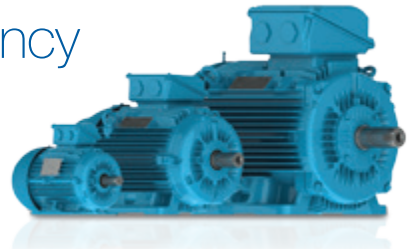
22 ways

to improve motor efficiency and prolong lifespan.



Reducing carbon footprint and cutting costs with the W22.

Learn how WEG's W22 range of electric motors exceeds the latest energy efficiency standards and offer cost-saving benefits.

Today, electric motors account for as much as 68% of industry's energy usage. Yet a huge amount of this energy is wasted, as organisations use solutions which are poorly designed, or inappropriate for their application. By reducing this wastage, companies not only help the environment, but also cut their costs and improve profitability.

At WEG, we are committed to provide solutions designed to help industry achieve these goals. And one of these solutions is our revolutionary W22 range of three-phase induction motors, designed to offer not only significantly lower energy consumption, but lower noise and vibration, higher reliability, easier maintenance and lower cost of ownership.

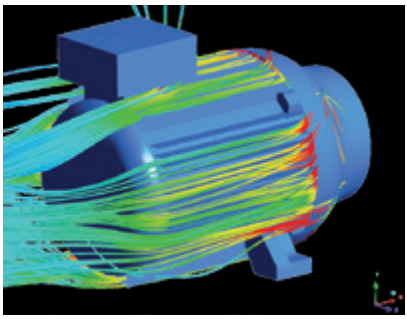
Consisting of four efficiency classes, each one designed to exceed the requirements of the IE1, IE2, IE3 and IE4 efficiency classes, the WEG W22 range can reduce energy losses by between 10% and 40% compared with other typical motors. It's an extremely effective way to reduce your carbon footprint, as well as your energy costs. However, it is amazing that energy efficiency is not the only feature of the W22 that will save you money. Here, we describe 22 features of the product which differentiate it from other motors of its type and which will deliver significant savings and a fast return on investment.

1. Maximum heat dissipation.

One of the main functions of an electric motor frame is to provide mechanical protection to the winding. It also provides the interface for installation through feet or flange.

The motor frame plays a crucial role in its thermal performance because it is responsible for transferring the heat generated inside the motor out to the frame surface where air blown by the fan will promote heat dissipation.

The W22 frame concept takes heat dissipation very seriously with eyebolts positioned in such a way that they do not block any airflow through the fins and also through the position of the terminal box which is placed towards the front of the frame (for frame sizes 225S/M to 355A/B). The quantity and distribution of the fins also have great impact in heat dissipation performance.



Efficiency and Reliability Tip:

Respect the minimum gap between any wall positioned near the back of the fan cover to allow air intake. Keep motor surroundings clean and periodically check for any air blockage that can reduce the cooling system performance. Remember that the cooler a motor runs, the longer it will last.

2. Solid integrated feet for increased mechanical rigidity and easier installation.

When converting electrical energy into mechanical the motor requires supporting points where the mechanical thrust, proportional to the demanded load torque, will be applied to the base. These supporting points are the motor feet. This said we can conclude that stronger feet guarantee reliable operation, mainly in heavy duty applications, for example, crushers.

The W22 design integrates the sides of the front and rear feet for higher mechanical stiffness. They are solid for a better distribution of the mechanical thrust imposed by the load.

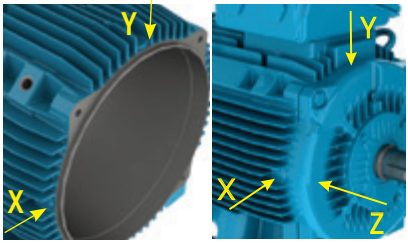
Efficiency and Reliability Tip:

As a manufacturer, we make all efforts to increase mechanical stiffness of our products. Remember that feet are the motor interface with the base, which means that the base must be level and flat in order to guarantee less vibration and safer operation.

