3653 en - 01.2005 / e

FLS

3-phase TEFV cage induction motors
Cast iron frame - 0.55 to 750 kW

Technical catalogue

3-phase TEFV induction motors
FLS cast iron
0.55 to 750 kW

The LEROY-SOMER range of 3-phase motors

Other LEROY-SOMER motor ranges

Single phase induction motor

3-phase induction motor
Aluminium alloy frame

VARMECA variable speed motor

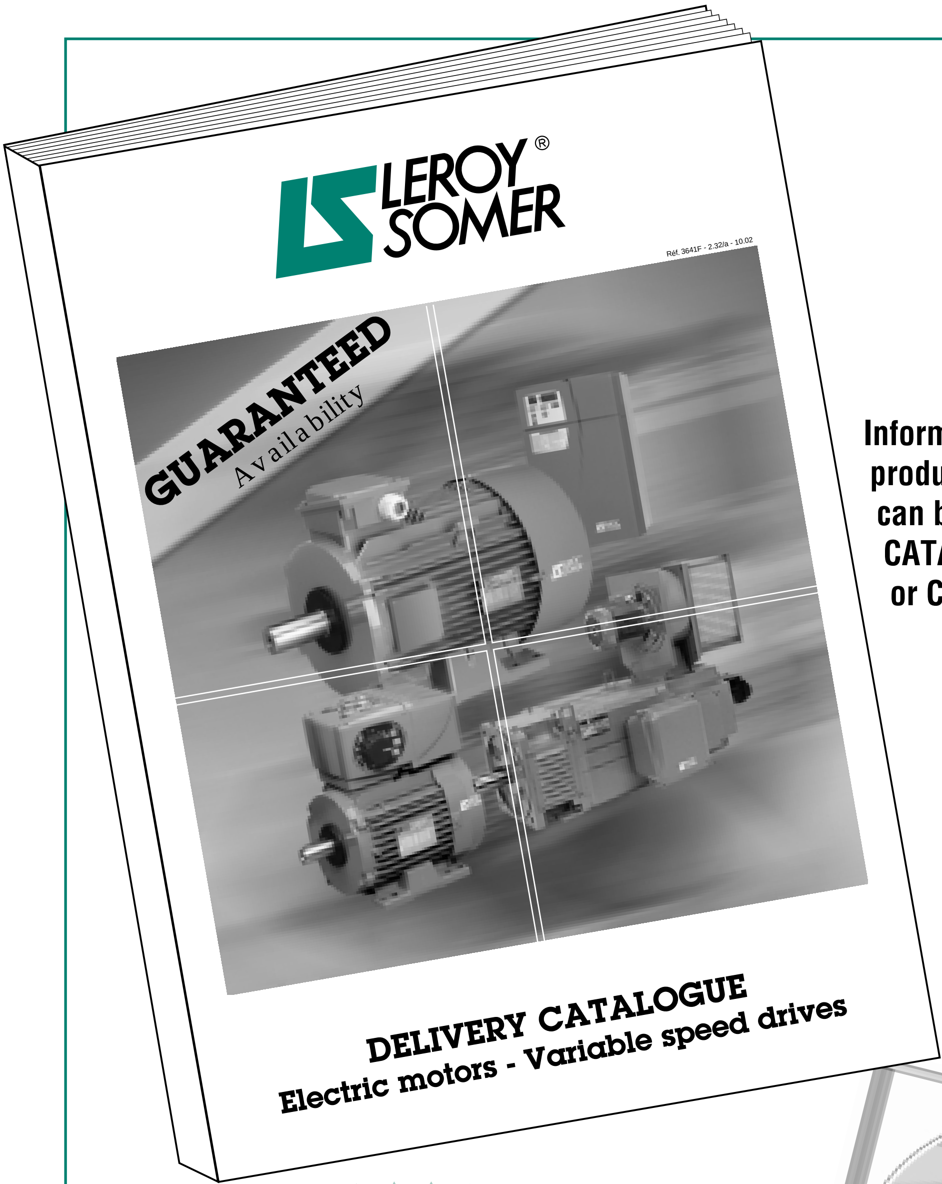
D.C. motor (drip-proof or enclosed)

Motor for variable speed drive systems

3-phase autosynchronous motor

DELIVERY
WITH GUARANTEED AVAILABILITY

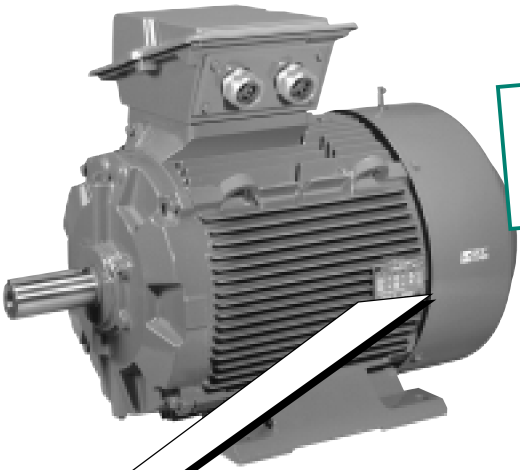
LEROY-SOMER offer their clients the opportunity to fix their own delivery dates, without prior consultation.



Information regarding products & availability can be found in CATALOGUE ref: 3641 or CD Rom ref: 3709

Guaranteed delivery dates thanks to unique, high performance logistics.

3-phase TEFV induction motors
FLS cast iron
0.55 to 750 kW



IP 55
Cl. F - ΔT 80 K
MULTI VOLTAGE

Use the **complete motor designation** as shown below when placing your **order**.

Simply go through the complete designation step by step.

4P 1500 min^{-1}	FLS	450	LA	500 kW	IM 1001 IM B3	230 / 400 V	50 Hz	IP 55
No. of poles Speed(s)	Range identification	Frame size IEC 72	Frame type	Rated power	Mounting arrangements IEC 34-7	Supply voltage	Mains frequency	Degree of Protection IEC 34-5
Sec. D5 Page 67	Page 3	Section D4	Section F Page 99	Section D4	Section C2 Page 27	Section D2 Page 58	Section D2 Page 58	Section B1 Page 18

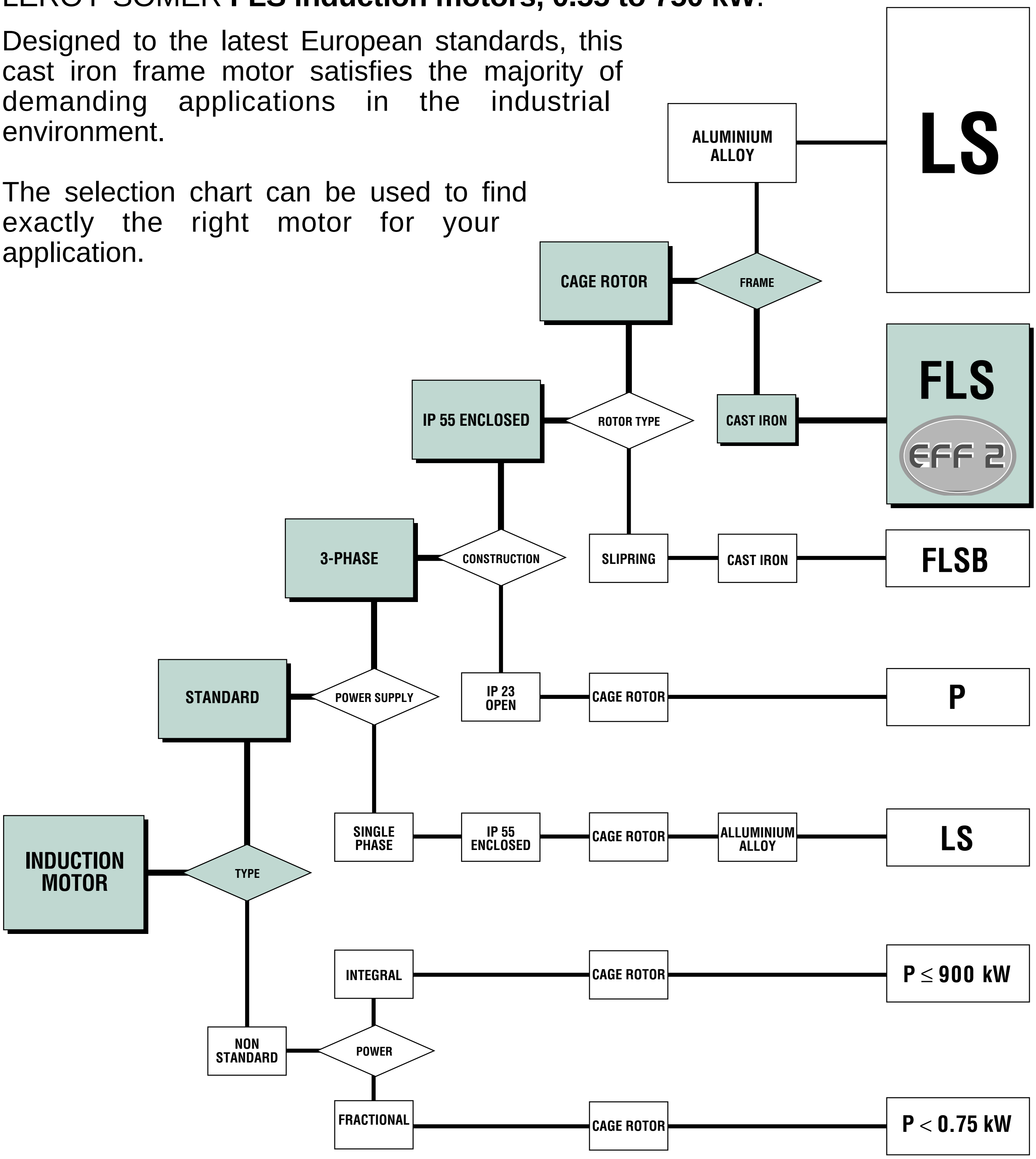
For **Direct selection,** see section : E
Page 87

3-phase TEFV induction motors
FLS cast iron
0.55 to 750 kW

This catalogue gives full information about
LEROY-SOMER **FLS induction motors, 0.55 to 750 kW**.

Designed to the latest European standards, this cast iron frame motor satisfies the majority of demanding applications in the industrial environment.

The selection chart can be used to find exactly the right motor for your application.



3-phase TEFV induction motors
FLS cast iron

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General information

A1 - Quality assurance

Industrial concerns are having to cope with an ever more competitive environment. Productivity depends to a considerable degree on the right investment at the right time.
LEROY-SOMER has the answer, building motors to precise standards of quality.

When carrying out quality checks on a machine's performance, the first step is to **measure the level of customer satisfaction.**

Careful study of this information tells us which points need looking at, improving and monitoring.

From the moment you place your order with our administrative staff until the motor is up and running (after design studies, launch and production activities) we keep you informed and involved.

Our own procedures are constantly under review. All our staff are involved in both operational process analysis and continuous training programmes. These initiatives help them serve you better, and increased skills bring increased motivation.

At LEROY-SOMER, we think it vital for our customers to know the importance we attach to quality.

LEROY-SOMER has entrusted the certification of its expertise to various international organizations.
Certification is granted by independent professional auditors, and recognises the high standards of the **company's quality assurance procedures.**
All activities resulting in the final version of the machine have therefore received official **ISO 9000** accreditation, **Edition 2000**. Products are also approved by official bodies who inspect their technical performance with regard to the various standards.
This is a fundamental requirement for a company of international standing.

A2 - Standards and approvals

A

ORGANIZATION OF STANDARDS AUTHORITIES

International bodies

	General Standardization	Electronics/Electrotechnical Standardization
Worldwide 	**ISO** International Standards Organization TC Technical committees / SC Sub-committees / WG Working groups	**IEC** International Electrotechnical Commission TC Technical committees / SC Sub-committees / WG Working groups
European 	**CEN** European Committee for Standardization **ECISS** European Committee for Iron and Steel Standards TC Technical committees	**CENELEC** European Committee for Electrotechnical Standardization TC Technical committees / SC Sub-committees / AHG Ad hoc groups

Country	Initials	Designation
AUSTRALIA	**SAA**	**S**tandards **A**ssociation of **A**ustralia
BELGIUM	**IBN**	**I**nstitut **B**elge de **N**ormalisation
CIS (ex-USSR)	**GOST**	**Go**sudarstvenne Komitet **St**andartov
DENMARK	**DS**	**D**ansk **S**tandardisieringsraad
FINLAND	**SFS**	**S**uomen **S**tandardisoimisliitto
FRANCE	**AFNOR including UTE**	**A**ssociation **F**rançaise de **N**ormalisation including: **U**nion **T**echnique de l'**É**lectricité
GERMANY	**DIN/VDE**	**V**erband **D**eutscher **E**lektrotechniker
GREAT BRITAIN	**BSI**	**B**ritish **S**tandards **I**nstitution
ITALY	**IEC**	**C**omitato **E**lecttrotechnico **I**taliano
JAPAN	**JIS**	**J**apanese **I**ndustrial **S**tandard
NETHERLANDS	**NNI**	**N**ederlands **N**ormalisatie - **I**nstituut
NORWAY	**NFS**	**N**orges **S**tandardisieringsforbund
SAUDI ARABIA	**SASO**	**S**audi **A**rabian **S**tandards **O**rganization
SPAIN	**UNE**	**U**na **N**orma **E**spañola
SWEDEN	**SIS**	**S**tandardisieringskommissionen **I** **S**verige
SWITZERLAND	**SEV or ASE**	**S**chweizerischer **E**lektrotechnischer **V**erein
UNITED STATES	**ANSI including NEMA**	**A**merican **N**ational **S**tandards **I**nstitute including: **N**ational **E**lectrical **Ma**nufacturers

A2 - Standards and approvals

Approvals

Certain countries recommend or insist on approval from national organizations.

Approved products must carry the recognized mark on their identification plates.

Country	Initials	Organization
USA	**UL**	Underwriters Laboratories
CANADA	**CSA**	Canadian Standards Association
etc.		

Approvals for LEROY-SOMER motors (versions derived from standard construction):

Country	Initials	Certification No.	Application
CANADA	**CSA**	LR 57 008	Standard adapted range (see section D2.2.3)
USA	**UL or ЯU**	E 68554 SA 6704 E 206450	Impregnation systems Stator/rotor assemblies for sealed units Complete motors up to 160 size
SAUDI ARABIA	**SASO**		Standard range
FRANCE	**LCIE** **INERIS**	Various nos.	Sealing, shocks, safety

For specific approved products, see the relevant documents.

International and national standard equivalents

International reference standards		National standards				
IEC	**Title** (summary)	**FRANCE**	**GERMANY**	**U.K.**	**ITALY**	**SWITZERLAND**
60034-1	Ratings and operating characteristics	NFEN 60034-1 NFC 51-120 NFC 51-200	DIN/VDE O530	BS 4999	CEI 2.3.VI.	SEV ASE 3009
60034-2	Determination of losses and efficiency	NFEN 60034-2	DIN/EN 60034-2	BS 4999-102		
60034-5	Classification of degrees of protection	NFEN 60034-5	DIN/EN 60034-5	BS EN 60034-5	UNEL B 1781	
60034-6	Cooling methods	NFEN 60034-6	DIN/EN 60034-6	BS EN 60034-6		
60034-7	Mounting arrangements and assembly layouts	NFEN 60034-7	DIN/EN 60034-7	BS EN 60034-7		
60034-8	Terminal markings and direction of rotation	NFC 51,118	DIN/VDE 0530 Teil 8	BS 4999-108		
60034-9	Noise limits	NFEN 60034-9	DIN/EN 60034-9	BS EN 60034-9		
60034-12	Starting characteristics for single-speed motors powered from the mains ≤ 660 V	NFEN 60034-12	DIN/EN 60034-12	BS EN 60034-12		SEV ASE 3009-12
60034-14	Mechanical vibration in machines of frame size > 56 mm	NFEN 60034-14	DIN/EN 60034-14	BS EN 60034-14		
60072-1	Dimensions and output powers for machines of between 56 and 400 frame and flanges of between 55 and 1080	NFC 51,104 NFC 51 105	DIN 748 (~) DIN 42672 DIN 42673 DIN 42631 DIN 42676 DIN 42677	BS 4999		
60085	Evaluation and thermal classification of electrical insulation	NFC 26206	DIN/EN 60085	BS 2757		SEV ASE 3584

Note: DIN 748 tolerances do not conform to IEC 60072-1.

A2 - Standards and approvals

FLS motors comply with the standards quoted in this catalogue

A

List of standards quoted in this document

Reference		Date	International standards
IEC 60034-1	EN 60034-1	1999	Electrical rotating machines: ratings and operating characteristics
IEC 60034-5	EN 60034-5	2000	Electrical rotating machines: classification of degrees of protection provided by casings of rotating machines.
IEC 60034-6	EN 60034-6	1993	Electrical rotating machines (except traction): cooling methods
IEC 60034-7	EN 60034-7	2000	Electrical rotating machines (except traction): symbols for mounting positions and assembly layouts
IEC 60034-8		2001	Electrical rotating machines: terminal markings and direction of rotation
IEC 60034-9	EN 60034-9	1997	Electrical rotating machines: noise limits
IEC 60034-12	EN 60034-12	1999	Starting characteristics for single-speed 3-phase cage induction motors for supply voltages less than or equal to 660V.
IEC 60034-14	EN 60034-14	1996	Electrical rotating machines: mechanical vibrations of certain machines with a frame size above or equal to 56 mm. Measurement, evaluation and limits of vibrational intensity.
IEC 60038		1999	IEC standard voltages
IEC 60072-1		1991	Dimensions and power series for electrical rotating machines: designation of casings between 56 and 400 and flanges between 55 and 1080.
IEC 60085		1984	Evaluation and thermal classification of electrical insulation.
IEC 60721-2-1		1987	Classification of natural environment conditions. Temperature and humidity.
IEC 60892		1987	Effects of an imbalance in the voltage system on the characteristics of three-phase squirrel-cage induction motors.
IEC 61000-2-10/11 and 2-2		1999	Electromagnetic compatibility (EMC): environment.
IEC guide 106		1989	Guidelines on the specification of environmental conditions for the determination of operating characteristics of equipment.
ISO 281		2000	Bearings - Basic dynamic loadings and nominal bearing life.
ISO 1680	EN 21680	1999	Acoustics - Test code for measuring airborne noise emitted by electrical rotating machines: a method for establishing an expert opinion for free field conditions over a reflective surface.
ISO 8821		1999	Mechanical vibration - Balancing. Conventions on shaft keys and related parts.
	EN 50102	1998	Degree of protection provided by the electrical housing against extreme mechanical impacts.

A3 - Tolerance on main performance parameters

Tolerances for electromechanical characteristics

IEC 60034-1 specifies standard tolerances for electromechanical characteristics.

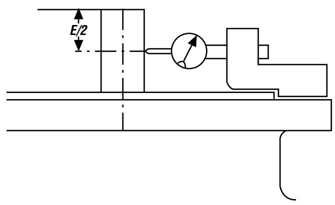
Parameters	Tolerances
Efficiency { machines P ≤ 50 kW machines P > 50 kW	**– 15 % (1 – η)** **– 10 % (1 – η)**
Cos φ	**– 1/6 (1 – cos φ)** **(min 0.02 - max 0.07)**
Slip { machines P < 1 kW machines P ≥ 1 kW	**± 30 %** **± 20 %**
Locked rotor torque	**–15%, + 25% of rated torque**
Starting current	**+ 20 %**
Run-up torque	**–15 % of rated torque**
Breakdown torque	**–10 % of rated torque** **> 1.5 M_N**
Moment of inertia	**± 10 %**
Noise	**+ 3 dB (A)**
Vibration	**+ 10% of the guaranteed class**

Note: IEC 60034-1 does not specify tolerances for current
- the tolerance is ± 10% in NEMA-MG1

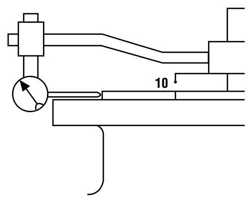
Tolerances and adjustments

The standard tolerances shown below are applicable to the drawing dimensions given in our catalogues. They comply fully with the requirements of IEC standard 60072-1.

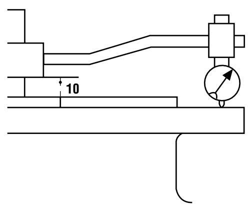
Characteristics	Tolerances
Frame size H ≤ 250 ≥ 280 Diameter ∅ of shaft extension: - 11 to 28 mm - 32 to 48 mm - 55 mm and over	**0, — 0.5 mm** **0, — 1 mm** **j6** **k6** **m6**
Diameter N of flange spigot	**j6 up to FF 500,** **js6 for FF 600 and over**
Key width	**h9**
Width of drive shaft keyway (normal keying)	**N9**
Key depth - square section - rectangular section	 **h9** **h11**
① ***Eccentricity of shaft in flanged motors*** (standard class) - diameter > 10 up to 18 mm - diameter > 18 up to 30 mm - diameter > 30 up to 50 mm - diameter > 50 up to 80 mm - diameter > 80 up to 120 mm	 **0.035 mm** **0.040 mm** **0.050 mm** **0.060 mm** **0.070 mm**
② ***Concentricity of spigot diameter*** and ③ ***perpendicularity of mating surface of flange in relation to shaft*** (standard class) Flange (FF) or Faceplate (FT): - F 55 to F 115 - F 130 to F 265 - FF 300 to FF 500 - FF 600 to FF 740 - FF 940 to FF 1080	 **0.08 mm** **0.10 mm** **0.125 mm** **0.16 mm** **0.20 mm**



① ***Eccentricity of shaft in flanged motors***



② ***Concentricity of spigot diameter***



③ ***Perpendicularity of mating surface of flange in relation to shaft***

A4 - Units of measurement and standard formulae

A

A4.1 - ELECTRICITY AND ELECTROMAGNETISM

Parameters				Unit		Units and expressions not recommended
Name	**French name**	**Symbol**	**Definition**	**SI**	**Non SI, but accepted**	**Conversion**
Frequency **Period**	Fréquence	f	$f = \frac{1}{T}$	Hz (hertz)		
Electric current	Courant électrique (intensité de)	I		A (ampere)		
Electric potential **Voltage** **Electromotive force**	Potentiel électrique Tension Force électromotrice	V U E		V (volt)		
Phase angle	Déphasage	φ	$U = Um \cos \omega t$ $i = im \cos (\omega t - \varphi)$	rad	° degree	
Power factor	Facteur de puissance	$\cos \varphi$				
Reactance **Resistance** **Impedance**	Réactance Résistance Impédance	X R Z	$Z = |Z| e^{j\varphi}$ $= R + jX$ $|Z| = \sqrt{R^2 + X^2}$ $X = L\omega - \frac{1}{C\omega}$	Ω (ohm)		j is defined as $j^2 = -1$ ω pulsation = 2 π . f
Self inductance	Inductance propre (self)	W	$L = \frac{\Phi}{I}$	H (henry)		
Capacitance	Capacité	C	$C = \frac{Q}{V}$	F (farad)		
Current load, **Quantity of electricity**	Quantité d'électricité	Q	$Q = \int Idt$	C (coulomb)	A.h 1 A.h = 3600 C	
Resistivity	Résistivité	ρ	$\rho = \frac{R \cdot S}{l}$	Ω.m		Ω/m
Conductance	Conductance	G	$G = \frac{1}{R}$	S (siemens)		1/ Ω = 1 S
Number of turns (coil) **Number of phases** **Number of pairs of poles**	Nombre de tours (spires) de l'enroulement Nombre de phases Nombre de paires de pôles	N m p				
Magnetic field	Champ magnétique	H		A/m		
Magnetic potential difference **Magnetomotive force**	Différence de potentiel magnétique Force magnétomotrice Solénation, courant totalisé	Um F, Fm H	$F = \oint H_s d_s$ $H = NI$	A		The unit AT (ampere-turns) is incorrect because it treats "turn" as a physical unit
Magnetic induction, **Magnetic flux density**	Induction magnétique, Densité de flux	B		T (tesla) = Wb/m²		(gauss) 1 G = 10^{-4} T
Magnetic flux,	Flux magnétique Flux d'induction	Φ	$\Phi = \iint_s Bn\, ds$	Wb (weber)		(maxwell) 1 max = 10^{-8} Wb
Magnetic vector potential	Potentiel vecteur	A		Wb/m		
Permeability **Permeability of vacuum**	Perméabilité du milieu Perméabilité du vide	$\mu = \mu_o \mu_r$ μ_o	$B = \mu H$ $\mu_o = 4\pi 10^{-7}$ H/m	H/m		
Permittivity	Permittivité	$\varepsilon = \varepsilon_o \varepsilon_r$	$\varepsilon_o = \frac{1}{36\pi 10^9}$ F/m	F/m		

LEROY SOMER

A4 - Units of measurement and standard formulae

A4.2 - THERMODYNAMICS

Parameters				Unit		Units and expressions not recommended
Name	**French name**	**Symbol**	**Definition**	**SI**	**Non SI, but accepted**	**Conversion**
Temperature Thermodynamic	Température Thermodynamique	T		K (kelvin)	temperature Celsius, t, °C $T = t + 273.15$	°C: Degree Celsius t_C: temp. in °C t_F: temp. in °F f temperature Fahrenheit °F $t = \frac{f-32}{1,8}$ $t_C = \frac{t_F-32}{1,8}$
Temperature rise	Ecart de température	ΔT		K	°C	1°C = 1 K
Thermal flux density	Densité de flux thermique	q, φ	$q = \frac{\Phi}{A}$	W/m²		
Thermal conductivity	Conductivité thermique	λ		W/m.K		
Total heat transmission coefficient	Coefficient de transmission thermique globale	K	$\varphi = K(Tr_2 - Tr_1)$	W/m².K		
Thermal capacity	Capacité thermique	C	$C = \frac{dQ}{dT}$	J/K		
Specific thermal capacity	Capacité thermique massique	c	$c = \frac{C}{m}$	J/kg.K		
Internal energy	Energie interne	U		J		

