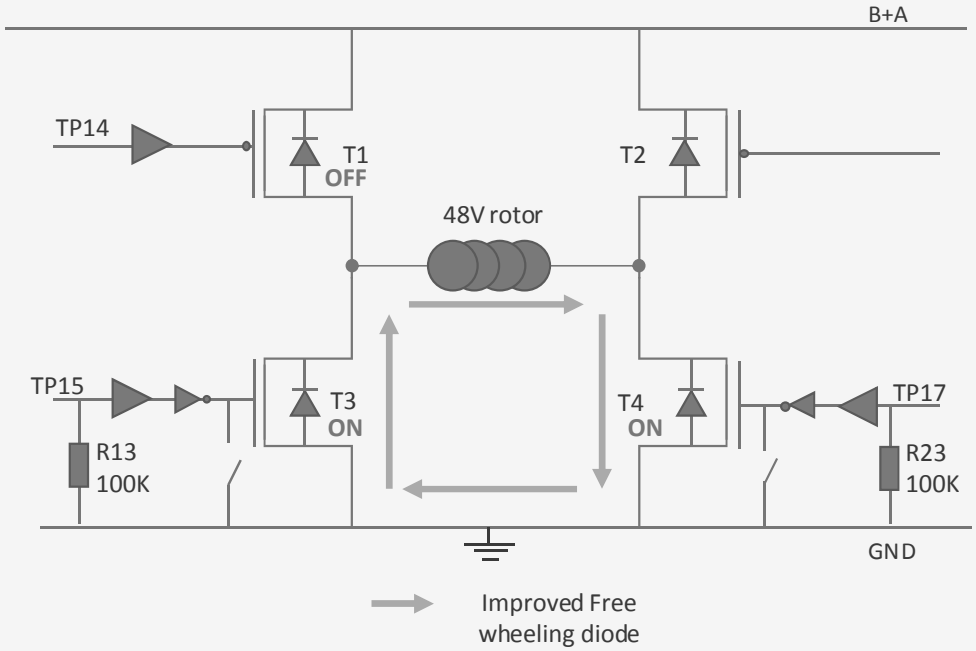


(1) Magnetization of the rotor when T1 ON and T4 ON with VEXC+ = B+A = 52V
(2) FWD when T1 OFF, T4 ON and T3 OFF in diode mode

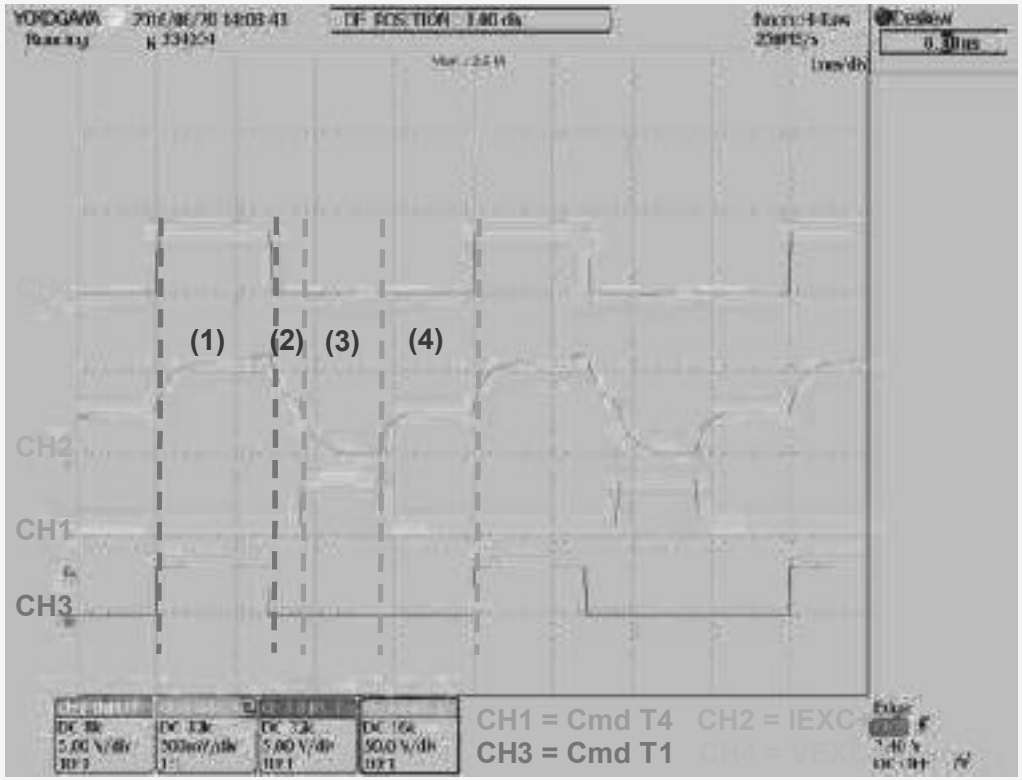
WP7 Valeo activities - Mechatronics module

