Australian Government

Department of Climate Change and Energy Efficiency

Motor standards and check-testing – An Australian perspective

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thinkchange

Australia's electric motors check-testing program

- 26 motors check-tested in 2011-2012
- Over 90% complied with MEPS
- Newer registrations supported by test certificates to Australia's 'Method A' which corresponds to the preferred test procedure set out in IEC60034-2-1
- These motors often perform poorly when efficiency measurements are made to 'Method B' in which the 'reference temperature' is very high (115˚C for Class F)

From IEC 60034-2:

5 Reference temperature

Unless otherwise specified, all I^2R losses shall be corrected to the temperatures given below:

Thermal class of the insulation system	Reference temperature °C
A, E	75
B	95
F	115
H	130

Standards development:

IEC 60034-2-1 (Working Group 28)

Standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles)

Standards development:

IEC 60034-2-1 (Working Group 28)

Significant advances in the new draft edition:

Single preferred test method for induction motors

IEC 60034-2-1 draft edition : Preferred testing methods

Table 2A – Induction machines: Preferred testing methods

Ref	Method	Description	Clause	Application	Required facility
2-1-1A	**Direct measurement: Input-Output**	Torque measurement	6.1.1	All single phase machines	Dynamometer for full-load
2-1-1B	**Summation of losses: Residual losses**	P_{LL} determined from residual loss	6.1.2	Three phase machines with rated output power up to 2 MW	Dynamometer for 1,25 x full-load
2-1-1C	**Summation of losses: Assigned value**	P_{LL} from assigned value	6.1.3	Three phase machines with rated output power greater 2 MW.	

Standards development:

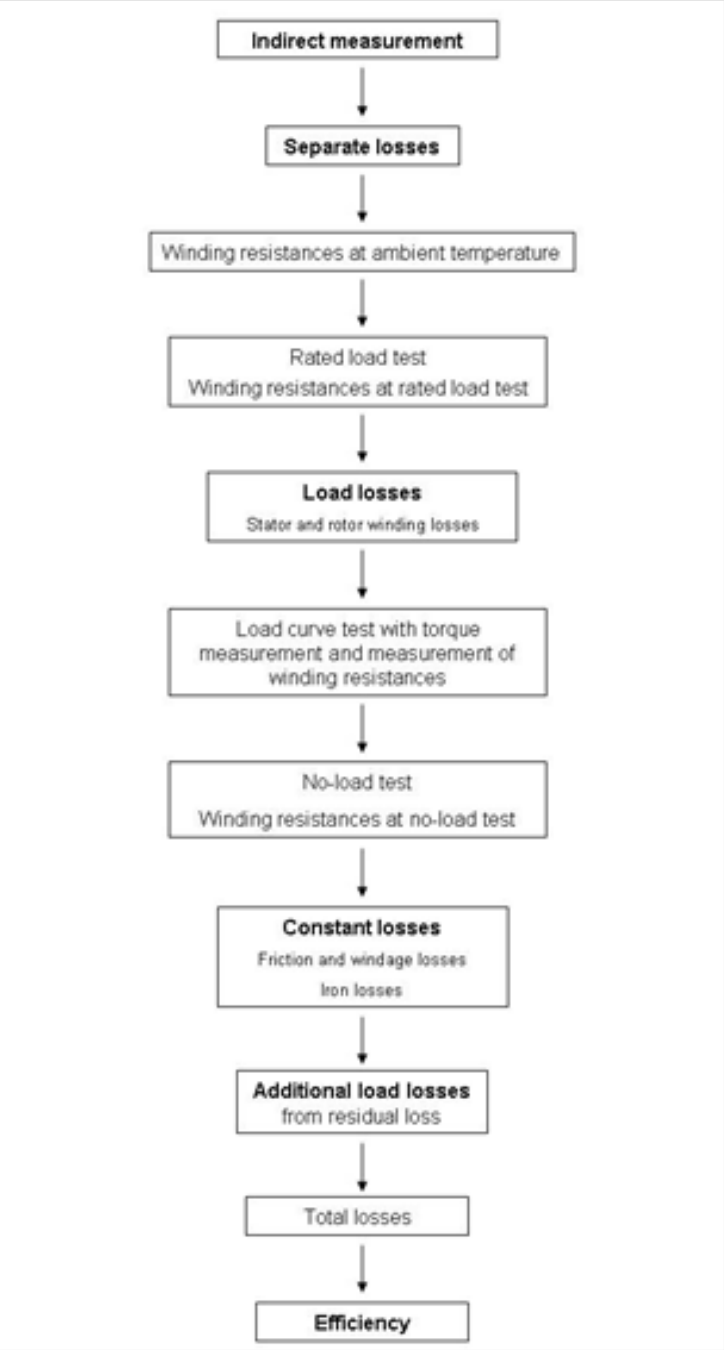
IEC 60034-2-1 (Working Group 28)

