USAGE OF DEWE3-A4 IN THE TU GRAZ RACING

DEWETRON

THE MEASURABLE DIFFERENCE

In this application note, we discuss the use of a DEWETRON DEWE3-A4 power analyzer for the development and testing of a formula student racing car. Particularly, we cover the following points:

> DQ-axis current measurements in an inverter

> System debugging and discharge verification

> Servomotor comparison for the DRS drive

FURTHER INFORMATION

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INTRODUCTION

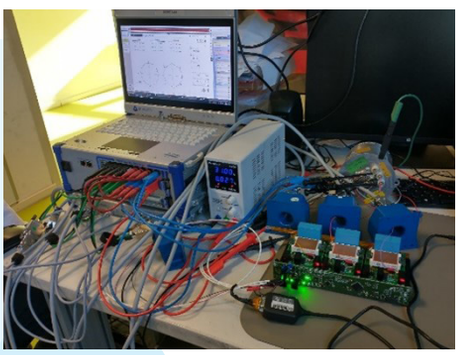
In the 2023 Formula Student season, the TU Graz Racing Team was equipped with a DEWETRON DEWE3-A4 power analyzer. This high-end power analyzer was used for several tasks during the development and testing of the TANKIA 2023 (race car). Additionally, it was used for the development of the TU Graz Racing Team‘s first self-designed inverter.

MEASUREMENT OF THE DQ-AXIS CURRENT IN AN INVERTER

During the season 2023, we (the TU Graz Racing Team) developed an inverter for the drive-motors of the TANKIA. To measure the power and efficiency of our inverter we used the DEWE3-A4 power analyzer.

The inverter uses a field-orientated control (FOC) to regulate the movement of the motor. This FOC controls the fields of the motor by controlling the currents in the dq-frame. In the context of a dq-frame, the q-field is used to generate the torque, and the d-field is used to attenuate the field of the permanent magnets if necessary. However, as the dq-frame is a virtual frame that cannot be measured directly, it must be calculated from the measured phase currents and the position of the motor.

With the DEWE3-A4 power analyzer and the OXYGEN measurement software, it was possible to measure these dq-currents based on the measured phase currents alone. There was no need for an additional position sensor, as the power analyzer can estimate the position based on the measured currents. Therefore, it was possible to validate the measurements, calculations, and controls required for a powerful and efficient inverter.



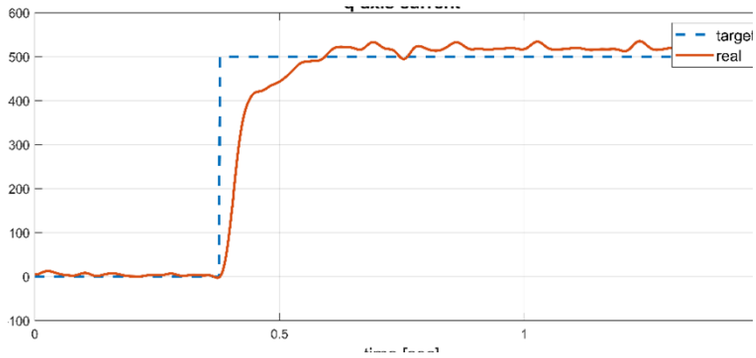


Fig. 1: Test setup and q-axis current

DEBUGGING OF SYSTEMS IN THE TANKIA AND DISCHARGE VERIFICATION

During the first high-voltage tests of the finished car, a few problems with the pre-and discharge system of the battery occurred. To find and correct these problems in the startup sequence we utilized the DEWE3-A4 to measure the voltage and current on the DC-link.

Additionally, we used the power analyzer to verify the functionality of the discharge system. This is used to discharge the DC-link capacitors of the inverter when the car is turned off and consists of a MOSFET and a PTC resistor. As a PTC resistor is a thermal resistor, the resistance increases as the temperature rises. At room temperature, the resistance is around 500 Ω. During a discharge cycle, the resistance changes quite drastically. However, the voltage can be safely reduced from 540 V to below 60 V within 0.2 seconds.