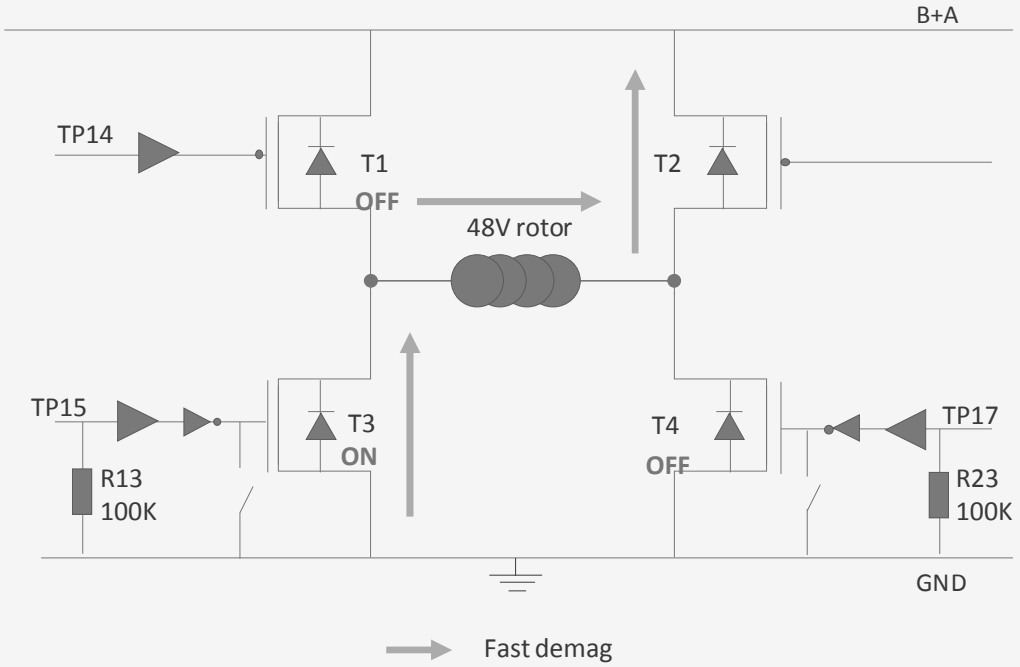
Improved FWD test





Fast Demagnetization test

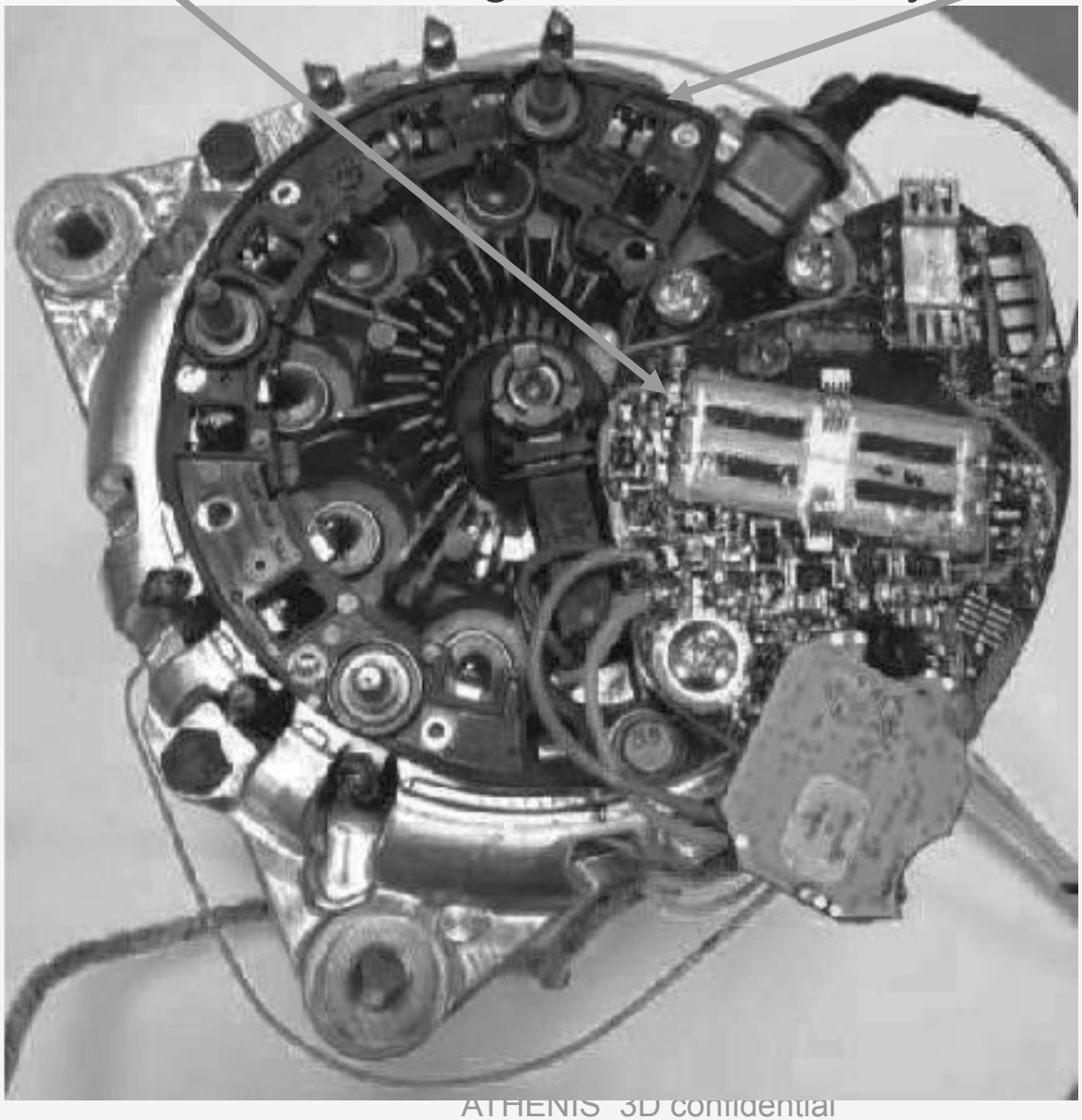




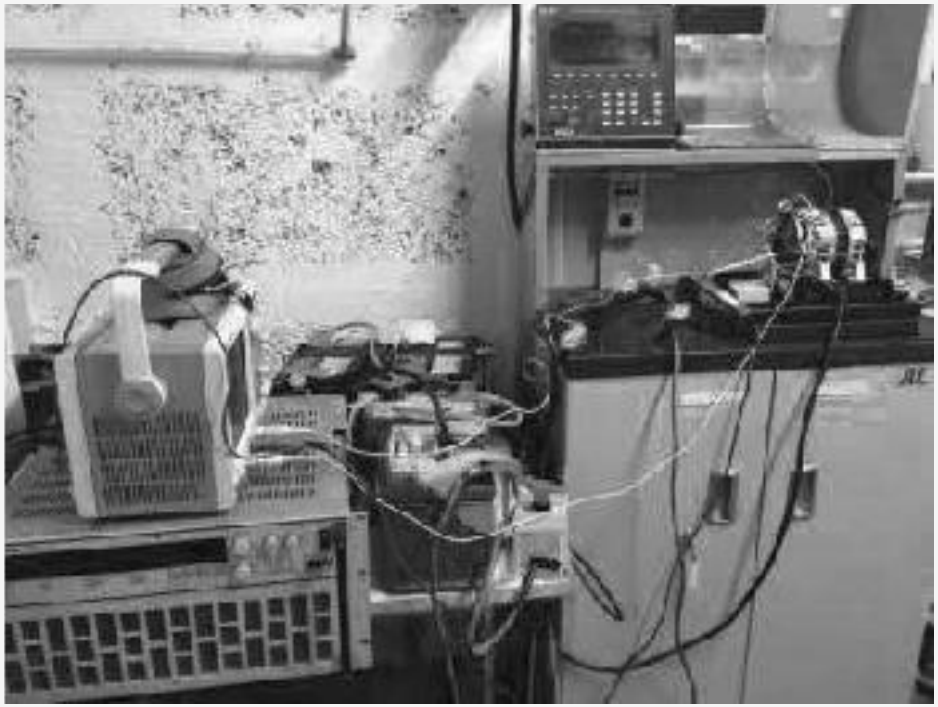
(1) Magnetization of the rotor when T1 ON and T4 ON
(2) Normal demagnetization when T1 OFF, T3 ON and T4 ON
(3) Fast demag when T4 OFF, T3 ON and T2 ON
(4) Normal demagnetization when T3 ON and T4 ON

WP7 Valeo activities - Mechatronics module

Assembled PCB with H-Bridge DBC on 48V synchronous machine



Tests on Bench



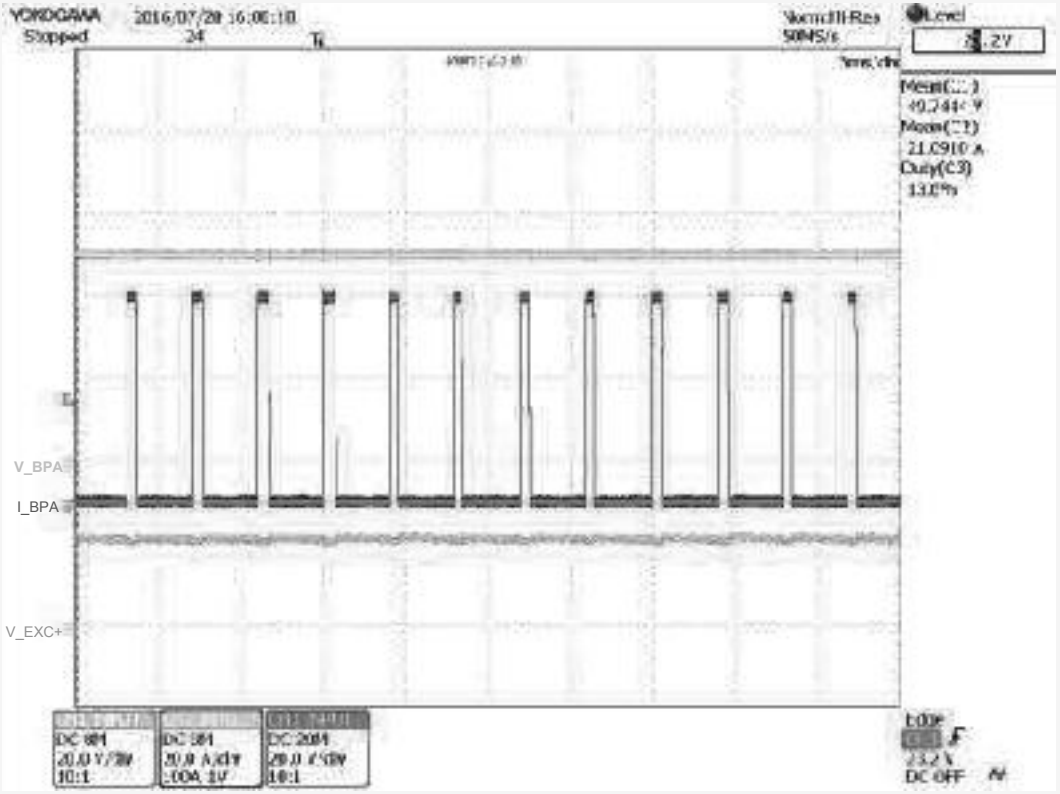


Figure 1 Regulation at 49.8V

Democar Activities

Team Main Activities

- Prototype delivery process for IBSG and GMG projects
  - Machine assembly follow-up
  - Calibration and testing
  - Customer delivery and technical support
  - System optimization and adaptation

- Democar activities
  - Democar complete build-up
  - Mechanical Electronics and software development
  - Customer demonstration
  - Hybrid architecture and functionalities evaluation

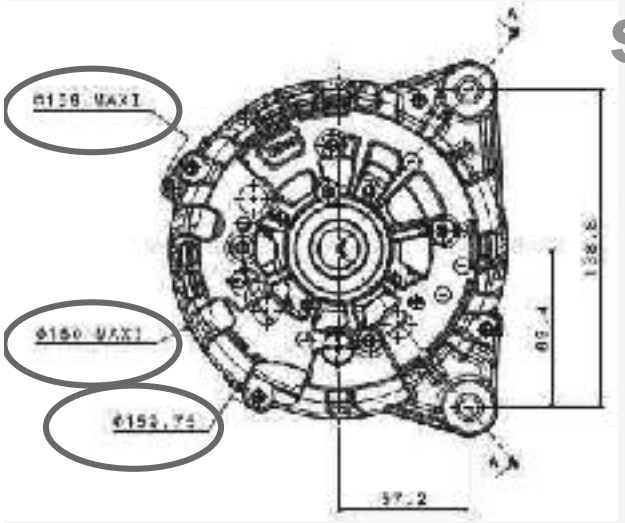
208 IStARS Coasting

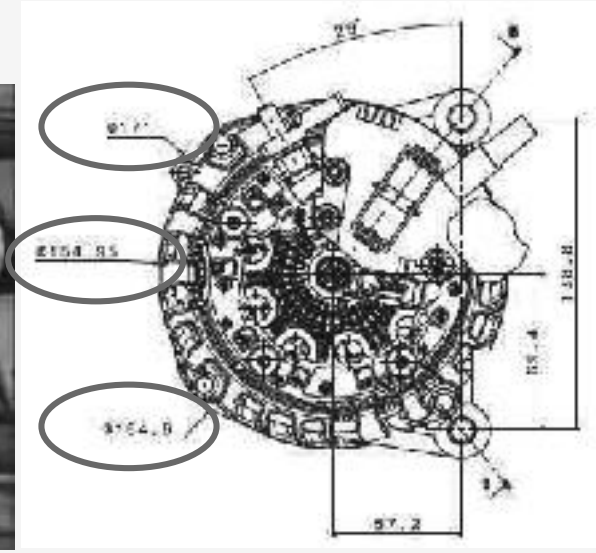
Coasting demonstration

Implementation on Democar (1): The Car

308 Peugeot 1.6l DV6

Implementation on Democar (1): The synchronous machine

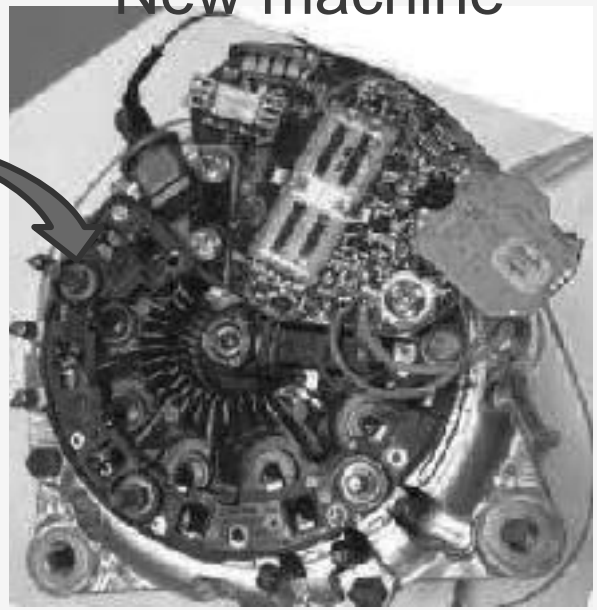




Original machine

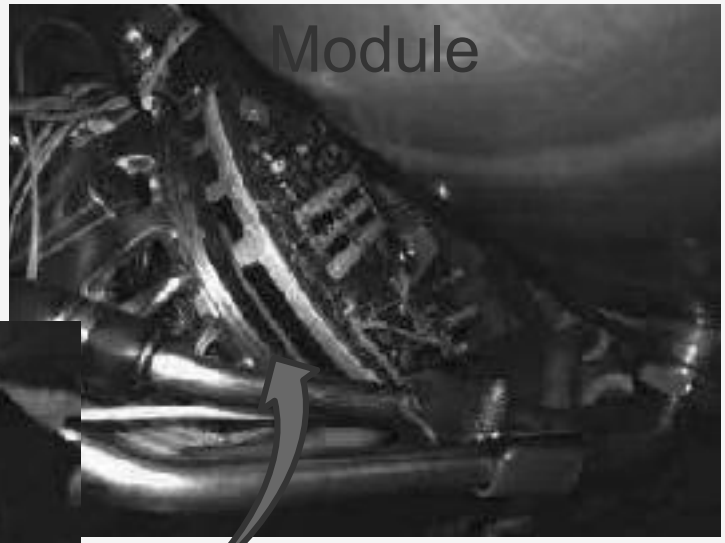
Replace the original machine by the new one

