Introduction to Measuring Electric Power During Transients

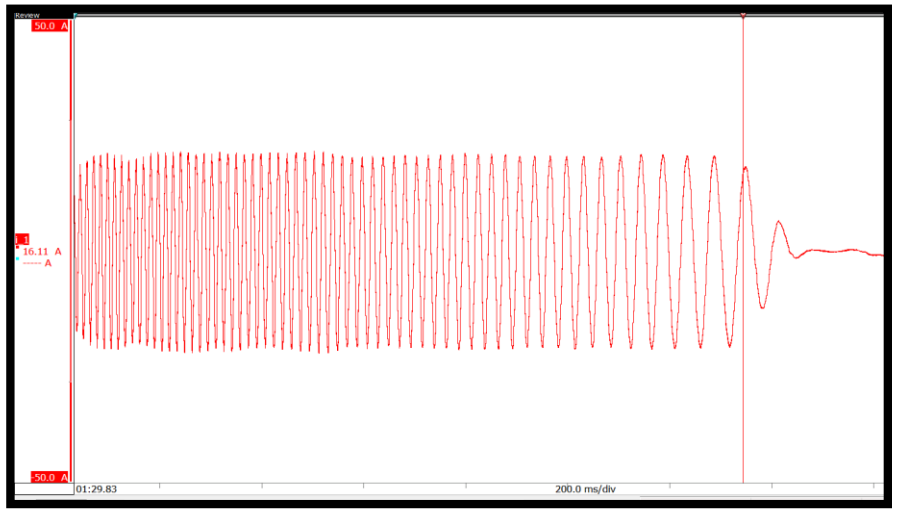
Agenda

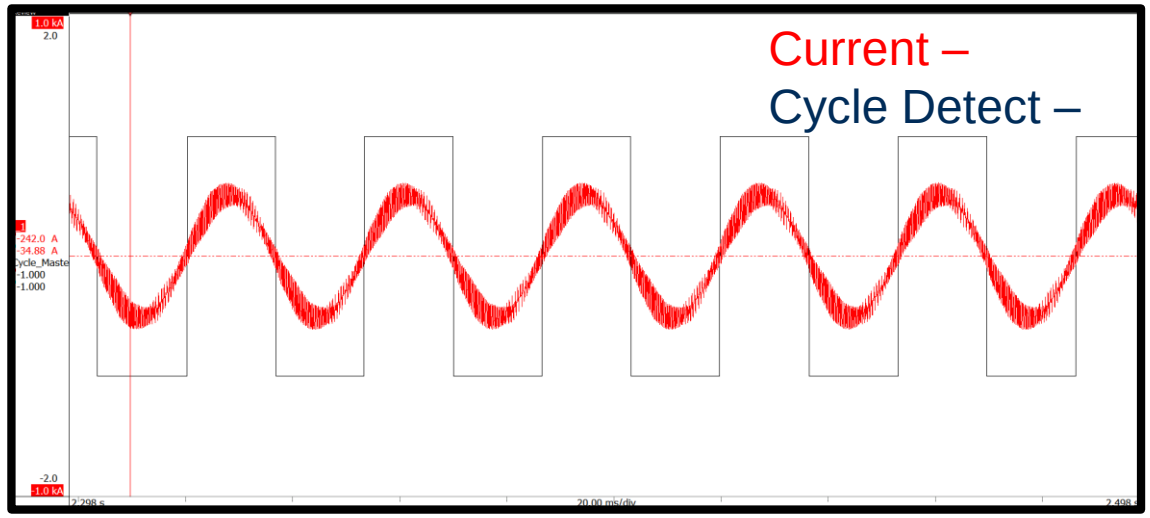
1. Transient power background
2. Transient power example
3. Drive cycles

Transient Power Review

Unique challenges of testing mobile power and efficiency

- No steady state frequency
  - PLL struggle locking changing frequency
- Constantly changing states
  - Transients
  - Multiple machines
- To compute any power result the “cycles” of the signals are needed
- The eDrive **hardware** detects the cycles using advanced digital algorithms in a DSP
- Cycle detect allows for dynamic testing