3. Flat surfaces distributed in NDE (2 in the frame) and DE (two in the endshield and one in the frame) for vibration monitoring, for frame sizes 160M to 355A/B.

The IEC 60034-14 defines two vibration grades, A and B, and it classifies a motor by size with vibration speed limits the motor must respect. These limits consider an uncoupled motor which means that at load conditions the set will have its own vibration level. The vibration level during operation depends on imperfect alignment between motor and load and on remaining unbalanced masses of motor and load.

Periodical monitoring of vibration levels gives a good indication of bearing conditions and overall application behaviour. A bearing failure often leads to a locked rotor condition which can cause the motor winding to burn out. With this in mind, the W22 range has as a standard feature, flat surfaces for vibration monitoring: two in the rear part of the frame, displaced 90° from each other and three in the drive end side: two in the endshield with another one in the front part of the frame.



Efficiency and Reliability Tip:

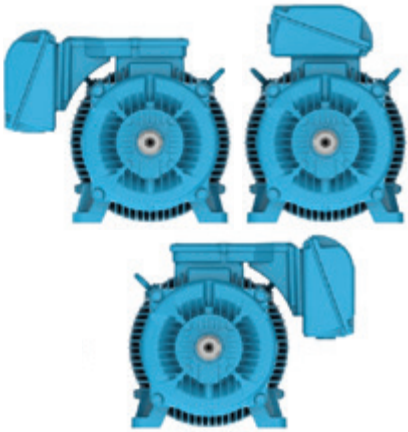
Periodical analysis of bearing vibration can help to identify several kinds of dysfunction, not exclusively to the motor, but to the entire application. Keeping records of main processes and machine vibration behaviour will provide peace of mind to maintenance managers and help minimise production breakdown.

4. Flexibility of terminal box mounting positions enabling reduced inventory and quicker modification.

Many companies map their main processes and identify the machines that are essential to keep those processes running. Most keep spare motors in stock as replacements should a breakdown occur, thus avoiding compromising their production.

Distributors may also stock motors with different terminal box configurations to suit specific customers, or adapt their stock by stripping down and reassembling motors. Both situations mean investing money, labour and warehouse space.

The W22 design allows fast modification leading to reduced stock demands and time to change the terminal box mounting position. For frame sizes 225S/M to 355A/B, a left hand side terminal box motor can be changed to a right hand side terminal box motor by just rotating the adaptor device and vice-versa.
It can also be modified into a top mounted terminal box by removing the adaptor device and adjusting the length of leads. Similarly, a motor with a top mounted terminal box can be modified into a side mounted terminal box by using a kit available from WEG.



Efficiency and Reliability Tip:

The terminal box on the W22 range can be rotated in 90° increments to suit supply cable connection orientated to the front, rear or either side of the motor.

5. Reduced noise pressure levels: limited to 80 dB(A) at 1 m from the motor for bidirectional 50 Hz DOL motors (including two poles) until frame size 355M/L.

Health and safety regulations push for reduced noise levels aiming at offering better conditions for operators in the industry.

With W22 motors, the cooling system was designed for optimum balance of airflow and noise level. The fan provides greater amounts of air to cool the motor and the fan cover with its aerodynamic outline is designed to avoid recirculation of air (loss of performance) and to better direct the airflow over the motor fins.

As a result, all our 50 Hz range, including two pole machines, is limited to 80 dB(A) at 1m from the motor without compromising flexibility: all fans are bidirectional.

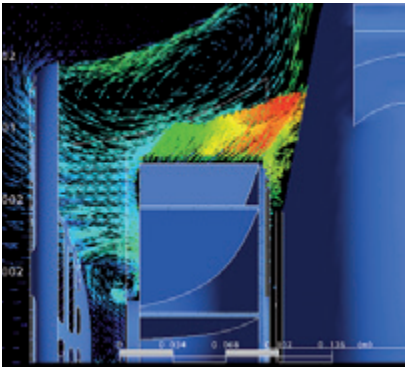
Efficiency and Reliability Tip:

Enquire at WEG about the availability of even lower noise level requirements.