Significant advances in the new draft edition:

Single preferred test method for induction motors

Order of tests and measurements fixed

Method 2-1-1B


Indirect measurement
Separate losses
Winding resistances at ambient temperature
Rated load test
Winding resistances at rated load test
Load losses
Stator and rotor winding losses
Load curve test with torque measurement and measurement of winding resistances
No-load test
Winding resistances at no-load test
Constant losses
Friction and windage losses
Iron losses
Additional load losses
from residual loss
Total losses
Efficiency

Standards development:

IEC 60034-2-1 (Working Group 28)

Significant advances in the new draft edition:

Single preferred test method for induction motors

Order of tests and measurements fixed

Measurement points for load-curve and no-load tests also fixed

‘Load-curve test’:

Apply the load to the machine at the following six load points: approximately 125%, 115%, 100%, 75%, 50% and 25% load. These tests shall be performed as quickly as possible to minimize temperature changes in the machine during testing.

No-load test:

Test at the following eight values of voltage, including rated voltage, so that:

- the values at approximately 110%, 100%, 95% and 90% voltage are used for the determination of iron losses;

- the values at approximately 60%, 50%, 40% and 30% voltage or down to voltage where the line current is not anymore decreasing or reaches a minimum stable value are used for the determination of windage and friction losses;

Standards development:

IEC 60034-2-1 (Working Group 28)

Significant advances in the new draft edition:

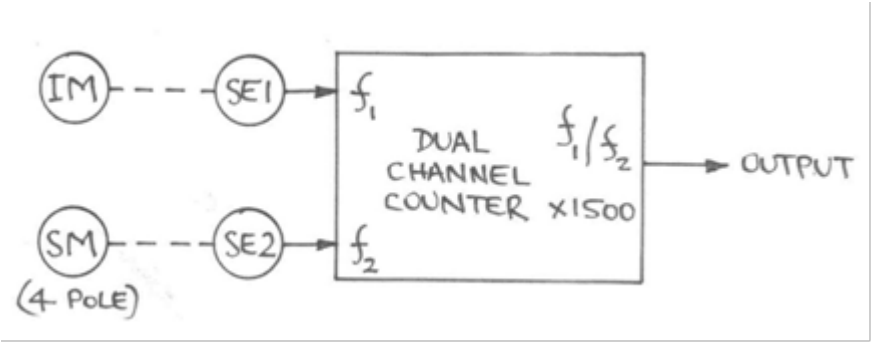
Single preferred test method for induction motors

Order of tests and measurements fixed

Measurement points for load-curve and no-load tests also fixed

Informative Annex on measurement of slip

Part of IEC 60034-2-1 informative annex on slip measurement



IM Induction machine under test (any number of poles)
SM Small synchronous motor (e.g. 4 poles) or main laboratory M-G set
SE1 Sequential shaft encoder, with e.g. 600 pulses per revolution (p.p.r.)
SE2 Sequential shaft encoder, with same no. of p.p.r. as SE1
f_1 Frequency of pulse train from SE1
f_2 Frequency of pulse train from SE2
Output Ratio f_1/f_2 x synchronous speed of SM