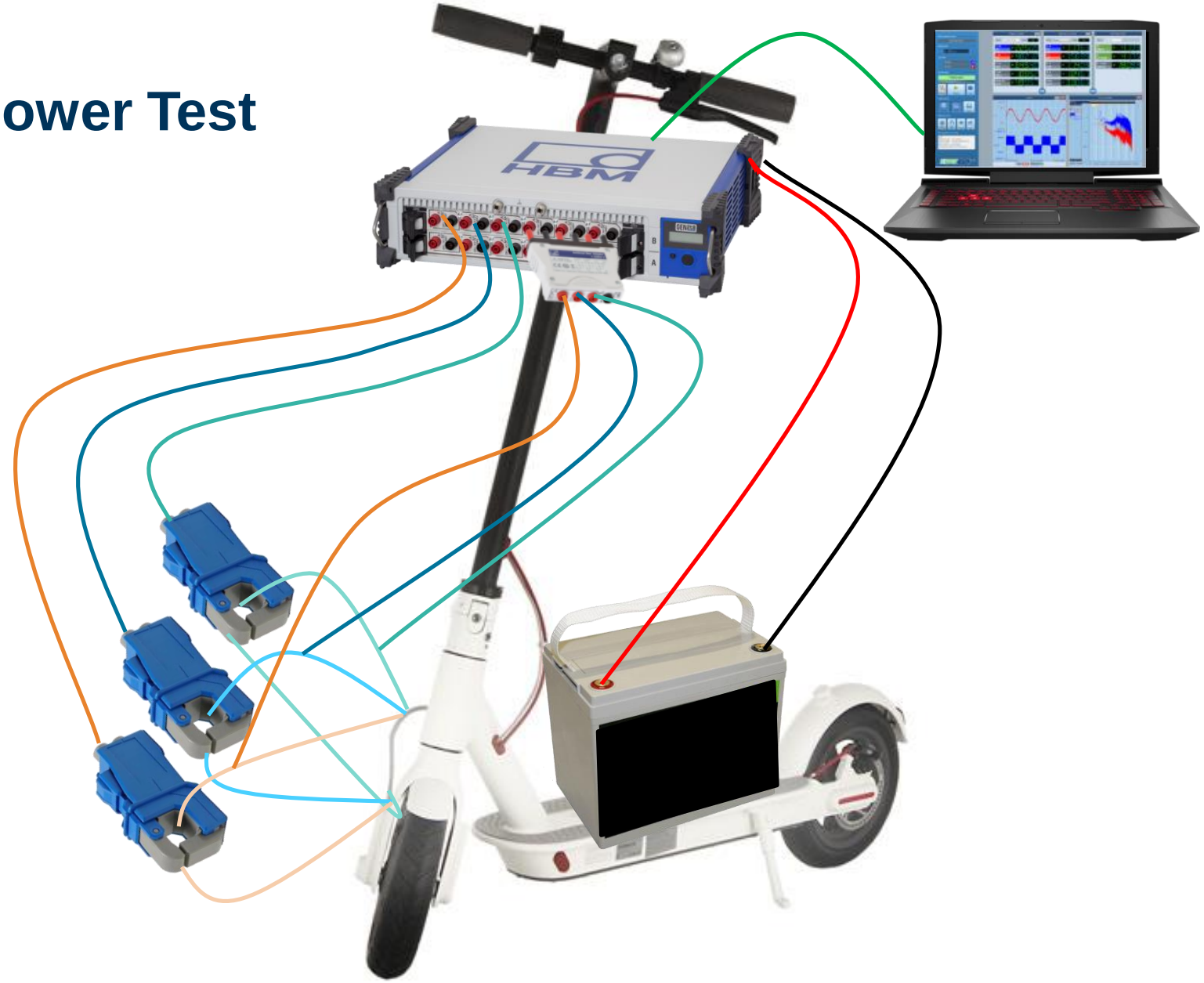


HBK
HOTTINGER BRÜEL & KJÆR

Transient Power Test Example

Electric Scooter Mobile Power Test

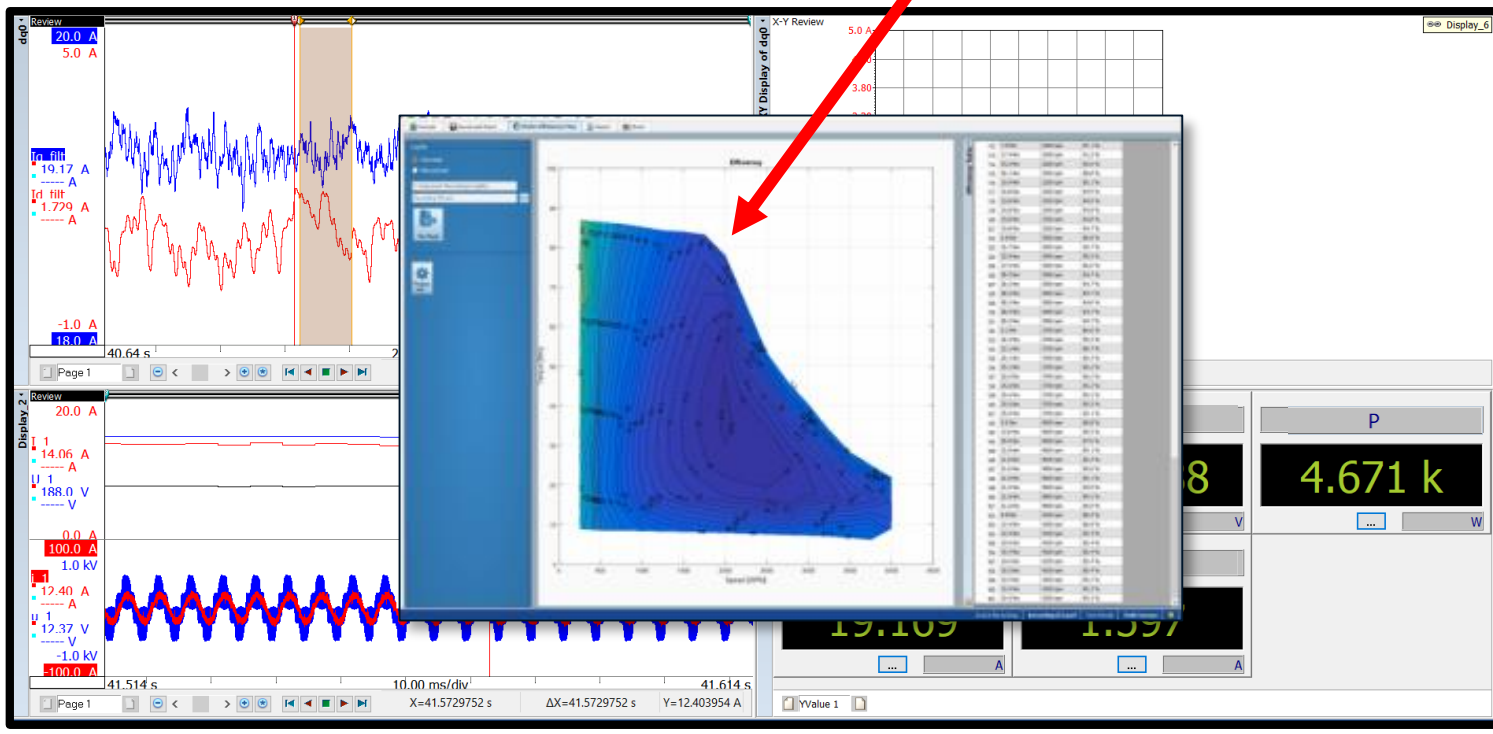
- Put Gen2tB on scooter
- Pulled 3 phase voltage cables
- Tapped Voltages and used clamps for currents
- Powered Gen2tB off 12V DC
- Streamed data to laptop



HBK
HOTTINGER BRÜEL & KJÆR

Visualize Real Time Data in a Variety of Ways

- Drivers need feedback to know what points they have achieved
- Visualize V, I, P, Id & Iq, PWM and More
- Trigger on any value
- Plot live heat maps



