

**APPLICATION NOTE:  
TESTING EV ELECTRIC MOTOR AND CONTROLLER**



**Elektro-Automatik**

# ELECTRIC VEHICLE MOTOR AND CONTROLLER TEST

## ABSTRACT

Each year vehicle electrification continues to increase, with all signs pointing to this trend accelerating in the future. Some of the factors contributing to this development are the increasing use of hybrid and fully electric vehicles to meet “green energy” goals, the desire for the greater reliability that electronic components generally provide and the need to reduce automotive recalls.

Electric Motor and Drive-train (Electric Mobility) Testing is a critical part of bringing any electric drive-train into production. In this paper the requirements for an electric drive-train test cell are discussed. The implementations of such test cells are described, and examples of test results are provided. The energy and power requirements for three-phase motor and controller, Unit Under Test (UUT) connected through a common dc bus are described.

The data used represents various steady state load conditions during durability test cycles. This “Smart Green Technology” concept not only reduces the energy requirement from the grid but also eliminates the inefficiencies by putting energy back on the grid.

## INTRODUCTION

This application note provides an example of testing an E-Motor and Controller for electric vehicles. Traditional test setups require a dedicated DC source and Load in parallel to deal with bi-directional energy flow. This can require a complex test setup to coordinate energy flow and to avoid damaging expensive test equipment.

The PSB 9000 is a bi-directional DC source and electronic load which simplifies the test setup, avoids catastrophic damage and decreases test times. This electronic load has the unique option of back-feeding converted energy into the grid.



Picture 1: PSB 9000 Bi-Directional DC Source and Regenerative Electronic Load

## Test Setup

This example provide a block diagram of the simplified test setup using the PSB 9000.

The model is PSB 9500-30 3U.

- Output/Input: 0-500 Vdc
- Current Source/Sink: 0-30 Adc
- Power: 5 kW

O-scope and shunt used for measurements. Digital signal for controller adjustments.

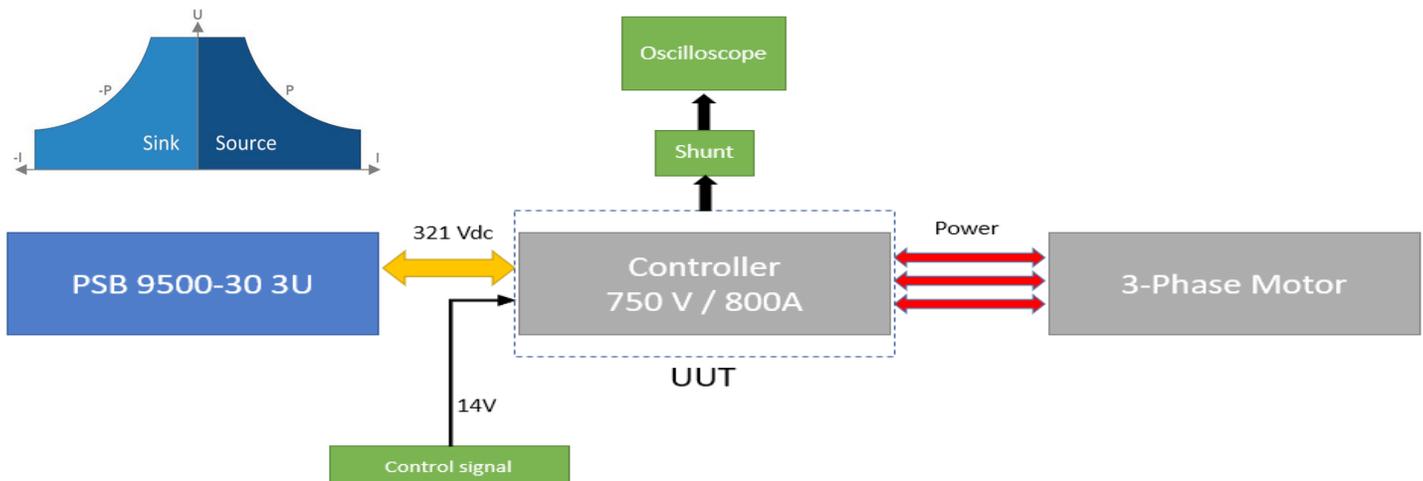


Figure 1: Test Setup

# PRINCIPLE OF ENERGY RECOVERY OPERATION

## Test Condition

UUT: Controller maximum power: 750 Vdc / 800 Adc (the test below provides 320 Vdc and programmed to 10 Adc).