6. Reduced operating temperatures through optimised cooling system (fan, fan cover and frame) designs.

An electric machine's lifespan is governed by its insulating material. The ageing of the insulating material is directly proportional to its operating temperature.

The cooling system of the W22 range, composed of fan, fan cover and motor frame is optimised providing outstanding heat dissipation. This allows for reduced operating temperatures that do not push the insulation material to its limits. It also eliminates any hotspots by providing a uniform temperature distribution throughout the frame.



Efficiency and Reliability Tip:

Motors driven by Variable Frequency Drives (VFD) will have a higher temperature rise due to the PWM wave-form imposed on the motor winding. Whilst VFD operation enables a significant increase in a processes performance in terms of improved efficiency and lower operating costs, the higher temperature rise combined with the voltage spikes from the switching frequency will contribute to shorten winding life-time. The insulating material of the W22 allows for VFD operation minimising impacts in the winding. See WISE chapter for further details on VFD operation.

7. Reliability of fan cover: withstands IK08 impact test for extra mechanical protection.

One way to verify motor suitability for harsh, tough applications is by checking its mechanical envelope against impacts. The EN 62262 – Degree of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code) ranks motor enclosures by specifying in Joules a scale which a motor must withstand.

W22 motors in frame sizes 160M to 355A/B are constructed in cast iron, being classified as IK08, what means the motors are resistant to a 5J impact.

Efficiency and Reliability Tip:

The correct dimensioning of the motor must consider the application severity and the surrounding environment. Contact WEG specialists for advice on sizing and features a motor must have to match your application.

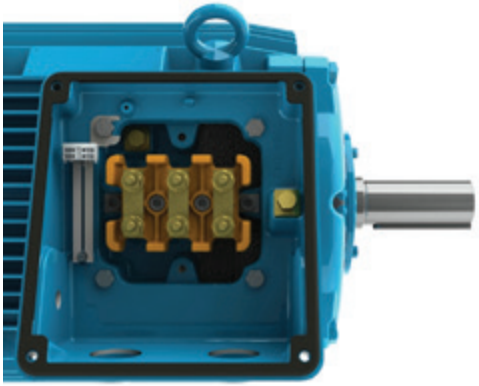
8. Oversized terminal box for easier and safer connection of mains and accessories.

The terminal box is the main interface of the electric motor with maintenance personnel. Large internal volume will provide easy access and better ergonomics during installation and maintenance operations.

W22 motors have a diagonally split oversized terminal box that provides optimal conditions for operators to access main and accessories terminals.

Efficiency and Reliability Tip:

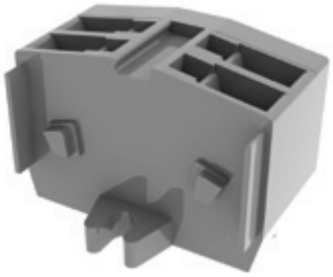
Motor must be disconnected from the power source during any intervention. Special attention should be taken with space heater connections once it is normally powered on when the motor is powered off.



9. Connector for fast accessories assembly.

For continuous monitoring, alarm and trip settings or to avoid condensation inside the motor, several types of accessories may be used aiming at assuring safer and longer operating hours.

The W22 introduces a connector configuration for frame sizes 160M to 355A/B, that does not require bolts to secure the terminals. The terminals are firmly assembled assuring reliable operation. Furthermore this connector can easily accommodate additional modules.



Efficiency and Reliability Tip:

Always select the accessories that best suit your application. For instance, for continuous temperature monitoring, RTDs can be chosen. For ambient with constant presence of moisture, higher than 60%, space heaters are advisable and so forth. Please contact WEG for more information.

10. Connection reliability: terminal block design prevents cable rotation assuring extra protection.

Terminal blocks are commonly used to allow simple and fast maintenance procedures. But they also play an important role by providing safe and reliable connections for motor terminals.