New machine

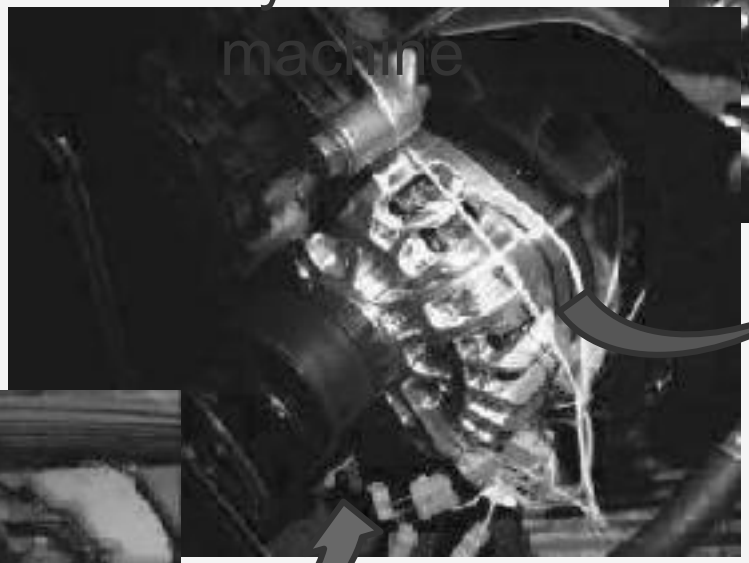


Implementation on Democar (2): The synchronous machine

48V Control Module

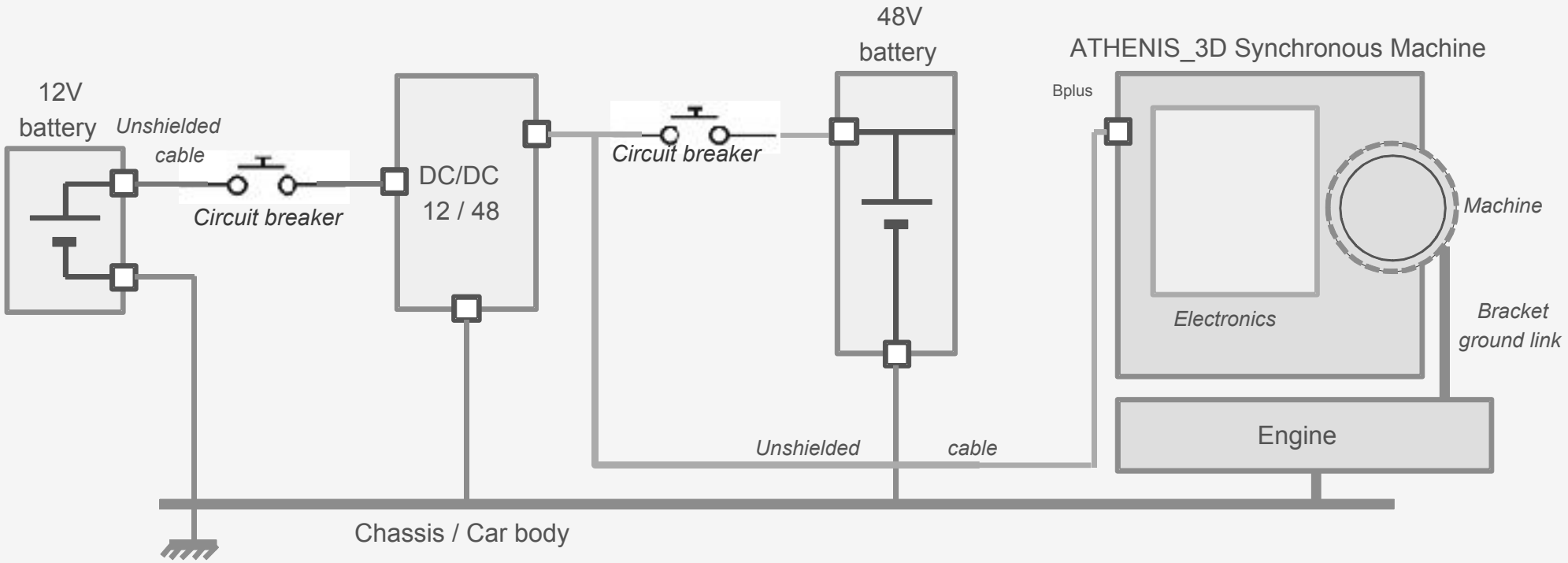


48V synchronous machine



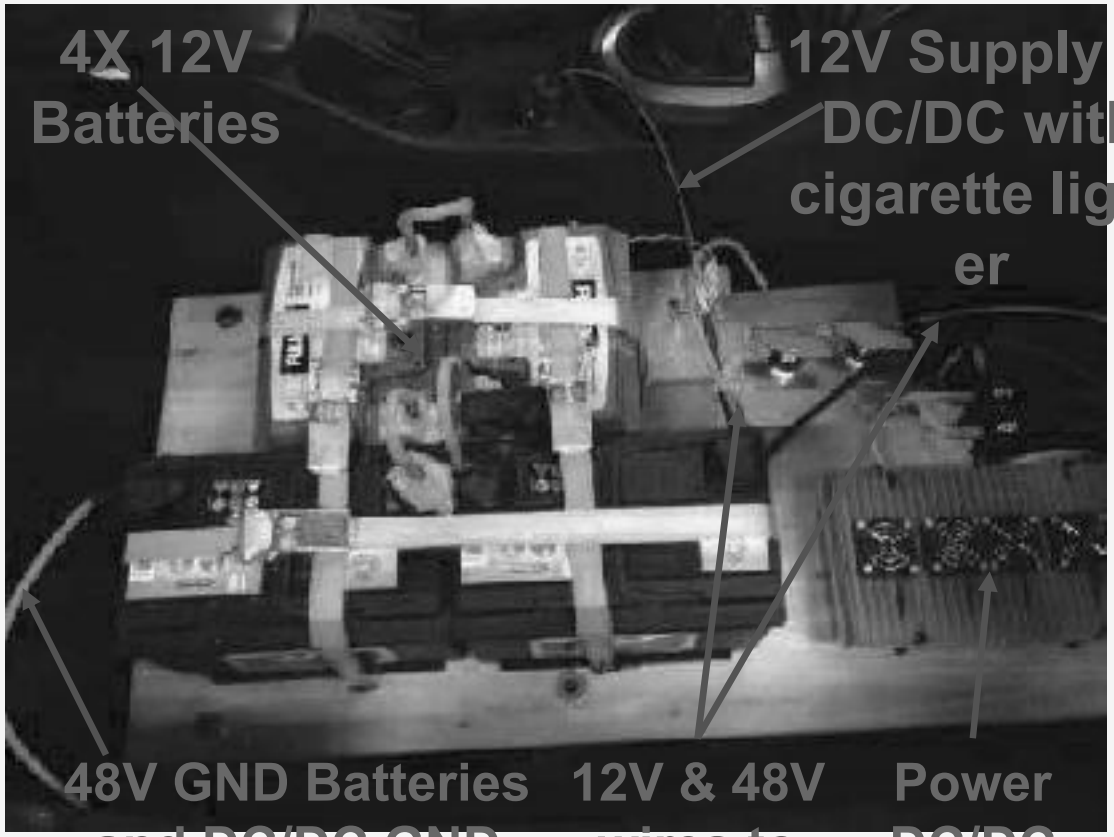
Thermal engine under roof

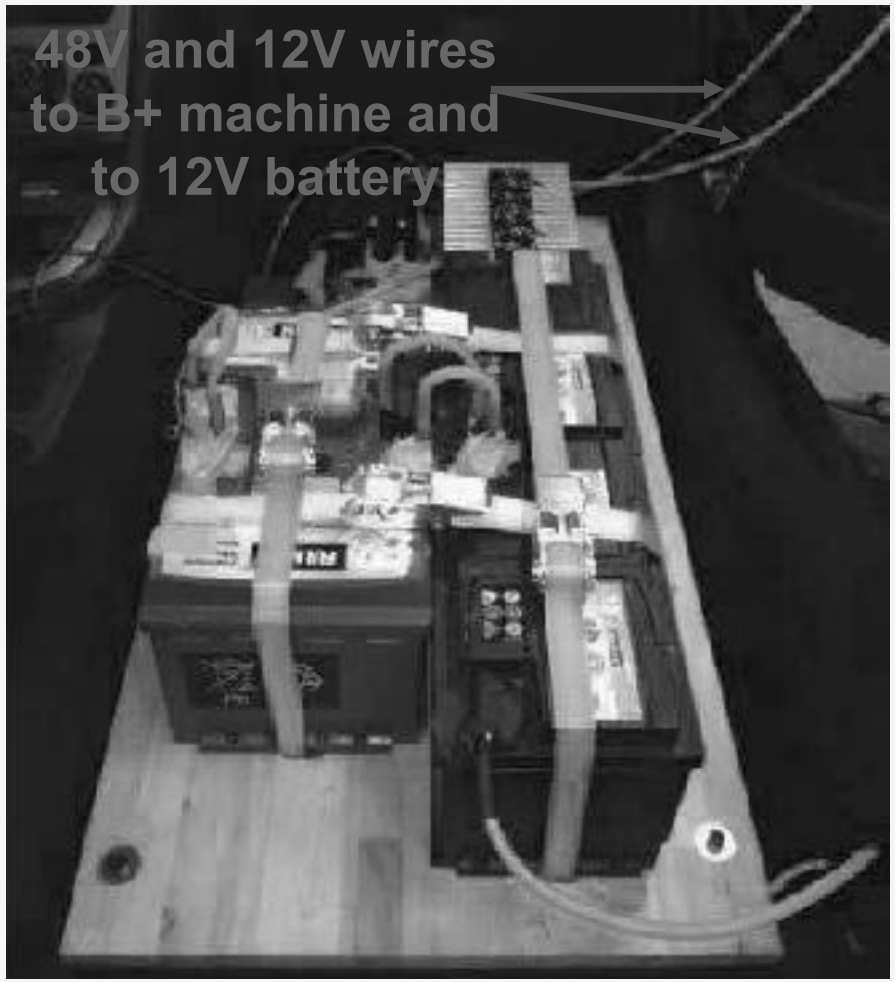
Implementation on Democar (3) : Batteries and DC/DC converter 48/12V wiring