A4.3 - NOISE AND VIBRATION

Parameters				Unit		Units and expressions not recommended
Name	**French name**	**Symbol**	**Definition**	**SI**	**Non SI, but accepted**	**Conversion**
Sound power level	Niveau de puissance acoustique	L_W	$L_W = 10 \lg(P/P_O)$ ($P_O = 10^{-12}$ W)	dB (decibel)		lg logarithm to base 10 lg10 = 1
Sound pressure level	Niveau de pression acoustique	L_P	$L_P = 20 \lg(P/P_O)$ ($P_O = 2x10^{-5}$ Pa)	dB		

A4.4 - DIMENSIONS

Parameters				Unit		Units and expressions not recommended
Name	**French name**	**Symbol**	**Definition**	**SI**	**Non SI, but accepted**	**Conversion**
Angle (plane angle)	Angle (angle plan)	$\alpha, \beta, T, \varphi$		rad	degree: ° minute: ' second: "	180° = π rad = 3.14 rad
Length **Width** **Height** **Radius**	Longeur Largeur Hauteur Rayon Longueur curviligne	l b h r s		m (metres)	micrometre	cm, dm, dam, hm 1 inch = 1" = 25.4 mm 1 foot = 1' = 304.8 mm µm micron µ angström: A = 0.10 nm
Area	Aire, superficie	A, S		m²		1 square inch = 6.45 10^{-4} m²
Volume	Volume	V		m³	litre: l liter: W	UK gallon = 4.546 10^{-3} m³ US gallon = 3.785 10^{-3} m³

A4 - Units of measurement and standard formulae

A4.5 - MECHANICS AND MOVEMENT

Parameters				Unit		Units and expressions not recommended
Name	**French name**	**Symbol**	**Definition**	**SI**	**Non SI, but accepted**	**Conversion**
Time **Time interval / duration** **Period (duration of cycle)**	Temps Intervalle de temps/durée Période (durée d'un cycle)	t T		s (second)	minute: min hour: h day: d	Symbols ' and " are reserved for angles minute not written as mn
Angular velocity **Rotational frequency**	Vitesse angulaire Pulsation	ω	$\omega = \frac{d\varphi}{dt}$	rad/s		
Angular acceleration	Accélération angulaire	α	$\alpha = \frac{d\omega}{dt}$	rad/s^2		
Speed **Velocity**	Vitesse Célérité	$u, v, w,$ c	$v = \frac{ds}{dt}$	m/s	1 km/h = 0.277 778 m/s 1 m/min = 0.016 6 m/s	
Acceleration **Acceleration of free fall**	Accélération Accélération de la pesanteur	a $g = 9.81 m/s^2$	$a = \frac{dv}{dt}$ in Paris	m/s^2		
Speed of rotation	Vitesse de rotation	N		s^{-1}	min^{-1}	tr/mn, RPM, TM...
Weight	Masse	m		kg (kilogram)	tonne: t 1 t = 1000 kg	kilo, kgs, KG... 1 pound: 1 lb = 0.4536 kg
Mass density	Masse volumique	ρ	$\frac{dm}{dV}$	kg/m^3		
Linear density	Masse linéique	ρ_e	$\frac{dm}{dL}$	kg/m		
Surface density	Masse surfacique	ρ_A	$\frac{dm}{dS}$	kg/m^2		
Momentum	Quantité de mouvement	P	$p = m.v$	kg. m/s		
Moment of inertia	Moment d'inertie	J, I	$I = \sum m.r^2$	kg.m^2		$J = \frac{MD^2}{4}$ kg.m^2 pound per square foot = 1 lb.ft^2 = 42.1 x 10^{-3} kg.m^2
Force **Weight**	Force Poids	F G	$G = m.g$	N (newton)		kgf = kgp = 9.81 N pound force = lbF = 4.448 N
Moment of force **Torque**	Moment d'une force	M T	$M = F.r$	N.m		mdaN, mkg, m.N 1 mkg = 9.81 N.m 30.48 cm.lbF = 1.356 N.m 1 in.lbF = 0.113 N.m
Pressure	Pression	p	$p = \frac{F}{S} = \frac{F}{A}$	Pa (pascal)	bar 1 bar = 10^5 Pa	1 kgf/cm^2 = 0.981 bar 1 psi = 6894 N/m^2 = 6894 Pa 1 psi = 0.06894 bar 1 atm = 1.013 x 10^5 Pa
Normal stress **Shear stress,**	Contrainte normale Contrainte tangentielle Cission	σ τ		Pa Leroy-Somer use		kg/mm^2, 1 daN/mm^2 = 10 MPa psi = pound per square inch 1 psi = 6894 Pa
Friction coefficient	Facteur de frottement	μ				incorrectly = cœfficient friction f
Work **Energy** **Potential energy** **Kinetic energy** **Quantity of heat**	Travail Énergie Énergie potentielle Énergie cinétique Quantité de chaleur	W E Ep Ek Q	$W = F.l$	J (joule)	Wh = 3600 J (watt-hour)	1 N.m = 1 W.s = 1 J 1 kgm = 9.81 J (calorie) 1 cal = 4.18 J 1 Btu = 1055 J (British thermal unit)
Power	Puissance	P	$P = \frac{W}{t}$	W (watt)		1 ch = 736 W 1 HP = 746 W
Volumetric flow	Débit volumique	q_v	$q_v = \frac{dV}{dt}$	m^3/s		
Efficiency	Rendement	η		< 1		%
Dynamic viscosity	Viscosité dynamique	η, μ		Pa.s		poise, 1 P = 0.1 Pa.s
Kinematic viscosity	Viscosité cinématique	ν	$\nu = \frac{\eta}{\rho}$	m^2/s		stokes, 1 St = 10^{-4} m^2/s

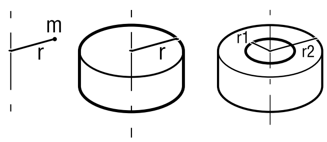
A5 - Unit conversions

Unit	MKSA (IS international system)	AGMA (US system)
Length	1 m = 3.2808 ft 1 mm = 0.03937 in	1 ft = 0.3048 m 1 in = 25.4 mm
Weight	1 kg = 2.2046 lb	1 lb = 0.4536 kg
Torque	1 Nm = 0.7376 lb.ft 1 N.m = 141.6 oz.in	1 lb.ft = 1.356 N.m 1 oz.in = 0.00706 N.m
Force	1 N = 0.2248 lb	1 lb = 4.448 N
Moment of inertia	1 kg.m^2 = 23.73 lb.ft^2	1 lb.ft^2 = 0.04214 kg.m^2
Power	1 kW = 1.341 HP	1 HP = 0.746 kW
Pressure	1 kPa = 0.14505 psi	1 psi = 6.894 kPa
Magnetic flux	1 T = 1 Wb / m^2 = 6.452 10^4 line / in^2	1 line / in^2 = 1.550 10^{-5} Wb / m^2
Magnetic losses	1 W / kg = 0.4536 W / lb	1 W / lb = 2.204 W / kg

Multiples and sub-multiples		
Factor by which the unit is multiplied	**Prefix to be placed before the unit name**	**Symbol to be placed before that of the unit**
10^{18} or 1,000,000,000,000,000,000	exa	E
10^{15} or 1,000,000,000,000,000	peta	P
10^{12} or 1,000,000,000,000	tera	T
10^{9} or 1,000,000,000	giga	G
10^{6} or 1,000,000	mega	M
10^{3} or 1,000	kilo	k
10^{2} or 100	hecto	h
10^{1} or 10	deca	da
10^{-1} or 0.1	deci	d
10^{-2} or 0.01	centi	c
10^{-3} or 0.001	milli	m
10^{-6} or 0.000,001	micro	µ
10^{-9} or 0.000,000,001	nano	n
10^{-12} or 0.000,000,000,001	pico	p
10^{-15} or 0.000,000,000,000,001	femto	f
10^{-18} or 0.000,000,000,000,000,001	atto	a

A6 - Standard formulae used in electrical engineering

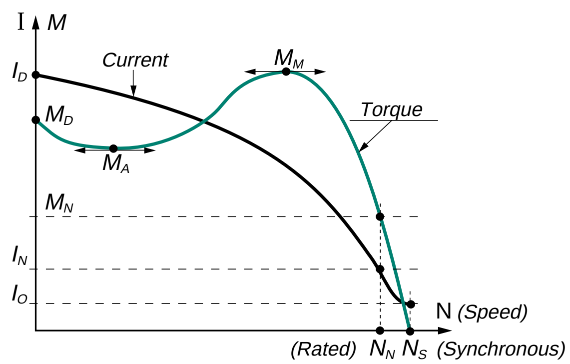
A6.1 - MECHANICAL FORMULAE

Title	Formula	Unit	Definitions / notes
Force Weight	$F = m \cdot \gamma$ $G = m \cdot g$	F in N m in kg γ in m/s^2 G in N m in kg g = 9.81 m/s^2	A force F is the product of a mass m by an acceleration γ
Torque	$M = F \cdot r$	M in N.m F in N r in m	The torque M of a force in relation to an axis is the product of that force multiplied by the distance r of the point of application of F in relation to the axis.
Power - Rotation - Linear	$P = M \cdot \omega$ $P = F \cdot V$	P in W M in N.m ω in rad/s P in W F in N V in m/s	Power P is the quantity of work yielded per unit of time $\omega = 2\pi N/60$ where N is the speed of rotation in min^{-1} V = linear velocity
Acceleration time	$t = J \cdot \frac{\omega}{M_a}$	t in s J in kg.m^2 ω in rad/s M_a in Nm	J is the moment of inertia of the system M_a is the moment of acceleration Note: all the calculations refer to a single rotational speed ω where the inertias at speed ω' are corrected to speed ω by the following calculation: $J_\omega = J_{\omega'} \cdot \left(\frac{\omega'}{\omega}\right)^2$
Moment of inertia Centre of gravity Solid cylinder around its shaft Hollow cylinder around its shaft	$J = m \cdot r^2$ $J = m \cdot \frac{r^2}{2}$ $J = m \cdot \frac{r_1^2 + r_2^2}{2}$	J in kg.m^2 m in kg r in m	
Inertia of a mass in linear motion	$J = m \cdot \left(\frac{v}{\omega}\right)^2$	J in kg.m^2 m in kg v in m/s ω in rad/s	The moment of inertia of a mass in linear motion transformed to a rotating motion.

A6 - Standard formulae used in electrical engineering

A6.2 - ELECTRICAL FORMULAE

Title	Formula	Unit	Definitions / notes
Accelerating torque	$M_a = \frac{M_D + 2M_A + 2M_M + M_N}{6} - M_r$ General formula: $M_a = \frac{1}{N_N}\int_0^{N_N}(M_{mot} - M_r)dN$	Nm	Moment of acceleration M_A is the difference between the motor torque M_{mot} (estimated), and the resistive torque M_r. N = instantaneous speed N_N = rated speed
Power required by the machine	$P = \frac{M \cdot \omega}{\eta_A}$	*P* in W *M* in N.m ω in rad/s η_A no unit	η_A expresses the efficiency of the driven machine. *M* is the torque required by the driven machine.
Power drawn by the 3-phase motor	$P = \sqrt{3} \cdot U \cdot I \cdot \cos\varphi$	*P* in W *U* in V *I* in A	φ phase angle by which the current lags or leads the voltage. *U* armature voltage. *I* current required by the driven machine.
Reactive power absorbed by the motor	$Q = \sqrt{3} \cdot U \cdot I \cdot \sin\varphi$	Q in VAR	
Reactive power supplied by a bank of capacitors	$Q = \sqrt{3} \cdot U^2 \cdot C \cdot \omega$	*U* in V *C* in µ F ω in rad/s	*U* = voltage at the capacitor terminals *C* = capacitor capacitance ω = rotational frequency of supply phases ($\omega = 2\pi f$)
Apparent power	$S = \sqrt{3} \cdot U \cdot I$ $S = \sqrt{P^2 + Q^2}$	S in VA	
Power supplied by 3-phase motor	$P = \sqrt{3} \cdot U \cdot I \cdot \cos\varphi \cdot \eta$		η expresses motor efficiency at the point of operation under consideration.
Slip	$g = \frac{N_S - N}{N_S}$		Slip is the difference between the actual motor speed *N* and the synchronous speed N_S
Synchronous speed	$N_S = \frac{120 \cdot f}{p}$	N_S in min^{-1} *f* in Hz	*p* = number of poles *f* = frequency of the power supply

Parameters	Symbol	Unit	Torque and current curve according to speed
Starting current Rated current No-load current	I_D I_N I_O	A	
Starting torque* Run up torque Breakdown torque Rated torque	M_D M_A M_M M_N	Nm	
Rated speed Synchronous speed	N_N N_S	min^{-1}	

* Torque is the usual term for expressing the moment of a force.

B

B1 - Definition of “Index of Protection” (IP/IK)

Indices of protection of electrical equipment enclosures
In accordance with IEC 60034-5 - EN 60034-5 (IP) - EN 50102 (IK)

FLS motors are IP 55 / IK 08 as standard

First number : protection against solid objects

IP	Tests	Definition
0		No protection
1	∅ 50 mm	Protected against solid objects over 50 mm (eg : accidental hand contact)
2	∅ 12 mm	Protected against solid objects over 12 mm (eg : finger)
3	∅ 2.5 mm	Protected against solid objects over 2.5 mm (eg : tools, wire)
4	∅ 1 mm	Protected against solid objects of over 1 mm (eg : small tools, thin wire)
5		Protected against dust (no deposits of harmful material)
6		Totally protected against dust

Second number : protection against liquids

IP	Tests	Definition
0		No protection
1		Protected against vertically dripping water (condensation)
2	15°	Protected against water dripping up to 15° from the vertical
3	60°	Protected against rain falling at up to 60° from the vertical
4		Protected against water splashes from all directions
5		Protected against jets of water from all directions
6		Protected against jets of water comparable to heavy seas
7	0.15 m, 1 m	Protected against the effects of immersion to depths of between 0.15 and 1 m
8 . . m	..m	Protected against the effects of prolonged immersion under pressure

Third number: mechanical protection

IK	Tests	Definition
00		No protection
01	150 g, 10 cm	Impact energy : 0.15 J
02	200 g, 10 cm	Impact energy : 0.20 J
03	250 g, 15 cm	Impact energy : 0.37 J
04	250 g, 20 cm	Impact energy : 0.50 J
05	350 g, 20 cm	Impact energy : 0.70 J
06	250 g, 40 cm	Impact energy : 1 J
07	0.5 kg, 40 cm	Impact energy : 2 J
08	1.25 kg, 40 cm	Impact energy : 5 J
09	2.5 kg, 40 cm	Impact energy : 10 J
10	5 kg, 40 cm	Impact energy : 20 J

Example:

IP 55 machine

IP : Index of protection

5. : Machine protected against dust and accidental contact.
Test result: ***no dust enters*** *in harmful quantities, no risk of direct contact with rotating parts.* The test will last for 2 hours.

.5 : Machine protected against jets of water from all directions from hoses at 3 m distance with a flow rate of 12.5 l/min at 0.3 bar.
The test will last for 3 minutes. *Test result:* ***no damage from water*** *projected onto the machine*.

3-phase TEFV induction motors
FLS cast iron
Environment

B2 - Environmental limitations

B2.1 - NORMAL OPERATING CONDITIONS

a / According to IEC 60034-1, motors can operate in the following normal conditions:

• ambient temperature within the range -16 and +40°C

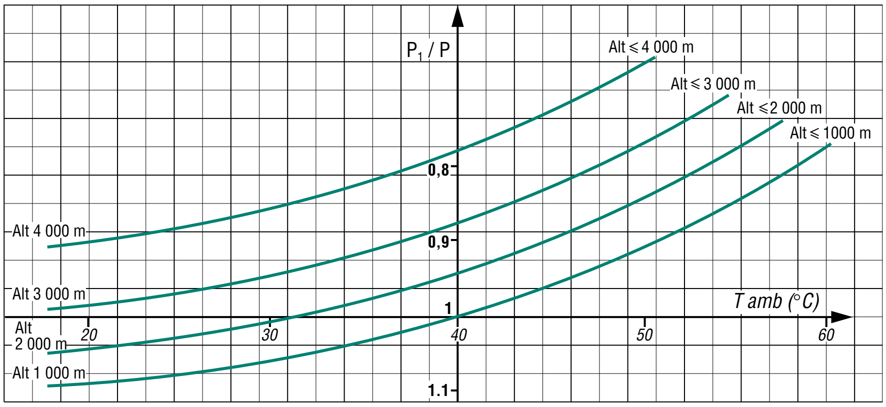
• altitude less than 1000 m

• atmospheric pressure: 1050 hPa (mbar)

b / Power correction factor:

For operating conditions outside these limits, apply the power correction coefficient shown in the chart on the right ***which maintains the thermal reserve***, as a function of the altitude and ambient temperature.

▼ ***Correction coefficient table***



Note: the output power can only be corrected upwards once the ability of the motor to start the load has been checked.

B2.2 - HARSH ENVIRONMENT

The construction of FLS cast iron motors is particularly recommended for applications in harsh operating conditions (impact, vibration) such as the iron and steel, cement, paper or sugar industries, etc.

Also, for operation in high or low temperatures, the choice of materials for the enclosure (adjacent expansion coefficients and high thermal inertia) makes the cast iron motor the best choice for this type of duty.

Cast iron motor required	Cast iron or aluminium motor*	Cast iron motor required
	-40°C	+100°C

** in this temperature zone, the choice of cast iron or aluminium motor depends on other requirements.*

The construction of FLSC cast iron motors with CORROBLOC anti-corrosion finish is required when the environmental conditions are humid, corrosive or harsh, for example polluted with:

- halogen products (chlorine, fluoride, etc)
- alkaline, sulphurous products
- alcohol
- anhydrides
- hydraulic or vegetable oils
- mercury

The essential criteria for anti-corrosion protection include stainless steel components, protection of active parts (stator and rotor), and special finishes.

B2 - Environmental limitations

B2.3 - RELATIVE AND ABSOLUTE HUMIDITY

Measuring the humidity

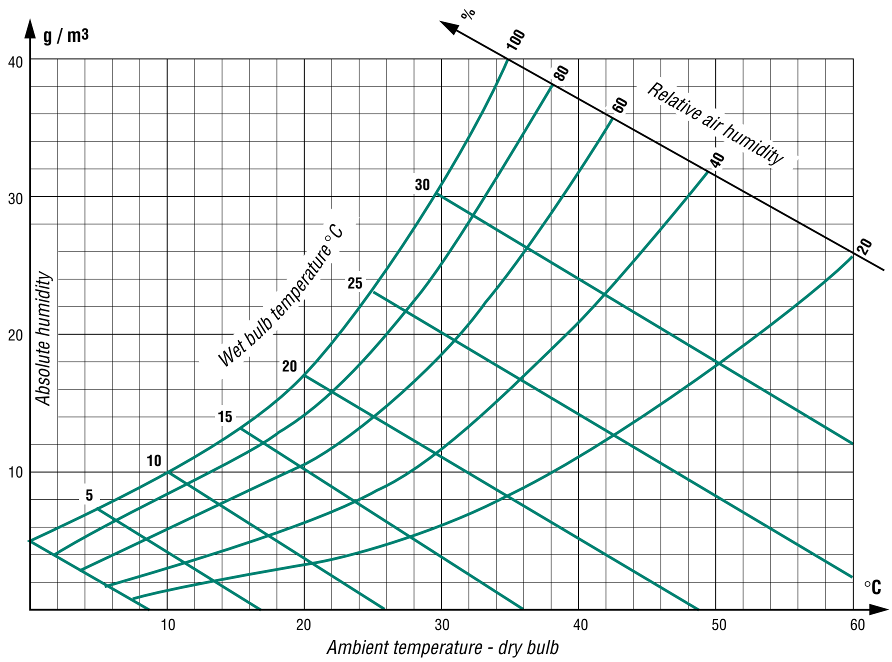
Humidity is usually measured by the "wet and dry bulb thermometer" method.

Absolute humidity, calculated from the readings taken on the two thermometers, can be determined using the chart on the right. The chart also provides relative humidity figures.

To determine the humidity correctly, a good air flow is required for stable readings, and accurate readings must be taken on the thermometers.

During the construction of cast iron motors, the materials of the various components which are in contact with one another are selected so as to minimise deterioration by galvanic effect. The voltages in the metal combinations used (cast iron-steel; cast iron-aluminium; steel-aluminium; steel-tin) are too low to cause deterioration. Only the brass cable gland in contact with the cast iron could cause problems, so it is fitted (when necessary) with an elastomer seal to reduce the risk.

In temperate climates, relative humidity is generally between 60 and 90%. For the relationship between relative humidity and motor impregnation, especially where humidity and temperature are high, see table on next page. ▼



B2.4 - DRAIN HOLES

Drain holes (M6 up to and including frame size 250, M8 thereafter) are provided at the lowest points of the enclosure, depending on the operating position (IM etc), to drain off any moisture that may have accumulated inside during cooling of the machine.

These holes are sealed with plugs which must be removed and then refitted from time to time.

Different types of plug: screw, siphon, breather, plastic plug.

For certain applications in particular, it is advisable to leave the drain holes open at the expense of the IP… index of protection.

B2.5 - DRIP COVERS

For machines operating outdoors, with the drive shaft downwards, drip covers are recommended.

This is an option and should be specified on the order if required.

(dimensions: section G3)

B3 - Impregnation and enhanced protection

B3.1 - NORMAL ATMOSPHERIC PRESSURE (750 mm HG)

The selection table below can be used to find the method of manufacture best suited to particular environments in which temperature and relative humidity show large degrees of variation (see relative and absolute humidity calculation method, on preceding page).

The symbols used refer to permutations of components, materials, impregnation methods and finishes (varnish or paint).

The protection of the winding is generally described by the term "tropicalization".

For high humidity environments, we recommend that the windings are pre-heated (see section B4.1).

Ambient termperature	Relative humidity FLS and FLSC RH ≤ 95%	Relative humidity FLSC RH > 95%*	Influence on manufacture
T < - 40°C	ask for estimate (quotation)	ask for estimate (quotation)	Power derating
-40 to +40°C	TR1	TC1	
-16 to +65°C	TR2**	TC2**	
T > 65	ask for estimate (quotation)	ask for estimate (quotation)	
Plate mark	**TR**	**TC**	
Influence on manufacture	Increased protection of windings		

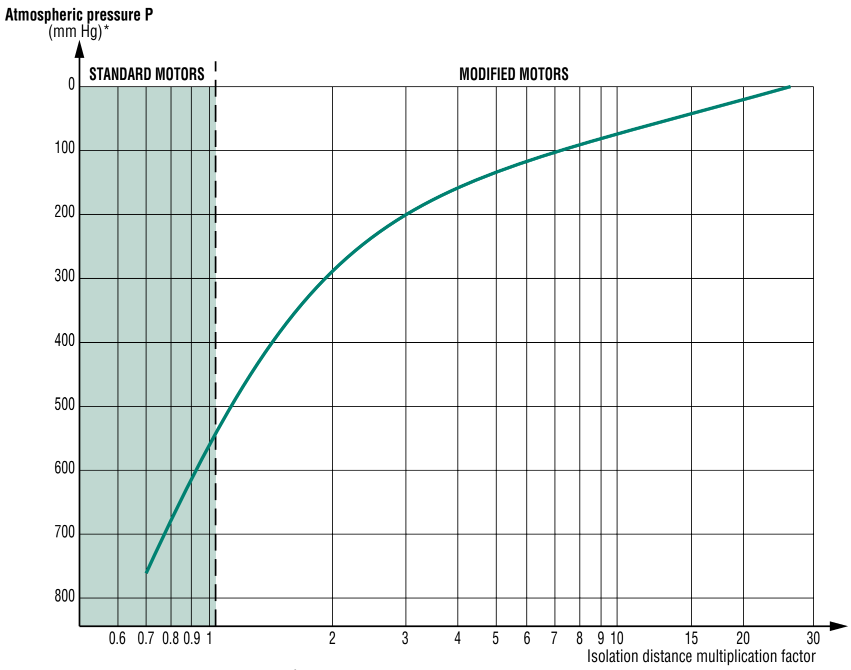
* *Non-condensing*
** *Caution, motor derating may be required (please consult Leroy-Somer).*

Standard impregnation

B3.2 - INFLUENCE OF ATMOSPHERIC PRESSURE

As atmospheric pressure decreases, air particles rarefy and the environment becomes increasingly conductive.

The curve below shows the increase in isolation distance required, according to atmospheric pressure.



* 1 mm Hg = 1.333 mbar = 1.333 x 10^2 Pa

Solutions for permanent applications: offers based on specification

- P > 550 mm Hg: Standard impregnation according to previous table - Possible derating or forced ventilation.
- P > 200 mm Hg: Coating of bearings - Flying leads up to a zone at P ~ 750 mm Hg - Derating to take account of insufficient ventilation - Forced ventilation.
- P < 200 mm Hg: Special manufacture based on specification.

In all cases, these problems should be resolved by a special contract worked out on the basis of a specification.

B4 - Heaters

B4.1 - SPACE HEATERS

Severe climatic conditions, e.g. *T* amb < - 40°C, RH > 95% etc, may require the use of space heaters (fitted to the motor windings) which serve to maintain the average temperature of the motor, provide trouble-free starting, and eliminate problems caused by condensation (loss of insulation).

The heater supply wires are brought out to a terminal block in the motor terminal box. The heaters must be switched off while the motor is running.