The terminal block used in W22 motors has walls that prevent cable rotation assuring extra protection against accidental contact between terminals.

Efficiency and Reliability Tip:

W22 terminal block provides larger contact area between power supply cables and motor terminals. Adequate tightening torques will guarantee safe and reliable operation.

11. Electrically insulated bearing hub: less replacement required compared to insulated bearings.

Large motors may present induced shaft currents due to the unbalanced waveform and high frequency components of the power supply. Motors driven by frequency converters may also experience electric current circulation through the bearings as a result of a Common Mode voltage effect. The Common Mode voltage is a high frequency electric potential relative to a common reference value (usually the DC link) present due to the inverter topology that makes the vector sum of voltages at any time different to zero. Practical experience shows that higher switching frequency tends to increase Common Mode voltage/current.

To avoid bearing circulating currents it is generally accepted to isolate one of the machine's bearings and to short circuit the shaft and frame in the other bearing. Usually an insulated bearing and a grounding brush are used for this function. Insulated bearings are expensive and are prone to wear which eventually requires replacement.

W22 motors have an insulated non-drive endshield bearing as standard for frames 315S/M and higher or as optional for frames 225S/M to 280S/M.

Efficiency and Reliability Tip:

Always follow WEG VFD guidelines for safer and longer operation. Go to **www.weg.net** and download our Technical Guide – Induction motors fed by PWM frequency converters for further information.

12. Drive endshield design promotes excellent heat dissipation via optimised fin positioning and greater bearing hub exposure.

The endshields are fundamental elements to the motor so that generated torque is transmitted to the load efficiently and reliably. The endshield design must also consider the dimensional characteristics of the mechanical interface surfaces and the heat dissipation.

In the W22 range the drive endshield is designed with the use of Finite Element Analysis software resulting in a stronger design and exposing the bearings to a larger heat dissipation area. Additionally the fins of the drive endshield are located at the point of highest heat concentration which results in the reduction of bearing temperatures.

Efficiency and Reliability Tip:

During maintenance procedures, always lubricate the bearings following the guidelines showing the type and amount of grease described on the motor nameplate. Excess or lack of grease can lead to a higher bearing temperature rise, reducing the expected bearing lifetime.

13. Extended lubrication intervals – less intervention leads to less maintenance costs.

The lubrication interval is a function of motor mounting (horizontal or vertical), rated speed, bearing size, type of grease and temperature rise.

In the W22 design, extended lubrication intervals are reached mainly due to the reduced bearing temperature rise. The lubrication intervals are up to 26% higher compared to the W21 design, which means less intervention for lubrication. As any intervention relies on personnel and equipment, the less the equipment requires maintenance, the less is the total cost of ownership.

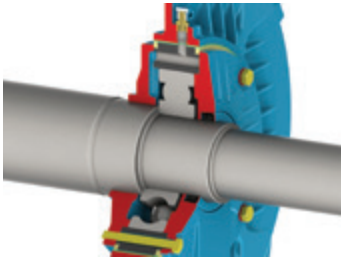
Efficiency and Reliability Tip:

As previously stated, respect the nameplate information when lubricating the motor. Do not mix grease types, even if they use the same elements. If another grease will be used in the application, contact WEG or a Distributor and enquire about lubrication intervals and the amount of grease.

14. Efficient lubrication system – grease inlet and outlet channels developed to improve the grease passages to and from the motor bearings.

After installation and running, AC induction motors do not require many interventions. Instead, periodical vibration checks are recommended to evaluate overall application conditions (for further information on vibration monitoring, see number 3) and to strictly follow bearing lubrication schedules. Lubrication plays an important role as it is the key maintenance point to guarantee safe and reliable operation.

In the W22 design the lubrication system received special attention in terms of the grease path in the endshield to the bearing, from the bearing to the outside of the motor and also the bearing caps.