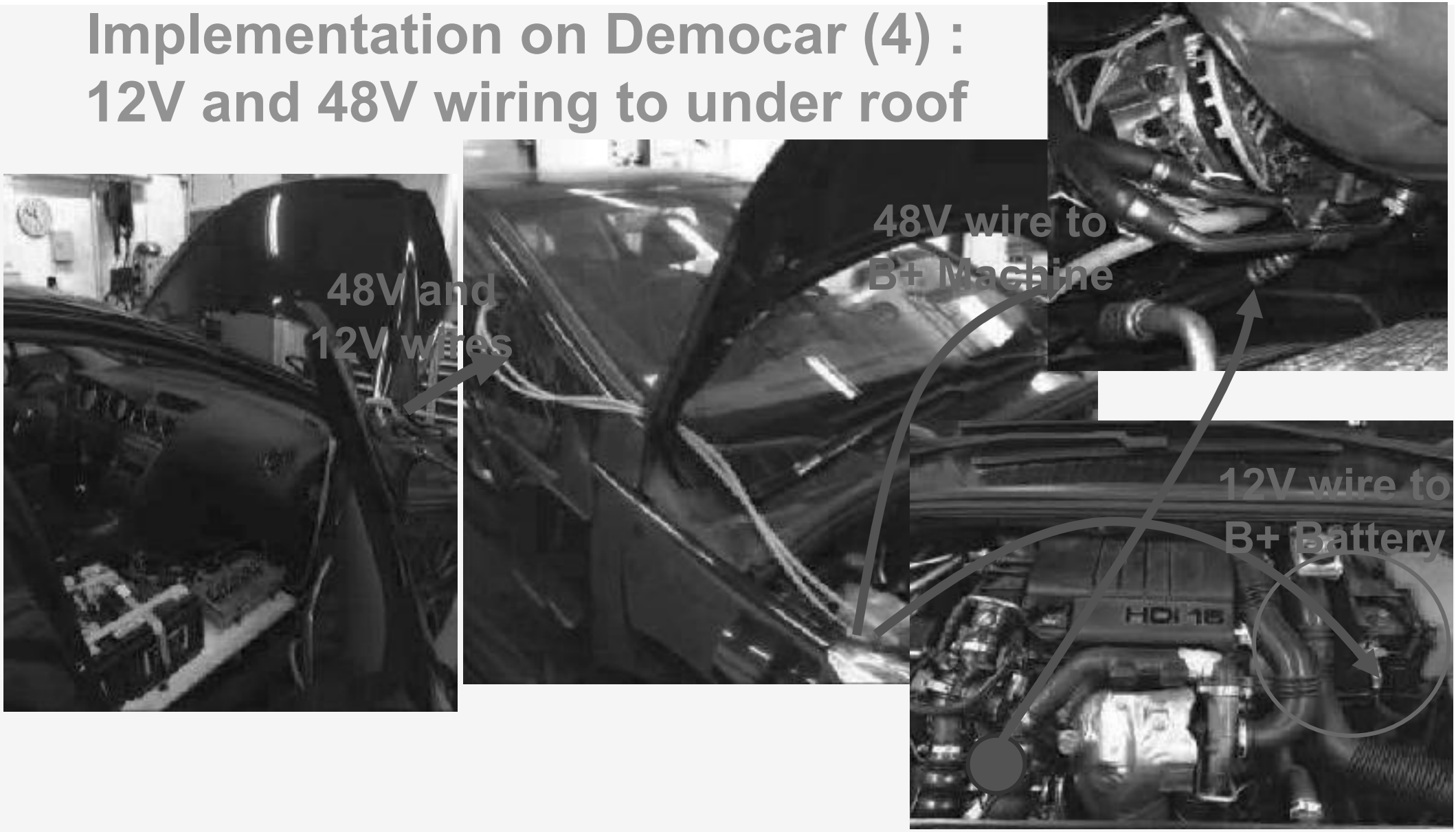
Implementation on Democar (3) : Batteries and DC/DC converter 48/12V wiring inside the car

Instead of the front passager seat



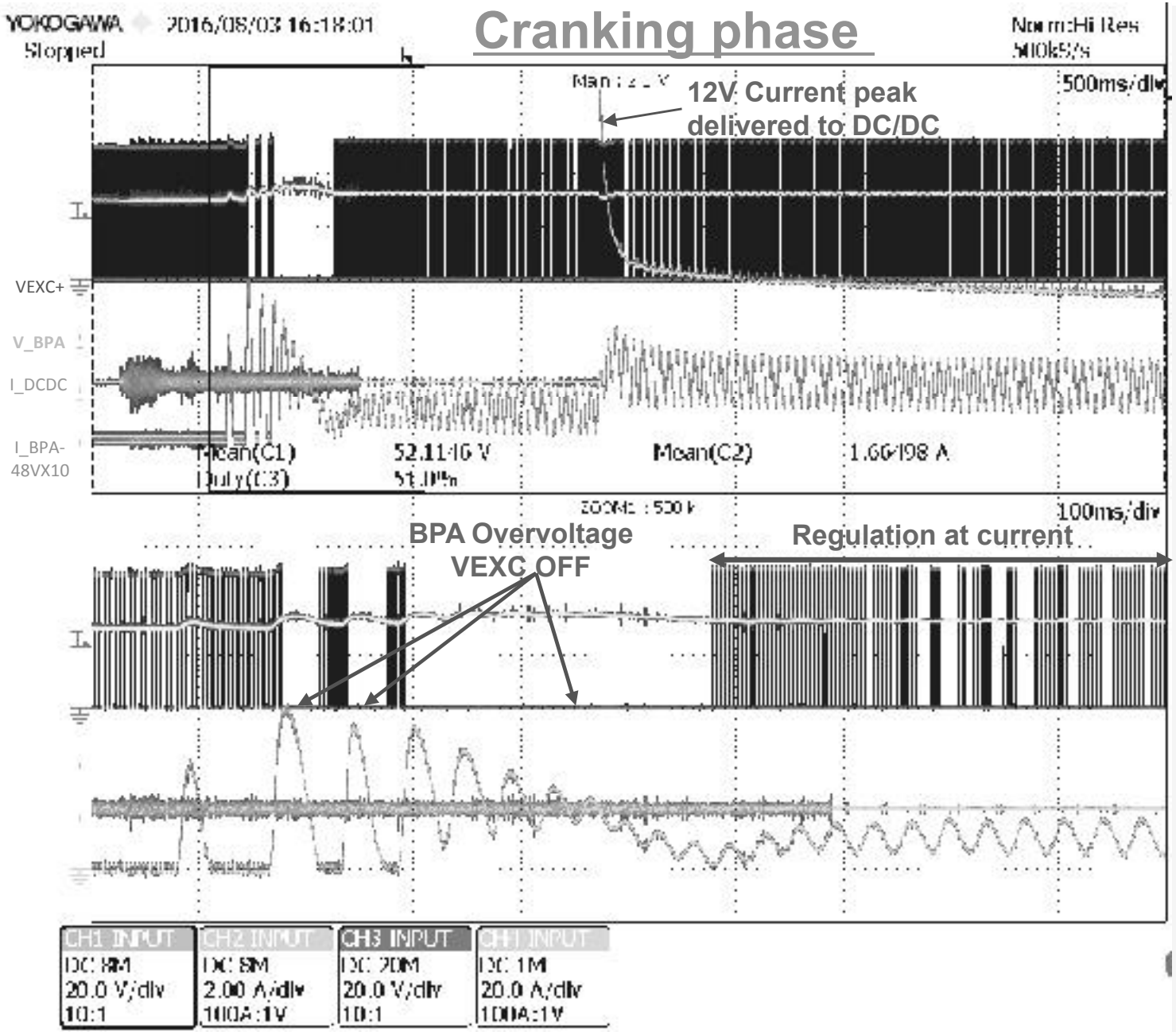


Implementation on Democar (4) : 12V and 48V wiring to under roof

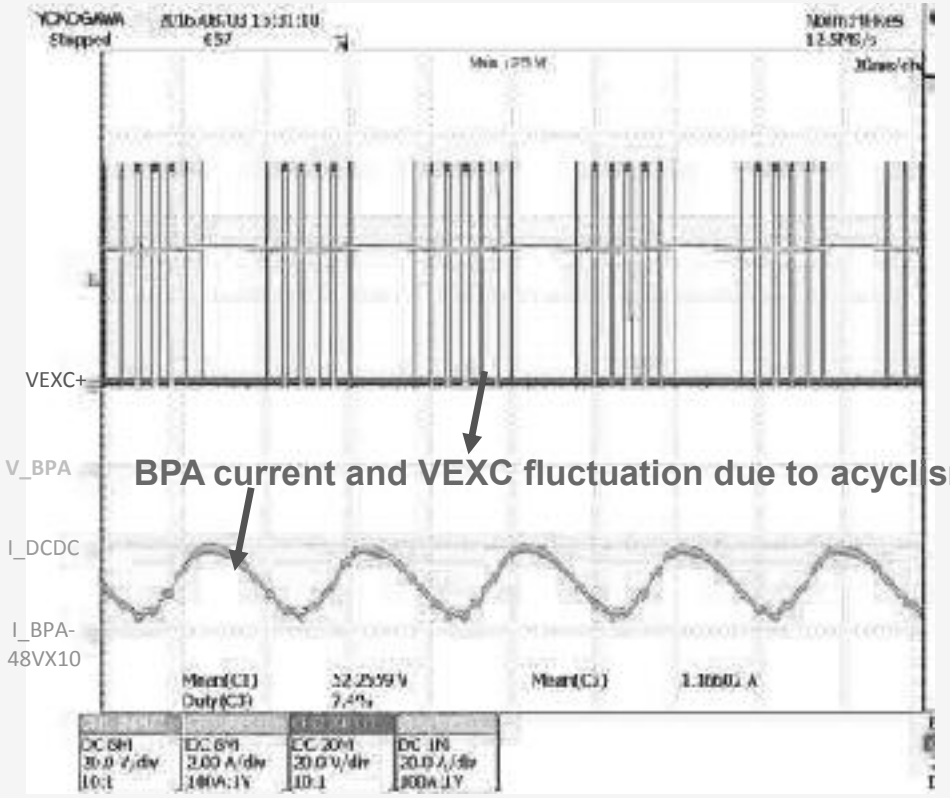


Vehicle Acquisitions

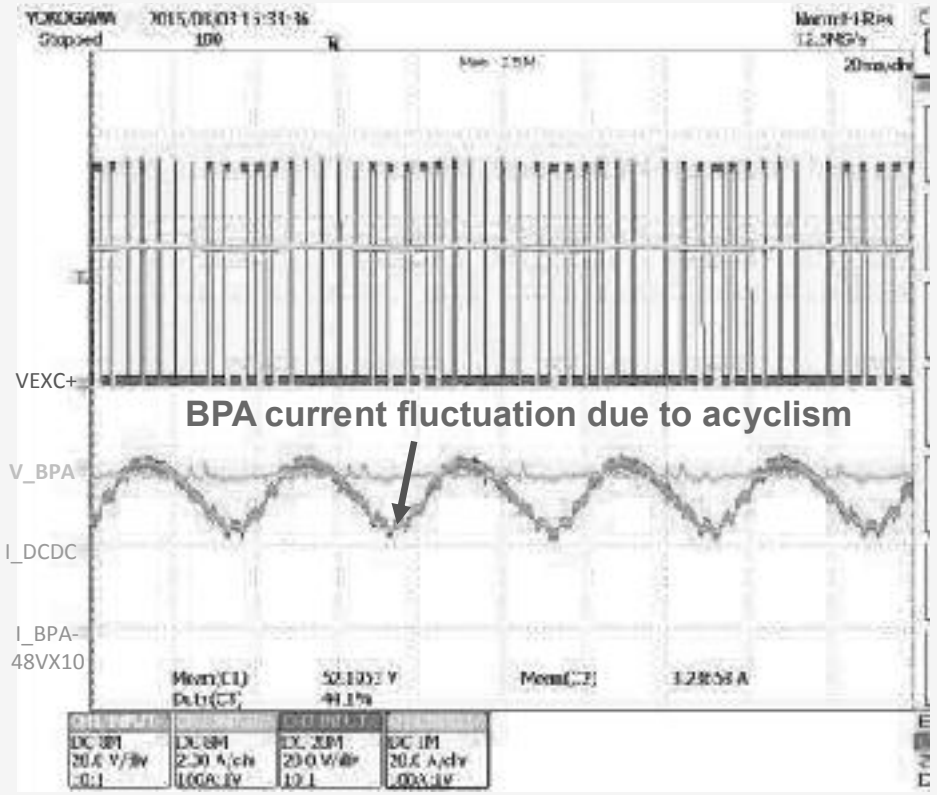
Acquisitions on Democar
Regulation algorithm Code n°1 within FPGA mezzanine



