

Testing of DC-DC Converters on TARDEC Testbed

John Kajs
SAIC



UNCLAS: Dist A. Approved for public release



Objectives

- Testing of 3 different battery to bus converters on HERMIT to increase level of fidelity beyond the initial stand-alone testing of DC-DC converters
 - All three were non-isolated with similar topology
 - Nominal 300 Volt battery to 600 Volt Bus
 - Similar to FCS-MGV topology
 - HERMIT battery is Li-Ion battery pack
 - Requires compatibility with
 - Thermal
 - EMI
 - Dynamic Response
 - Converters tested were developed by
 - Satcon (under a U.S. Army Research Lab contract)
 - US Army Research Lab converter in house developed
 - Magnet Motors

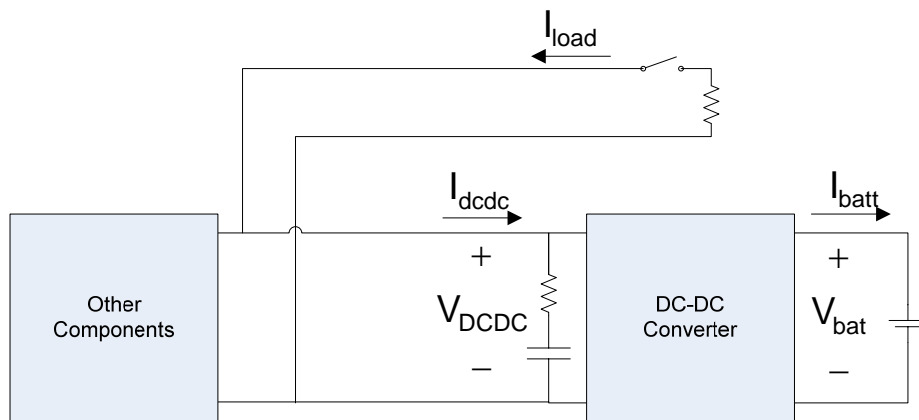
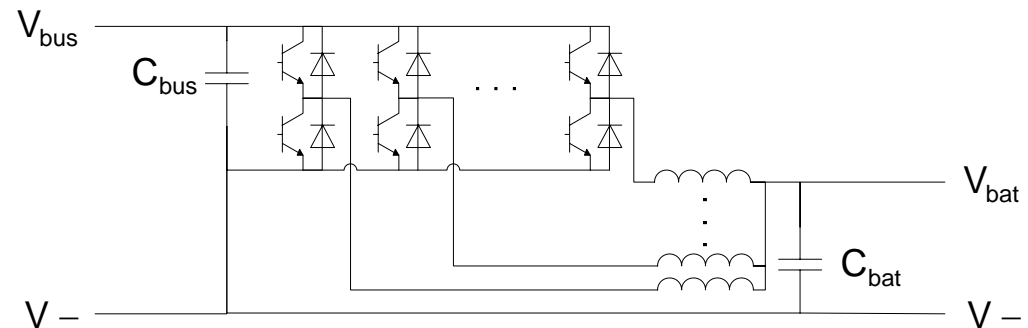


Nominal Converter Ratings

	Satcon	ARL	MM DCC09
Power (Pk)	300 kW (boost) 150 kW (buck)	170 kW (boost) 170 kW (buck)	150kW
Power (Cont)	150kW	150 kW	100kW
Coolant	5GPM	2GPM	6GPM
Max Inlet	80°C	80°C	90°C
# of Phases	8 interleaved	4 interleaved	6 interleaved
Technology	Silicon	Silicon	Si IGBT/SiC Diode
Fsw	20 kHz	17 kHz	32kHz
Dimensions	25"x23"x6"	15.5"x16.5"x9"	21"x15.5"x6"
High Side Cap.	720 uF	238 uF	280uF
Low Side Cap.	1260 uF	180 uF	