Motor type	No. of poles	Power: P(W)
FLS 80	2 - 4 - 6 - 8	10
FLS 90 to FLS 132	2 - 4 - 6 - 8	25
FLS 160 to FLS 200	2 - 4 - 6 - 8	50
FLS 225 and FLS 250	2 - 4 - 6 - 8	100
FLS 280 and FLS 315	2 - 4 - 6 - 8	100*
FLS 355 to FLS 450	2 - 4 - 6 - 8	150*

The space heaters use 200/240V, single-phase, 50 or 60 Hz.

* It is possible to increase the power when asking for estimate (quotation).

B4.2 - D.C. INJECTION

An alternative to the use of space heaters is to inject direct current into two of the phases wired in series from a D.C. voltage source which can give the total power indicated in the table above. This method can only be used on motors of less than 10 kW.

This is easily calculated: if R is the resistance of the windings in series, the D.C. voltage will be given by the equation (Ohm's law):

$$U_{(V)} = \sqrt{P_{(W)} \cdot R_{(\Omega)}}$$

Resistance should be measured with a micro-ohmmeter.

B4.3 - A.C. INJECTION

A single-phase A.C. voltage (from 10 to 15% of rated voltage), can be used between 2 phases placed in series.

This method can be used on the whole FLS range.

B5 - External finish

LEROY-SOMER motors are protected with a range of surface finishes.

The surfaces receive appropriate special treatments, as shown below.

Standard FLSC motors conform to System IIIa

B

Preparation of surfaces

SURFACE	PARTS	TREATMENT
Cast iron	All cast iron elements (internal and external) (end shields, housing, terminal box, etc)	- SA 2.5 shot blasting - Application of primer (25 to 30 µm) or a coat of polyvinyl butyral 20 µm or epoxy ester
Steel	Terminal box accessories	Phosphatization + Primer
	Covers	Electrostatic painting or Epoxy powder

Definition of atmospheres

An atmosphere is said to be harsh when components are attacked by bases, acids or salts. It is said to be corrosive when components are attacked by oxygen.

Painting systems

PRODUCTS	ATMOSPHERE	SYSTEM	APPLICATIONS	RESISTANCE TO SALINE MIST standard NFX 41002
LEROY-SOMER motors	Moderately harsh, humid, accidental alkaline or acidic splashes	IIa	1 base coat (surface treatment) 1 coat polyurethane 25/40 µm	**250 hours**
	Coastal Corrosive	IIIa	1 base coat (surface treatment) 1 base coat Epoxy before assembly on inside and outside of flanges, cast iron housings and terminal boxes 30/40 µm 1 coat polyurethane finish 25/40 µm	**350 hours**
	Special conditions Very harsh, polluted with chlorinated or sulphurous products	IVb	1 base coat (surface treatment) 1 base coat Epoxy 35/40 µm 1 intermediate coat Epoxy 35/40 µm 1 coat Epoxy finish 35/40 µm	**500 hours**

Exposure to saline mist conforming to standard NFX 41 002 (5% of NaCl at 6 < PH < 7.5 at 35° and 1 bar).

For very specific atmospheres, special or adapted systems are available. Please consult Leroy-Somer.

LEROY-SOMER standard paint colour reference:

RAL 6000

B6 - Interference suppression

Airborne interference

Emission

For standard motors, the housing acts as an electromagnetic screening, reducing electromagnetic emissions measured at 0.25 metres from the motor to approximately 5 gauss (5×10^{-4} T).

However, electromagnetic emissions may be noticeably reduced by a special construction of aluminium alloy end shields and a stainless steel shaft.

Immunity

The construction of motor housings (especially finned aluminium alloy frames) isolates external electromagnetic sources to the extent that any field penetrating the casing and magnetic circuit will be too weak to interfere with the operation of the motor.

Power supply interference

The use of electronic systems for starting, speed control or power supply can create harmonics on the supply lines which may interfere with the operation of machines. These phenomena are taken into account in determining the machine dimensions, which act as quenching chokes in this respect.

The IEC 61000 standard, currently in preparation, will define permissible rejection and immunity rates: only then will machines for general distribution (especially single-phase motors and commutator motors) have to be fitted with suppression systems.

Three-phase squirrel cage machines do not in themselves produce interference of this type. Mains connection equipment (contactors) may, however, need interference protection.

Application of Directive 89-336 modified by Directives 92-31 and 93-68 concerning electromagnetic compatibility (EMC).

a - for motors only

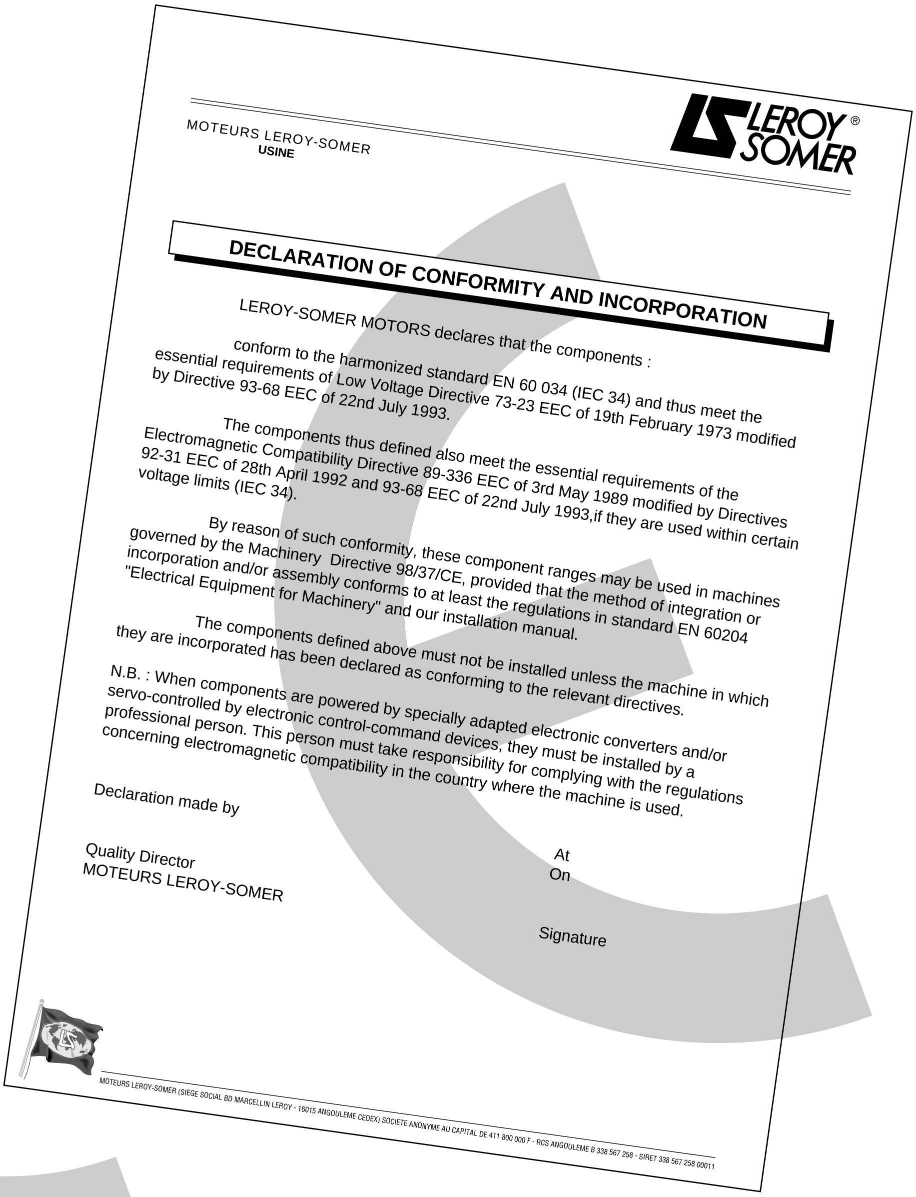
According to amendment 1 of IEC 60034-1, induction motors are not transmitters and do not produce interference (via carried or airborne signals) and therefore conform inherently to the essential requirements of the EMC directives.

b - for motors supplied by inverters (at fixed or variable frequency)

In this case, the motor is only a sub-assembly of a device which the system builder must ensure conforms to the essential requirements of the EMC directives.

Application of the Low Voltage Directive 73-23 EEC modified by Directive 93/68

All motors have been subject to this directive since 1 July 1997. The main requirements concern the protection of people, animals and property against risks caused by operation of the motors (see the commissioning and maintenance manual for precautions to be taken).


MOTEURS LEROY-SOMER
USINE

DECLARATION OF CONFORMITY AND INCORPORATION

LEROY-SOMER MOTORS declares that the components :

conform to the harmonized standard EN 60 034 (IEC 34) and thus meet the essential requirements of Low Voltage Directive 73-23 EEC of 19th February 1973 modified by Directive 93-68 EEC of 22nd July 1993.

The components thus defined also meet the essential requirements of the Electromagnetic Compatibility Directive 89-336 EEC of 3rd May 1989 modified by Directives 92-31 EEC of 28th April 1992 and 93-68 EEC of 22nd July 1993,if they are used within certain voltage limits (IEC 34).

By reason of such conformity, these component ranges may be used in machines governed by the Machinery Directive 98/37/CE, provided that the method of integration or incorporation and/or assembly conforms to at least the regulations in standard EN 60204 "Electrical Equipment for Machinery" and our installation manual.

The components defined above must not be installed unless the machine in which they are incorporated has been declared as conforming to the relevant directives.

N.B. : When components are powered by specially adapted electronic converters and/or servo-controlled by electronic control-command devices, they must be installed by a professional person. This person must take responsibility for complying with the regulations concerning electromagnetic compatibility in the country where the machine is used.

Declaration made by

Quality Director
MOTEURS LEROY-SOMER

At
On

Signature

MOTEURS LEROY-SOMER (SIEGE SOCIAL BD MARCELLIN LEROY - 16015 ANGOULEME CEDEX) SOCIETE ANONYME AU CAPITAL DE 411 800 000 F - RCS ANGOULEME B 338 567 258 - SIRET 338 567 258 00011

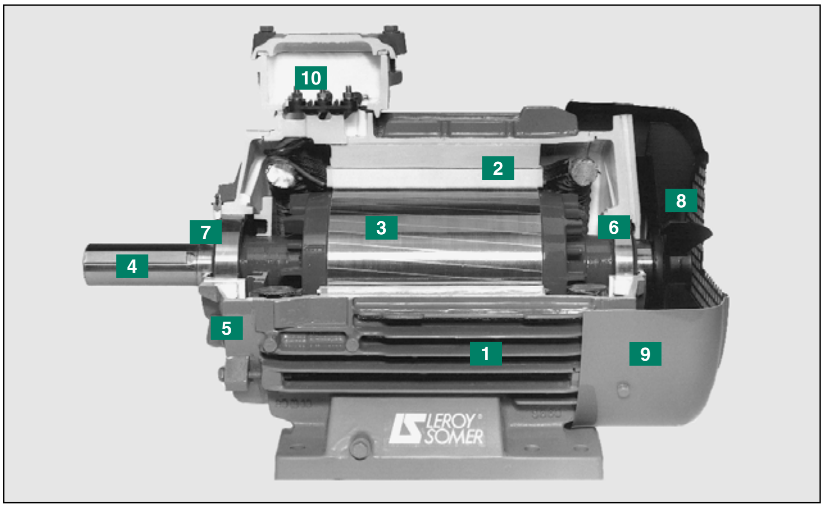
CE product marking

The fact that motors conform to the essential requirements of the Directives is shown by the CE mark on their nameplates and/or packaging and documentation.

C1 - Components

C1.1 - DESCRIPTION OF STANDARD FLS CAST IRON MOTORS

Component	Materials	Remarks
1 Finned housing	Cast iron	- with integral feet, or without feet • 4, 6 or 8 fixing holes for foot-mounted housings • lifting rings for frame size ≥ 100 - earth terminal on foot or fin or terminal box base
2 Stator	Insulated low-carbon magnetic steel laminations Insulated electroplated copper	- low carbon content guarantees long-term lamination pack stability - welded packs - semi-enclosed slots - class F insulation
3 Rotor	Insulated low-carbon magnetic steel laminations carbon Aluminium (A5L) or copper	- inclined cage bars - rotor cage pressure die-cast in aluminium (or alloy for special applications) or soldered in copper - shrink-fitted to shaft, or keyed for soldered rotors - rotor balanced dynamically, class N, 1/2 key
4 Shaft	Steel	- for frame size ≤ 132: • shaft end fitted with screw and washer • closed keyway - for frame size ≥ 160: • tapped hole • open keyway
5 End shields	Cast iron	
6 Bearings and lubrication		- ball bearings C3 play - type ZZ "greased for life" up to frame size 132 - semi-protected or open type from frame size 160 upwards, regreasable - bearings preloaded at NDE up to 315 S, preloaded at DE from size 315 M upwards
7 Labyrinth seal Lipseals	Plastic or steel Synthetic rubber	- labyrinth seal at drive end for foot-mounted motors, frame size ≤ 132 - seal at drive end for foot and flange or flange-mounted motors, frame size ≤ 132 - lipseal at drive end and non drive end for frame sizes 160 to 225 MT inclusive - labyrinth seal at drive end and non drive end for frame sizes ≥ 315 M/L and ≥ 355 - decompression grooves for 225M to 280M
8 Fan	Composite material up to and including size 280. Metal from 315 ST upwards.	- 2 directions of rotation: straight blades
9 Fan cover	Pressed steel	- fitted, on request, with a drip cover for operation in vertical position, shaft end facing down.
10 Terminal box	Cast iron body for all frame sizes. Sheet steel cover from size 80 to 132. Cast iron cover for larger sizes.	- IP 55 - fitted with a terminal block with 6 terminals up to 355 LD, 12 terminals thereafter - ISO plastic up to 225 MT, terminal box fitted with cable gland. - sizes 225 M to 450, cable gland baseplate without drilled holes (optional horn or cable gland). - 1 earth terminal in each terminal box



C1 - Components

C1.2 - DESCRIPTION OF THE FLSC CORROBLOC FINISH

The CORROBLOC finish is a top coat for the FLS cast iron motor described in C2.1. In addition to the basic cast iron motor construction, its special finishes resist corrosion in particularly harsh environments, and these qualities are enhanced with age.

Component	Materials	Remarks
2 Stator 3 Rotor		- dielectric and anti-corrosion protection of the stator (coil end turns) and rotor
Nameplate	Stainless steel	- nameplate: indelible marking
Screws	Stainless steel	- captive screws for terminal box lid (frame size ≤ 132)
Terminal box	Body and cover in cast iron	
Cable gland	Brass	
External finish		- system IIIa as defined on page 23

C1.3 - EXTENSION TO THE FLSC CORROBLOC RANGE

Applications:

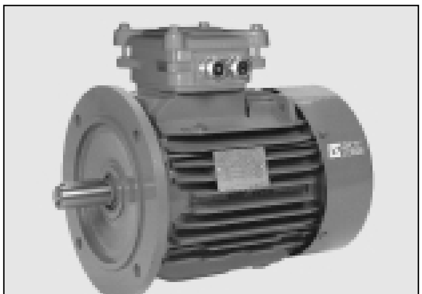
- IP 55 enhanced dust and damp protection for motors subjected to water spray
- IP 56 dust and damp protection, non-ventilated, for marine applications with intermittent duty
- 500 hours resistance to saline mist
- stainless steel

3-phase TEFV induction motors
FLS cast iron
Construction

C2 - Mounting arrangements


IM 1001 (IM B3)


IM 2101 (IM B34)


IM 3001 (IM B5)


IM 3601 (IM B14)


IM 2001 (IM B35)


IM 3011 (IM V1)

The various mounting arrangements for machines are defined in IEC 60034-7. Below is an extract from the standard which shows equivalent terms in current use.

Code I	Code II
IM B 3	IM 1001
IM V 5	IM 1011
IM V 6	IM 1031
IM B 6	IM 1051
IM B 7	IM 1061
IM B 8	IM 1071
IM B 20	IM 1101
IM B 15	IM 1201
IM B 35	IM 2001
IM V 15	IM 2011
IM V 36	IM 2031
IM B 34	IM 2101
IM B 5	IM 3001
IM V 1	IM 3011
IM V 21	IM 3051
IM V 3	IM 3031
IM V 4	IM 3211
IM V 2	IM 3231
IM B 14	IM 3601
IM V 18	IM 3611
IM V 19	IM 3631
IM B 10	IM 4001
IM V 10	IM 4011
IM V 14	IM 4031
IM V 16	IM 4131
IM B 9	IM 9101
IM V 8	IM 9111
IM V 9	IM 9131
IM B 30	IM 9201
IM V 30	IM 9211
IM V 31	IM 9231

Codes I and II are interchangeable. It should however be noted that the above code list is not exhaustive and you should therefore refer to IEC 60034-7 for other designations. On the next page you will find the most common mounting arrangements with line drawings and an explanation of the standard symbols used.

Mounting options according to frame size
Some operating positions are prohibited for standard motors.
Select the possible configurations for machine installation from the table below.
In the case of difficulty, please consult Leroy-Somer.

Frame size	Mounting positions											
	IM 1001	IM 1051	IM 1061	IM 1071	IM 1011*	IM 1031	IM 3001	IM 3011*	IM 3031	IM 2001	IM 2011*	IM 2031
80 to 200	●	●	●	●	●	●	●	●	●	●	●	●
225 and 250	●	●	●	●	●	●	❍	●	●	●	●	●
280 and 315	●	❍	❍	❍	❍	❍	❍	●	●	●	●	❍
355 to 450	●	❍	❍	❍	❍	❍	❑	●	❍	●	●	❍

● : possible positions ❑ : positions not available
❍ : please consult Leroy-Somer specifying the coupling method and the axial and radial loads if applicable.
* : the use of a drip cover is recommended for these mounting arrangements

3-phase TEFV induction motors
FLS cast iron
Construction

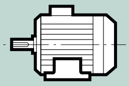
C2 - Mounting arrangements

Mountings and positions (IEC standard 60034-7)

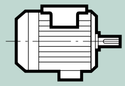
Foot-mounted motors

- refer to the previous table for possible mounting positions according to frame size

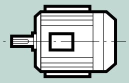
IM 1001 (IM B3)
- Horizontal shaft
- Feet on floor



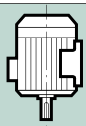
IM 1071 (IM B8)
- Horizontal shaft
- Feet on top



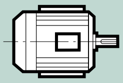
IM 1051 (IM B6)
- Horizontal shaft
- Wall-mounted with feet on left hand side when viewed from drive end



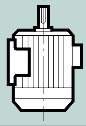
IM 1011 (IM V5)
- Vertical shaft facing down
- Feet on wall



IM 1061 (IM B7)
- Horizontal shaft
- Wall-mounted with feet on right hand side when viewed from drive end



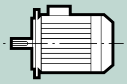
IM 1031 (IM V6)
- Vertical shaft facing up
- Feet on wall



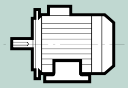
(FF) flange-mounted motors

- refer to the previous table for possible mounting positions according to frame size

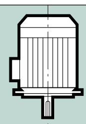
IM 3001 (IM B5)
- Horizontal shaft



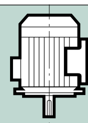
IM 2001 (IM B35)
- Horizontal shaft
- Feet on floor



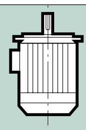
IM 3011 (IM V1)
- Vertical shaft facing down



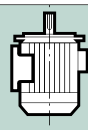
IM 2011 (IM V15)
- Vertical shaft facing down
- Feet on wall



IM 3031 (IM V3)
- Vertical shaft facing up



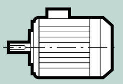
IM 2031 (IM V36)
- Vertical shaft facing up
- Feet on wall



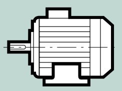
(FT) face-mounted motors

- all frame sizes ≤ 132 mm
  All positions are allowed

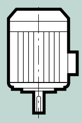
IM 3601 (IM B14)
- Horizontal shaft



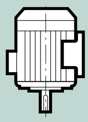
IM 2101 (IM B34)
- Horizontal shaft
- Feet on floor



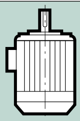
IM 3611 (IM V18)
- Vertical shaft facing down



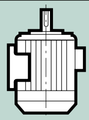
IM 2111 (IM V58)
- Vertical shaft facing down
- Feet on wall



IM 3631 (IM V19)
- Vertical shaft facing up



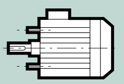
IM 2131 (IM V69)
- Vertical shaft facing up
- Feet on wall



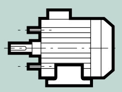
Motors without drive end shield

- on request

IM 9101 (IM B9)
- Threaded tie rods
- Horizontal shaft



IM 1201 (IM B15)
- Foot-mounted and threaded tie rods
- Horizontal shaft



C3 - Bearings and lubrication

C3.1 - BEARINGS AND BEARING LIFE

Definitions

Load ratings

- Basic static load C_o:

This is the load for which permanent deformation at point of contact between a bearing race and the ball (or roller) with the heaviest load reaches 0.01% of the diameter of the ball (or roller).

- Basic dynamic load C:

This is the load (constant in intensity and direction) for which the nominal lifetime of the bearing will reach 1 million revolutions.

The static load rating C_o and dynamic load rating C are obtained for each bearing by following the method in ISO 281.

Lifetime

The lifetime of a bearing is the number of revolutions (or number of operating hours at a constant speed) that the bearing can accomplish before the first signs of fatigue (spalling) begin to appear on a ring, ball or roller.

- Nominal lifetime L10h

According to the ISO recommendations, the nominal lifetime is the length of time completed or exceeded by 90% of apparently identical bearings operating under the conditions specified by the manufacturer.

Note: The majority of bearings last much longer than the nominal lifetime; the average lifetime achieved or exceeded by 50% of bearings is around 5 times longer than the nominal lifetime.

Determination of nominal lifetime

Constant load and speed of rotation

The nominal lifetime of a bearing expressed in operating hours L_{10h}, the basic dynamic load C expressed in daN and the applied loads (radial load F_r and axial load F_a) are related by the following equation:

$$L_{10h} = \frac{1000000}{60 \cdot N} \cdot \left(\frac{C}{P}\right)^p$$

where N = speed of rotation (min-1)

P ($P = X\,F_r + Y\,F_a$): dynamic load equivalent (F_r, F_a, P in daN)

p: an index which depends on the type of contact between the races and balls (or rollers)

p = 3 for ball bearings

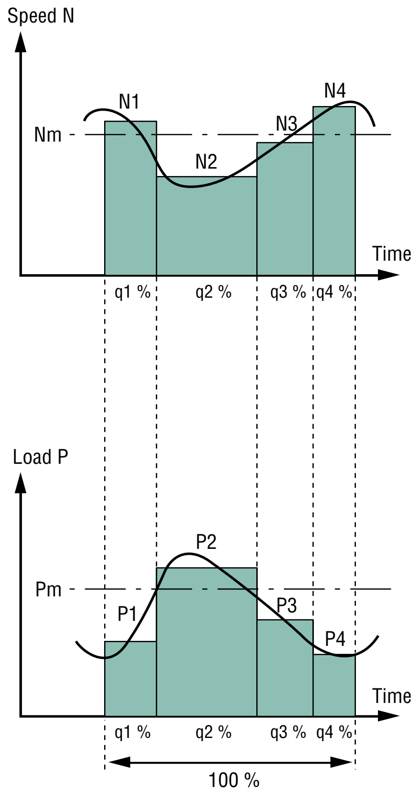
p = 10/3 for roller bearings

The formulae that give Equivalent Dynamic Load (values of factors X and Y) for different types of bearing may be obtained from their respective manufacturers.

Variable load and speed of rotation

For bearings with periodically variable load and speed, the nominal lifetime is established using the equation:

$$L_{10h} = \frac{1000000}{60 \cdot N_m} \cdot \left(\frac{C}{P_m}\right)^p$$



N_m: average speed of rotation

$$N_m = N_1 \cdot \frac{q_1}{100} + N_2 \cdot \frac{q_2}{100} + \ldots (\text{min}^{-1})$$

P_m : average equivalent dynamic load

$$P_m = \sqrt[1/p]{P_1^{1/p} \cdot \left(\frac{N_1}{N_m}\right) \cdot \frac{q_1}{100} + P_2^{1/p} \cdot \left(\frac{N_2}{N_m}\right) \cdot \frac{q_2}{100} + \ldots} \ (\text{daN})$$

with q_1, q_2, etc as a%

Nominal lifetime L_{10h} is applicable to bearings made of bearing steel and normal operating conditions (lubricating film present, no contamination, correctly fitted, etc).

Situations and data differing from these conditions will lead to either a reduction or an increase in lifetime compared to the nominal lifetime.

Corrected nominal lifetime

If the ISO recommendations (DIN ISO 281) are used, improvements to bearing steel, manufacturing processes and the effects of operating conditions may be integrated in the nominal lifetime calculation.

The theoretical pre-fatigue lifetime L_{nah} is thus calculated using the formula:

$L_{nah} = a_1\, a_2\, a_3\, L_{10h}$

with:

a_1: failure probability factor

a_2: factor for the characteristics and tempering of the steel

a_3: factor for the operating conditions (lubricant quality, temperature, speed of rotation, etc)

Under normal operating conditions for FLS motors, the corrected nominal lifetime, calculated with a failure probability factor a1 = 1 (L_{10ah}), is longer than the nominal lifetime L_{10h}.