Figure C1 - Slip measurement system block diagram

Standards development:

IEC 60034-2-1 (Working Group 28)

Significant advances in the new draft edition:

Single preferred test method for induction motors

Order of tests and measurements fixed

Measurement points for load-curve and no-load tests also fixed

Informative Annex on measurement of slip

Laboratory ambient temperature range now specified: 15-30˚C

Standards development:

IEC 60034-2-1 (Working Group 28)

Much more work to be done, for example:

Measuring equipment specifications are inadequate at present, and do not take the different test methods into account

Recognition must be given to the important 'quality indicators' which the 'A' and 'B' parameters in the residual loss smoothing process represent

Calibration of torque transducers, especially for very high accuracy (input-output) dynamometry should not be based on Euramet cg-14 as currently proposed. (Applies only to *static* torque measuring devices)

The estimated uncertainties associated with the various test methods must be evaluated, and that work *not* be left to individual laboratories.

An international round-robin series of motor efficiency measurements should be undertaken

Standards development:

IEC 60034-2-1 (Working Group 28)

Further:

How difficult will it be to apply the preferred efficiency measurement method (‘Method B’) to motors rated at only 0.12 kW?

(This will require very accurate torque measurements at 25% of rated output, i.e., 30 W).

At 2-pole speed this is about 0.1 Nm!)

Standards development:

IEC 60034-2-3 (Working Group 28)

Specific test methods for determining losses and efficiency of converter-fed AC induction motors

Standards development:

IEC 60034-2-3 (Working Group 28)

This draft technical specification (TS) deals with **motors** and compares their performance when fed from sinusoidal and '**reference converter**' supplies

A 'reference converter' is specified, the characteristics of which are not necessarily the same as those found in converters which are commercially available.

Compares the performance of a given motor on both ‘sinusoidal’ and converter supplies.

Reference converter does not necessarily represent all commercially available drives.

Output fundamental frequency to be 50 Hz

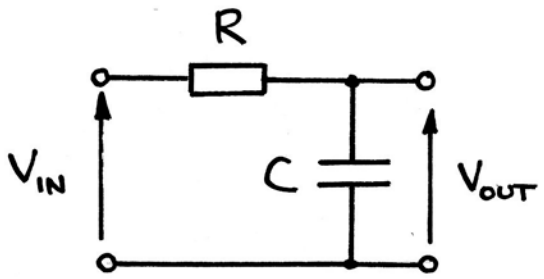
100% modulation
(No ‘missing pulses’)

Fundamental voltage to equal motor voltage rating
(May require higher than rated input voltage to converter)

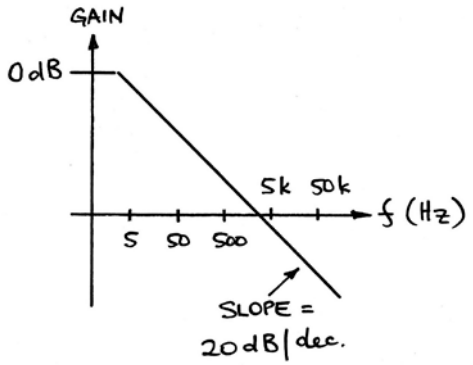
Carrier frequency to be 2 or 4 kHz (period 0.5 ms or 0.25 ms respectively)