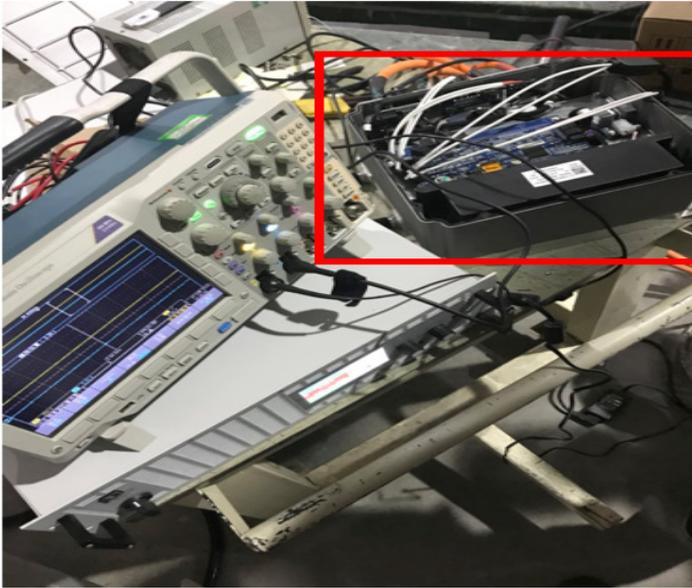
The motor RPM is approximately 6,000 RPM, Clockwise and Counter-Clockwise at no-load condition.

## Test Method

The E-Motor runs at 6,000 RPM in clockwise direction, pulling positive current up to 10 Adc (Source).

After approximately 100msec, the control controller turns voltage to the motor OFF and the current quickly dissipates into the PSB 9000 at approximately -5 Adc (Sink).

Voltage is re-applied and the motor spins back up to steady state current of 10 Adc.



Picture 2: Controller

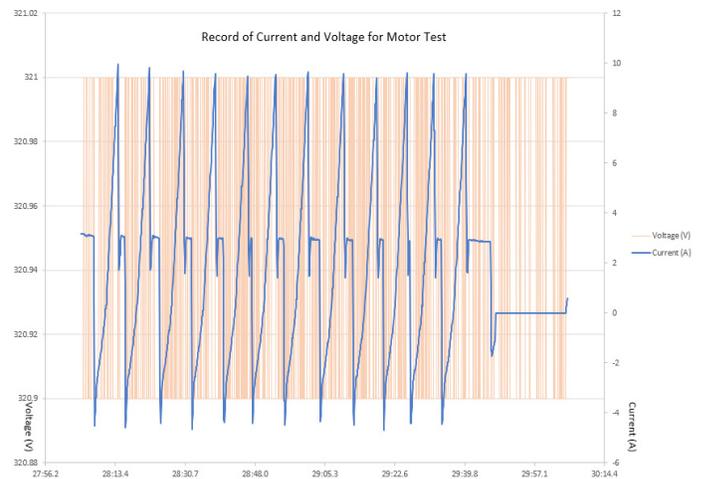
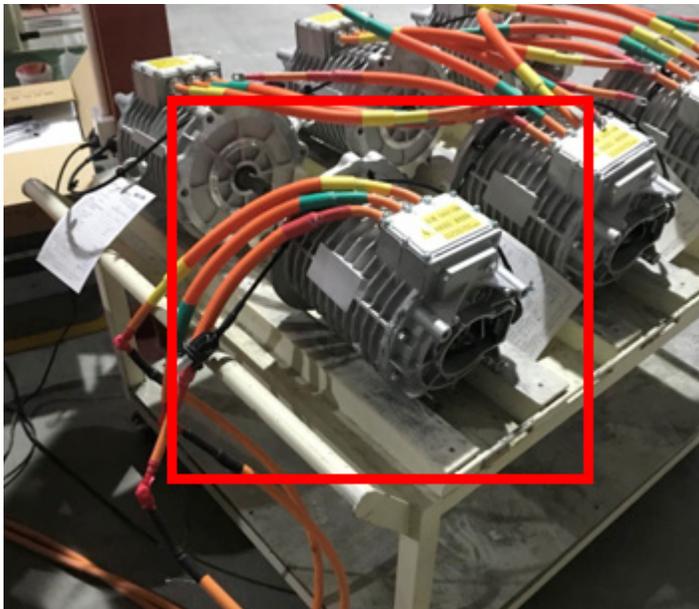


Figure 2: Voltage and current trace, 100msec sample rate.



Picture 3: 3-Phase AC Motor

As the PSB 9000 sources and sinks. Voltage stability maintains at 320.9 Vdc even during the transition of positive to negative current flow.