C3.2 - TYPES OF BEARING AND STANDARD FITTING ARRANGEMENTS

		Horizontal shaft	Vertical shaft	
			Shaft facing down	Shaft facing up
	Mounting arrangement	B3 / B6 / B7 / B8	V5	V6
Foot-mounted motors	**standard mounting**	The DE bearing is: - located at DE for frame ≤ 132 - locked for 160 ≤ frame ≤ 315 S The NDE bearing is locked for frames 315 M to 450	The DE bearing is: - located at DE for frame ≤ 132 - locked for 160 ≤ frame ≤ 315 S The NDE bearing is locked for frames 315 M to 450	The DE bearing is: - located at DE for frame ≤ 90 - locked for 100 ≤ frame ≤ 315 S The NDE bearing is locked for frames 315 M to 450
	on request	DE bearing locked for frames ≤ 132	DE bearing locked for frames ≤ 132	DE bearing locked for frames ≤ 90
	Mounting arrangement	B5 / B35 / B14 / B34	V1 / V15 / V18 / V58	V3 / V36 / V19 / V69
Foot-mounted motors (or foot and flange)	**standard mounting**	The DE bearing is locked for frames 80 to 315 S The NDE bearing is locked for frames 315 M to 450	The DE bearing is locked for frames 80 to 315 S The NDE bearing is locked for frames 315 M to 450	The DE bearing is locked for frames 80 to 315 S The NDE bearing is locked for frames 315 M to 450

Important: When ordering, state correct mounting type and position (see section C1).

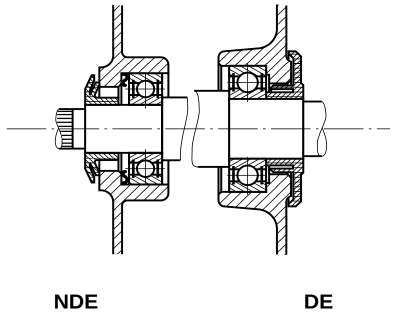
Motor		No. of poles	Standard fitting arrangement			
					Assembly diagram reference	
Frame/Type	LEROY-SOMER designation		Non drive end bearing (N.D.E.)	Drive end bearing (D.E.)	Foot-mounted motors	Flange-mounted (or foot and flange) motors
80 L	FLS 80 L	2 ; 4 ; 6 ; 8	6203 ZZ C3	6204 ZZ C3	1	2
90 S	FLS 90 S	2 ; 4 ; 6 ; 8	6204 ZZ C3	6205 ZZ C3	1	2
90 L	FLS 90 L	2 ; 4 ; 6 ; 8	6204 ZZ C3	6205 ZZ C3	1	2
100 L	FLS 100 LK	2 ; 4 ; 6 ; 8	6205 ZZ C3	6206 ZZ C3	1	2
112 M	FLS 112 M	2 ; 4 ; 6 ; 8	6205 ZZ C3	6206 ZZ C3	1	2
132 S	FLS 132 S	2 ; 4 ; 6 ; 8	6207 ZZ C3	6208 ZZ C3	1	2
132 M	FLS 132 M	2 ; 4 ; 6 ; 8	6207 ZZ C3	6308 ZZ C3	1	2
160 M	FLS 160 M (A,B)	2 ; 4 ; 6 ; 8	6210 Z C3	6309 Z C3	3	4
160 L	FLS 160 L	2 ; 4 ; 6 ; 8	6210 Z C3	6309 Z C3	3	4
180 M	FLS 180 MR	2 ; 4	6210 Z C3	6310 Z C3	3	4
180 L	FLS 180 L	4 ; 6 ; 8	6212 Z C3	6310 Z C3	3	4
200 L	FLS 200 L (A,B)	2 ; 4 ; 6 ; 8	6313 C3	6313 C3	5	5
225 S	FLS 225 ST	4 ; 8	6313 C3	6313 C3	5	5
225 M	FLS 225 MT	2	6313 C3	6313 C3	5	5
225 M	FLS 225 M	4 ; 6 ; 8	6314 C3	6314 C3	8	8
250 M	FLS 250 M	2 ; 4 ; 6 ; 8	6314 C3	6314 C3	8	8
280 S	FLS 280 S	2 ; 4 ; 6 ; 8	6314 C3	6316 C3	8	8
280 M	FLS 280 M	2 ; 4 ; 6 ; 8	6314 C3	6316 C3	8	8
315 S	FLS 315 ST	2	6317 C3	6317 C3	6	6
315 S	FLS 315 ST	4 ; 6 ; 8	6318 C3	6318 C3	6	6
315 M	FLS 315 M	2	6317 C3	6317 C3	7	7
315 M	FLS 315 M	4 ; 6 ; 8	6320 C3	6320 C3	7	7
315 L	FLS 315 L (A,B)	2	6317 C3	6317 C3	7	7
315 L	FLS 315 L (A,B)	4 ; 6 ; 8	6320 C3	6320 C3	7	7
355 L	FLS 355 L (A,B,C,D)	2	6317 C3	6317 C3	7	7
355 L	FLS 355 L (A,B,C,D)	4 ; 6 ; 8	6322 C3	6322 C3	7	7
355 LK	FLS 355 LK (A,B)	4 ; 6 ; 8	6324 C3	6324 C3	7	7
400 L	FLS 400 LV (B)	4	6324 C3	6324 C3	7	7
400 L	FLS 400 L (A,B)	4 ; 6 ; 8	6324 C3	6324 C3	7	7
400 LK	FLS 400 LK (A,B)	4 ; 6 ; 8	6328 C3	6328 C3	7	7
450 L	FLS 450 L (A,B)	4 ; 6 ; 8	6328 C3	6328 C3	7	7
450 L	FLS 450 LV (A,B)	4	6328 C3	6328 C3	7	7

Important: From the FLS 315 ST upwards, for 2-pole motors with a 60 Hz supply, specify the axial and radial loads during consultation.

C3 - Bearings and lubrication

C3.2.1 - Bearing assembly diagrams

1



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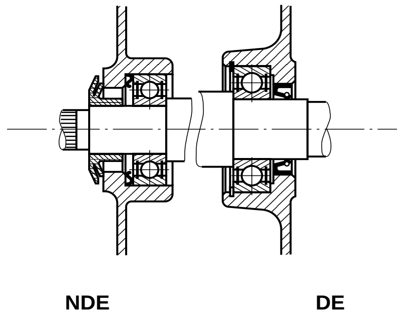

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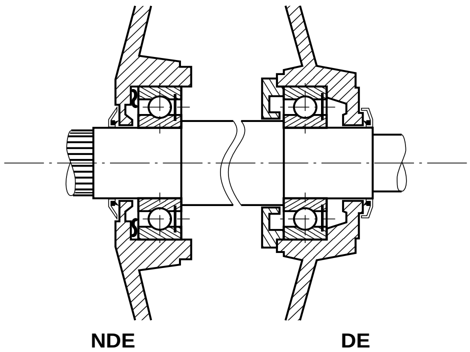

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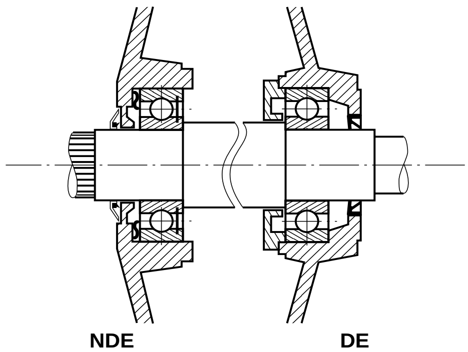

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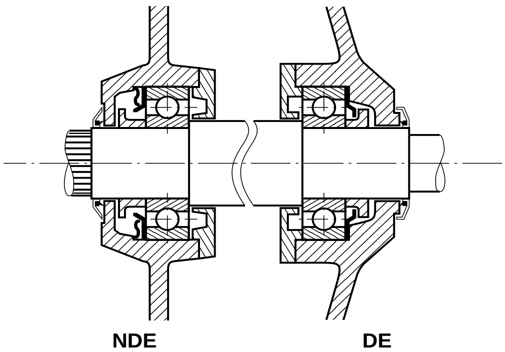

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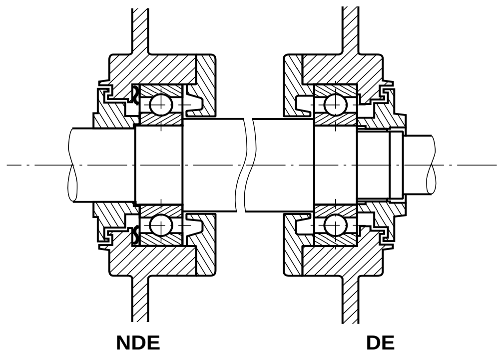

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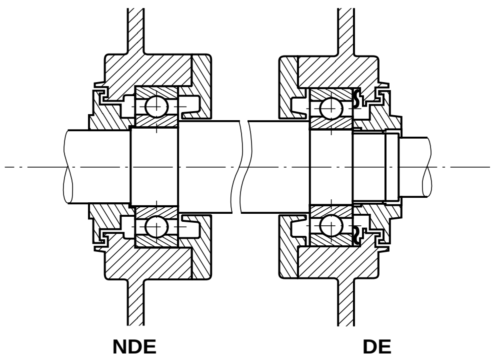

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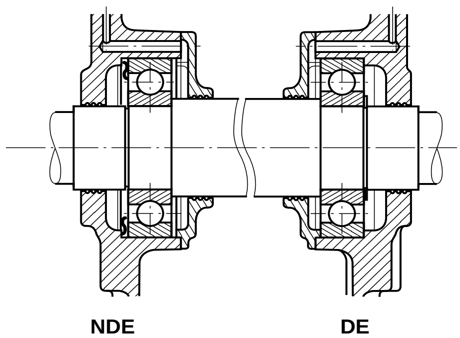


C3 - Bearings and lubrication

C3.2.2 - Permissible axial load (in daN) on main shaft extension for standard bearing assembly

Horizontal motor

Nominal lifetime L_{10h} of bearings: 25,000 hours

Motor		2 poles N = 3000 min^{-1}		4 poles N = 1500 min^{-1}		6 poles N = 1000 min^{-1}		8 poles N = 750 min^{-1}	
Frame size	Type	→ IM B3 / B6 IM B7 / B8 IM B5 / B35 IM B14 / B34	← IM B3 / B6 IM B7 / B8 IM B5 / B35 IM B14 / B34	→ IM B3 / B6 IM B7 / B8 IM B5 / B35 IM B14 / B34	← IM B3 / B6 IM B7 / B8 IM B5 / B35 IM B14 / B34	→ IM B3 / B6 IM B7 / B8 IM B5 / B35 IM B14 / B34	← IM B3 / B6 IM B7 / B8 IM B5 / B35 IM B14 / B34	→ IM B3 / B6 IM B7 / B8 IM B5 / B35 IM B14 / B34	← IM B3 / B6 IM B7 / B8 IM B5 / B35 IM B14 / B34
80	FLS 80	23	(61)*	37	(75)*	45	(83)*	55	(93)*
90	FLS 90 S/L	19	(69)*	35	(85)*	44	(94)*	55	(105)*
100	FLS 100 LK	32	(88)*	46	(102)*	63	(119)*	78	(134)*
112	FLS 112 M	32	(88)*	46	(102)*	63	(119)*	78	(134)*
132	FLS 132 S/M	86	(188)*	125	(227)*	159	(261)*	192	(294)*
160	FLS 160 M/MA/MB	163	195	224	256	272	304	299	331
160	FLS 160 L	154	186	210	242	253	285	282	314
180	FLS 180 MR	188	220	240	272	-	-	-	-
180	FLS 180 L	-	-	241	287	276	322	313	359
200	FLS 200 L/LA/LB	270	342	370	442	424	496	483	555
225	FLS 225 ST/MT	261	333	355	427	-	-	456	528
225	FLS 225 M	-	-	400	480	468	548	533	613
250	FLS 250 M	296	376	400	480	468	548	533	613
280	FLS 280 S	343	423	461	541	532	612	579	659
280	FLS 280 M	325	405	423	503	455	535	526	606
315	FLS 315 ST	492	332	461	621	546	706	570	730
315	FLS 315 M	486	326	746	546	905	705	963	763
315	FLS 315 LA	504	344	728	528	886	686	938	738
315	FLS 315 LB	487	327	733	533	847	647	890	690
355	FLS 355 LA	453	293	788	587	934	694	1006	766
355	FLS 355 LB	448	288	771	531	892	652	945	705
355	FLS 355 LC	443	285	751	512	-	-	-	-
355	FLS 355 LD	440	280	736	496	805	565	871	631
355	FLS 355 LKA	-	-	-	-	-	-	1038	758
355	FLS 355 LKB	-	-	862	582	923	643	1018	738
400	FLS 400 LA	-	-	873	593	941	661	1038	758
400	FLS 400 LB/LVB	-	-	862	582	923	643	1018	738
400	FLS 400 LKA	-	-	-	-	-	-	1264	910
400	FLS 400 LKB	-	-	-	-	1162	941	1237	883
450	FLS 450 LA/LVA	-	-	1061	707	1179	808	1264	910
450	FLS 450 LB/LVB	-	-	1041	687	1162	941	1237	883

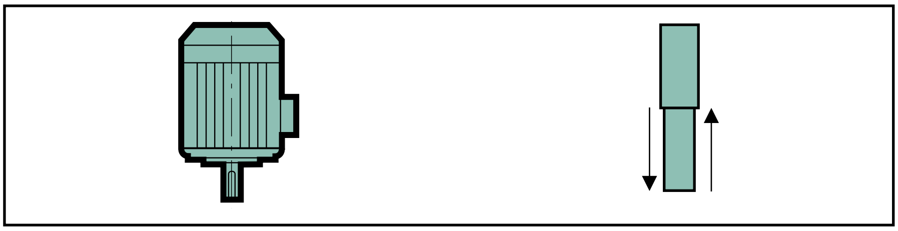
( )* The axial loads shown above for IM B3 / B6 / B7 / B8 with frame size ≤ 132 are the permissible axial loads for locked DE bearings (non-standard assembly, special order).

C3 - Bearings and lubrication

C3.2.2 - Permissible axial load (in daN) on main shaft extension for standard bearing assembly

Vertical motor
Shaft facing down

Nominal lifetime L_{10h}
of bearings: 25,000 hours



Motor		2 poles N = 3000 min^{-1}		4 poles N = 1500 min^{-1}		6 poles N = 1000 min^{-1}		8 poles N = 750 min^{-1}	
Frame size	Type	↓ IM V5 IM V1 / V15 IM V18 / V58..	↑ IM V5 IM V1 / V15 IM V18 / V69..	↓ IM V5 IM V1 / V15 IM V18 / V69..	↑ IM V5 IM V1 / V15 IM V18 / V69..	↓ IM V5 IM V1 / V15 IM V18 / V69..	↑ IM V5 IM V1 / V15 IM V18 / V69..	↓ IM V5 IM V1 / V15 IM V18 / V69..	↑ IM V5 IM V1 / V15 IM V18 / V69..
80	FLS 80 L	22	(63)*	35	(79)*	42	(89)*	52	(99)*
90	FLS 90 S/L	17	(73)*	31	(91)*	41	(100)*	52	(111)*
100	FLS 100 LK	29	(93)*	41	(111)*	57	(129)*	72	(144)*
112	FLS 112 M	29	(93)*	41	(111)*	57	(129)*	72	(144)*
132	FLS 132 S/M	73	(207)*	110	(251)*	140	(291)*	176	(321)*
160	FLS 160 M/MA/MB	145	223	204	287	249	339	278	369
160	FLS 160 L	134	220	187	281	226	332	259	359
180	FLS 180 MR	164	257	214	320	-	-	-	-
180	FLS 180 L	-	-	208	342	240	384	276	426
200	FLS 200 L/LA/LB	230	402	324	517	374	581	432	646
225	FLS 225 ST/MT	218	402	303	515	-	-	401	634
225	FLS 225 M	-	-	324	600	382	689	449	753
250	FLS 250 M	238	465	324	600	382	689	449	753
280	FLS 280 S	265	545	362	699	491	790	463	869
280	FLS 280 M	281	507	307	701	347	761	389	869
315	FLS 315 ST	380	509	457	737	554	814	551	903
315	FLS 315 M	361	545	582	861	764	976	800	1084
315	FLS 315 LA	344	572	546	876	726	988	756	1091
315	FLS 315 LB	306	596	514	909	644	1018	681	1098
355	FLS 355 LA	244	648	512	1050	684	1175	721	1341
355	FLS 355 LB	222	667	475	1067	605	1199	618	1367
355	FLS 355 LC	195	692	425	1081	-	-	-	-
355	FLS 355 LD	175	707	391	1107	432	1259	494	1397
355	FLS 355 LKA	-	-	-	-	-	-	700	1510
355	FLS 355 LKB	-	-	612	1106	571	1372	624	1563
400	FLS 400 LA	-	-	672	1058	649	1315	700	1510
400	FLS 400 LB/LVB	-	-	612	1106	571	1372	624	1563
400	FLS 400 LKA	-	-	-	-	-	-	767	1953
400	FLS 400 LKB	-	-	-	-	671	1772	605	2088
450	FLS 450 LA/LVA	-	-	868	1247	791	1668	767	1953
450	FLS 450 LB/LVB	-	-	729	1366	671	1772	605	2088

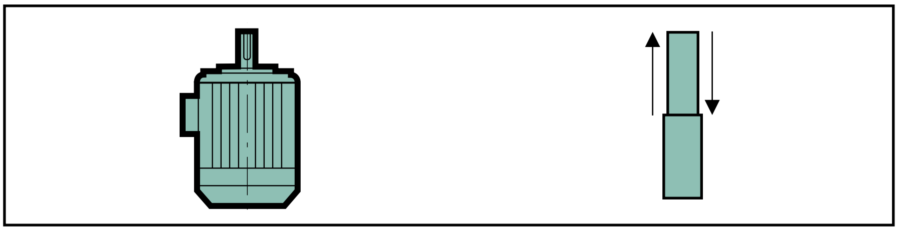
( )* The axial loads shown above for IM V5 with frame size ≤ 132 are the permissible axial loads for locked DE bearings (non-standard assembly, special order).

C3 - Bearings and lubrication

C3.2.2 - Permissible axial load (in daN) on main shaft extension for standard bearing assembly

Vertical motor
Shaft facing up

Nominal lifetime L_{10h}
of bearings: 25,000 hours



Motor		2 poles N = 3000 min^{-1}		4 poles N = 1500 min^{-1}		6 poles N = 1000 min^{-1}		8 poles N = 750 min^{-1}	
Frame size	Type	↓ IM V6 IM V3 / V36 IM V19 / V69..	↑ IM V6 IM V3 / V36 IM V19 / V69..	↓ IM V6 IM V3 / V36 IM V19 / V69..	↑ IM V6 IM V3 / V36 IM V19 / V69..	↓ IM V6 IM V3 / V36 IM V19 / V69..	↑ IM V6 IM V3 / V36 IM V19 / V69..	↓ IM V6 IM V3 / V36 IM V19 / V69..	↑ IM V6 IM V3 / V36 IM V19 / V69..
80	FLS 80 L	(60)*	25	(73)*	41	(80)*	51	(90)*	51
90	FLS 90 S/L	(67)*	23	(81)*	41	(91)*	50	(102)*	61
100	FLS 100 LK	85	37	97	55	113	73	128	88
112	FLS 112 M	85	37	97	55	113	73	128	88
132	FLS 132 S/M	175	105	212	149	242	189	278	219
160	FLS 160 M/MA/MB	177	191	236	255	281	307	310	337
160	FLS 160 L	166	188	219	249	258	300	291	327
180	FLS 180 MR	196	225	246	288	-	-	-	-
180	FLS 180 L	-	-	254	296	286	338	322	380
200	FLS 200 L/LA/LB	302	330	396	445	446	509	504	574
225	FLS 225 ST/MT	290	330	375	443	-	-	493	562
225	FLS 225 M	-	-	404	520	462	609	529	673
250	FLS 250 M	318	385	404	520	462	609	529	673
280	FLS 280 S	345	465	442	619	511	710	543	789
280	FLS 280 M	321	467	387	621	427	681	469	789
315	FLS 315 ST	380	509	457	737	554	814	551	903
315	FLS 315 M	361	545	582	861	764	976	800	1084
315	FLS 315 LA	344	572	546	876	726	988	756	1091
315	FLS 315 LB	306	596	514	909	644	1018	681	1098

355 to 450: consult Leroy-Somer before ordering

( )* The axial loads shown above for IM V6 with frame size ≤ 90 are the permissible axial loads for locked DE bearings (non-standard assembly, special order).

C3.2.3 - Permissible radial load on main shaft extension

In pulley and belt couplings, the drive shaft carrying the pulley is subjected to a radial force Fpr applied at a distance X (mm) from the shoulder of the shaft extension (length E).

- **Radial force applied to drive shaft extension: Fpr**

The radial force Fpr expressed in daN applied to the shaft extension is found by the formula.

$$\text{Fpr} = 1.91\ 10^6 \frac{P_N \cdot k}{D \cdot N_N} \pm P_P$$

where:

P_N = rated motor power (kW)

D = external diameter of the drive pulley (mm)

N_N = rated speed of the motor (min^{-1})

k = factor depending on the type of transmission

P_P = weight of the pulley (daN)

The weight of the pulley is positive when it acts in the same direction as the tension force in the belt (and negative when it acts in the opposite direction).

Range of values for factor k(*)

- toothed belts .... k = 1 to 1.5
- V-belts .... k = 2 to 2.5
- flat belts
  - with tensioner .... k = 2.5 to 3
  - without tensioner .... k = 3 to 4

(*) A more accurate figure for factor k can be obtained from the transmission suppliers.

- **Permission radial force on the drive shaft extension**

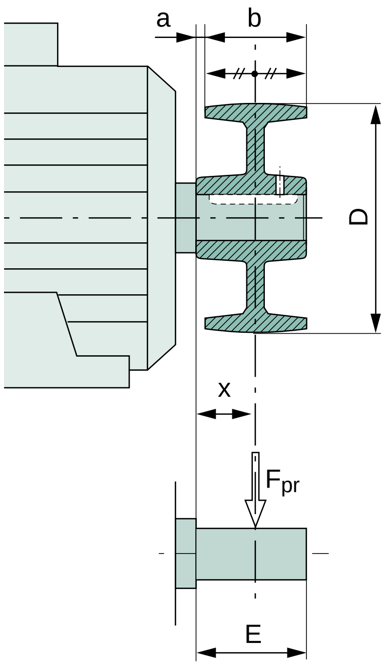
The charts on the following pages indicate, for each type of motor, the radial force FR at a distance X permissible on the drive end shaft extension, for a bearing life L_{10h} of 25,000 hours.

Note: For frame sizes ≥ 315 M, the selection charts are applicable for a motor installed with the shaft horizontal.

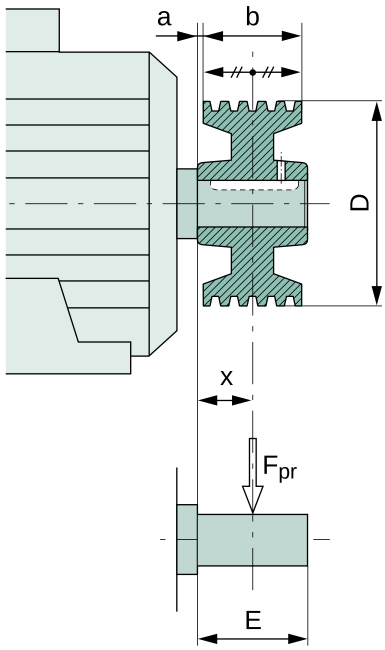
- **Change in bearing life depending on the radial load factor**

For a radial load Fpr (Fpr ≠ F_R), applied at distance X, the bearing life L_{10h} changes, at a first approximation, in the ratio k_R, (k_R = Fpr / F_R) as shown in the chart opposite, for standard assemblies.

If the load factor k_R is greater than 1.05, you should consult our technical department, stating mounting position and direction of force before opting for a special fitting arrangement.