‘Linearity extension’ to be correctly applied

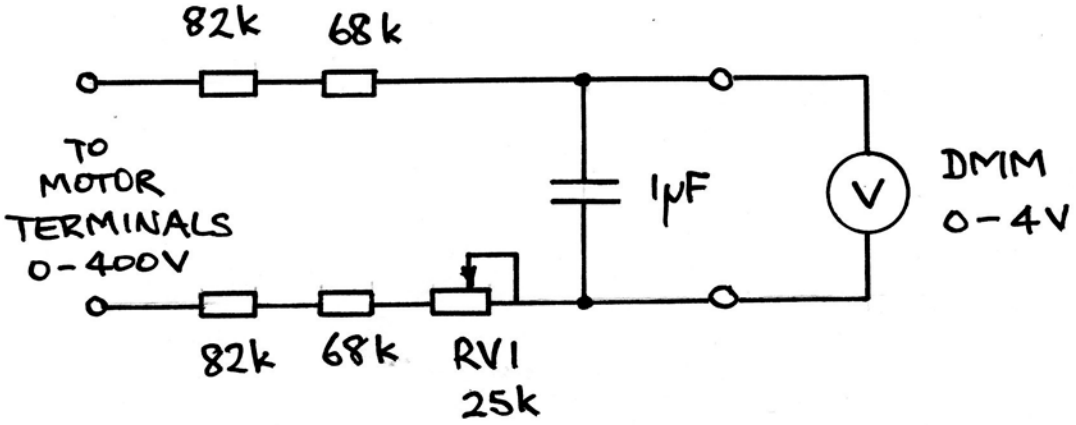
The Flux Voltmeter



R-C 'approximate' integrator

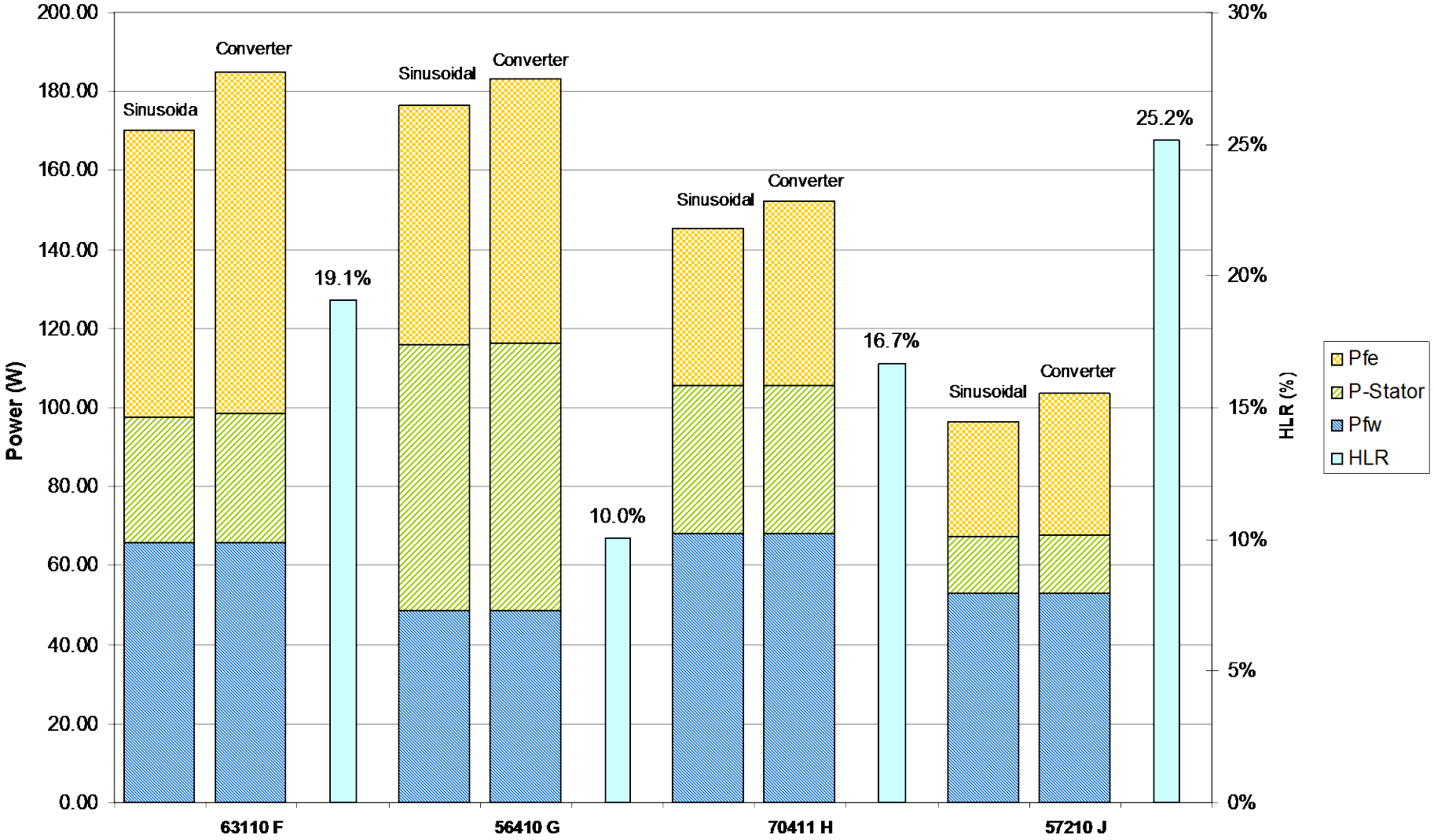