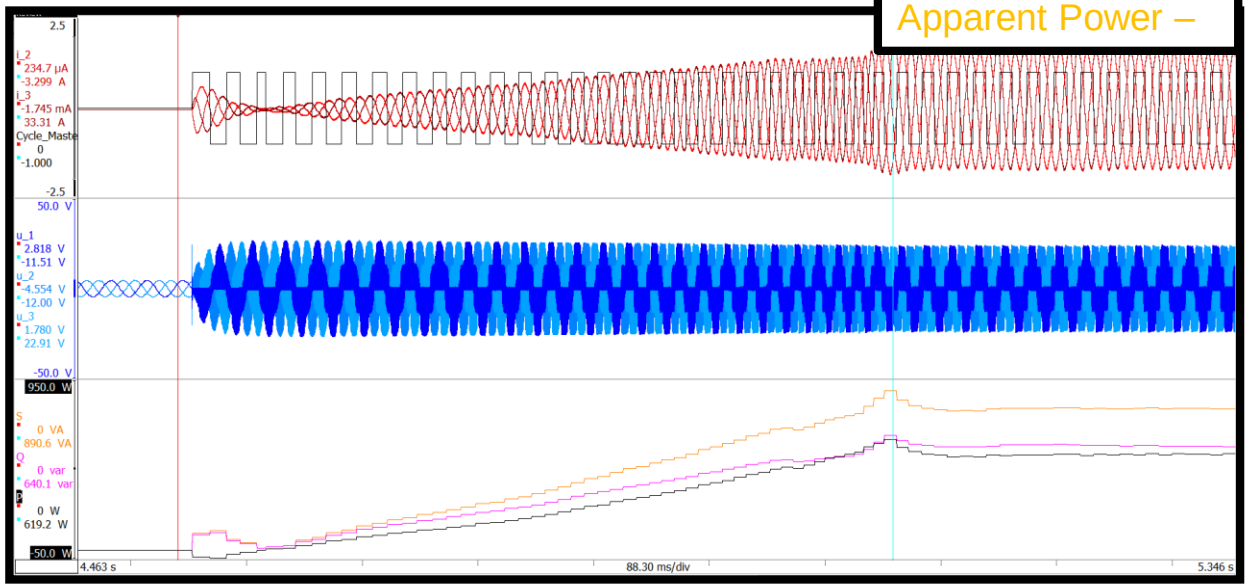
HBK
HOTTINGER BRÜEL & KJÆR

Dynamic Testing with Cycle Detect

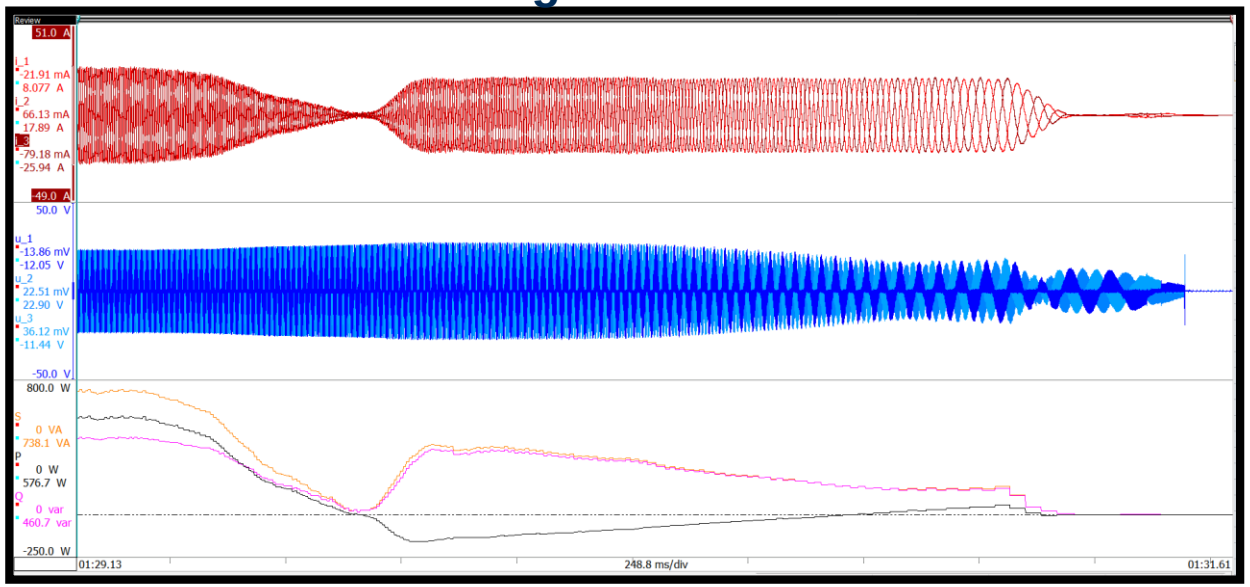
- Drive cycles and in vehicle testing require dynamic power measurements
- Cycle detect allows measurement of signals as frequency is changing
- Dynamic testing lets users characterize real world scenarios
- Regeneration effects driver experience and create additional losses with poor management