Efficiency and Reliability Tip:

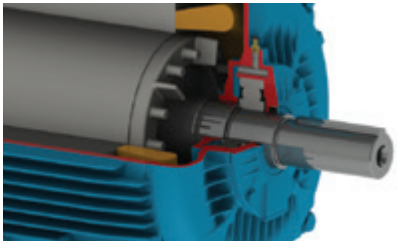
As an optional feature, a grease outlet pipe can be supplied to be fitted in the non-drive endshield. This pipe guides the grease out of the fan cover.
It is recommended to keep the fan cover interior clean.

15. WSeal® shaft sealing – higher protection against contaminants through a W-Ring (double lipped V-Ring) plus a metallic cap.

By precisely following the bearing maintenance schedule and guidelines for grease, and lubricating intervals, you will guarantee longer lifetime. This is essential if bearing contaminants, such as liquids and dusts, are to be avoided. Additionally the protection against external contaminants must be suitable for the environment where the motor is installed.

The W22 in frame sizes 225S/M to 355A/B introduces the most recent development in shaft sealing: the WSeal®. The WSeal® is composed of a double-lipped V-Ring, or W-Ring plus a metallic cap. The W-Ring receives grease and the metallic cap is fitted.
Among the other sealing systems available for W22 line, there is the W3Seal®, developed by WEG, which ensures the degree of protection IP66 to the motors.

Note: For flanged motors the sealing system may vary from WSeal®.



Efficiency and Reliability Tip:

Proper dimensioning of a product consists on defining not only the kW rating and speed, but also analysing the overall operational and environmental conditions in which the motor will be applied. This analysis should highlight conditions, accessories and requirements the motor must comply with. Not sure about the right motor for your application? Enquire at the nearest WEG office.

16. Earth terminals on both sides of the frame providing flexibility during installation.

The IEC 60034-1 Rotating electrical machines – Part 1: Rating and Performance defines that machines shall be provided with an earthing terminal or another device to permit the connection of a protective conductor or an earthing conductor.

In the W22 range, one earthing terminal is placed inside the terminal box, following the IEC 60034-1 recommendation, with a further second placed adjacently to the terminal box. For frames 225S/M to 355A/B, two additional earth terminals on each side of the frame are provided to equalize electrical potential and provide greater safety for operators. This exceeds the IEC 60034-1 requirements that define earthing terminals on the frame for outputs greater than 100 kW.

Efficiency and Reliability Tip:

When using the flexibility of a terminal box mounting position you can also rely on the earthing terminal position, flexibility to be in-line with the IEC standard that defines that, 'the earthing conductor shall be situated in the vicinity of the terminals for the line conductors'.

17. Drain plug: from an IP55 drain to an IP66 by changing drain position.

Industrial motors are usually fitted with drain holes and drain plugs to avoid condensation of water inside the motor. This is due to the fact that when the motor cools down it tends to suck external air into the machine. Depending on the ambient relative humidity, moisturised air may reach the interior area of frame. This moisture will eventually condense so the motor design should have means to allow this water to be drained out of the frame.

The W22 line motors are supplied with drain holes for draining the condensed water from inside the motor. The position of these drain holes ensures efficient condensed water draining from the motor enclosure. The drain holes are fitted with rubber plugs for frame sizes 160M to 355A/B, that allow continuous condensed water draining from the motor (drain plug at open position IP55) and depending on the motor application, the drain plug can be closed to ensure the degree of protection IP66 to the drain region (other parts of the motor will require different features to guarantee this degree of protection).

Efficiency and Reliability Tip:

Include in your checklist opening the drain plug during periodic maintenance to drain condensed water from the motor.

18. Frame range with extended outputs.

The DIN EN 50347 standard provides a table of ratings per frame size that manufacturers should comply with. However, it is limited to, for example, outputs up to 132 kW and frame sizes up to 315, which means that beyond this manufacturers are not limited to a standard but to individual market practices.