Frequency response

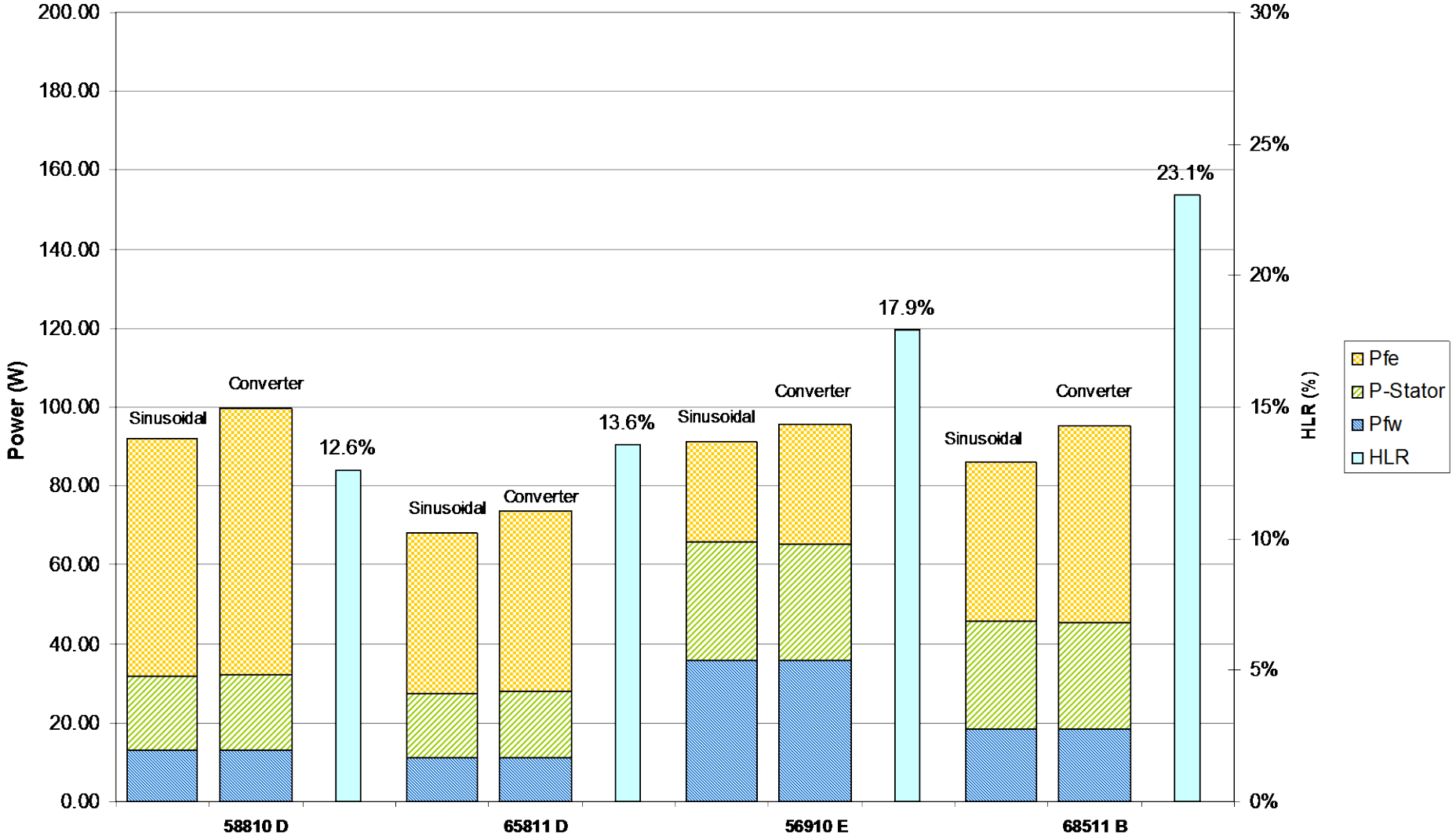


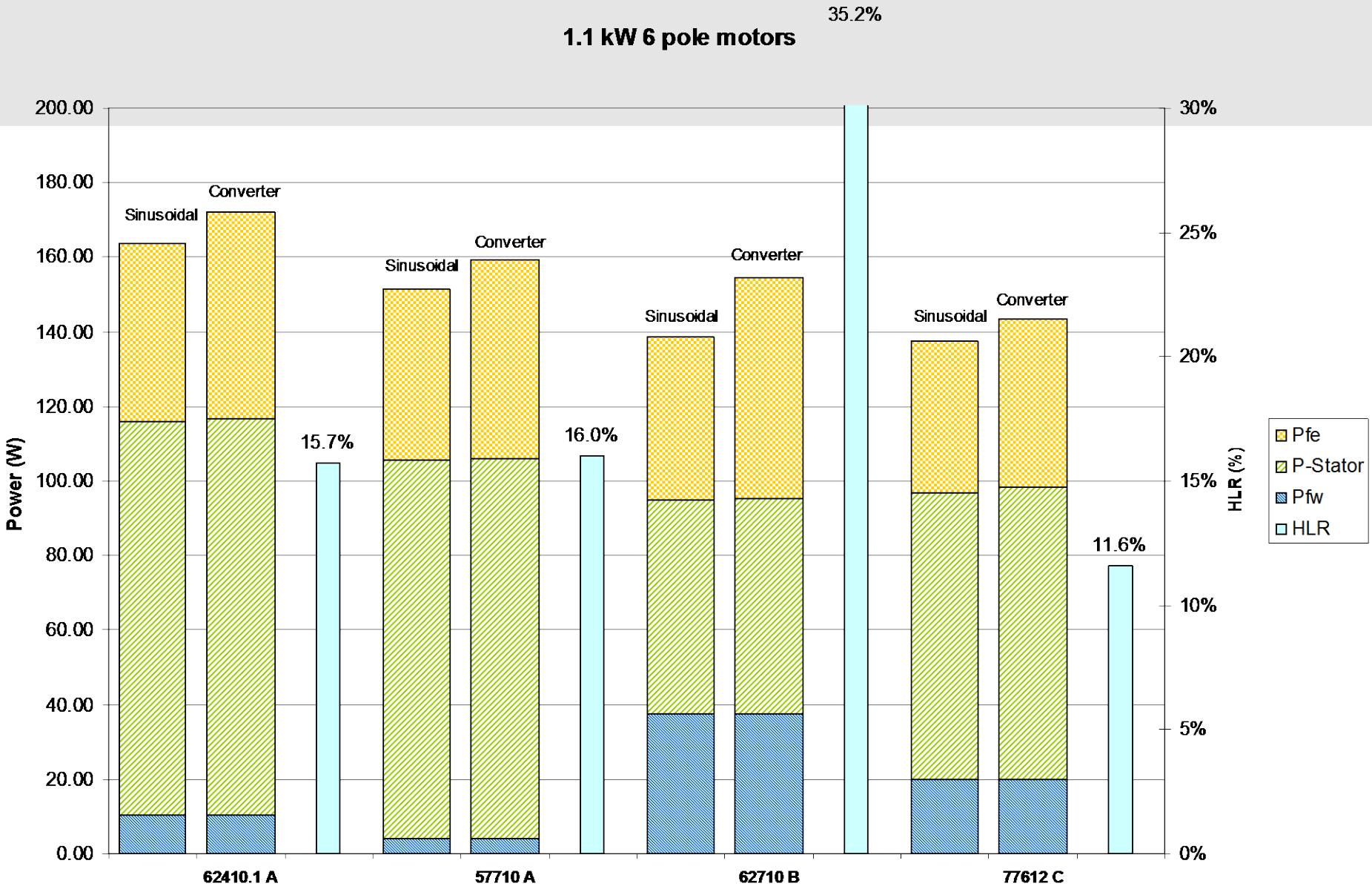
Practical flux voltmeter

1.1 kW 2 pole motors