Current –
Voltage –
Power –
Reactive Power –
Apparent Power –

Acceleration

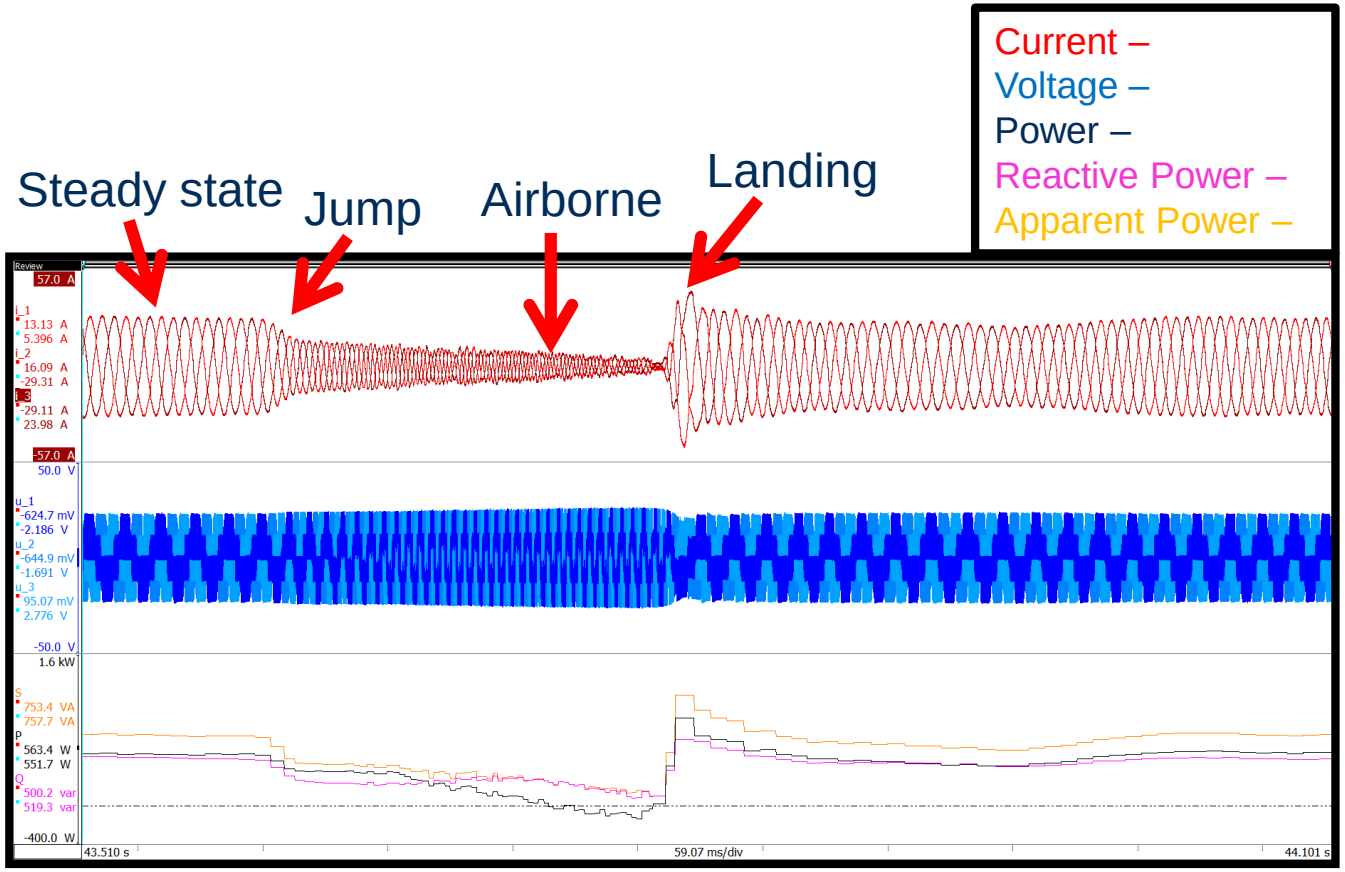


Regeneration



Jump and land

- How do systems handle unexpected disturbances?
- Replicate loss of traction or airborne
- Track energy usage and system control