Acquisitions on Democar
Regulation algorithm Code n° 1 within FPGA mezzanine



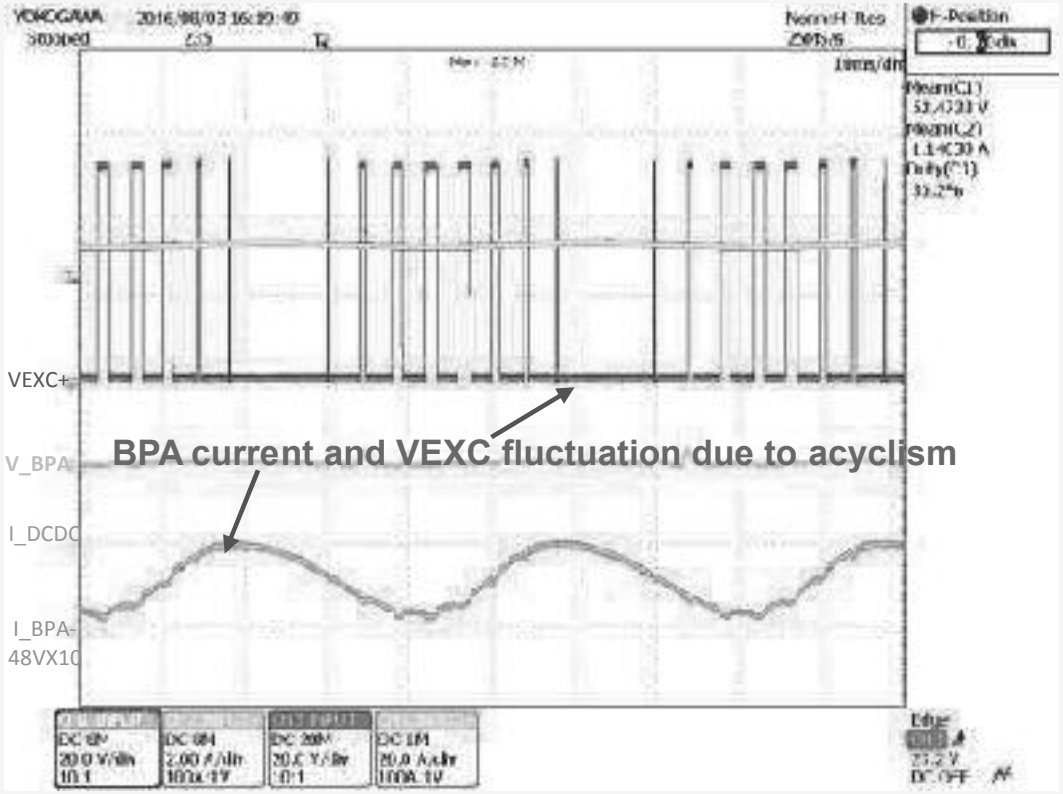
Regulation with no external loads



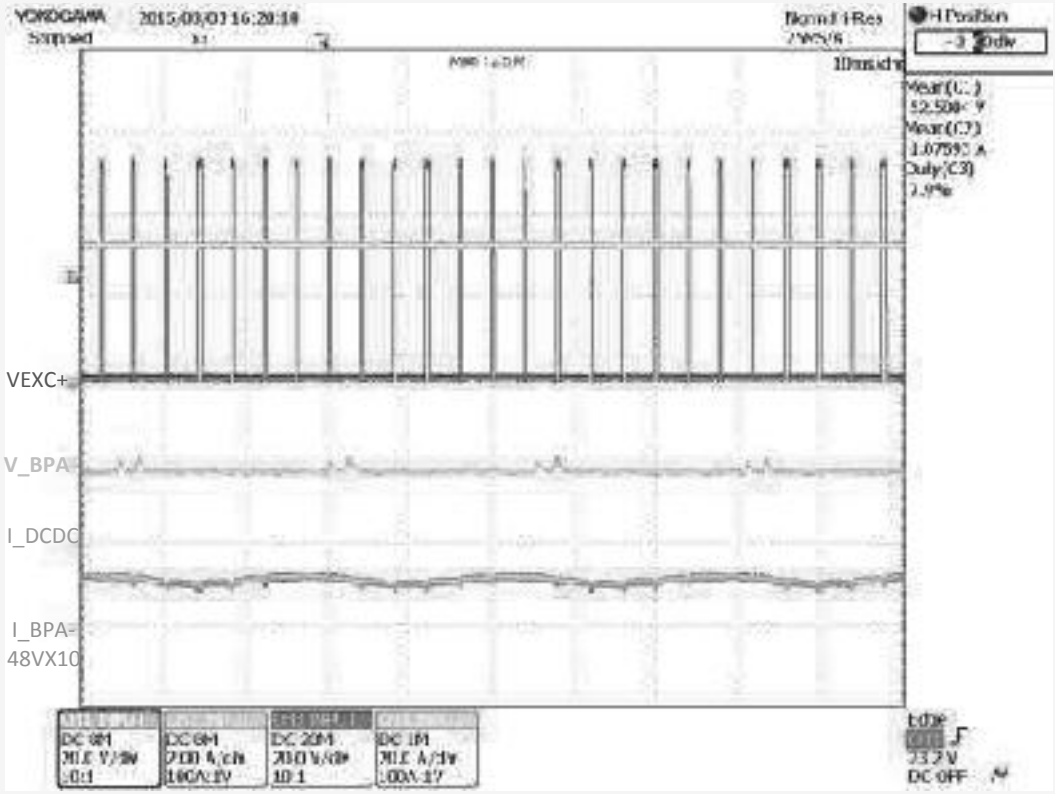
Regulation with 20 A external loads

Acquisitions on Democar
Regulation algorithm Code n°1 within FPGA mezzanine

No acyclism effect is observed with engine speed > 1000RPM



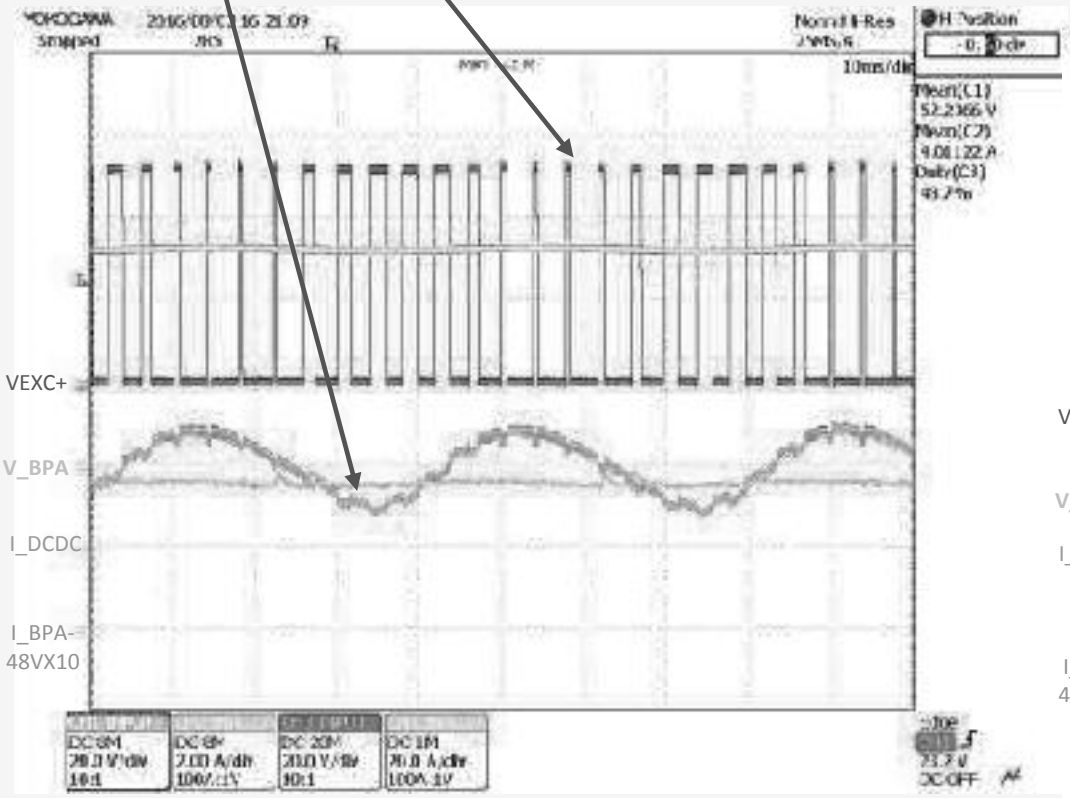
Warning lights ON at 800RPM



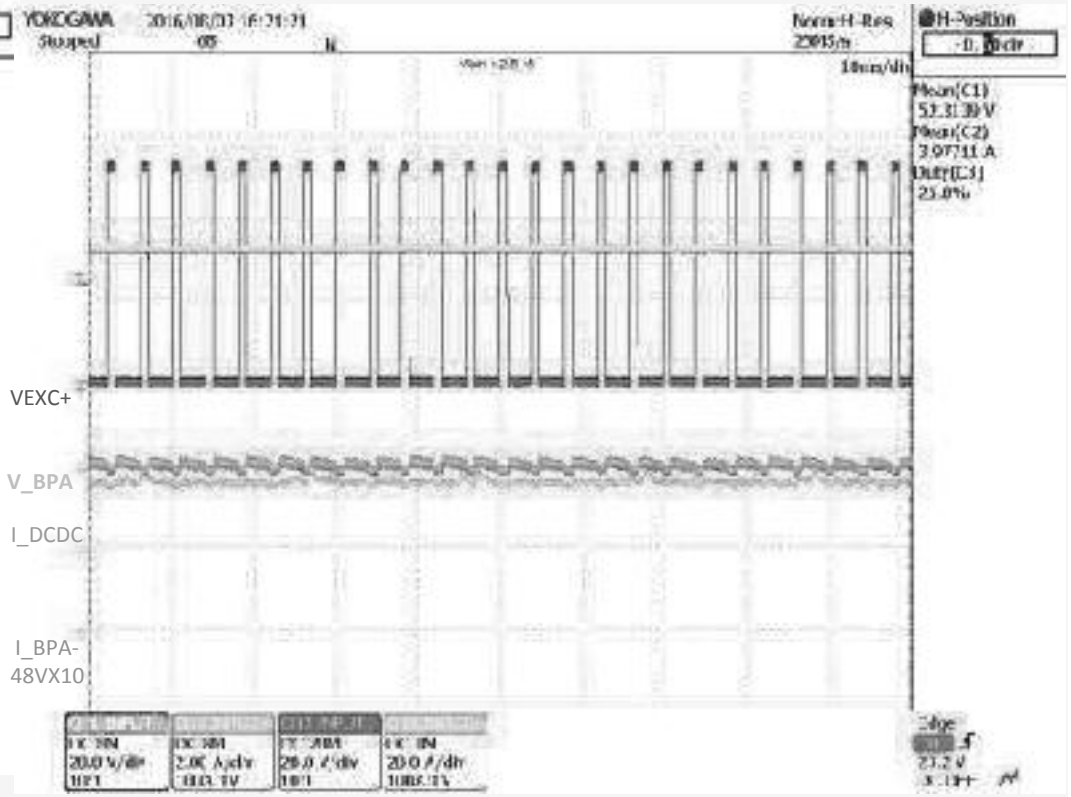