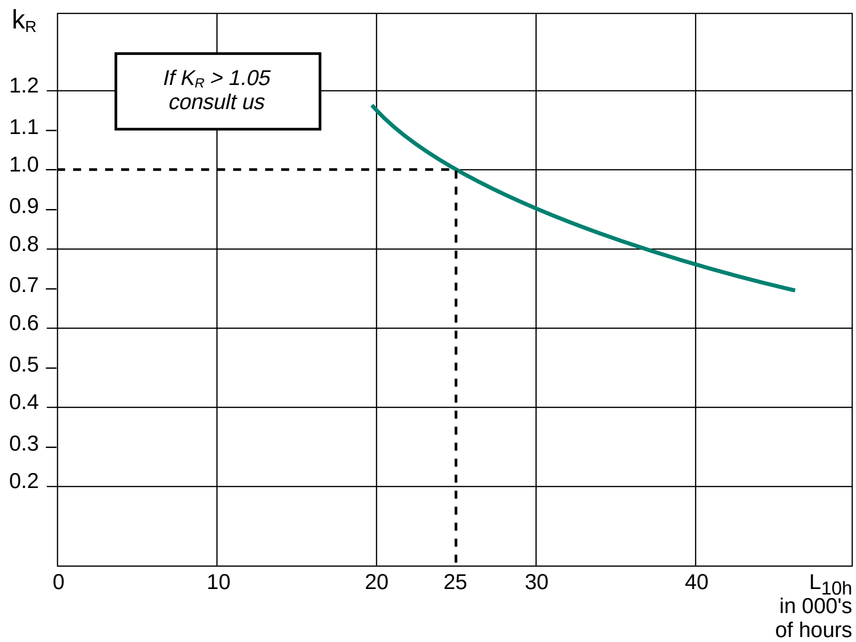


$$\left\{ \begin{array}{l} x = a + \frac{b}{2} \\ \text{where} \\ x \leq E \end{array} \right.$$



$$\left\{ \begin{array}{l} x = a + \frac{b}{2} \\ \text{where} \\ x \leq E \end{array} \right.$$

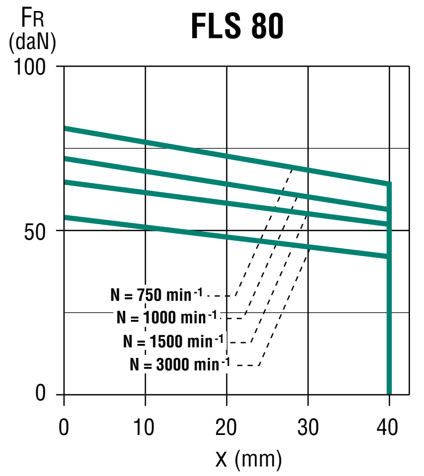
▼ ***Change in bearing life L_{10h} depending on the radial load factor k_R for standard fitting arrangements.***

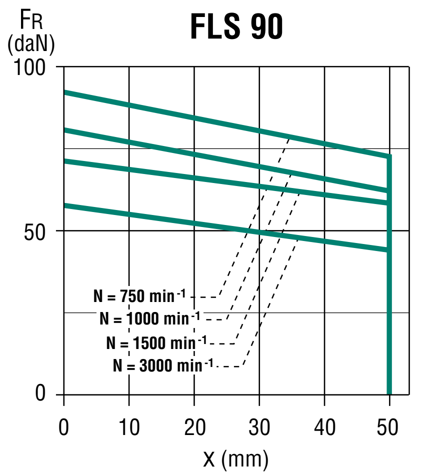


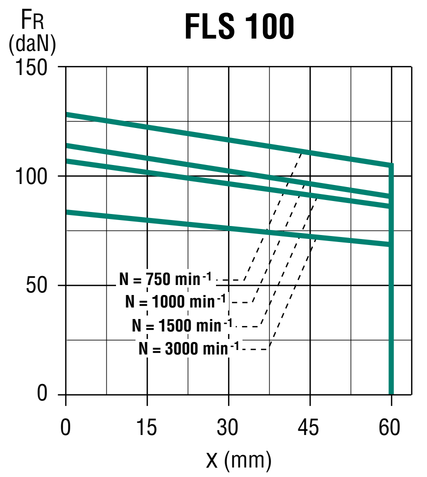
C3 - Bearings and lubrication

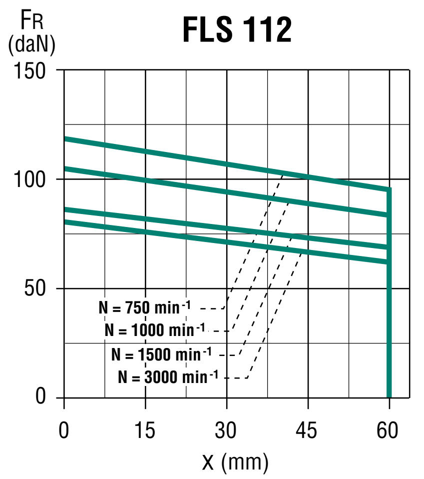
C3.2.4 - Standard fitting arrangement

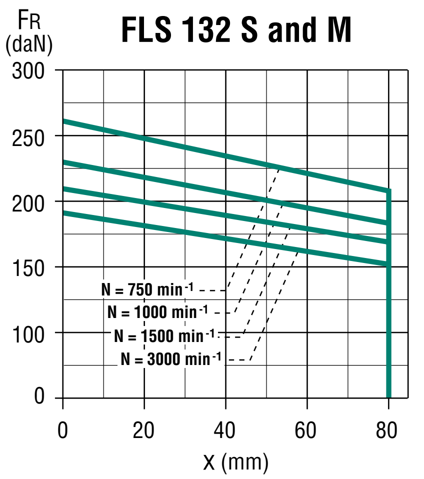
Permissible radial load on main shaft extension with a bearing life L_{10h} of 25,000 hours.

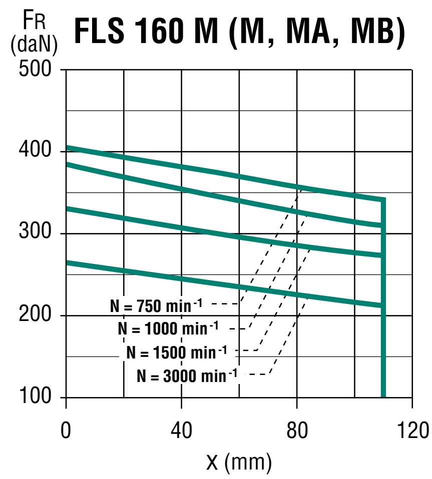


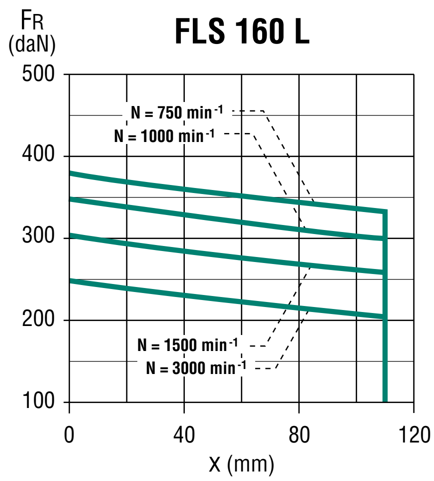


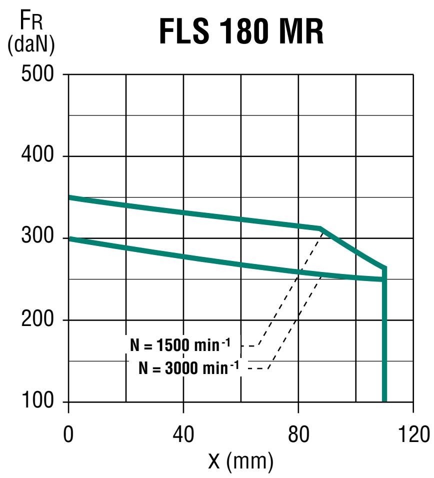


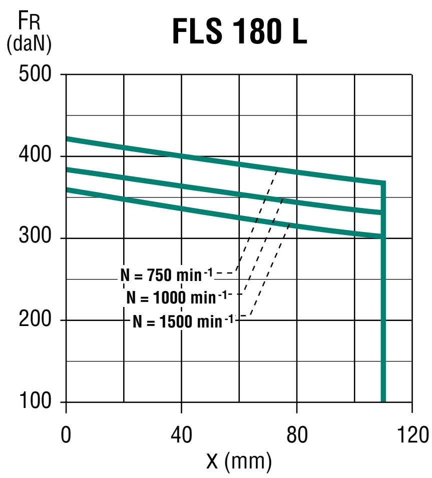








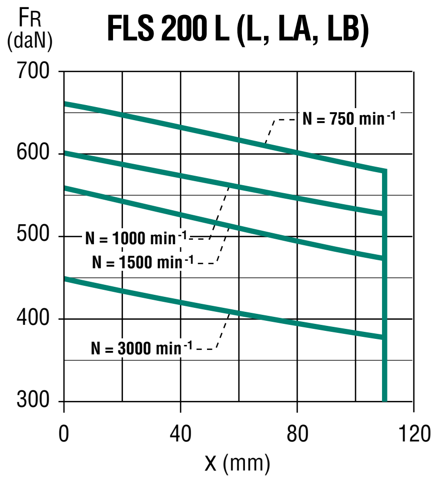


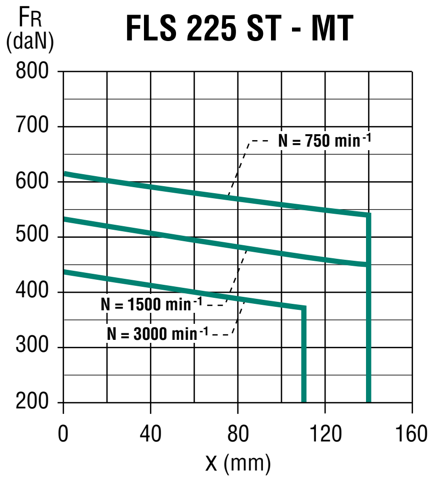


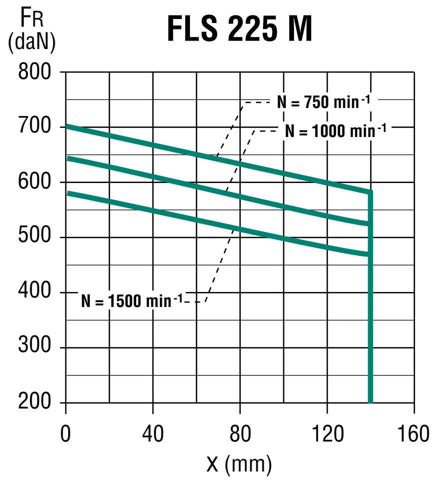
C

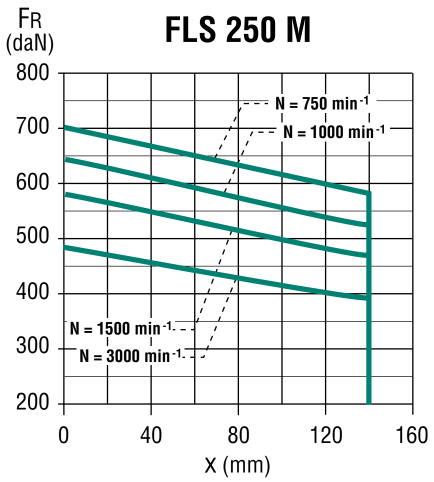
C3.2.4 - Standard fitting arrangement

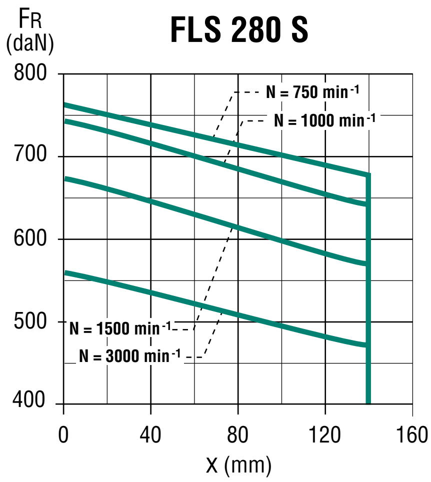
Permissible radial load on main shaft extension with a bearing life L_{10h} of 25,000 hours.

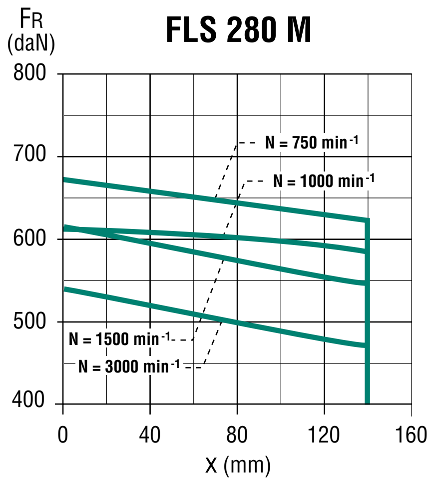


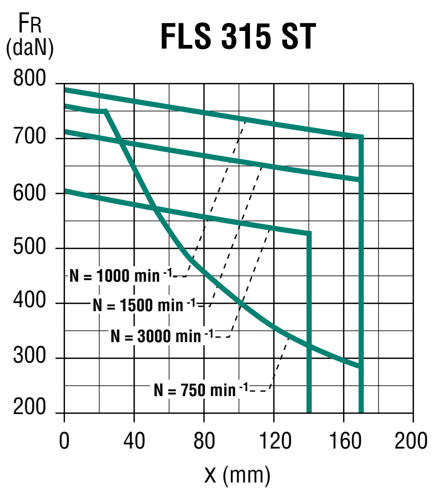


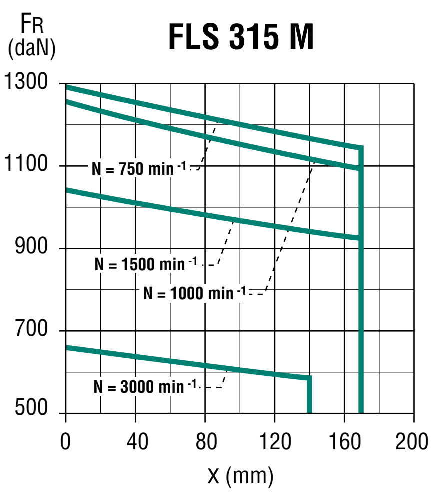


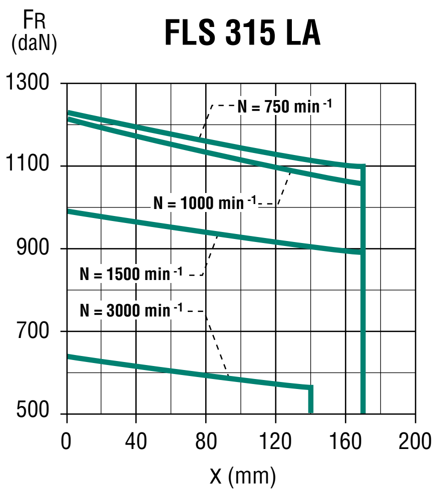








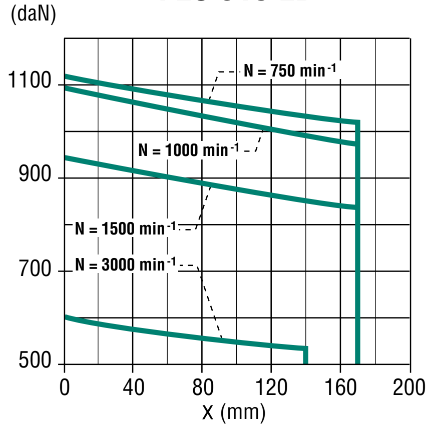




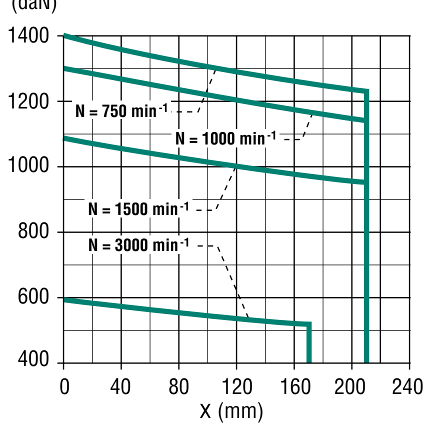
C3.2.4 - Standard fitting arrangement

Permissible radial load on main shaft extension with a bearing life L_{10h} of 25,000 hours.

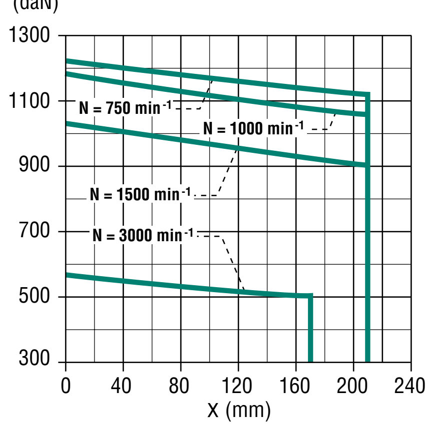
FLS 315 LB



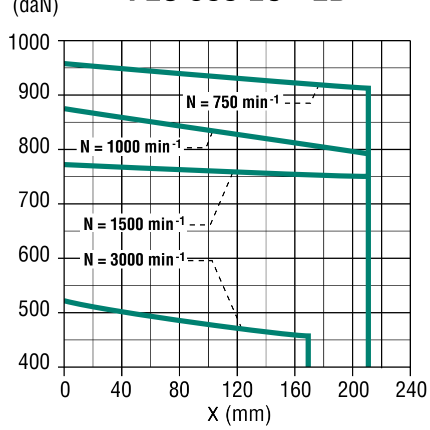
FLS 355 LA



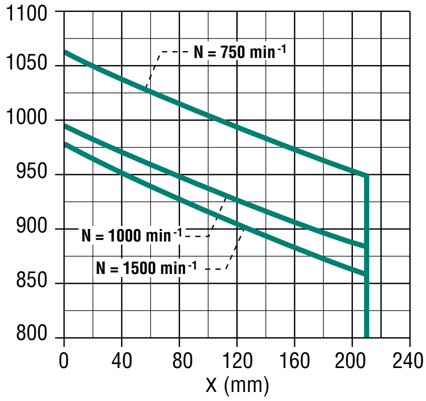
FLS 355 LB



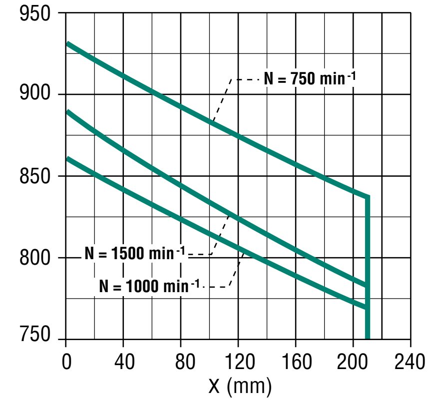
FLS 355 LC - LD



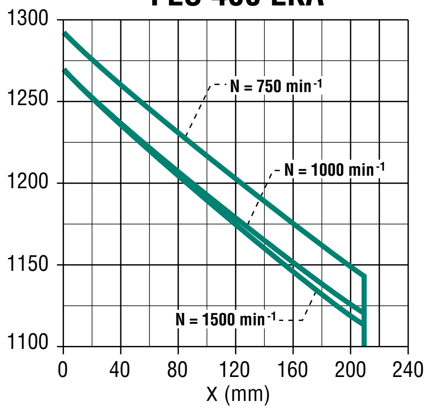
FLS 400 LA
FLS 355 LKA



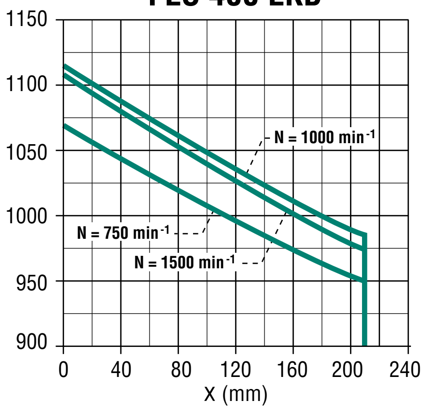
FLS 400 LB - LVB
FLS 355 LKB



FLS 450 LA - LVA
FLS 400 LKA



FLS 450 LB - LVB
FLS 400 LKB



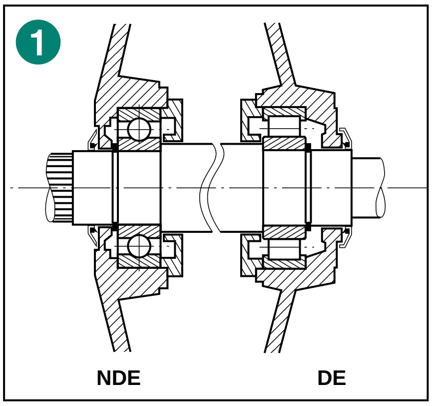
C3 - Bearings and lubrication

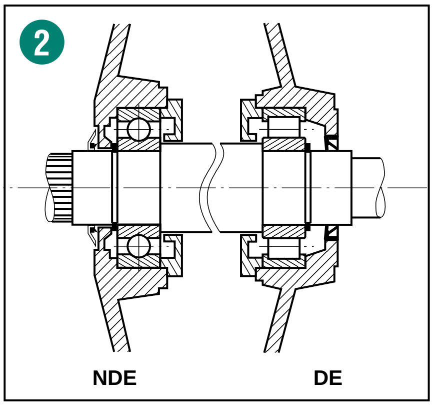
C3.3 - TYPES AND SPECIAL FITTING ARRANGEMENTS FOR DE ROLLER BEARINGS

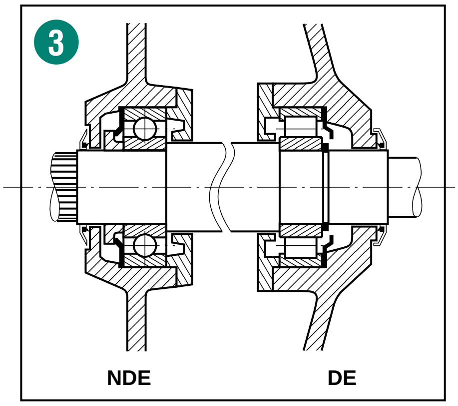
Motor		No. of poles	Standard fitting arrangement			
					Assembly diagram reference	
Frame size	LEROY-SOMER designation		Non drive end bearing (N.D.E.)	Drive end bearing (D.E.)	Foot-mounted motors	Flange-mounted (or foot and flange) motors
160 M	FLS 160 M/MA/MB	4 ; 6 ; 8	6210 Z C3	NU 309	1	2
160 L	FLS 160 L	4 ; 6 ; 8	6210 Z C3	NU 309	1	2
180 M	FLS 180 MR	4	6210 Z C3	NU 310	1	2
180 L	FLS 180 L	4 ; 6 ; 8	6212 Z C3	NU 310	1	2
200 L	FLS 200 L/LA/LB	4 ; 6 ; 8	6313 C3	NU 313	3	3
225 S	FLS 225 ST	4 ; 8	6313 C3	NU 313	3	3
225 M	FLS 225 M	4 ; 6 ; 8	6314 C3	NU 314	5	5
250 M	FLS 250 M	4 ; 6 ; 8	6314 C3	NU 314	5	5
280 S	FLS 280 S	4 ; 6 ; 8	6314 C3	NU 316	5	5
280 M	FLS 280 M	4 ; 6 ; 8	6314 C3	NU 316	5	5
315 S	FLS 315 ST	4 ; 6 ; 8	6318 C3	NU 318	4	4
315 M	FLS 315 M	4 ; 6 ; 8	6320 C3	NU 320	4	4
315 L	FLS 315 L	4 ; 6 ; 8	6320 C3	NU 320	4	4
355 L*	FLS 355 LA/LB/LC/LD	4 ; 6 ; 8	6322 C3	NU 322	4	4
355 L*	FLS 355 LKA/LKB	4 ; 6 ; 8	6324 C3	NU 324	4	4
400 L*	FLS 400 LA/LB	4 ; 6 ; 8	6324 C3	NU 324	4	4
400 L*	FLS 400 LKA/LKB	4 ; 6 ; 8	6328 C3	NU 328	4	4
450 L*	FLS 450 LA/LB/LVA/LVB	4 ; 6 ; 8	6328 C3	NU 328	4	4

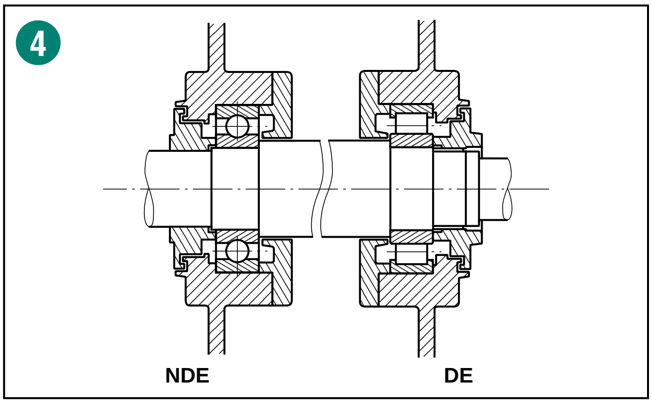
* in the vertical position, the axial and radial force values must be specified.

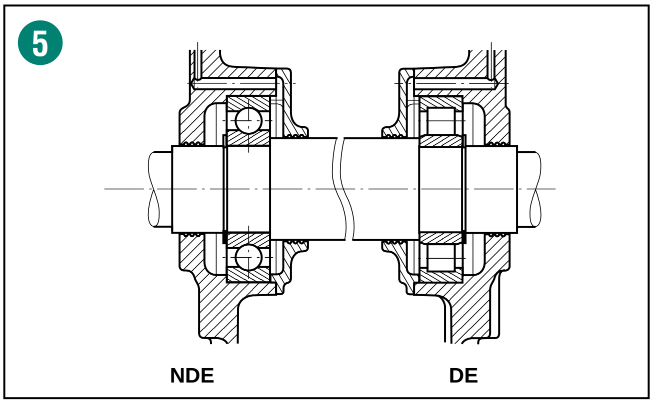
C3.3.1 - Bearing assembly diagrams





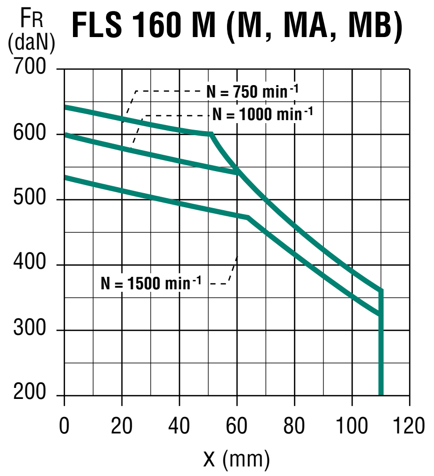


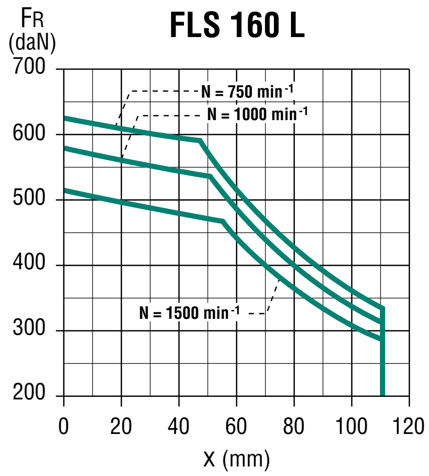


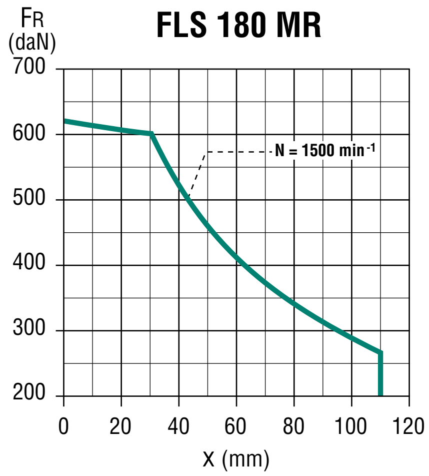


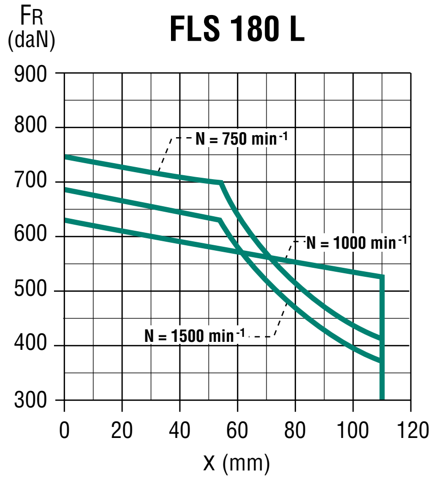
C3.3.2 - Special fitting arrangements

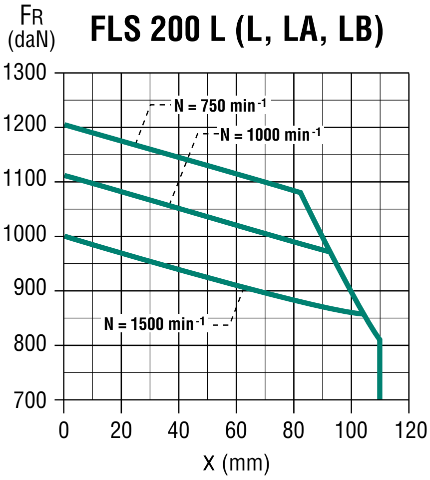
Permissible radial load on main shaft extension with a bearing life L_{10h} of 25,000 hours.