In the W22 range WEG is introducing two frames: 315L and 355A/B. With these frames, the standard output offerings were distributed to accommodate 315L, 355M/L and 355A/B. In the table (right) 2 and 4 pole limits (*) are shown:

Frame	3000 rpm	1500 rpm
315L	Up to 315 kW	Up to 315 kW
355M/L	Up to 355 kW	Up to 400 kW
355A/B	Up to 450 kW	Up to 500 kW

(*) This limit corresponds to TEFC standard range. Tailor-made motors can reach higher outputs.

Efficiency and Reliability Tip:

Please refer to W22 efficiency versions chapter to understand how to improve your overall process efficiency.

19. WISE® insulation system: better materials for VFD application.

The application of new technologies has become more and more widespread across all industry sectors resulting in many changes in how electric motors are applied and controlled. The use of VFD(*) is recognised to be one of the major driving forces for energy efficiency because it can adjust motor output to best suit load requirements.

However, voltage spikes from the PWM waveform can have harmful effects on the motor winding, leading to premature failure of the insulation system. This worsens as the switching frequency is increased.

W22 motors are fitted with WISE insulation (WEG Insulation System Evolution) which permits them to operate driven by VFD. The WISE® is a system composed of: class H insulation wire (200°C), enhanced insulation materials and a solvent-free resin.

(*) Variable Frequency Drives (also known as variable speed drives (VSDs) or frequency converters)

Efficiency and Reliability Tip:

Motors can operate driven by VFD without filters if the following conditions are respected				
Motor rated voltage	**Voltage peak on motor terminals (phase to phase)**	**dV/dt on motor terminals (phase to phase)**	**Rise time**	**Time between pulses**
Vn < 460 V	≤ 1600 V	≤ 5200 V/µs	≥ 0.1 µs	≥ 6 µs
460 V ≤ Vn < 575 V	≤ 2000 V	≤ 6500 V/ µs		
575 V ≤ Vn ≤ 1000 V	≤ 2400 V	≤ 7800 V/ µs		

1 – For the three cases above the maximum recommended switching frequency is limited to 5 kHz.

2 – If one of the above conditions is not followed accordingly (including the switching frequency), a filter must be installed on VFD outlet.

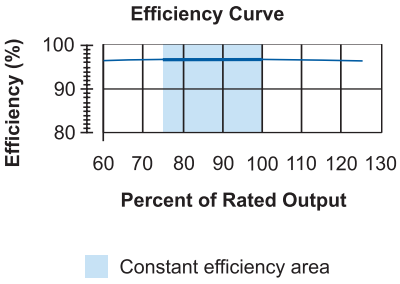
20. Flat efficiency curve: from 75% up to 100% of load the efficiency is kept constant for maximum energy saving.

The pressure for a great sustainability approach in all kinds of industries associated with soaring energy costs have put energy efficient products in the spotlight. Additionally it is widely acknowledged that VFD can eliminate a large amount of wasted energy due to its ability of adapting motor output to load requirements.

The W22 motors play an important role in energy saving with regards to partial loads because their design allows for constant efficiency from 75% up to nominal load.

Efficiency and Reliability Tip:

Although efficiency is kept constant from 75% up to 100% of load, the dimensioning must always aim at positioning the motor very close to the optimum performance point, i.e. the rated point. This will guarantee that other performance values, such as power factor, are maximised.



21. Standard, High, Premium and Super Premium Efficiency designs exceeding IE1, IE2, IE3 and IE4 levels defined by IEC 60034-30-1.