Warning lights ON at 1200RPM

Acquisitions on Democar
Regulation algorithm Code n°1 within FPGA mezzanine

BPA current and VEXC fluctuation due to acyclism

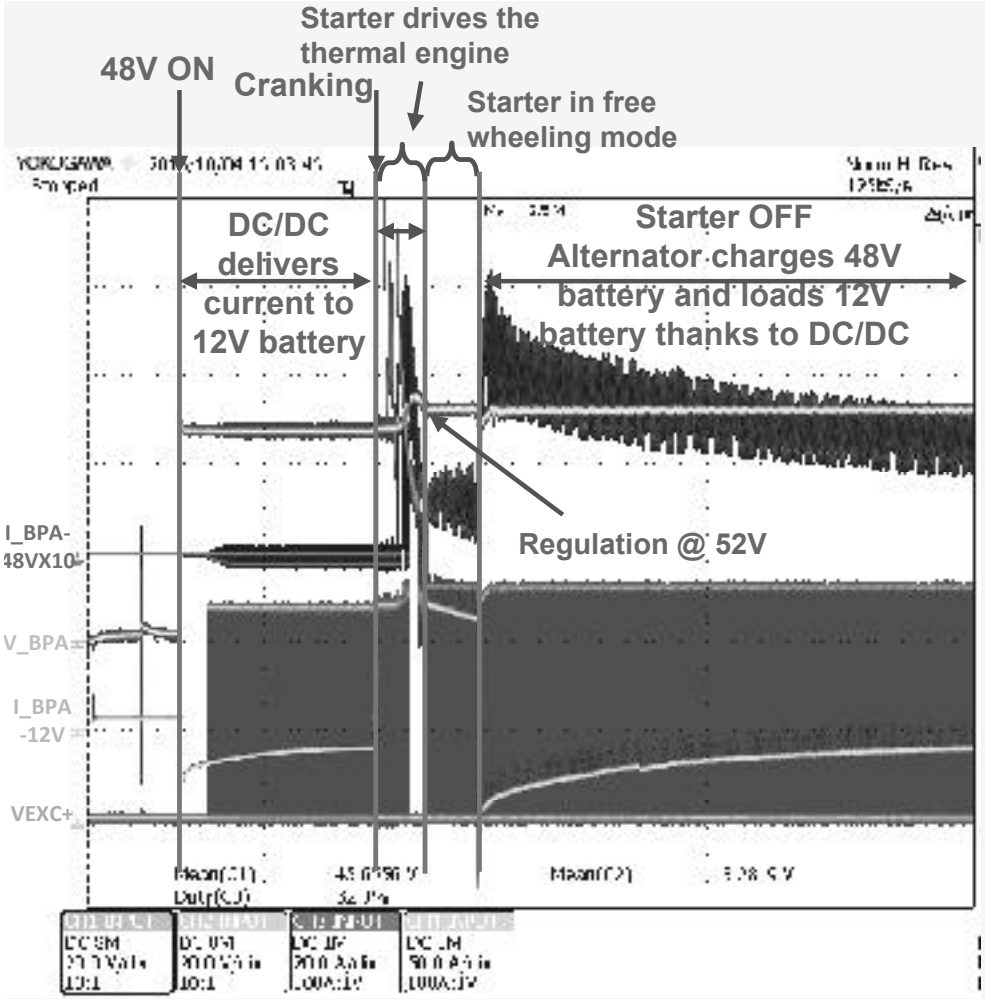


No acyclism effect is observed with engine speed > 1000RPM

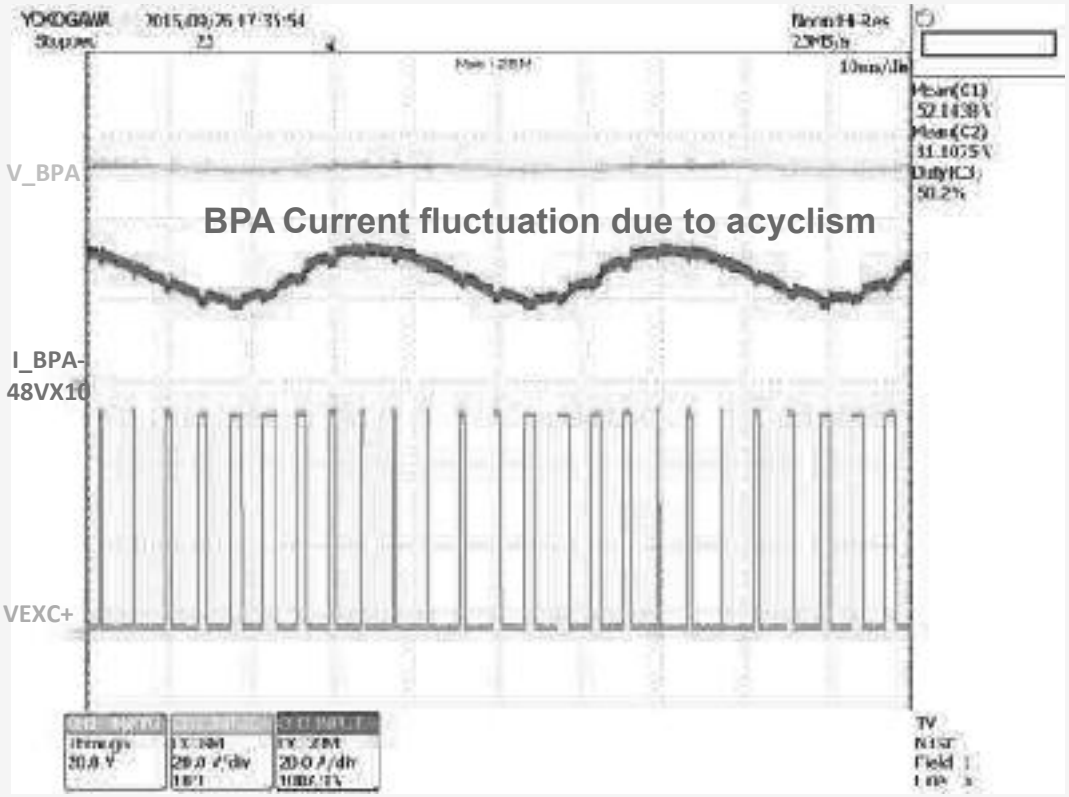


Regulation with 30A external loads at 800RPM and 1500 RPM

Acquisitions on Democar
Regulation algorithm Code n°2 within FPGA mezzanine with less regulation gain