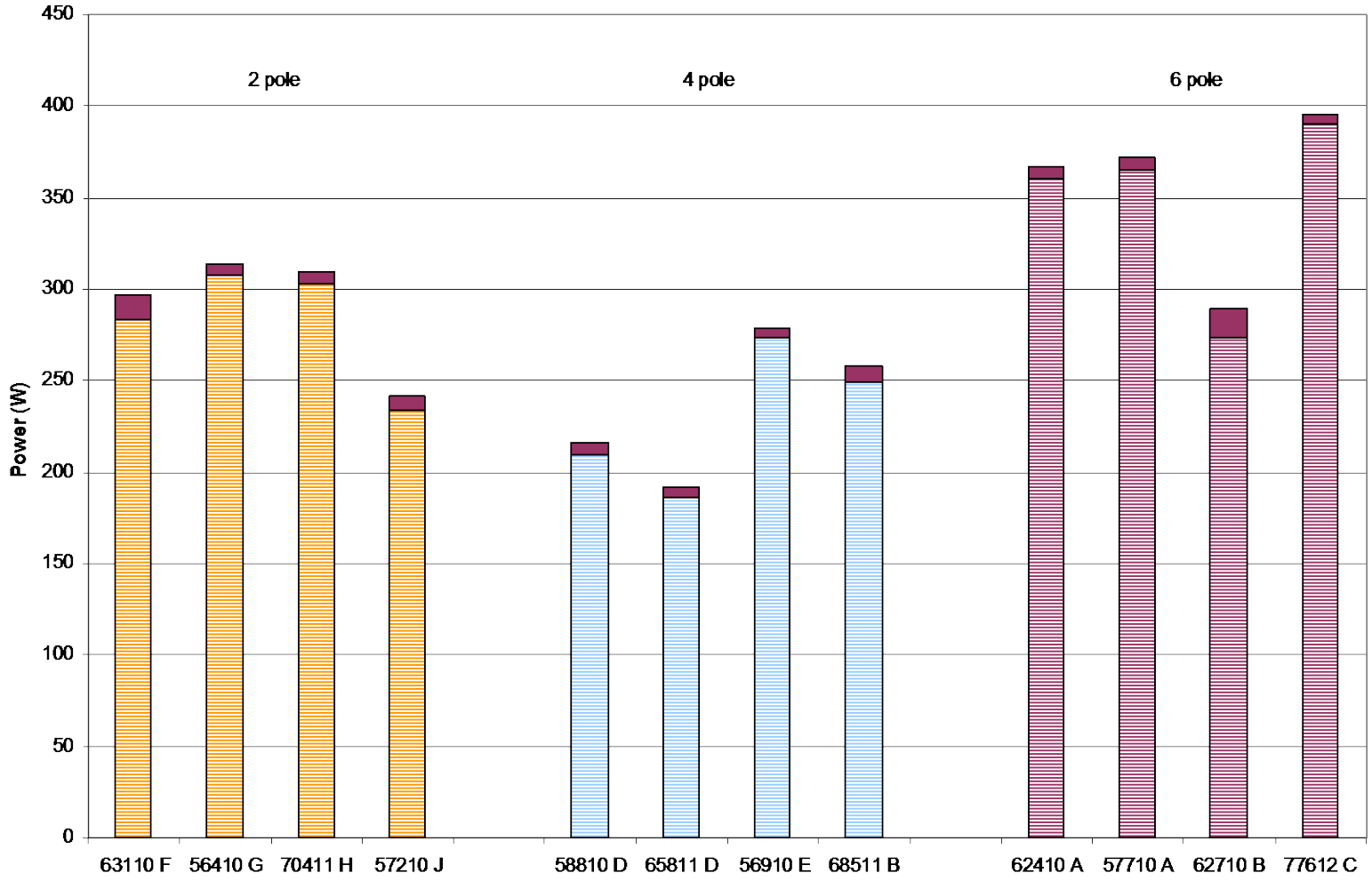
1.1 kW 4 pole motors



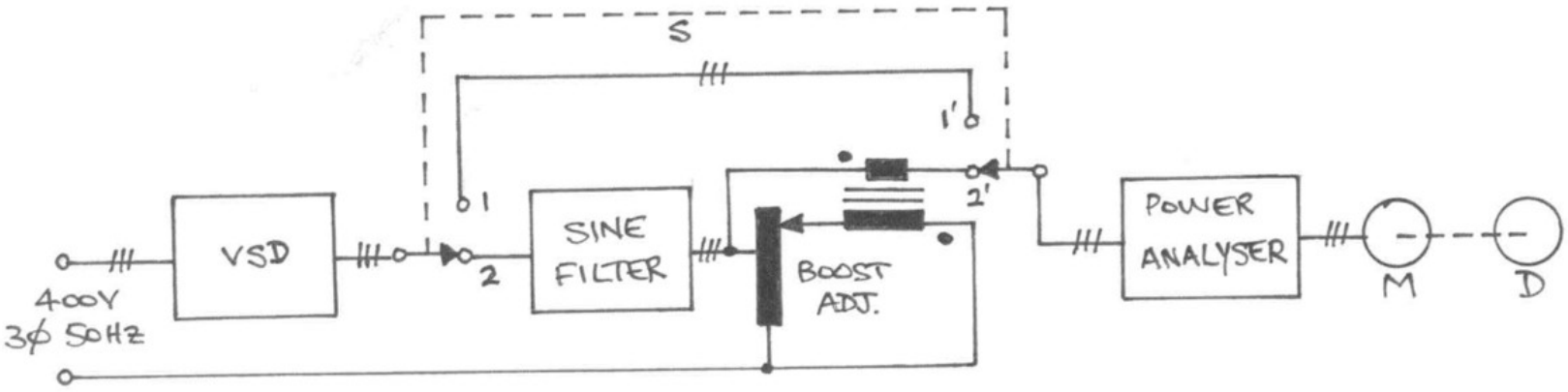

35.2%
1.1 kW 6 pole motors
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Power (W)
30%
25%
20%
15%
10%
5%
0%
HLR (%)
Sinusoidal
Converter
15.7%
16.0%
11.6%
62410.1 A
57710 A
62710 B
77612 C
Pfe
P-Stator
Pfw
HLR

Is Harmonic loss ratio a useful concept?

Converter contribution to total losses



Possible ‘A-B’ comparison measurement method for IEC 60034-2-3



Thank you

Questions?