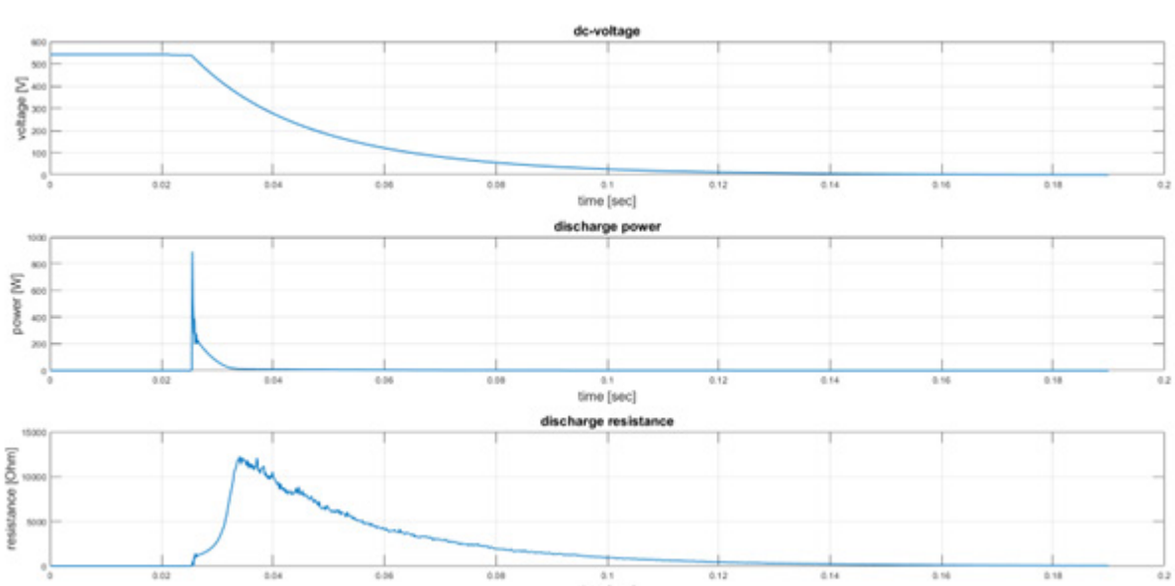


Fig. 2: DC voltage, discharge power and discharge resistance

COMPARISON OF SEVERAL SERVO MOTORS USED FOR DRS ACTUATION

For the actuation of the drag reduction systems (DRS), a servo motor is used which is built into the flaps of the rear wing. The power available for this servo is limited by the low-voltage power distribution (LVPD) used to monitor the power. The power peaks at the moment of actuation were higher than expected and causing troubles leading to a failure of the system. By means of the DEWE3-A4, we analyzed these peaks of several servo motors, compared different servo motors and operating systems, and consequently resolved the failure of the system.

It became evident that the first (trouble-generating) servo motor generates a lot of noise on the supply line, especially, when it reaches the mechanical stop (at around 0.06 seconds). The second servo draws much less power and generates less noise but is still able to reach the mechanical stop after roughly the same time as the first servo.

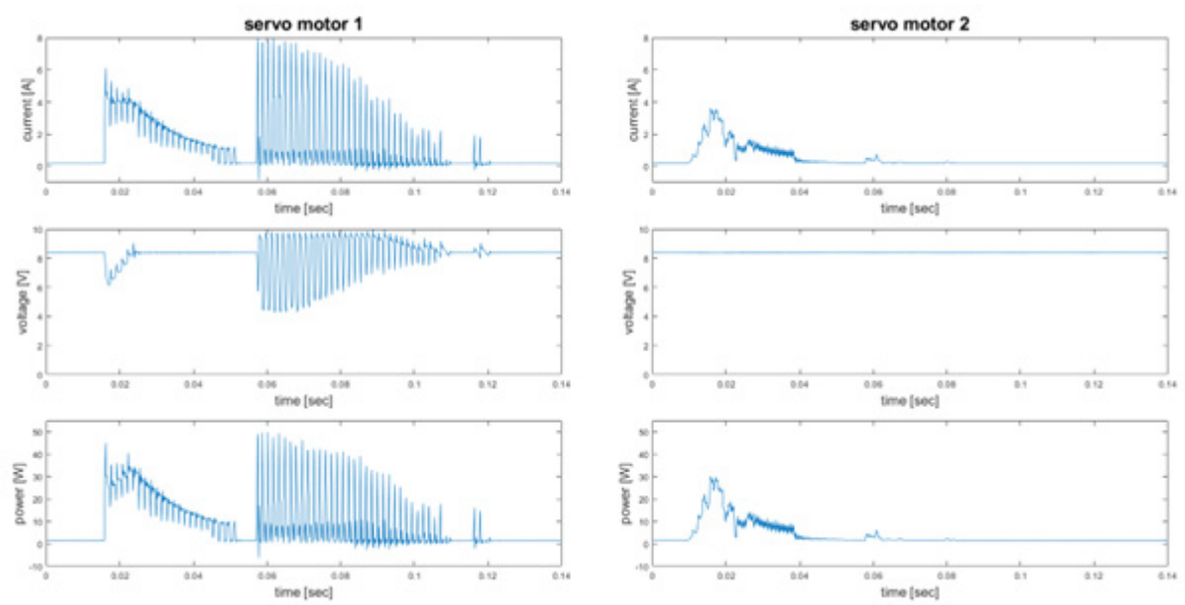


Fig 3: Comparison of servo motors 1 and 2

SUMMARY

During the 2023 Formula Student season, we implemented the DEWE3-A4 power analyzer in the development and testing process of our racecar TANKIA 2023. We used the portable power analyzer and its measurement software OXYGEN for several tasks including:

> the optimization of the DRS, via comparison and analysis of several servo motors,
> the debugging of the start-up sequence,
> the verification of the discharge system,
> and the measurement of the dq-axis current in our self-designed inverter.

WRITTEN BY

TU Graz Racing Team – We are a student racing team founded in 2002 and based in Graz. We have been part of Formula Student since 2004 and achieved numerous successes during the last few years. The highlight was the 1st place in the world rankings in 2018 among more than 600 competitors.

Fig 4: TU Graz Racing Team and DEWETRON