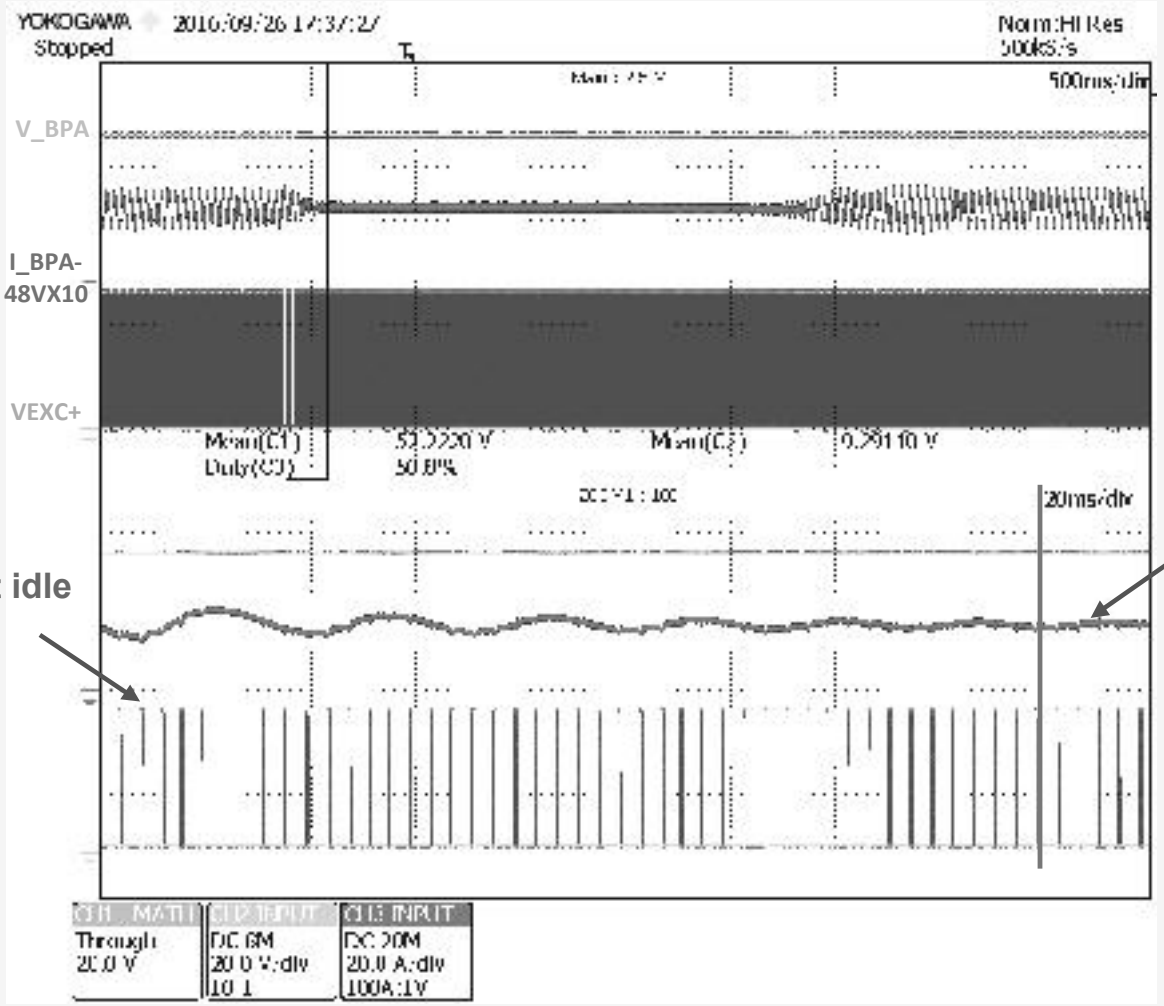


Cranking phase



Regulation after cranking

Acquisitions on Democar
Regulation algorithm Code n°2 within FPGA mezzanine

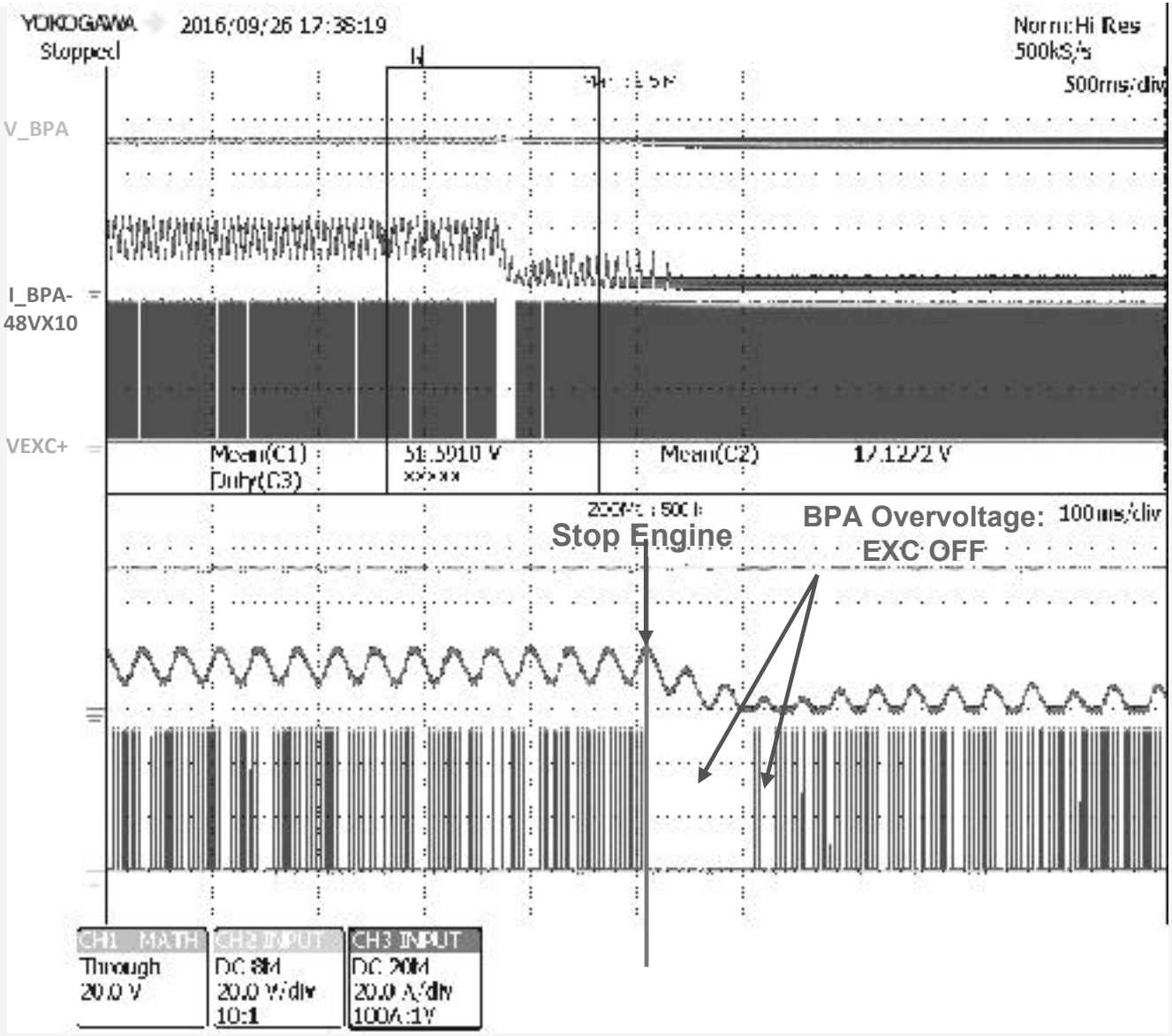


Acyclism effect at idle speed

No acyclism effect at higher speed (> 1000 RPM)

Acceleration from 0 RPM to 2000 RPM then deceleration until 0 RPM

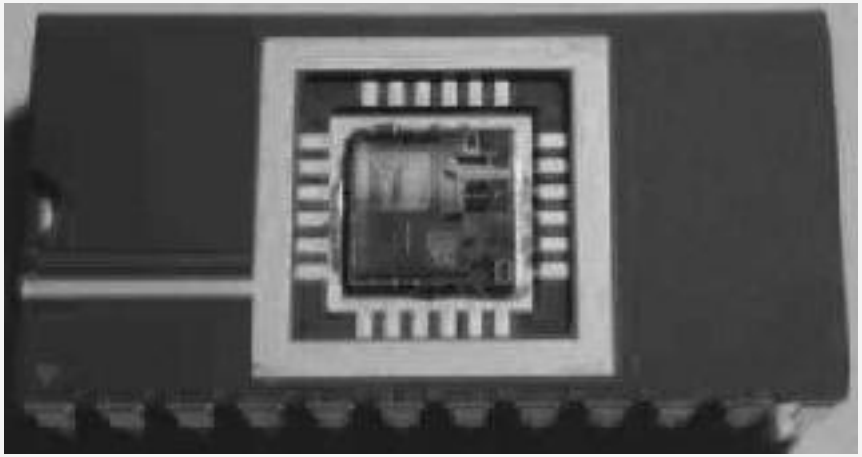
Acquisitions on Democar
Regulation algorithm Code n°2 within FPGA mezzanine



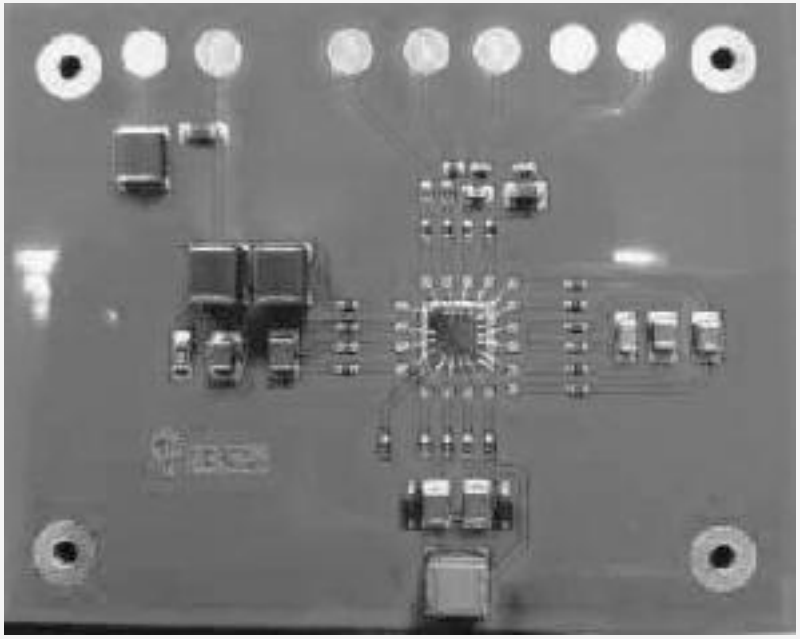
Thermal engine Turn off phase

WP7 Activities Status on Demonstrator 2

- DC/DC converter design and evaluation
  - Shipping of V1 bare die to UniPI with no integrated digital
    - Evaluation of V1 by UniPi
  - Shipping of V2 bare die with integrated digital to UniPi and Valeo
    - Evaluation of V2 by UniPi and Valeo



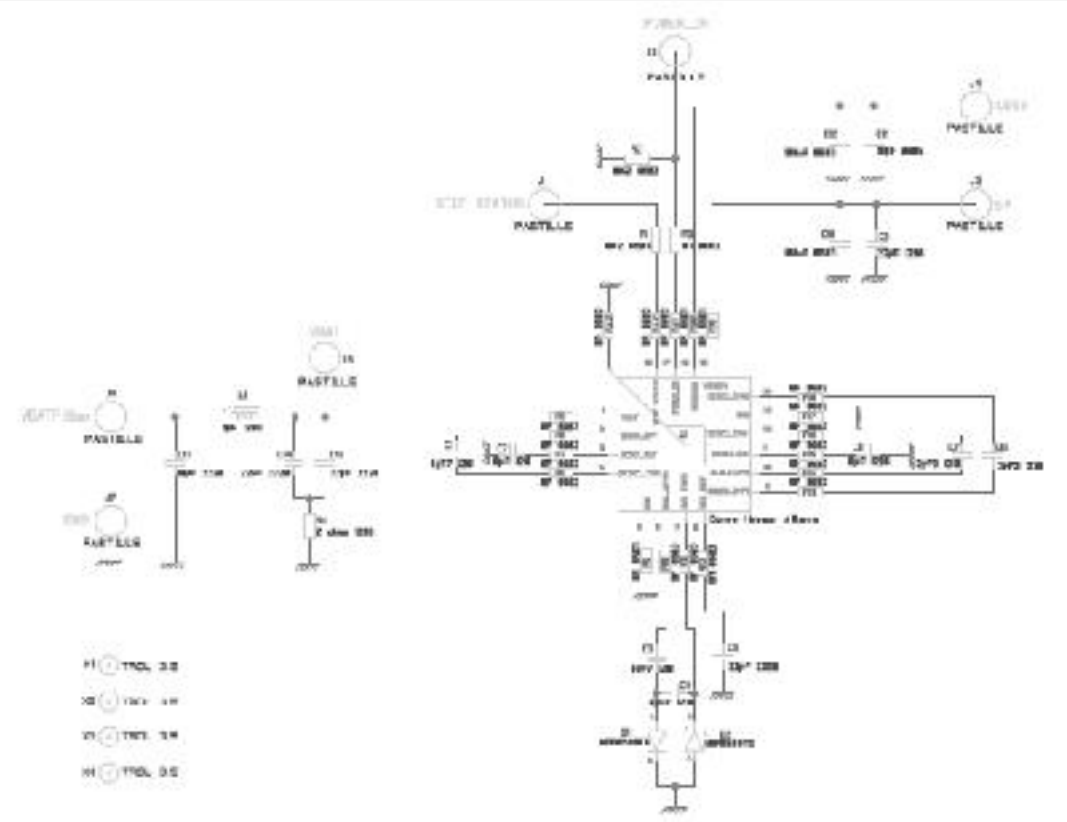
V1 test chip on ceramic (UniPi)