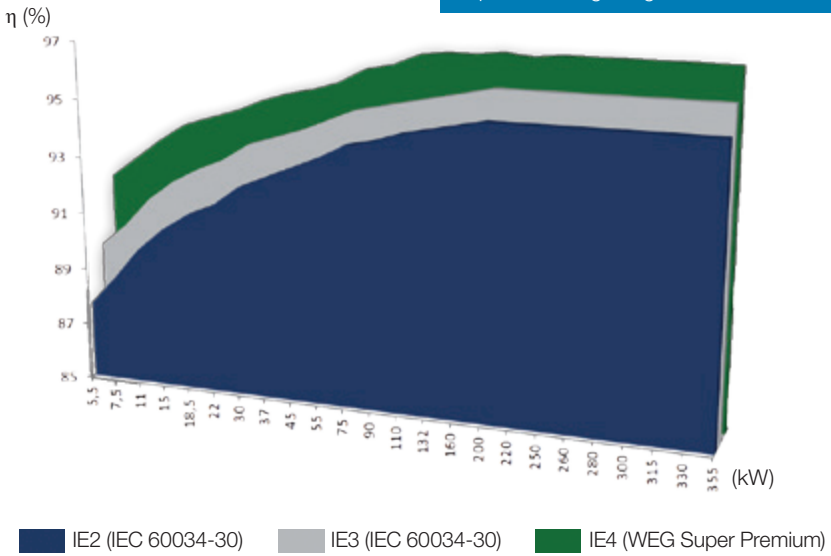
The IEC has published the new standard related to energy-efficiency: 60034-30-1. This standard proposes efficiency classes' harmonisation amongst different practices throughout the world.
It defines four minimum efficiency classes and identifies them using the IE code: Standard Efficiency (IE1), High Efficiency (IE2), Premium Efficiency (IE3) and Super Premium Efficiency (IE4). Standard Efficiency levels were taken from CEMEP* EFF2 levels in 50 Hz and from Brazilian figures in 60 Hz. High efficiency levels in 50 Hz were taken from CEMEP EFF1 levels and in 60 Hz they are identical to those from NEMA** EPAct. Premium Efficiency levels in 50 Hz were defined as having losses of about 15% to 20% lower compared to the limits of High Efficiency and in 60 Hz they are identical to the NEMA Premium figures. The Super Premium presents from 20% to 40% less losses in comparison to the conventional motors providing the world's highest efficiency levels available for an induction electric motor. The standard also defines that IEC 60034-2-1 must be used with regards to testing methods. The methods defined in this standard are recognised as being of lower uncertainty. Manufacturers must state in their documentation which method they use to determine the stray load losses, because they are not comparable if different methods are used. W22 motors are available in four versions, exceeding the minimum levels established by the IEC 60034-30-1. WEG is using the indirect method defined in IEC 60034-2-1 with stray load losses being determined from measurement.

*Commission on Environmental Markets and Economic Performance

**National Electrical Manufacturers Association

Efficiency and Reliability Tip:

The Directives EC 640/2009 and EU 4/2014 establish the IE3 or IE2+VFD for 7.5 to 375kW or IE2 for 0.75 to 5.5kW from 1st January 2015 as the Minimum Efficiency Performance Standards for electric motors in the European market. Please contact the nearest WEG office or distributor for further information on energy savings or visit our website http://www.weg.net/green/uk/index.html



Efficiency comparison to 4 poles 60 Hz motors

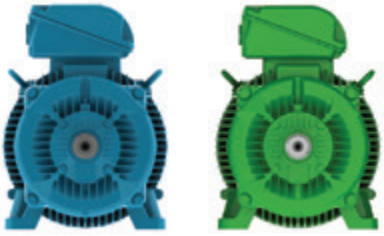
22. Super Premium Efficiency ratings in the same frame sizes as High Efficiency for complete interchangeability.

The Directives EC 640/2009 and EU 4/2014 also establish that Premium Efficiency (IE3) or IE2 + VFD will be required to the complete range 0.75 kW up to 375 kW as from 1st January 2017.

The W22 range is available in the four IEC 60034-30-1 efficiency levels respecting the kW ratio per frame defined in EN 50347 which means that you can replace an IE2 or even IE1 motor with a Premium (IE3) with total peace of mind.

Efficiency and Reliability Tip:

The W22 design is WEG's answer to the global demands for increased energy efficiency. It also encompasses many performance advantages in terms of noise and vibration levels, extended lubrication intervals and flexibility. Please contact the nearest WEG office our distributor and get access to the future.