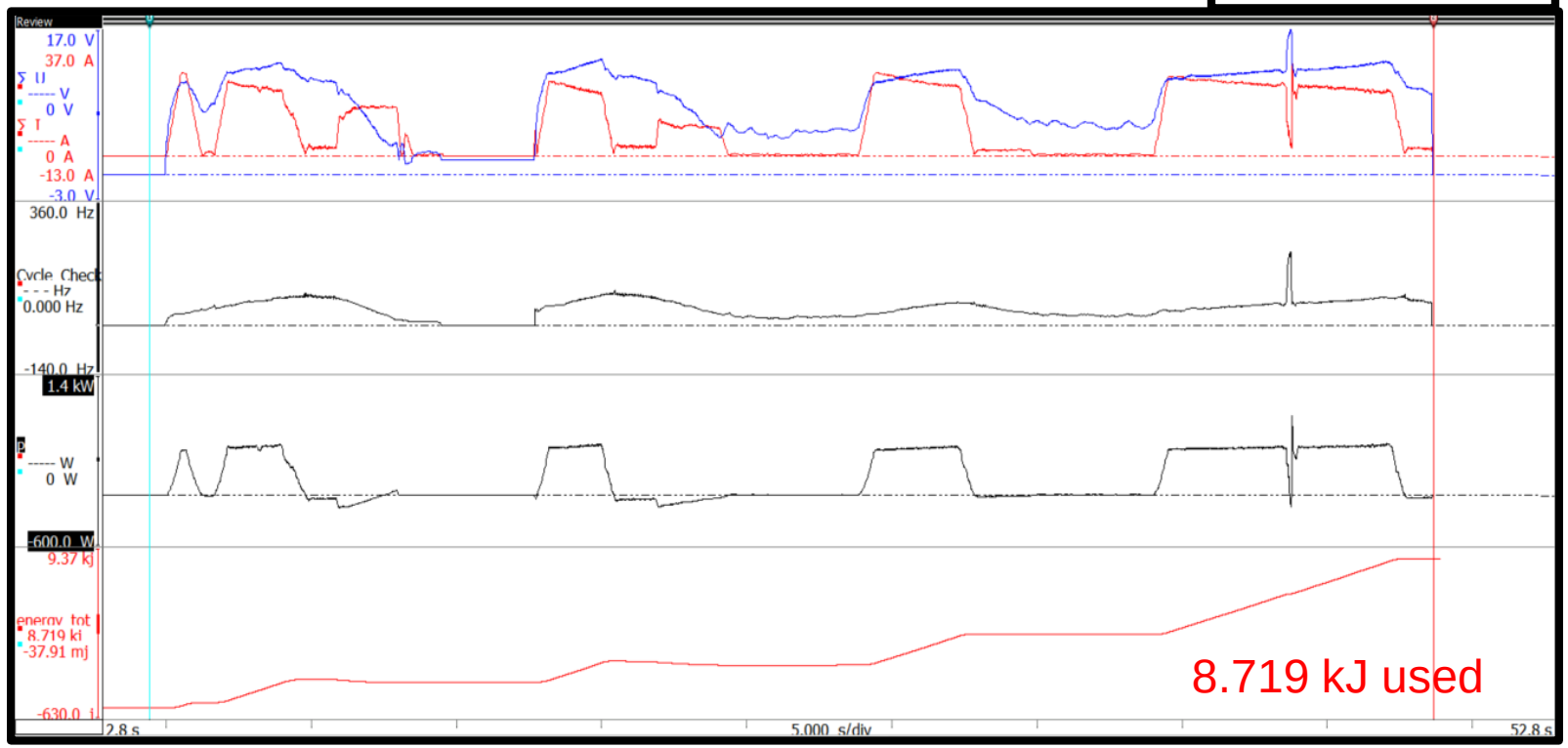


HBK
HOTTINGER BRÜEL & KJÆR

Energy Used During a Drive Cycle

- Drive cycles performed on:
  - Dyno
  - Chassis dyno
  - Vehicle runs
- Used to understand energy usage