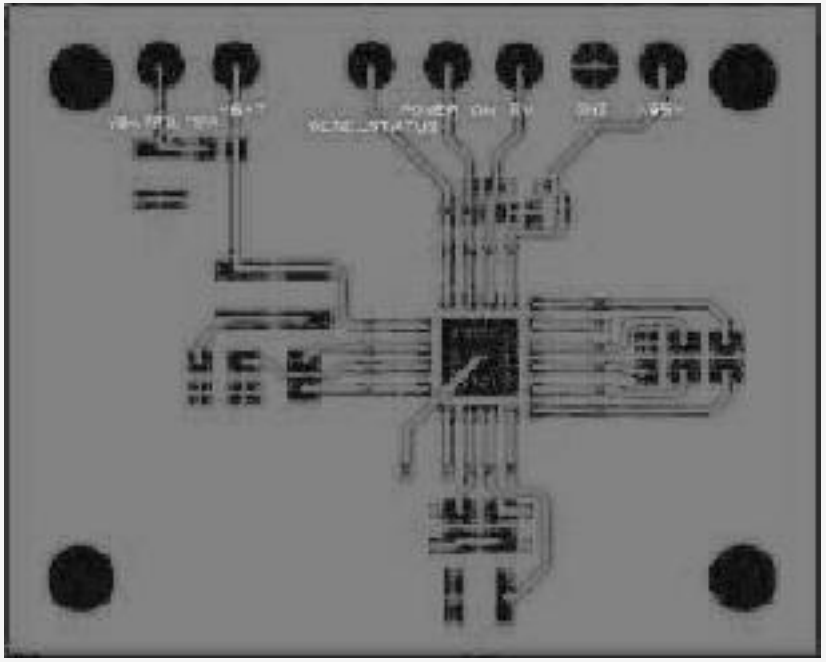


V2 test chip on PCB (Valeo)

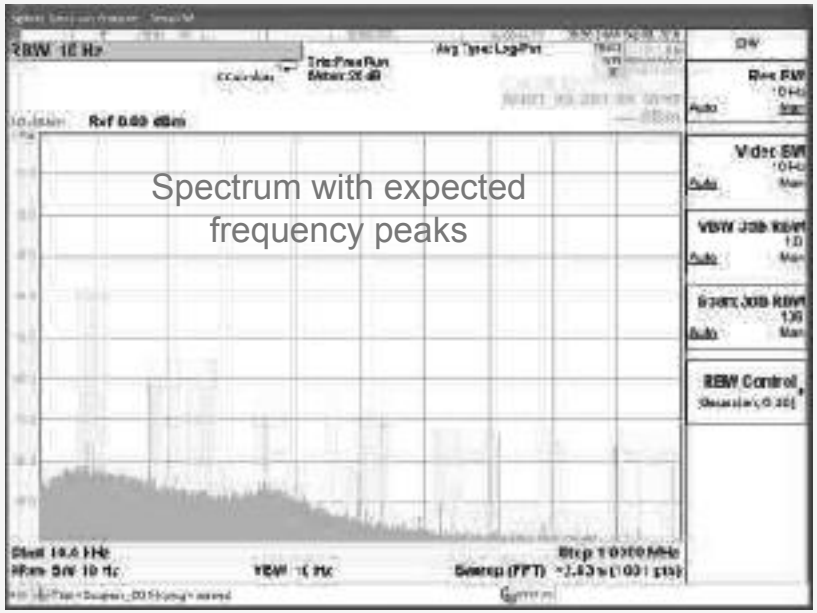
WP7 Valeo activities on Demonstrator2

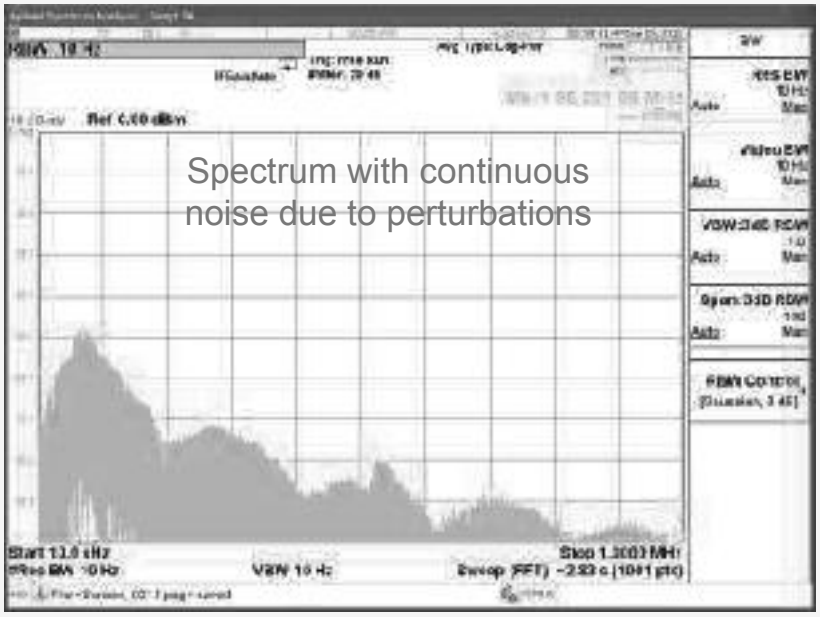
- DC/DC converter design and evaluation : Valeo PCB
  - Manufacturing of the PCB to test the DC/DC converter
  - Assembly of V2 bare die on PCB by Valeo

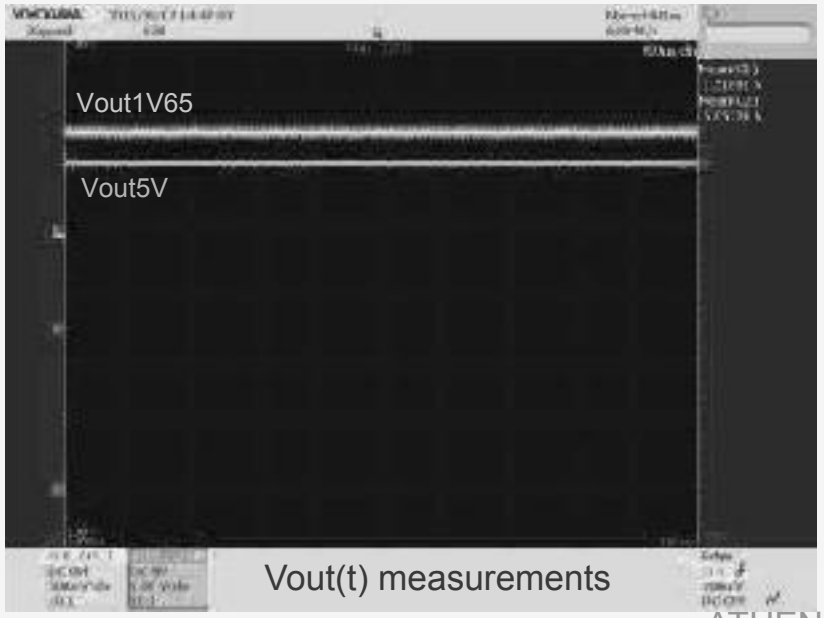


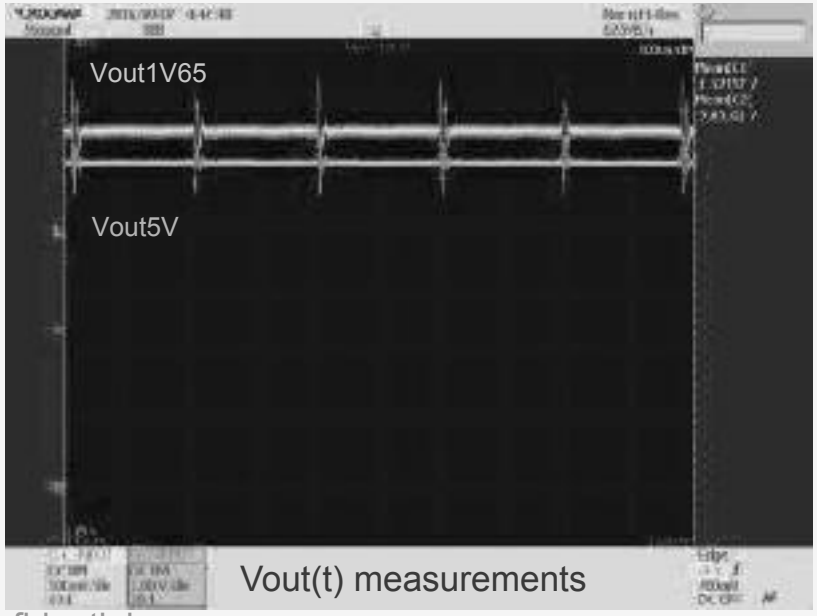


WP7 Valeo results on Demonstrator2









Conclusion

- H-Bridge validated on bench
  - EXC current Control
  - Improved free wheeling diode by transistor ON
  - Fast demagnetization for overvoltage protection
- H-Bridge validated on vehicle
  - Regulation at 52V
  - Energy transfer to 12V network with DC/DC converter
- Technology to be developed for 48V mild hybrid electronics integration in wounded rotor electrical engines

Lessons Learnt

- Control Module
  - Not developed as planned with ams due to not enough visibility on automotive business
  - Back up solution engaged to develop an Hbridge with 4 H35-MOSFETs mounted on DBC
  - No smart driver develop due to lack of time (lead time from CEA-Leti out of the project time): the Hbridge is controlled by an external PCB
  - The 3D technology is not developed for a project with mass production in short term

- DC/DC converter
  - Concept validated
  - Huge interest for insulation between input and output
  - Need an additional development to solve issues encountered during evaluation