

# Fast Efficiency Mapping for Control and Calibration

#### **ELECTRIC POWER TESTING SOLUTIONS**





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# Measurement Points → Time Consumption

#### Efficiency Map is 200 points

- 10 temperatures
- 5 saturations
- 5 states of charge
- 200\*10\*5\*5 = 50,000 Points
- Transitions
- Heating up & cooling down
- Other tests control, transient, calibration
- Plus Re-running tests

Points	10 second Measurement	1 second Measurement	.1 second Measurement
50k	139 hours	13.9 hours	1.39 hours
20k	55.5 hours	5.6 hours	.56 hours
5k	13.9 hours	1.39 hours	.139 hours



#### **eDrive Value**

- Accurate & Fast efficiency measurements
- Complex system mapping
  - Electromechanical
  - Many phases
- Live plotting
- Auditable testing
  - Stored data

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- Public equations
- Feedback to control systems



FD

#### Fast and Accurate - Power is calculated on a 1/2 Cycle Basis

- 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
- RMS values, power, efficiency, and advanced calculations are done on the cycle basis
- Current - Cycle Detect

Current and cycle detect for a single phase of a 3-phase system. This highlights the cycle detect identifying  $\frac{1}{2}$  cycles for calculation.

- Allows for dynamic testing
- Accuracy 0.015% + 0.02% with Auto-Range



#### Accurate measurements on the Cycle Basis

- Results as fast as ½ cycle or averages of several cycles
  - Choose correct averaging period for best results
- Allows for the accurate measurement of high frequency
- Time alignment of all electrical & mechanical signals
  - Same averaging period
- Auto-Range to minimize measurement uncertainty



8 Cycle average for electrical and mechanical values at a steady state



## **Fast Efficiency Testing**

- Take measurement as soon as dyno is settled
- Measure power & efficiency dynamically
- Spend less time with the machine heating up / cooling down
- Plot maps live
- Measure high power points





#### Auditable Testing – All Data recorded & Equations are public

- eDrive stores all signals to hard disk @ 2MS/s per channel
- Calculated power results have the data to support them
- Correlate tests to models
- Re-run tests in data



Current and line to line voltages for a 3-phase machine

99	Cycle_Master_out	@CycleDetect ( Cycle_source_out ; Cycle_level_out ; Cycle_hyst_out )	
	1		
109	L1	<pre>@CycleRMS(i_1;Cycle_count_out;Cycle_Master_out)</pre>	
110	1_2	<pre>@CydeRMS(i_2;Cyde_count_out;Cyde_Master_out)</pre>	
111	I_3	<pre>@CydeRMS(i_3; Cyde_count_out; Cyde_Master_out)</pre>	
117	U_1 @CycleRMS ( u_1 ; Cycle_count_out ; Cycle_Master_out )		
118	U_2	U_2 @CydeRMS(u_2;Cyde_count_out;Cyde_Master_out)	
119	U_3 @CycleRMS (u_3; Cycle_count_out; Cycle_Master_out)		

All used formulas are public and user formulas can be added



#### **Feedback to Automation Systems - Integration Tools**

#### Real Time Feedback:

- CAN 2.0 or FD
- EtherCAT
- API
- ▲ System Control:
  - LabVIEW
  - C+
  - Python
  - TTL signals





#### **Thank You Questions?** -



HBM Electric Power Testing



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File: HBM eDrive - Short Customer Introduction 2021 02 v02 en - public

### The HBM eDrive components for advanced power analysis

- GEN DAQ configurable, expandable mainframes
  - Up to 51 power channels
  - Continuous streaming or storage per set point in real time
  - Support for up to 6 torque transducers
- 3 channel Power card
  - Voltages up to +/- 1500 V DC
  - Sample rate 2 MS/s @ 18 bit
  - Accuracy 0.015% rd. + 0.02% rg.
  - On board DSP with user programmable math
- High accuracy HBM torque and current transducer
- Options
  - EtherCAT and CAN FD interfaces
  - Various inputs for NVH, temperatures, CAN..... ...and also "scope cards" up to 250 MS/s

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