- Require dynamic power tracking
  - Cycle detect to follow fundamental

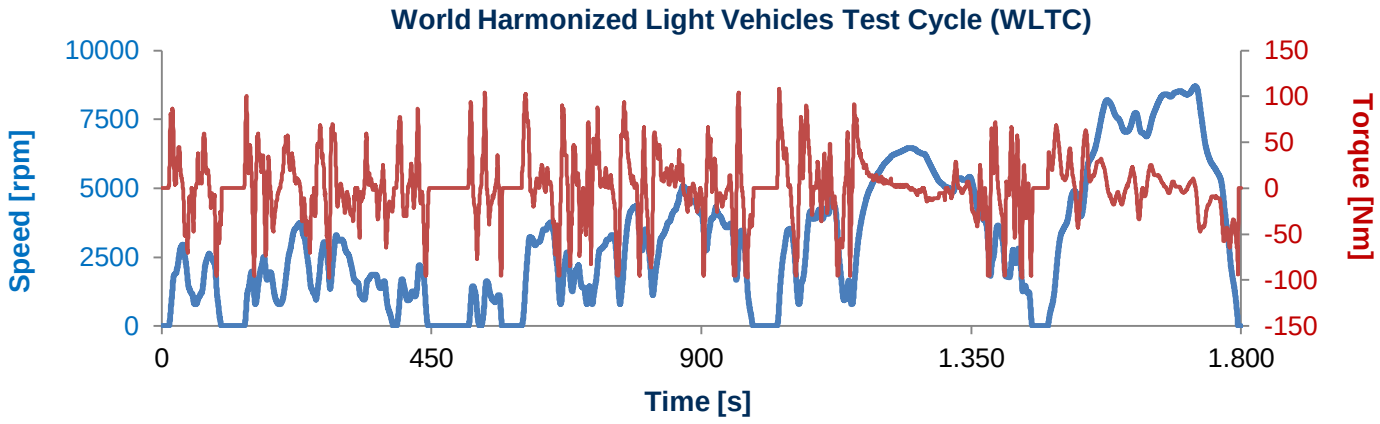
RMS Current –
RMS Voltage –
Cycle Frequency –
Power –
Energy –