Converter Topology & Simple Test Setup

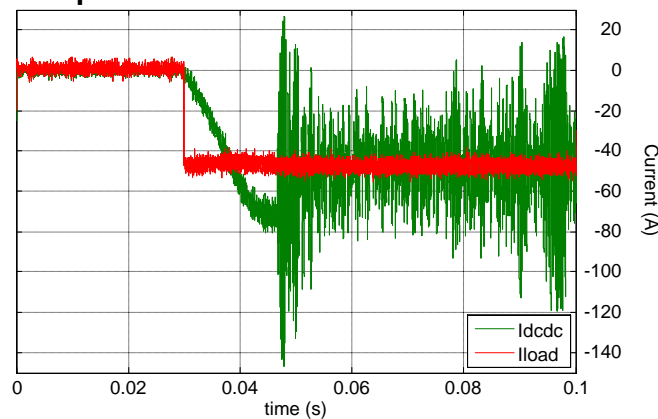
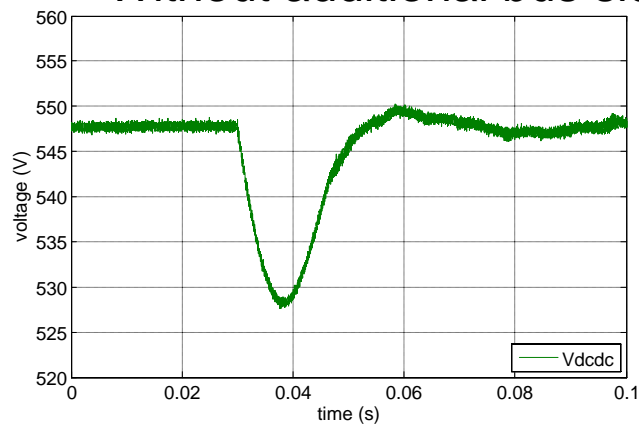
Basic Circuit Topology
Each converter had different # legs



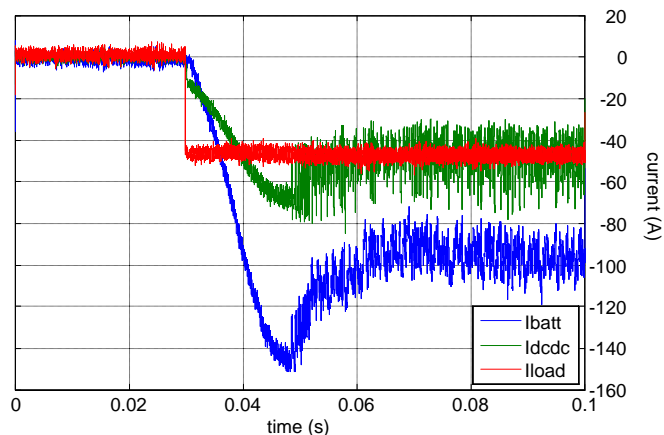
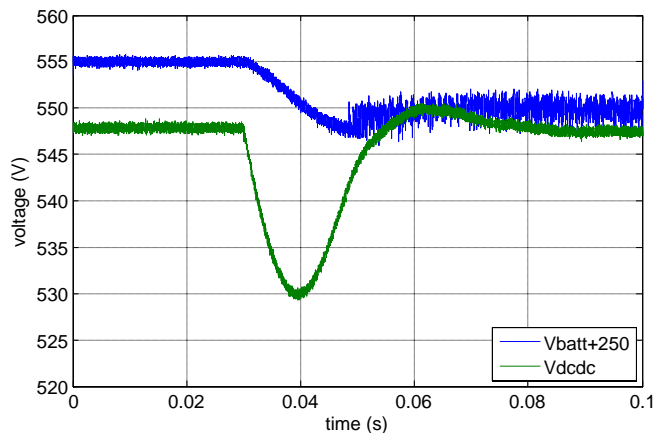
Converters had to interact not only with load but other converters (primarily motor drives)