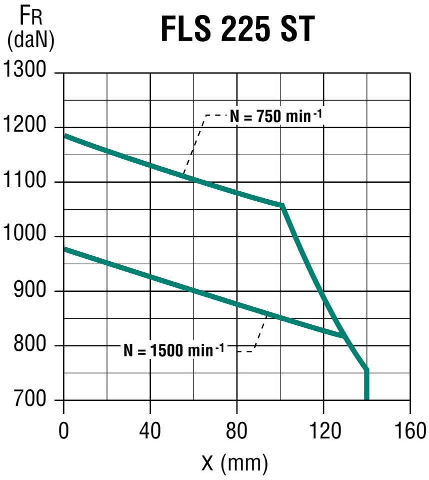


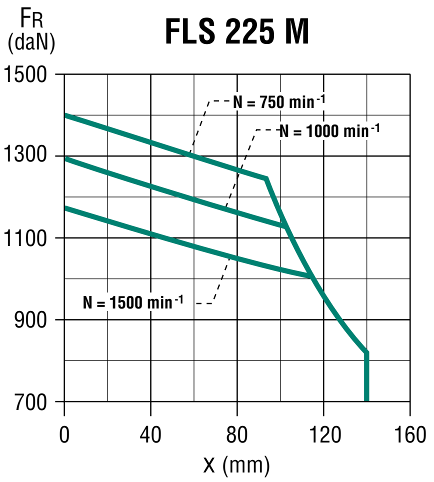


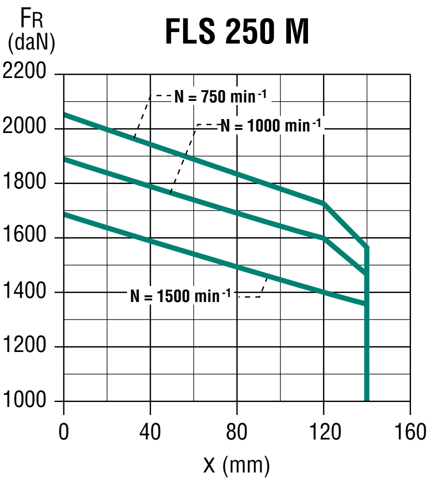


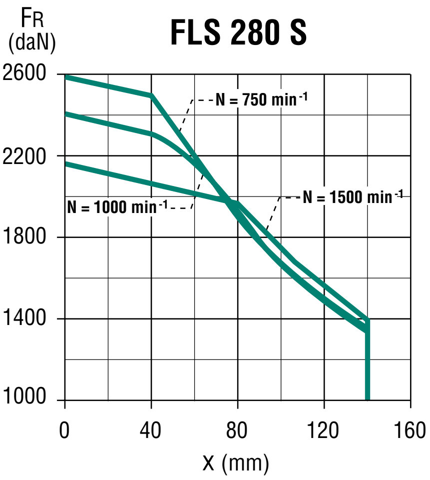








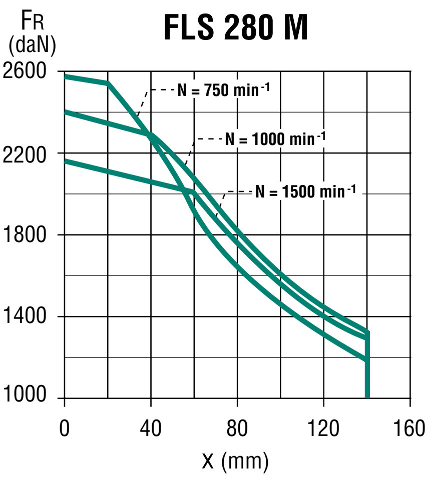


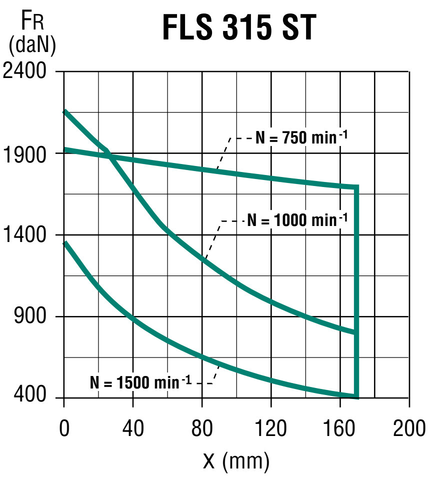


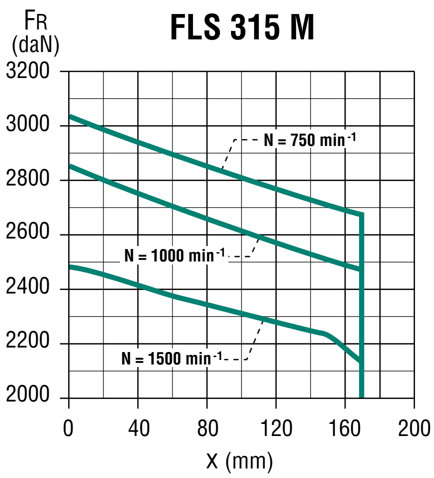
C3 - Bearings and lubrication

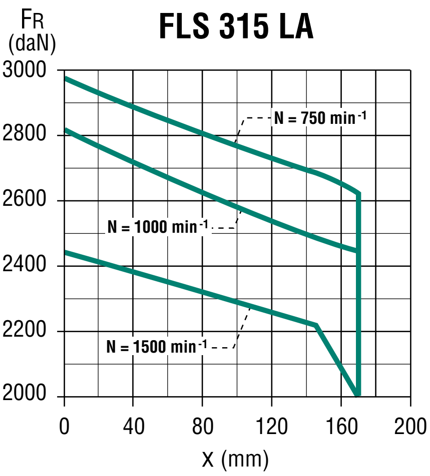
C3.3.2 - Special fitting arrangements

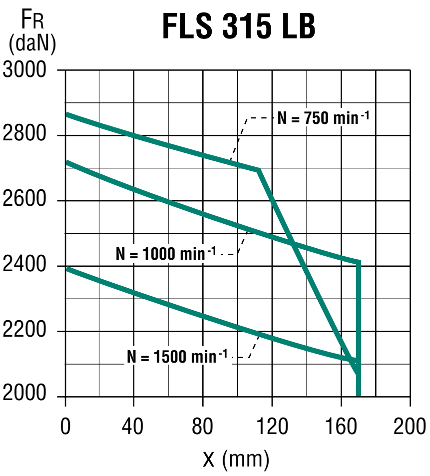
Permissible radial load on main shaft extension with a bearing life L_{10h} of 25,000 hours.

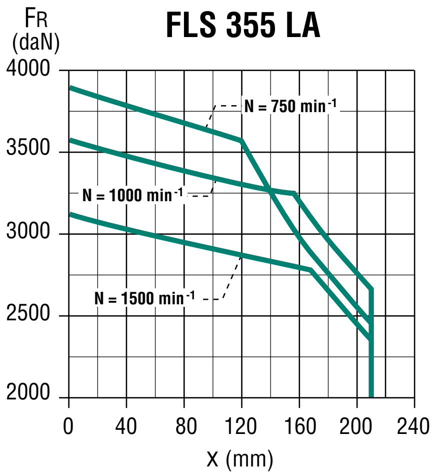


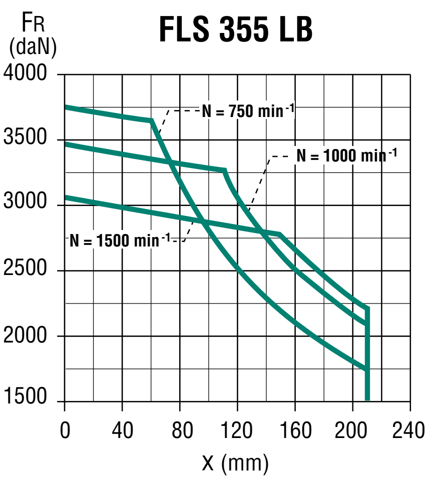


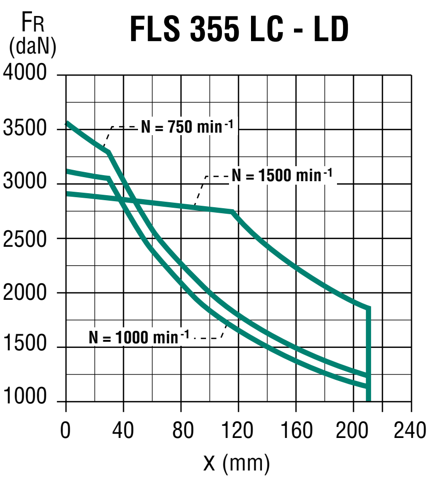


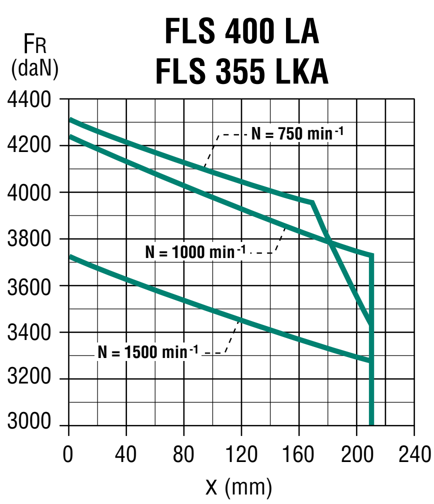






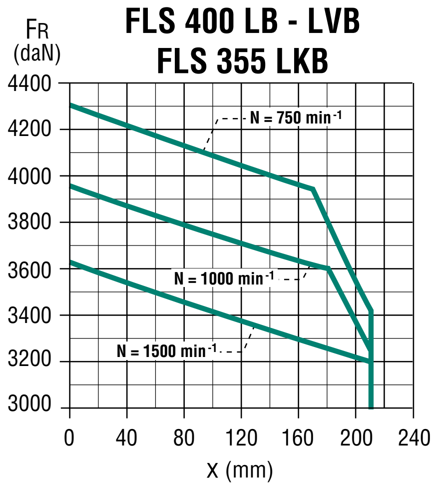


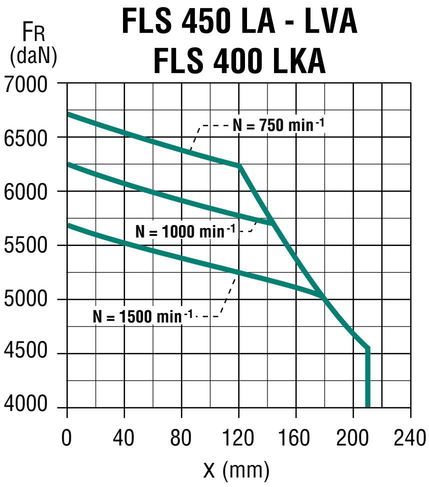


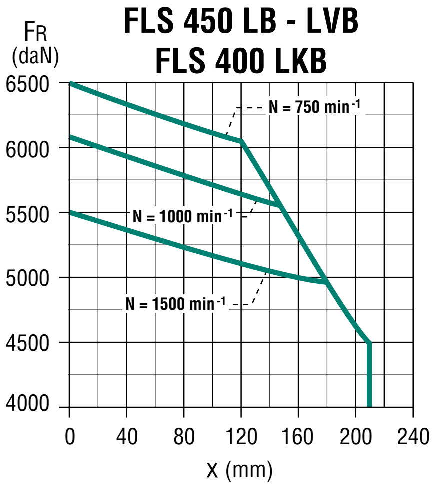


C3.3.2 - Special fitting arrangements

Permissible radial load on main shaft extension with a bearing life L_{10h} of 25,000 hours.







C3 - Bearings and lubrication

C3.4 - LUBRICATION AND MAINTENANCE OF BEARINGS

Role of the lubricant

The principal role of the lubricant is to avoid direct contact between the metal parts in motion: balls or rollers, slip-rings, cages, etc. It also protects the bearing against wear and corrosion.

The quantity of lubricant needed by a bearing is normally quite small. There should be enough to provide good lubrication without undesirable overheating. As well as lubrication itself and the operating temperature, the amount of lubricant should be judged by considerations such as sealing and heat dissipation.

The lubricating power of a grease or an oil lessens with time owing to mechanical constraints and straightforward ageing. Used or contaminated lubricants should therefore be replaced or topped up with new lubricant at regular intervals.

Bearings can be lubricated with grease, oil or, in certain cases, with a solid lubricant.

C3.4.1 - Lubrication with grease

A lubricating grease can be defined as a product of semi-fluid consistency obtained by the dispersion of a thickening agent in a lubricating fluid and which may contain several additives to give it particular properties.

Composition of a grease
Base oil: 85 to 97%
Thickener: 3 to 15%
Additives: 0 to 12%

The base oil lubricates

The oil making up the grease **is of prime importance.** It is the oil that lubricates the moving parts by coating them with a protective film which prevents direct contact. The thickness of the lubricating film is directly linked to the viscosity of the oil, and the viscosity itself depends on temperature. The two main types used to make grease are mineral oils and synthetic oils. Mineral oils are suitable for normal applications in a range of temperatures from -30° to +150°C. Synthetic oils have the advantage of being effective in severe conditions (extreme variations of temperature, harsh chemical environments, etc).

The thickener gives the grease consistency

The more thickener a grease contains, the ‘harder’ it will be. Grease consistency varies with the temperature. In falling temperatures, the grease hardens progressively, and the opposite happens when temperatures rise.

The consistency of a grease can be quantified using the NLGI (National Lubricating Grease Institute) classification. There are 9 NLGI grades, from 000 for the softest greases up to 6 for the hardest. Consistency is expressed by the depth to which a cone may be driven into a grease maintained at 25°C.

If we only consider the chemical nature of the thickener, lubricating greases fall into three major categories:

• **conventional greases with a metallic soap base** (calcium, sodium, aluminium, lithium). Lithium soaps have several advantages over other metallic soaps: a high melting point (180° to 200°), good mechanical stability and good water resistant properties.

• **greases with a complex soap base** The main advantage of this type of soap is a very high melting point (over 250°C).

• **soapless greases.** The thickener is an inorganic compound, such as clay. Their main property is the absence of a melting point, which makes them practically non-liquefying.

Additives improve some properties of greases

Additives fall into two types, depending on whether or not they are soluble in the base oil.

The most common insoluble additives - graphite, molybdenum disulphide, talc, mica, etc, improve the friction characteristics between metal surfaces. They are therefore used in applications where heavy pressure occurs.

The soluble additives are the same as those used in lubricating oils: antioxidants, anti-rust agents, etc.

C3.4.2 - Grease life

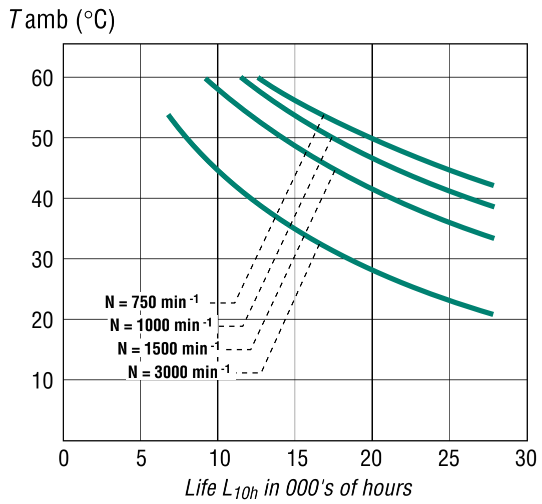
The lifetime of a lubricating grease depends on:

- the characteristics of the grease (type of soap and base oil, etc)
- service stress (type and size of bearing, speed of rotation, operating temperature, etc)
- contamination

C3.4.2.1 - Permanently greased bearings

For **motors from 80 frame to 132 frame**, the type and size of the bearings make for long grease life and therefore lubrication for the lifetime of the machine. The grease life L_{10h} according to speed of rotation and ambient temperature is shown on the chart opposite.

▼ ***Grease life L_{10h} in 000’s of hours, for frames sizes ≤ 132.***



C3 - Bearings and lubrication

C3.4.2.2 - Bearings with grease nipples

The chart opposite shows the regreasing intervals, depending on the type of motor, for standard bearing assemblies of frame size ≥ 160 fitted with grease nipples, operating at an ambient temperature of 40°C on a horizontal shaft machine.

Note: the quality and quantity of grease and the regreasing interval are shown on the machine nameplate.

The chart opposite is valid for FLS motors lubricated with ESSO UNIREX N3 grease, which is used as standard.

C3.4.2.3 - Special assembly

For special assemblies (motors fitted with DE roller bearings or other types), machines of frame size ≥ 160 have bearings with grease nipples. Instructions for bearing maintenance are given on the nameplates on these machines.

▼ ***Regreasing intervals according to frame size and speed of rotation (for standard bearing assemblies).***

		3600	3000	1800	1500	1200	1000	900	750	Qty. of grease cm^3
160 M/L	**DE**	4 000	5 200	10 000	12 000	16 000	19 000	21 500	26 000	13
	NDE	3 500	4 600	9 000	11 000	15 000	18 000	20 000	24 000	10
180 MR	**DE**	3 500	4 600	9 000	11 000					15
	NDE	3 500	4 600	9 000	11 000					10
180 L	**DE**			9 000	11 000	15 000	18 000	20 000	24 000	15
	NDE			7 700	9 700	13 000	16 000	18 000	22 000	12
200 L		2 200	3 200	7 000	9 000	12 000	15 000	17 000	21 000	23
225 ST				7 000	9 000			17 000	21 000	23
225 MT		2 200	3 200							23
225 M				6 500	8 300	11 000	14 000	16 000	20 000	26
250 M		1800	2800	6 500	8 300	11 000	14 000	16 000	20 000	26
280	**DE**	1 200	2 000	5 500	7 200	10 000	12 500	14 000	18 000	33
	NDE	1 800	2 800	6 500	8 300	11 000	14 000	16 000	20 000	26
315 ST 2P			1 700							37
315 ST 4P & +				4 600	6 200	8 600	11 000	13 000	16 000	40
315 M/L 2P			1 700							37
315 M/L 4P & +				3 800	5 400	7 600	10 000	11 500	14 500	50
355 L 2P			1 700							37
355 L 4P & +				3 000	4 500	6 600	9 000	10 500	13 500	60
355 LK/400 L				2 300	3 700	6 000	8 000	10 000	12 000	72
400 LK/450 L				1 000	2 300	4 000	6 000	8 000	10 000	93

(standard values: for maintenance purposes, refer to the values on the machine nameplates).

Important: From the FLS 315 ST upwards, for 2-pole motors with a 60 Hz supply, specify the axial and radial loads during consultation.

3-phase TEFV induction motors
FLS cast iron
Construction

C4 - Cooling

FLS motors are of standard configuration IC 411

New designation for the IC (International Cooling) coded cooling method in the IEC 60034-6 standard.

The standard allows for two designations (general formula and simplified formula) as shown in the example opposite.

IC 4 A 1 A 1

- 1 → Circulation mode for secondary fluid (1: self-circulating)
- A → Secondary fluid (A : air)
- 1 → Circulation method for primary fluid (1: self-circulating)
- A → Primary fluid (A: air)
- 4 → Circuit layout (4: machine surface-cooled)

Note: the letter A may be omitted if this will not lead to confusion. This contracted formula becomes the simplified formula.
Simplified form: ***IC 411.***

Circuit layout

Characteristic number	Designation	Description
0(1)	Free circulation	The coolant enters and leaves the machine *freely*. It is taken from and returned to the fluid round the machine.
1(1)	Machine with an intake pipe	The coolant is taken up elsewhere than from the fluid round the machine, brought into the machine through an *intake pipe* and emptied into the fluid round the machine.
2(1)	Machine with an outlet pipe	The coolant is taken up from the fluid round the machine, brought away from the machine by an *outlet pipe* and does not go back into the fluid round the machine.
3(1)	Machine with two pipes (intake and outlet)	The coolant is taken up elsewhere than from the fluid round the machine, brought to the machine through an *intake pipe*, then taken away from the machine through an *outlet pipe* and does not go back into the fluid round the machine.
4	Surface cooled machine using the fluid round the machine	The primary coolant circulates in a closed circuit, transferring its heat to a secondary coolant (the one surrounding the machine) through the machine casing. The casing surface is either smooth or finned to improve heat transmission.
5(2)	Built-in heat exchanger (using the surrounding environment)	The primary coolant circulates in a *closed* circuit, transferring its heat to a secondary coolant (the one surrounding the machine) in an integral heat exchanger inside the machine.
6(2)	Machine-mounted heat exchanger (using the surrounding environment)	The primary coolant circulates in a closed circuit, transferring its heat to a secondary coolant (the one surrounding the machine) in a heat exchanger that forms an independent unit, mounted on the machine.
7(2)	Built-in heat exchanger (not using the surrounding environment)	The primary coolant circulates in a closed circuit, transferring its heat to a secondary coolant (which is not the one round the machine) in an integral heat exchanger inside the machine.
8(2)	Machine-mounted heat exchanger (not using the surrounding environment)	The primary coolant circulates in a closed circuit, transferring its heat to a secondary coolant (which is not the one round the machine) in a heat exchanger that forms an independent unit, mounted on the machine.
9(2)(3)	Separate heat exchanger (using/not using the surrounding environment)	The primary coolant circulates in a closed circuit, transferring its heat to the secondary fluid in a heat exchanger that forms an independent unit, away from the machine.

Coolant

Characteristic letter	Type of fluid
A	Air
F	Freon
H	Hydrogen
N	Nitrogen
C	Carbon dioxide
W	Water
U	Oil
S	Any other fluid (must be identified separately)
Y	The fluid has not yet been selected (used temporarily)

Method of circulation

Characteristic number	Designation	Description
0	Free circulation	The circulation of the coolant is due only to differences in temperature. Ventilation caused by the rotor is negligible.
1	Self-circulating	The circulation of the coolant depends on the rotational speed of the main machine, and is caused by the action of the rotor alone, or a device mounted directly on it.
2, 3, 4		Not yet defined.
5(4)	Built-in, independent device	The coolant is circulated by a built-in device which is powered independently of the rotational speed of the main machine.
6(4)	Independent device mounted on the machine	The coolant is circulated by a device mounted on the machine which is powered independently of the rotational speed of the main machine.
7(4)	Entirely separate independent device or using the pressure of the coolant circulation system	The coolant is circulated by a separate electrical or mechanical device, independent and not mounted on the machine, or by the pressure in the coolant circulation system.
8(4)	Relative displacement	The circulation of the coolant is produced by the relative movement between the machine and the coolant, either by displacement of the machine in relation to the coolant, or by the flow of the surrounding coolant.
9	Any other device	The coolant is circulated using a method other than those defined above: it must be described in full.

(1) Filters or labyrinths for dust removal or noise protection can be fitted inside the casing or in the ducting. The first designation numbers 0 to 3 also apply to machines in which the coolant is taken up at the outlet of a watercooler designed to lower the temperature of the ambient air or recirculated through a watercooler so as not to increase the ambient temperature.

(2) The nature of the heat exchanger elements is not specified (smooth or finned tubes, corrugated surfaces, etc).

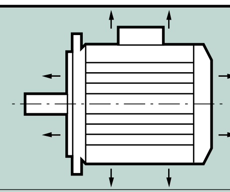
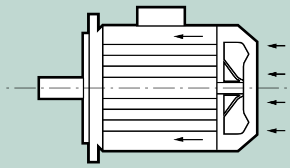
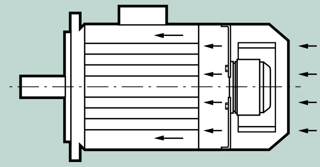
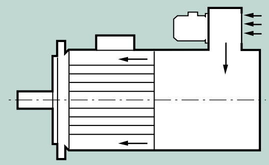
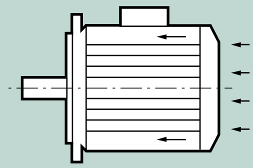
(3) A separate heat exchanger can be installed near to or at a distance from the machine. A secondary gas coolant may or may not be the surrounding medium.