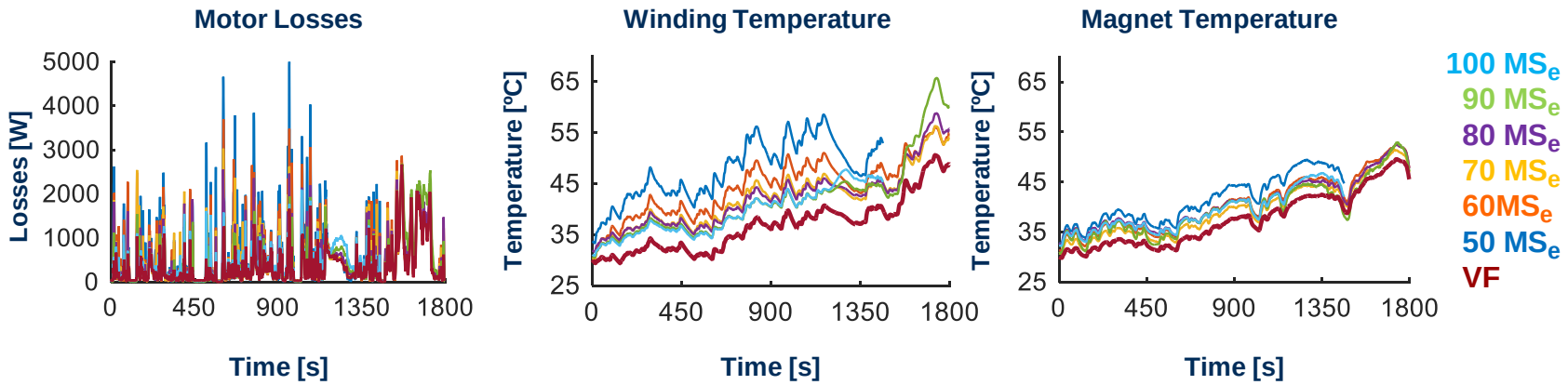


HBK
HOTTINGER BRÜEL & KJÆR

Dynamic Efficiency Testing on a Test Stand

Drive Cycle Testing

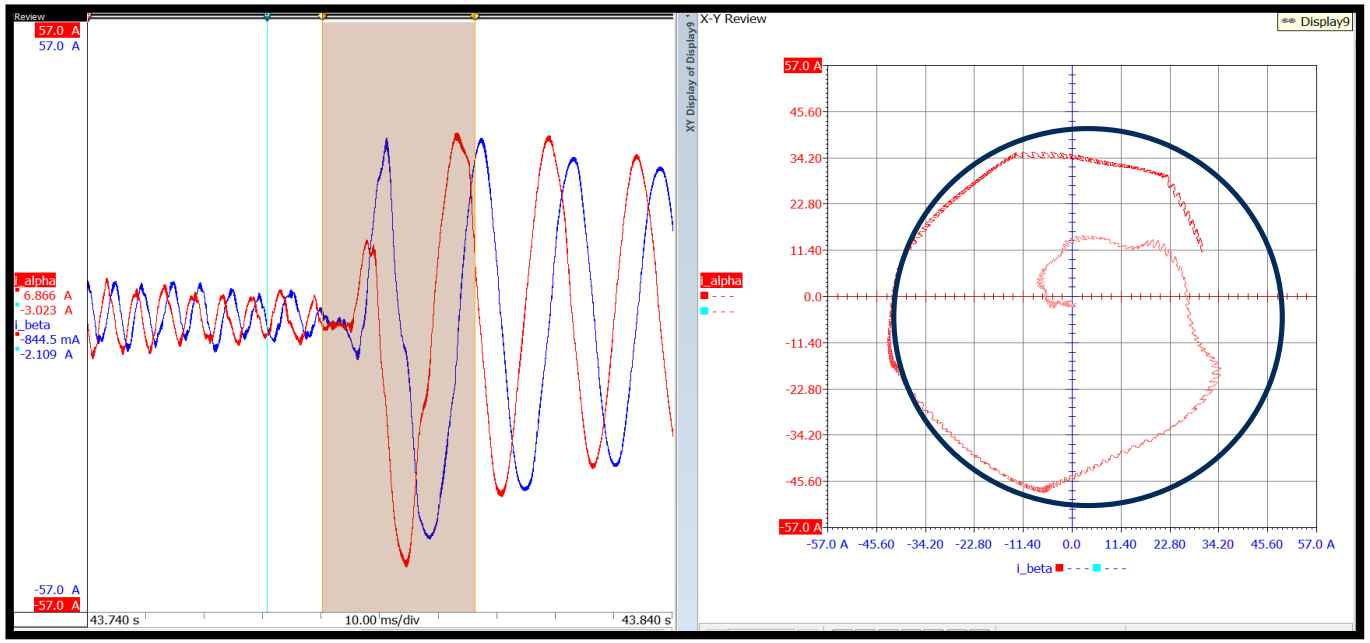




Dynamic Controls Work

3 Phase Scooter – Jump and land

- Does the controller behave acceptably during transients
- Get an understanding for what the machine controller may be doing
  - Useful for calibration
  - Useful for reverse engineering/benchmarking
- Understand calibration for customer experience



Questions?

Mitch Marks
Business Development at HBK - Hottinger, Brüel & Kjær

HBK Electric Power Test