WEG Worldwide Operations

ARGENTINA
San Francisco - Cordoba
Phone: +54 3564 421484
info-ar@weg.net

Cordoba - Cordoba
Phone: +54 351 4641366
weg-morbe@weg.com.ar

Buenos Aires
Phone: +54 11 42998000
ventas@pulverlux.com.ar

AUSTRALIA
Scoresby - Victoria
Phone: +61 3 97654600
info-au@weg.net

AUSTRIA
Markt Piesting - Wiener Neustadt-Land
Phone: +43 2633 4040
watt@wattdrive.com

BELGIUM
Nivelles - Belgium
Phone: +32 67 888420
info-be@weg.net

BRAZIL
Jaraguá do Sul - Santa Catarina
Phone: +55 47 32764000
info-br@weg.net

CHILE
La Reina - Santiago
Phone: +56 2 27848900
info-cl@weg.net

CHINA
Nantong - Jiangsu
Phone: +86 513 85989333
info-cn@weg.net

Changzhou – Jiangsu
Phone: +86 519 88067692
info-cn@weg.net

COLOMBIA
San Cayetano - Bogota
Phone: +57 1 4160166
info-co@weg.net

ECUADOR
El Batan - Quito
Phone: +593 2 5144339
ceccato@weg.net

FRANCE
Saint-Quentin-Fallavier - Isère
Phone: +33 4 74991135
info-fr@weg.net

GERMANY
Türnich - Kerpen
Phone: +49 2237 92910
info-de@weg.net

Balingen - Baden-Württemberg
Phone: +49 7433 90410
info@weg-antriebe.de

GHANA
Accra
Phone: +233 30 2766490
info@zestghana.com.gh

INDIA
Bangalore - Karnataka
Phone: +91 80 41282007
info-in@weg.net

Hosur - Tamil Nadu
Phone: +91 4344 301577
info-in@weg.net

ITALY
Cinisello Balsamo - Milano
Phone: +39 2 61293535
info-it@weg.net

JAPAN
Yokohama - Kanagawa
Phone: +81 45 5503030
info-jp@weg.net

MALAYSIA
Shah Alam - Selangor
Phone: +60 3 78591626
info@wattdrive.com.my

MEXICO
Huehuetoca - Mexico
Phone: +52 55 53214275
info-mx@weg.net

Tizayuca - Hidalgo
Phone: +52 77 97963790

NETHERLANDS
Oldenzaal - Overijssel
Phone: +31 541 571080
info-nl@weg.net

PERU
La Victoria - Lima
Phone: +51 1 2097600
info-pe@weg.net

PORTUGAL
Maia - Porto
Phone: +351 22 9477700
info-pt@weg.net

RUSSIA and CIS
Saint Petersburg
Phone: +7 812 363 2172
sales-wes@weg.net

SOUTH AFRICA
Johannesburg
Phone: +27 11 7236000
info@zest.co.za

SPAIN
Coslada - Madrid
Phone: +34 91 6553008
wegiberia@wegiberia.es

SINGAPORE
Singapore
Phone: +65 68589081
info-sg@weg.net

Singapore
Phone: +65 68622220
watteuro@watteuro.com.sg

SCANDINAVIA
Mölnlycke - Sweden
Phone: +46 31 888000
info-se@weg.net

UK
Redditch - Worcestershire
Phone: +44 1527 513800
info-uk@weg.net

UNITED ARAB EMIRATES
Jebel Ali - Dubai
Phone: +971 4 8130800
info-ae@weg.net

USA
Duluth - Georgia
Phone: +1 678 2492000
info-us@weg.net

Minneapolis - Minnesota
Phone: +1 612 3788000

VENEZUELA
Valencia - Carabobo
Phone: +58 241 8210582
info-ve@weg.net

For those countries where there is not a WEG own operation, find our local distributor at www.weg.net.

WEG Group - Energy Business Unit
Jaraguá do Sul - SC - Brazil
Phone: +55 (47) 3276-4000
energia@weg.net
www.weg.net

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