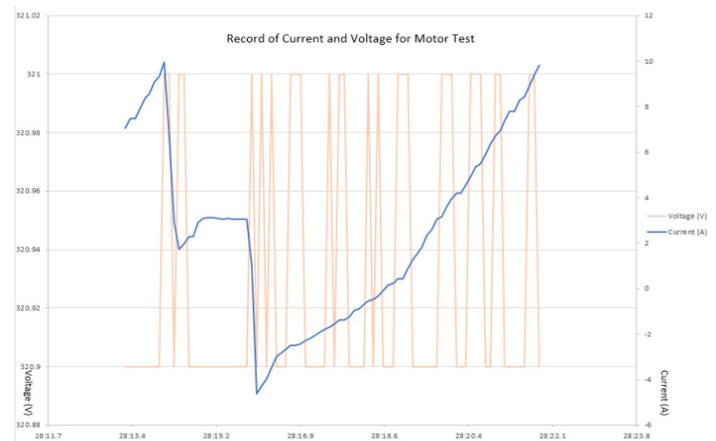


Figure 3: Zoomed in.

## Added benefits of PSB 9000

The PSB features an Auto-Ranging output stage. Typical programmable DC sources offer full output power at maximum voltage so at reduced voltages, the available power is greatly reduced. Auto-Ranging dynamically adjusts available output current at reduced voltages, maintaining full power from 33% to 100% of full scale voltage. This is particularly useful when testing wide-ranging input products.

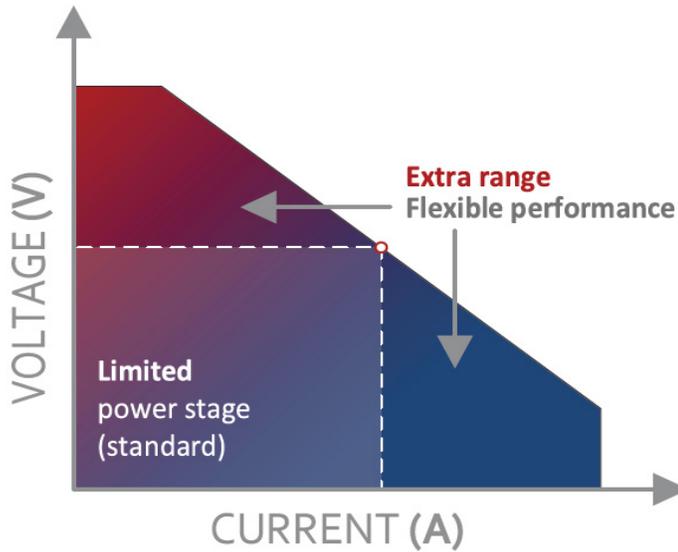


Figure 4: Auto-Ranging adds flexibility

Another added benefit is the PSB's ability to recycle the loaded energy back to the grid at approximately 95% efficiency. This results in operational energy cost savings and since the unit only dissipates 5% of the energy in the form of heat, the power density is industry leading at 15-kW in a single 3U rack mount chassis.

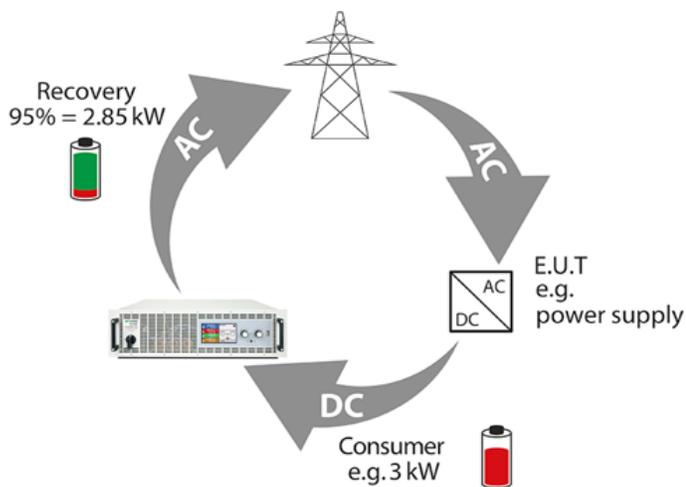


Figure 5: Energy recycling

The PSB 9000 3U is available from 5 kW up to 480 kW in a per-configured chassis. Remote interface options include Ethernet, CAN Profibus, ProfiNet, ModBus, USB, RS232 or GPIB to make integration even easier.

If you have questions about our PSB 9000 3U Series, please contact EA Elektro-Automatik and we'll be happy to help.

Digital interface modules



Picture 4: 480 kW PSB 9000 for Electric Bus Test

EA



**Elektro-Automatik**