Satcon Converter Response

Without additional bus side capacitance



With 3600 uF & 51 m-Ohm added at bus side of converter

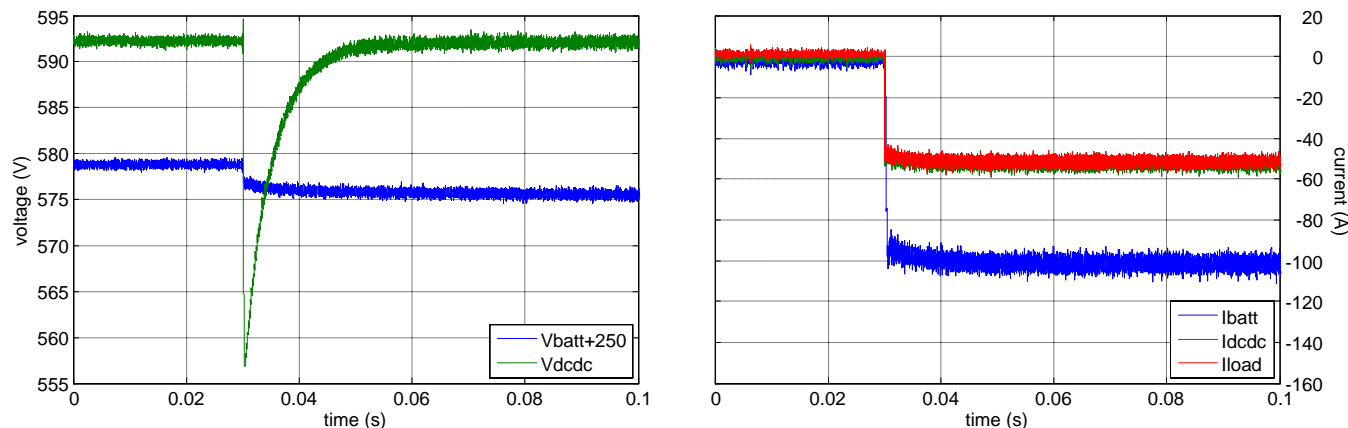


High frequency currents ONLY seen when connected to HERMIT bus.

Oscillations $< 1/4$ switching frequency

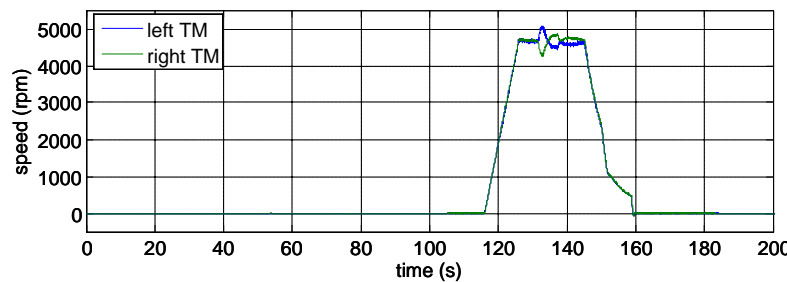
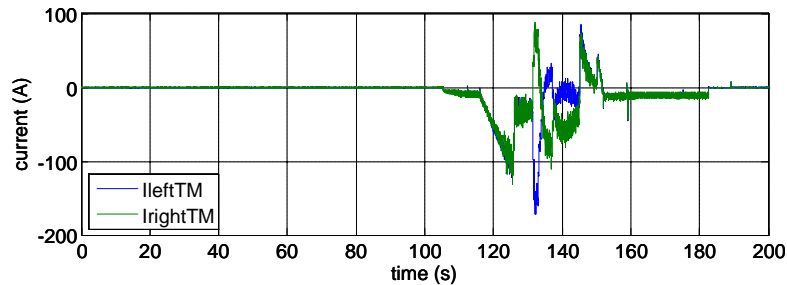
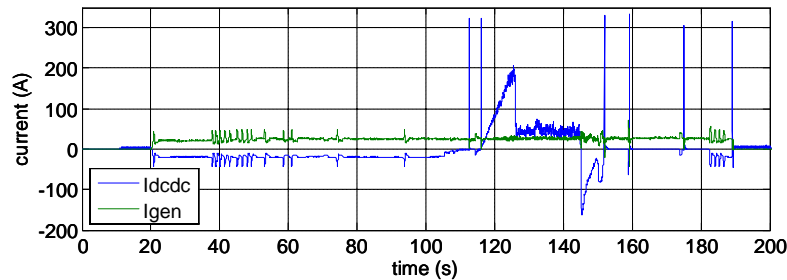
UNCLAS: Dist A. Approved for public release