(4) Use of such a device does not exclude the ventilating action of the rotor or the existence of an additional fan mounted directly on the rotor.

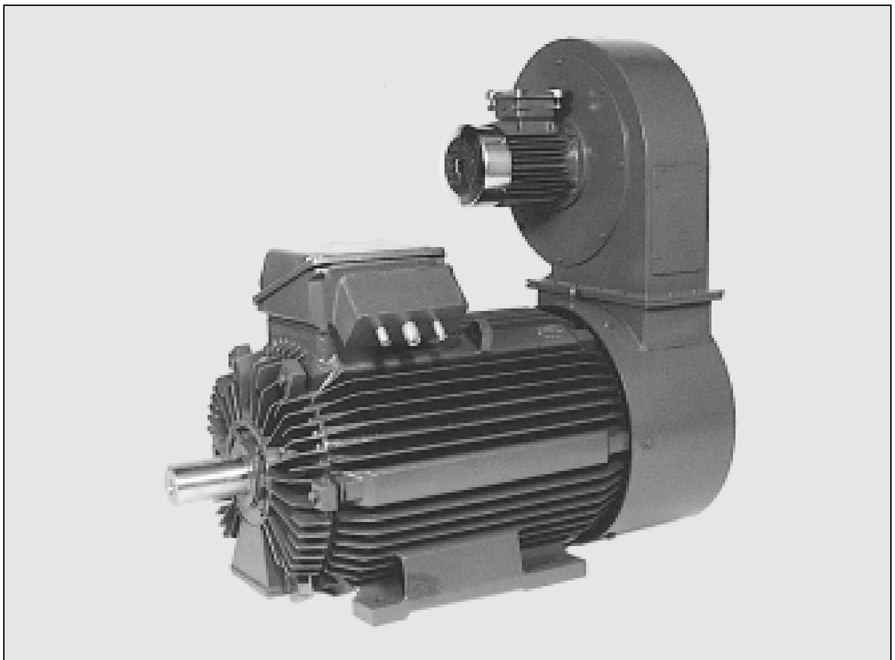
3-phase TEFV induction motors
FLS cast iron
Construction

C4 - Cooling

C4.1 - STANDARD CODES

IC 410	Enclosed machine, surface-cooled by natural convection and radiation. No external fan.	
IC 411	Enclosed machine. Smooth or finned ventilated casing. External shaft-mounted fan.	
IC 416 A*	Enclosed machine. Smooth or finned enclosed casing. External motorized axial (A) fan supplied with the machine.	
IC 416 R*	Enclosed machine. Smooth or finned enclosed casing. External motorized radial (R) fan supplied with the machine.	
IC 418	Enclosed machine. Smooth or finned casing. No external fan. Ventilation provided by air flow coming from the driven system.	

* Features not within manufacturer's standard range.



Application of cooling systems to the LEROY-SOMER range

Frame size	IC 410	IC 411	IC 416 A	IC 416 R
80	❍	●	❑	❑
90 to 450	❍	●	❍	❍

● : standard construction
❍ : possible (ask for estimate)
❑ : not possible

Another cooling system may be fitted as an option: complete immersion of the motor in oil (ask for estimate).

C4 - Cooling

C4.2 - VENTILATION

C4.2.1 - Motor ventilation

In compliance with IEC 60034-6, the motors in this catalogue are cooled using method IC 411, ie. "surface-cooled machine using the ambient air circulating round the machine".

Cooling is achieved by a fan mounted at the NDE of the motor, inside a fan cover which acts as a safety guard. The fan draws the air through the grille in the cover and sends it along the housing fins, giving an identical heat balance in either direction of rotation.

Note: Obstruction - even accidental - of the fan cover grille (grille clogged or placed against a wall) has an adverse effect on the motor cooling process.

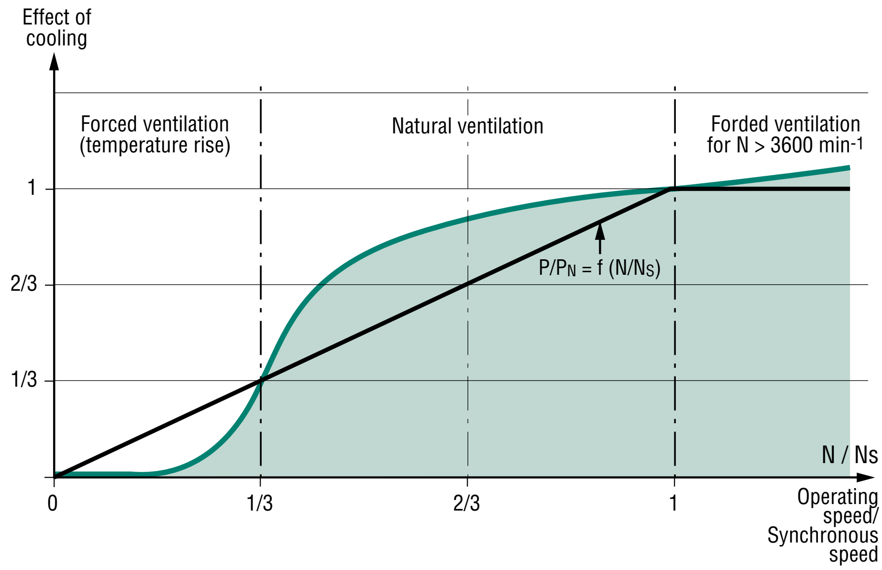
We recommend a minimum distance of 1/3 of the frame size between the end of the cover and any possible obstacle (wall, machine, etc).

Cooling of variable speed motors

Special precautions need to be taken when standard induction motors are being used with variable speed, powered by an inverter or voltage controller.

In prolonged operation at low speed, cooling efficiency is lost. It is therefore advisable to install forced ventilation that will produce a constant flow independent of the motor speed.

In prolonged operation at high speed, the fan may make excessive noise. It is again advisable to install a forced ventilation system.



C4.2.2 - Non-ventilated applications in continuous operation

Motors can be supplied without fans. Dimensions will depend on the application.

a) IC 418 cooling system

If they are placed in the air flow from a fan, these motors are capable of achieving their power rating if the speed of the air between the housing fins and the overall flow rate of the air between the fins comply with the data in the table opposite.

Frame size	2 poles		4 poles		6 poles and above	
	flow rate m^3/h	speed m/s	flow rate m^3/h	speed m/s	flow rate m^3/h	speed m/s
80	120	7.5	60	4	40	2.5
90	200	11.5	75	5.5	60	3.5
100	300	15	130	7.5	95	5
112	460	18	200	9	140	6
132	570	21	300	10.5	220	7
160	1000	21	600	12.5	420	9
180	1200	21	900	16	600	10
200	1800	23	1200	16	750	10
225	2000	24	1500	18	1700	13
250	3000	25	2600	20	1700	13
280	3000	25	2600	20	2000	15
315	5000	25	2600	20	2000	15
355	5200	25	2800	20	2200	15
400	5500	25	3000	20	2400	15
450	6000	25	3200	20	2600	15

These air flows are valid for normal working conditions as described in section B2.1.

C4 - Cooling

a) IC 410 cooling system

Used for general applications without cooling, these motors will provide the output powers given in the table below (if this is the case, their internal design is suited to the power provided, for an ambient temperature of 40°C and a temperature rise corresponding to insulation class F).

Non-ventilated three-phase induction motors - 50 Hz - IC 410 (temperature rise class F)

Power kW	No. of poles 2 poles	No. of poles 4 poles	No. of poles 6 poles	No. of poles 8 poles
0.18	-	-	FLS 80 L	FLS 90 L
0.25	-	FLS 80 L	FLS 80 L	FLS 90 L
0.37	FLS 80 L	FLS 80 L	FLS 90 L	FLS 100 LK
0.55	FLS 80 L	FLS 90 S	FLS 90 L	FLS 100 LK
0.75	FLS 80 L	FLS 90 L	FLS 100 LK	FLS 112 M
0.9	FLS 90 L	FLS 90 L	-	-
1.1	FLS 90 L	FLS 100 LK	FLS 112 M	FLS 132 S
1.5	FLS 100 LK	FLS 112 M	FLS 112 M	FLS 132 M
1.85	FLS 112 M	FLS 112 M	FLS 132 M	FLS 160 MB
2.2	FLS 112 M	FLS 112 M	FLS 132 M	FLS 160 L
3	FLS 132 S	FLS 132 M	FLS 160 L	FLS 180 L
3.7	-	-	FLS 160 L	FLS 180 L
4	FLS 132 M	FLS 132 M	FLS 180 L	FLS 200 L
5.5	FLS 160 L	FLS 180 MR	FLS 200 LA	FLS 225 ST
7.5	FLS 180 MR	FLS 180 L	FLS 225 M	FLS 225 M
11	FLS 200 L	FLS 200 L	FLS 250 L	FLS 280 S
15	FLS 225 MT	FLS 225 M	FLS 280 S	FLS 280 M
18.5	FLS 250 M	FLS 250 M	FLS 280 M	FLS 315 ST
22	FLS 280 S	FLS 280 S	FLS 315 ST	FLS 315 M
30	FLS 280 M	FLS 280 M	FLS 315 M	FLS 315 LA
37	FLS 315 ST	FLS 315 ST	FLS 315 LA	FLS 315 LB
45	FLS 315 M	FLS 315 M	FLS 315 LB	FLS 355 LA
55	FLS 315 LA	FLS 315 LA	FLS 355 LA	FLS 355 LB
75	FLS 355 LA	FLS 355 LA	FLS 355 LB	FLS 400 LA
90	FLS 355 LB	FLS 355 LB	FLS 355 LD	FLS 400 LB
110	FLS 355 LD	FLS 355 LD	FLS 400 LA	FLS 450 LA
132	FLS 355 LD	FLS 355 LD	FLS 400 LB	FLS 450 LB
160	-	FLS 400 LB	FLS 450 LB	-
200	-	FLS 450 LB	-	-

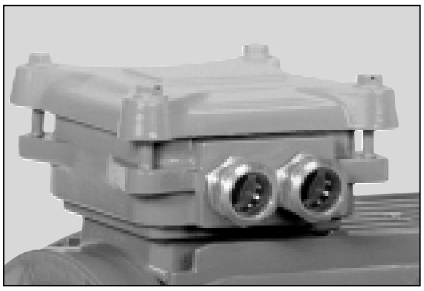
Dimensions: see pages 99 to 105

C5 - Mains connection

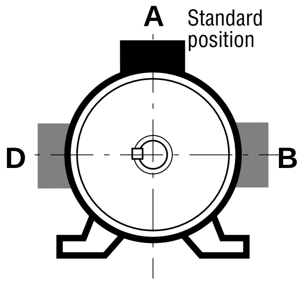
C5.1 - TERMINAL BOX

Placed as standard on the top of the motor near the drive end, the terminal box has IP 55 protection and is fitted with a cable gland (see table in C5.2).

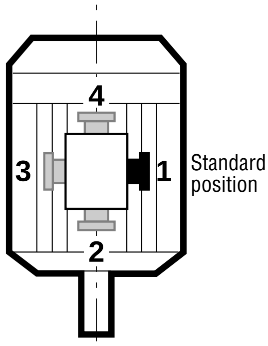
The standard position of the cable gland is on the right, seen from the drive end but, owing to the symmetrical construction of the box, it can usually be placed in any of the 4 directions (see table opposite).



▼ Positions of the terminal box in relation to the drive end (motor in IM 1001 position)



▼ Positions of the cable gland in relation to the drive end



Position 2 not recommended (not possible on standard FF flange-mounted motor)

Terminal box position	A	B	D
FLS 80 to 132	●	-	-
FLS 160 to 225 MT	●	❍	-
FLS 225 M to 450	●	●	●*

● : standard ● : fixed-price option ❍ : to estimate only - : not available

N.B. : The FLS 355 LK, 400 and 450 are fitted with an auxiliary terminal box on the non drive end, which must remain in the axis of the main terminal box.

* except the FLS 315 ST

Cable gland position	1	2	3	4
Foot-mounted motor				
FLS 80 to 355 L	●	●	●	●
FLS 355 LK to 450	●	-	●	-
FT face-mounted motor				
FLS 80 to 132	●	❍	●	●
FF flange-mounted motor				
FLS 80 to 355 L	●	❍	●	●
FLS 355 LK to 450	●	-	●	-

● : standard ● : possible by simply removing the terminal box
❍ : ask for estimate - : not available

C5.1.1 - Flying leads

According to specification, motors can be supplied with flying leads or multicore cables. Please state cable characteristics (type and supplier, cross-section, length, number of conductors), connection method (on stator coil end turns, or on a separate panel), and the cable gland position required.

C5.2 - TABLE OF TERMINAL BOXES AND CABLE GLANDS FOR RATED SUPPLY VOLTAGE OF 360 to 480V (according to EN 50262)

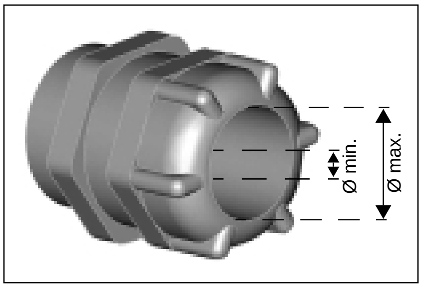
Frame size	Single-speed motor		Two-speed motor		Cable gland for accessories: PTO / PTF / etc
	D.O.L. starting	YΔ starting	2 windings	1 winding	
80	ISO 20	-	2 x ISO 20	ISO 20	ISO 16
90	ISO 20	-	2 x ISO 20	ISO 20	ISO 16
100 LK	ISO 20	ISO 20	2 x ISO 20	ISO 20	ISO 16
112 / 132 S	ISO 20	ISO 20	2 x ISO 20	ISO 20	ISO 16
132 M	ISO 25	ISO 25	2 x ISO 25	ISO 25	ISO 16
160 / 180 MR	1 x ISO 25	2 x ISO 25	2 x ISO 25	2 x ISO 25	ISO 16
180	1 x ISO 32	2 x ISO 32	2 x ISO 32	2 x ISO 32	ISO 16
200	1 x ISO 32	2 x ISO 32	2 x ISO 32	2 x ISO 32	ISO 16
225 ST/MT	1 x ISO 40	2 x ISO 40	2 x ISO 40	2 x ISO 40	ISO 16
225 M / 250 / 280	Motors supplied with an undrilled cable gland mounting plate, without nozzle or cable gland[1]				ISO 16
315 to 355 LD	Motors supplied with an undrilled cable gland mounting plate, without nozzle or cable gland[1]				ISO 16
355 LK to 450	Motors supplied with an undrilled cable gland mounting plate, without nozzle or cable gland[1]				ISO 16

- standard cable gland material: polyamide 6/6 up to and including size 250.
- on request, special brass or stainless steel cable glands can be fitted.

1. For frame sizes 225 M to 450, the cable gland mounting plates are supplied without cable glands or drill holes. In order to receive them with drill holes and fitted with cable glands if required, you should specify the number of cables, their diameter and the type of cable gland required on your order.

Tightening capacity of cable glands
(NFC 68 311 and 312 standards)

Type of cable gland	Min. cable Ø - Max. cable Ø (mm)	
	Polyamide cable gland	Brass cable gland
ISO 16	6 - 10	5.5 - 9.5
ISO 20	10 - 15	8.5 - 13
ISO 25	13 - 19	12 - 17
ISO 32	17 - 25	15 - 22
ISO 40	24 - 32	19.5 - 28



C5 - Mains connection

C5.3 - TERMINAL BLOCKS - DIRECTION OF ROTATION

The motors are fitted with a block of six terminals complying with standard NFC 51 120, with the terminal markings complying with IEC 60034-8 (or NFEN 60034-8).

N.B. : Motors of frame size 355 LK, 400 and 450 are fitted with twelve M 14 terminals linked in pairs. The wiring diagram therefore remains the same.

When the motor is running in U1, V1, W1 or 1U, 1V, 1W from a direct mains supply L1, L2, L3, it turns clockwise when seen from the drive shaft end.

If any two of the phases are changed over, the motor will run in an anti-clockwise direction (make sure that the motor has been designed to run in both directions).

Motor type	Terminals
FLS 80 to 112 M	M5
FLS 132 S to 160 L	M6
FLS 180 MR	M6
FLS 180 L	M8
FLS 200	M8
FLS 225 ST-MT	M8
FLS 225 M	M10
FLS 250	M10

If the motor is fitted with thermal protection or space heaters, these are connected and labelled in the main terminal box up to the 355 LD, and in an auxiliary box from the 355 LK to the 450.

Motor type	Terminals
FLS 280	M12
FLS 315	M12
FLS 355 L	M12
FLS 355 LK	M14
FLS 400 L	M14
FLS 400 LK	M14
FLS 450 L	M14

Tightening torque for the nuts on the terminal blocks ▼

Terminal	M4	M5	M6	M8	M10	M12	M14
Torque N.m	2	3.2	5	10	20	35	50

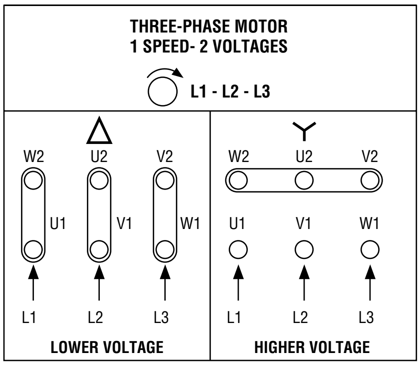
C5.4 - WIRING DIAGRAMS

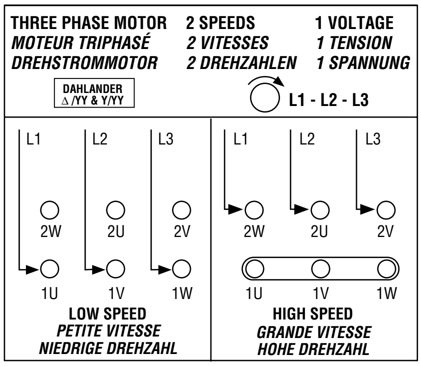
All motors are supplied with a wiring diagram in the terminal box.

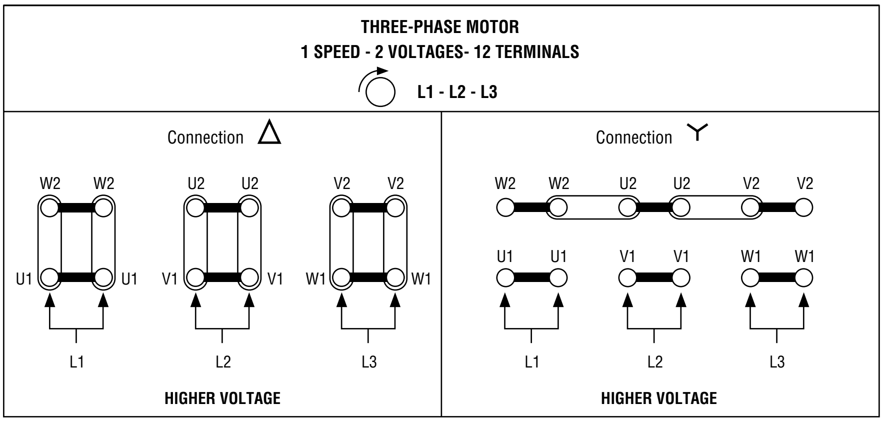
The diagrams normally used are shown opposite.

On the following pages are outline diagrams with internal and external connections.

N.B. : Motors of frame size 355 LK, 400 and 450 are fitted with twelve M 14 terminals linked in pairs. The wiring diagram therefore remains the same.







C5.5 - EARTH TERMINALS

One is located inside the terminal box and the other on one of the feet or one of the cooling fins.

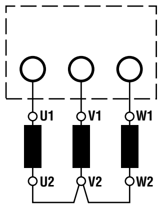
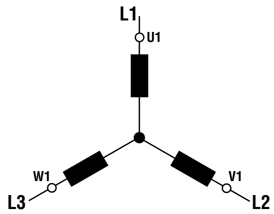
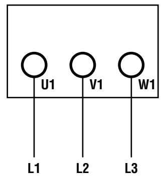
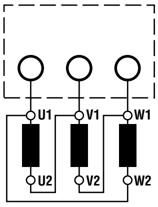
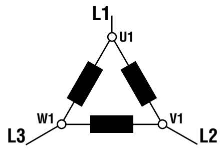
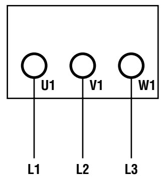
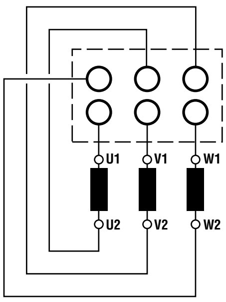
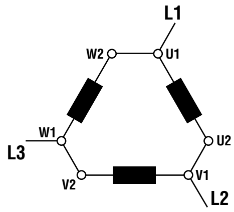
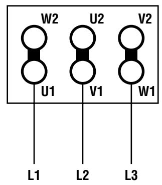
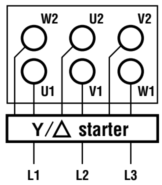
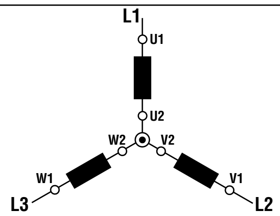
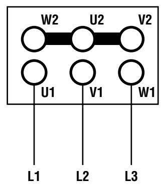
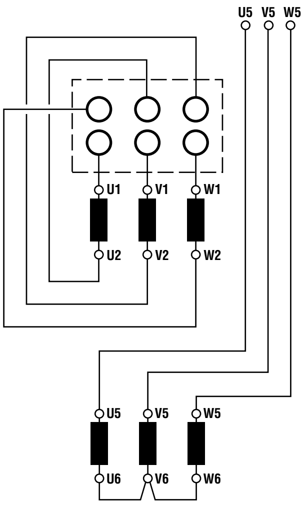
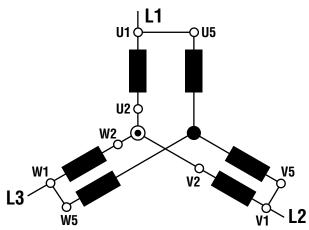
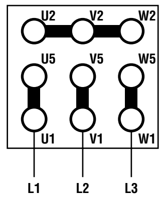
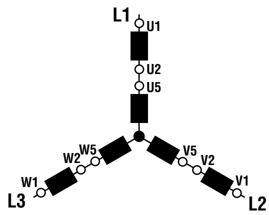
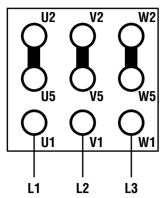
A threaded stud with a hexagonal nut is used to connect cables with cross-sections at least as large as the cross-section of the phase conductors.

It is indicated by the sign: ⏚ in the terminal box moulding and on the foot or fin.