ARL Stand-Alone Converter Response



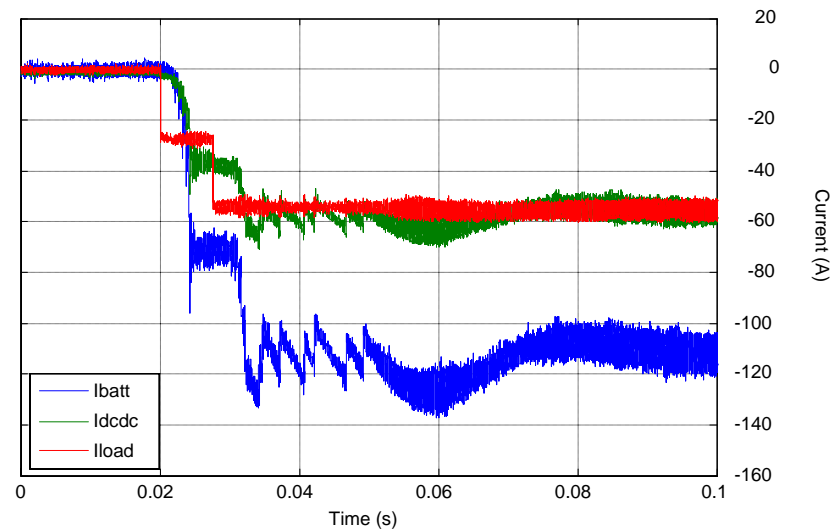
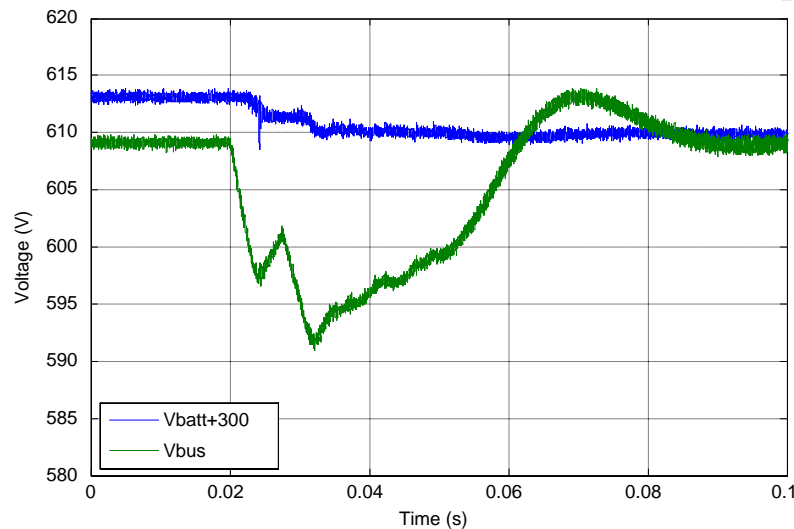
Initial testing identified issues with bi-directional control when connected with HERMIT system (dynamic related) which was corrected

ARL Converter Vehicle Emulation Testing



- Successfully operated with emulated vehicle while doing a simple maneuver
- Identified issue with transition from boost to buck mode (source of current spikes)
- Prior to Vehicle testing would want to correct transition spikes shown

Magnet Motors Converter Response



- Adequately controlled system when utilized with simple vehicle testing
- Required re-tuning after switching from stand-alone to vehicle configuration
 - Higher gains than were available may be desirable based on trying range of available gains

Conclusions

- All three have been tested to some level of effectiveness on HERMIT
- All three had some level of changes to work better
 - Satcon has more difficulty with bus interactions
 - ARL has best regulation in boost mode but transition control algorithm needs some work
 - Magnet Motors converter could use some broader range of gains than initially available
- All 3 converters are planned to undergo a more thorough comparison on HERMIT interacting with the vehicle operation