3-phase TEFV induction motors FLS cast iron Construction

C6 - Motor connections

Single-speed motors

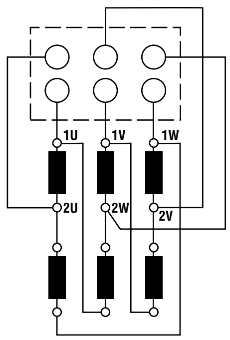
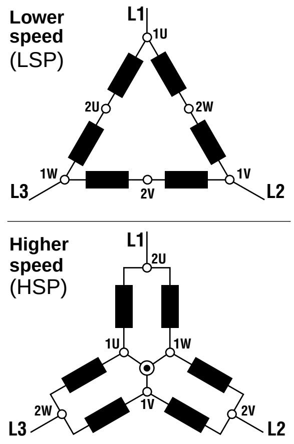
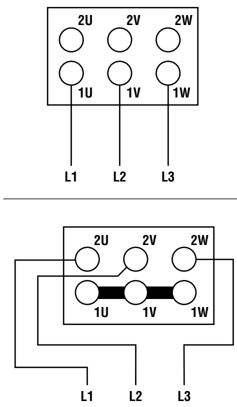
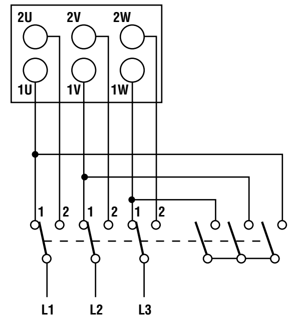
Voltages and connection	Internal connection diagrams	Outline diagrams	External connection diagrams	
			D.O.L. starting	Y / Δ starting
Single-voltage motors (3 TERMINALS)				
- Voltage: U - Connection: Y internal e.g. 400 V / Y				—
- Voltage: U - Connection: Δ internal e.g. 400 V / Δ				—
Dual-voltage motors with Y, Δ connections (6 TERMINALS)				
- Voltage: U - Connection Δ (at lower marked voltage) e.g. 230 V / Δ				
- Voltage: U.√3 - Connection Y (at higher marked voltage) e.g. 400 V / Y				—
Dual-voltage motors with series-parallel connections (9 TERMINALS)				
- Voltage: U - Connection Y Y (at lower marked voltage) e.g. 230 V / Y Y				—
- Voltage: 2 U - Connection Y (series-star (at higher marked voltage) e.g. 460 V / Y				—

C6 - Motor connections

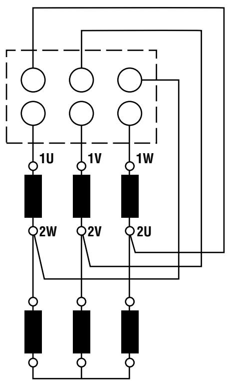
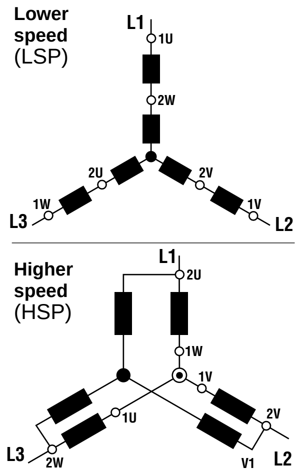
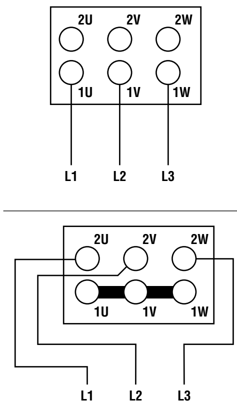
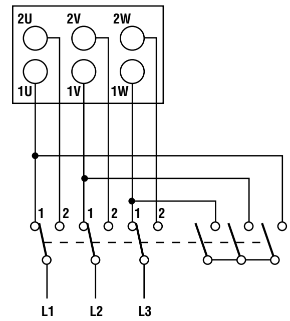
Two-speed motors

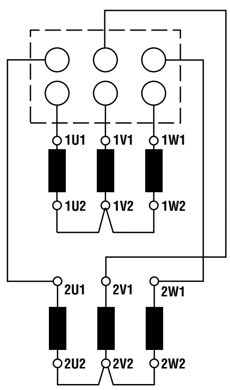
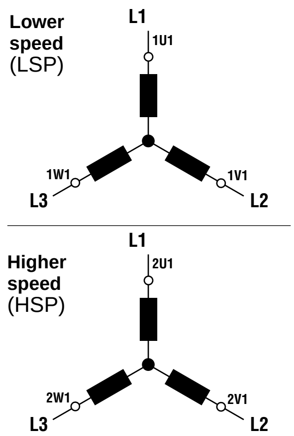
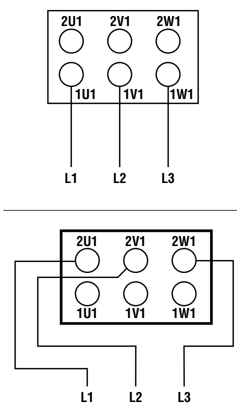
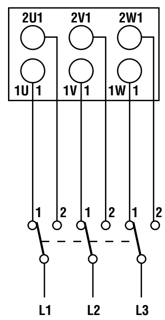
<table>
<tr><th rowspan="2">Voltages and connection</th><th rowspan="2">Internal connection diagrams</th><th rowspan="2">Outline diagrams</th><th colspan="2">External connection diagrams</th></tr>
<tr><th>Manually operated</th><th>Switch operated</th></tr>
<tr><th colspan="5">Single-voltage motors (6 TERMINALS)</th></tr>
<tr><td>Dahlander "constant torque" or "normal use"

6 terminals
(Δ internal)

Δ - Y Y</td><td></td><td></td><td></td><td>LSP
(HSP for 2 contacts)</td></tr>
<tr><td>Dahlander or PAM centrifugal machines

6 terminals
(Y internal)

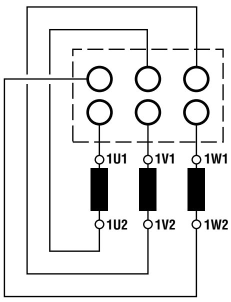
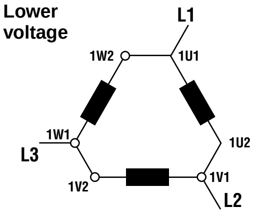
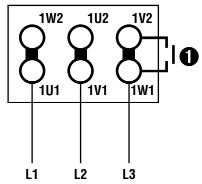
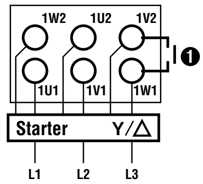
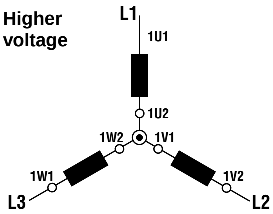
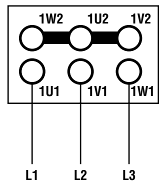
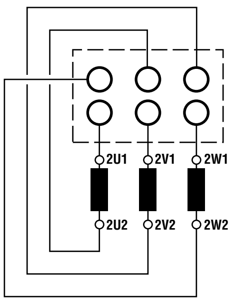
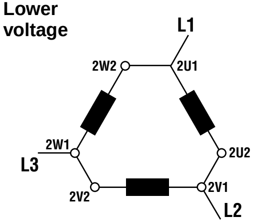
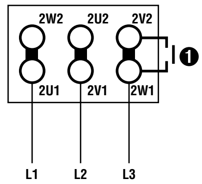
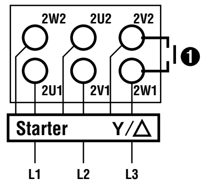
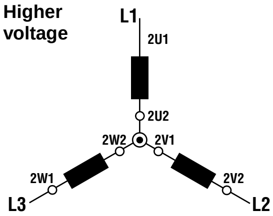
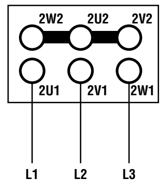
Y - Y Y</td><td></td><td></td><td></td><td>LSP
(HSP for 2 contacts)</td></tr>
<tr><td>Two separate windings

2 x 3 terminals
(Y internal)</td><td></td><td></td><td></td><td>LSP
(HSP for 2 contacts)</td></tr>
</table>

Note: the standardized markings appear on the cables coming from the stator windings.

C6 - Motor connections

Two-speed motors

Voltages and connection	internal connections diagrams	Outline diagrams	External connection diagrams – D.O.L. starting	External connection diagrams – Y / ∆ starting
Dual-voltage motors with Y, ∆ connections (12 TERMINALS)				
- Voltage: U - Connection ∆ (at lower marked voltage) e.g. 230 V / ∆	**Lower speed** (LSP) 	**Lower voltage** 		
- Voltage: U.√3 - Connection Y (at higher marked voltage) e.g. 400 V / Y		**Higher voltage** 		—
- Voltage: U - Connection ∆ (at lower marked voltage) e.g. 230 V / ∆	**Higher speed** (HSP) 	**Lower voltage** 		
- Voltage: U.√3 - Connection Y (at higher marked voltage) e.g. 400 V / Y		**Higher voltage** 		—

It is advisable to open the unused circuit (for the speed not in use) to avoid induced currents.

❶ : safety switch open when machine runs at the second speed.

D1 - Duty cycle - Definitions

Typical duty cycles (according to IEC 60034-1)

The typical duty cycles are described below:

1 - Continuous duty - Type S1

Operation at constant load of sufficient duration for thermal equilibrium to be reached (see figure 1).

2 - Short-time duty - Type S2

Operation at constant load during a given time, less than that required for thermal equilibrium to be reached, followed by a rest and de-energized period of sufficient duration to re-establish machine temperatures within 2 K of the coolant (see figure 2).

3 - Intermittent periodic duty - Type S3

A sequence of identical duty cycles, each consisting of a period of operation at constant load and a rest and de-energized period (see figure 3). Here, the cycle is such that the starting current does not significantly affect the temperature rise (see figure 3).

4 - Intermittent periodic duty with starting - Type S4

A sequence of identical duty cycles, each consisting of a significant starting period, a period of operation at constant load and a rest and de-energized period (see figure 4).

5 - Intermittent periodic duty with electrical braking - Type S5

A sequence of periodic duty cycles, each consisting of a starting period, a period of operation at constant load, a period of rapid electrical braking and a rest and de-energized period (see figure 5).

6 - Periodic continuous duty with intermittent load - Type S6

A sequence of identical duty cycles, each consisting of a period of operation at constant load and a period of operation at no load. There is no rest and de-energized period (see figure 6).

7 - Periodic continuous duty with electrical braking - Type S7

A sequence of identical duty cycles, each consisting of a starting period, a period of operation at constant load and a period of electrical braking. There is no rest and de-energized period (see figure 7).

8 - Periodic continuous duty with related changes of load and speed - Type S8

A sequence of identical duty cycles, each consisting of a period of operation at constant load corresponding to a predetermined rotation speed, followed by one or more periods of operation at other constant loads corresponding to different rotation speeds (in induction motors, this can be done by changing the number of poles). There is no rest and de-energized period (see figure 8).

9 - Duty with non-periodic variations in load and speed - Type S9

This is a duty in which the load and speed generally vary non-periodically within the permissible operating range. This duty frequently includes applied overloads which may be much higher than the full load or loads (see figure 9).

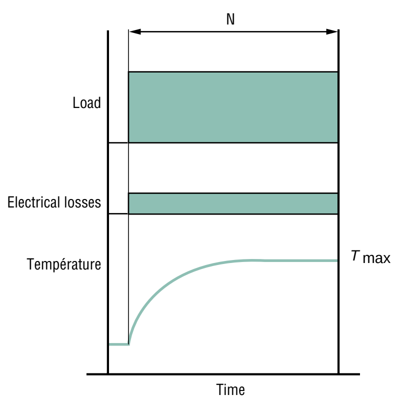
Note - For this type of duty, the appropriate full load values must be used as the basis for calculating overload.

10 - Operation at discrete constant loads - Type S10

This duty consists of a maximum of 4 discrete load values (or equivalent loads), each value being applied for sufficient time for the machine to reach thermal equilibrium. The minimum load during a load cycle may be zero (no-load operation or rest and de-energized period) (see figure 10).

Note: In section D4.6, there is a method for specifying machines in intermittent duty.

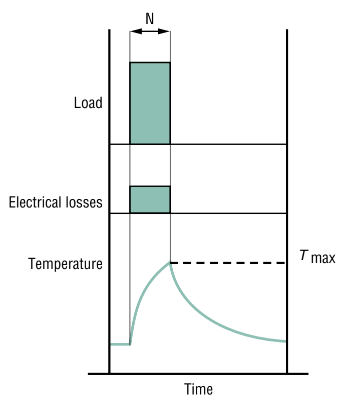
▼ Fig. 1. - Continuous duty, Type S1.



N = operation at constant load

T_{max} = maximum temperature attained

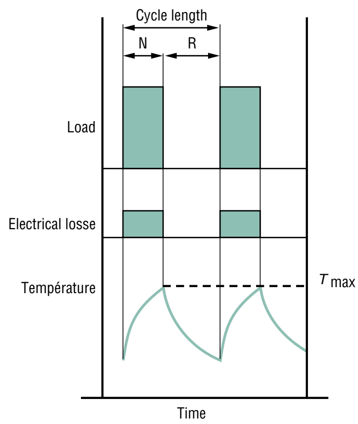
▼ Fig. 2. - Short-time duty, Type S2.



N = operation at constant load

T_{max} = maximum temperature attained

▼ Fig. 3. - Intermittent periodic duty, Type S3.



N = operation at constant load

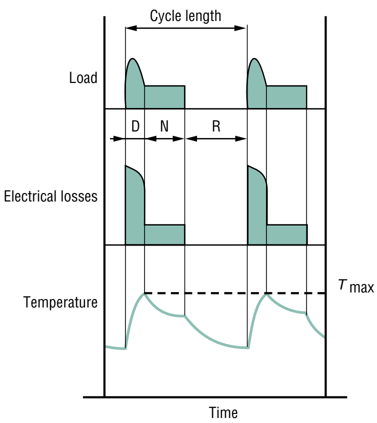
R = rest

T_{max} = maximum temperature attained

$$\text{Operating factor (\%)} = \frac{N}{N + R} \bullet 100\delta$$

D1 - Duty cycle - Definitions

▼ ***Fig. 4. - Intermittent periodic duty with starting, Type S4.***



D = starting

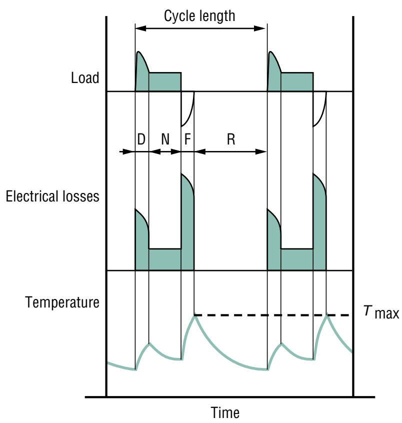
N = operation at constant load

R = rest

T_{max} = maximum temperature attained during cycle

Operating factor (%) = $\frac{D + N}{N + R + D} \bullet 100$

▼ ***Fig. 5. - Intermittent periodic duty with electrical braking, Type S5.***



D = starting

N = operation at constant load

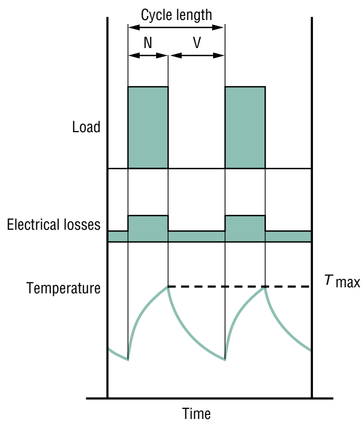
F = electrical braking

R = rest

T_{max} = maximum temperature attained during cycle

Operating factor (%) = $\frac{D + N + F}{D + N + F + R} \bullet 100$

▼ ***Fig. 6. - Periodic continuous duty with intermittent load, Type S6.***



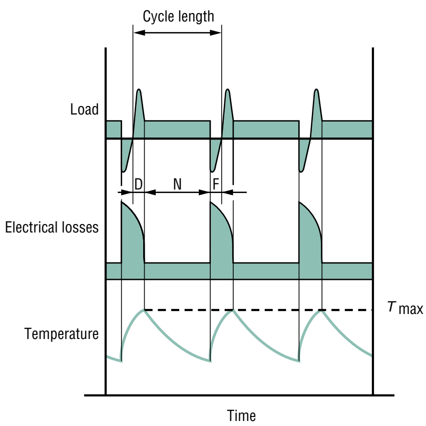
N = operation at constant load

V = no-load operation

T_{max} = maximum temperature attained during cycle

Operating factor (%) = $\frac{N}{N + V} \bullet 100$

▼ ***Fig. 7. - Periodic continuous duty with electrical braking, Type S7.***



D = starting

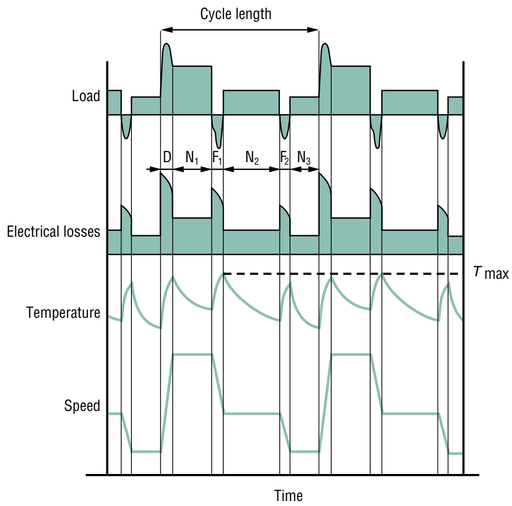
N = operation at constant load

F = electrical braking

T_{max} = maximum temperature attained during cycle

Operating factor = 1

▼ ***Fig. 8. - Periodic continuous duty with related changes of load and speed, Type S8.***



F_1F_2 = electrical braking

D = starting

$N_1N_2N_3$ = operation at constant loads.

T_{max} = maximum temperature attained during cycle

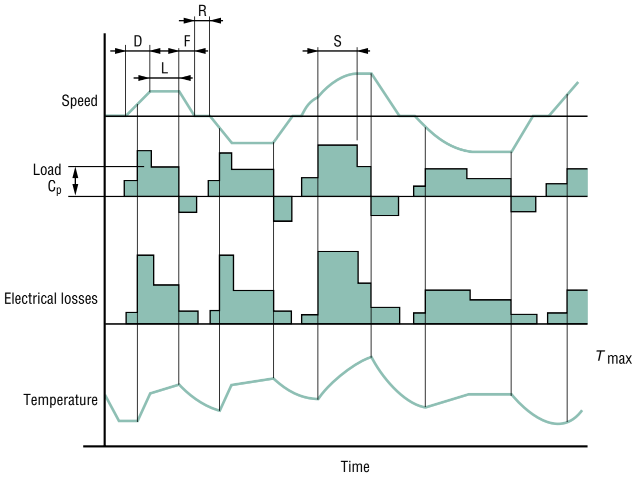
Operating factor = $\frac{D + N_1}{D + N_1 + F_1 + N_2 + F_2 + N_3}$ 100 %

$\frac{F_1 + N_2}{D + N_1 + F_1 + N_2 + F_2 + N_3}$ 100 %

$\frac{F_2 + N_3}{D + N_1 + F_1 + N_2 + F_2 + N_3}$ 100 %

D1 - Duty cycle - Definitions

▼ ***Fig. 9. - Duty with non-periodic variations in load and speed, Type S9.***



D = starting

L = operation at variable loads

F = electrical braking

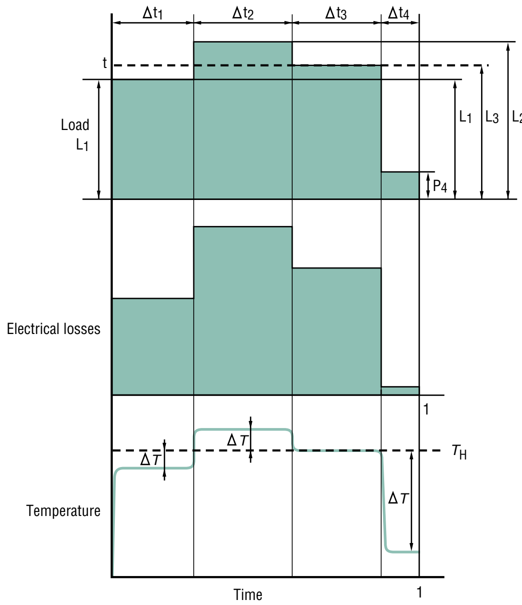
R = rest

S = operation at overload

C_p = full load

T_{max} = maximum temperature attained.

▼ ***Fig. 10 - Duty at discrete constant loads, Type S10.***



L = load

N = power rating for duty type S1

p = $p / \frac{L}{N}$ = reduced load

t = time

T_p = total cycle time

t_i = discrete period within a cycle

Δt_i = t_i / T_p = relative duration of period within a cycle

Pu = electrical losses

H_N = temperature at power rating for duty type S1

ΔH_i = increase or decrease in temperature rise at the ith period of a cycle

Power is determined according to duty cycle. See section D4.6.

D2 - Supply voltage

D2.1 - REGULATIONS AND STANDARDS

The statement by the electricity consultative committee dated 25th June 1982, and the 6th edition (1983) of publication No. 38 of the International Electrotechnical Committee (IEC) have laid down time scales for the harmonisation of standard voltages in Europe.
Since 1998, voltages at the point of delivery have to be maintained between the following extreme values:

- ***Single-phase current: 207 to 244 V***
- ***Three-phase current: 358 to 423 V***

The IEC 60038 standard gives the European reference voltage as 230/400 V three-phase and 230 V single-phase, with a tolerance of +6% to -10% until 2003 and ±10% from then on.

The tolerances usually permitted for power supply sources are indicated below:

• Maximum line drop between customer delivery point and customer usage point: 4%.

• Variation in frequency around nominal frequency:
- continuous state : ±1%
- transient state : ±2%

• Three-phase mains phase-balance error:
- zero-sequence component and/or negative phase sequence component compared to positive phase sequence component: < 2%

• Harmonics:
- relative harmonic content: <10%
- individual harmonic voltages:
to be established

• Surges and transient power cuts: to be established

The motors in this catalogue are designed for use on the European power supply of 230/400 V ±10% - 50 Hz.

This means that the same motor can operate on the following existing supplies:
- 220/380 V ±5%
- 230/400 V ±5% and ±10%
- 240/415 V ± 5%

and is therefore suitable for a large number of countries worldwide where for example it is possible to extend them to some 60 Hz supplies:
- 265/460 V ± 10%

From 2008, 380 and 415 V - 50 Hz voltage supplies must be eliminated.

D2 - Supply voltage

230 / 400 V

SECTION TWO - TABLES OF STANDARD VOLTAGES

Table 1 – A.C. systems having a nominal voltage between 100V and 1000V inclusive and related equipment

In the following table, the three-phase, four-wire systems and single-phase three-wire systems include single-phase circuits (extensions, services, etc.) connected to these systems.

The lower values in the first and second columns are voltages to neutral and the higher values are voltages between phases. When one value only is indicated, it refers to three-wire systems and specifies the voltage between phases. The lower value in the third column is the voltage to neutral and the higher value is the voltage between lines.

The voltages in excess of 230/400 V are intended exclusively for heavy industrial applications and large commercial premises.

Three-phase 3- or 4-wire systems		Single-phase 3-wire systems
Nominal voltage (V)		Tension nominale (V)
50 Hz	60 Hz	60 Hz
—	120/208	120/240
—	240	—
230/400 [1)]	277/480	—
400/690 [1)]	480	—
—	347/600	—
1 000	600	—

1) The nominal voltage of existing 220/380 V and 240/415 V systems should evolve towards the recommended value of 230/400 V. The transition period should be as short as possible and should not exceed the year 2003. During this period, as a first step, the electricity supply authorities of countries having 220/380 V systems should bring the voltage within the range 230/400 V +6%, -10% and those of countries having 240/415 V systems should bring the voltage within the range 230/400V +10%, -6%. At the end of this transition period the tolerance of 230/400 V ±10% should have been achieved ; reduction of this range should be envisaged thereafter. All the above considerations apply also to the present 370/600 V value with respect to the recommended value 400/690 V.

Under normal system conditions it is recommended that the voltage at the point of delivery should not differ from the nominal voltage by more than ± 10 %.

D2.2 - EFFECTS ON MOTOR PERFORMANCE

D2.2.1 - Voltage range

The characteristics of motors will of course vary with a corresponding variation in voltage of ±10% around the rated value.

An approximation of these variations is given in the table opposite (precise values for each motor can be supplied on request).

	Voltage variation as a %				
	UN-10%	UN-5%	UN	UN+5%	UN+10%
Torque curve	0.81	0.90	1	1.10	1.21
Slip	1.23	1.11	1	0.91	0.83
Rated current	1.10	1.05	1	0.98	0.98
Rated efficiency	0.97	0.98	1	1.00	0.98
Rated power factor (Cos φ)	1.03	1.02	1	0.97	0.94
Starting current	0.90	0.95	1	1.05	1.10
Nominal temperature rise	1.18	1.05*	1	1*	1.10
P (Watt) no-load	0.85	0.92	1	1.12	1.25
Q (reactive V A) no-load	0.81	0.9	1	1.1	1.21

* According to standard IEC 60034-1, the additional temperature rise must not exceed 10 K within ±5% of UN.

D2 - Supply voltage

D2.2.2 - Simultaneous variation of voltage and frequency

Within the tolerances defined in IEC guide 106, machine input and performance are unaffected if the variations are of the same polarity and the voltage/frequency ratio U/f remains constant.

If this is not the case, variations in performance are significant and require the machine specification to be changed.

Variation in main motor parameters (approx.) within the limits defined in IEC Guide 106.

U/f	Pu	M	N	Cos φ	Efficiency
Constant	$Pu\frac{f'}{f}$	M	$N\frac{f'}{f}$	cos φ unchanged	Efficiency unchanged
Variable	$Pu\frac{f'}{f}\left(\frac{u'}{u}\right)^2$	$M\left(\frac{u'/u}{f/f'}\right)^2$	$N\frac{f'}{f}$	Depends on level of saturation of machine	

M = minimum and maximum values of starting torque.

D2.2.3 - Use of 400V - 50 Hz motors on 460V - 60 Hz supplies

For a rated power at 60 Hz 15 to 20% greater than the rated power at 50 Hz (see section E), the main characteristics are modified according to the following variations, which necessitate replating of the motor:

- Efficiency increases by 0.5 - 3%
- Power factor increases by 0.5 - 3%
- Rated current decreases by 0 - 5%
- I_D / I_N increases by around 10%
- Slip and rated torque M_N, M_D / M_N, M_M / M_N remain more or less constant

VERY IMPORTANT NOTE:

The motors defined in this catalogue which can be used with a 60 Hz supply, will NOT CONFORM with CSA or UL standards. To conform with these standards, a different type of construction is needed.

D2.2.4 - Motors powered by a 500V - 50 Hz supply

Motors powered by this supply and Y or Δ connected are a special type of construction and a quotation should be obtained from Leroy-Somer. Their characteristics with regard to speed, efficiency, cos φ, M_D / M_N and I_D / I_N are almost unchanged. Only the current varies in the voltage ratio for a given power. Exact values will be supplied with the quotation.

D2.2.5 - Phase voltage imbalance

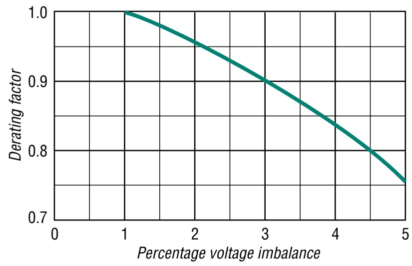
The phase imbalance for voltage is calculated as follows:

$$\%\ \text{voltage imbalance} = 100 \times \frac{\text{maximum difference in voltage compared to average voltage value}}{\text{average voltage value}}$$

The effect on motor performance is summarized in the table opposite.

If this imbalance is known before the motor is purchased, it is advisable, in order to establish the type of motor required, to apply the derating specified in standard IEC 60892, illustrated on the graph opposite.

Percentage imbalance	0	2	3.5	5
Stator current	100	101	104	107.5
% increase in losses	0	4	12.5	25
Temperature rise	1	1.05	1.14	1.28

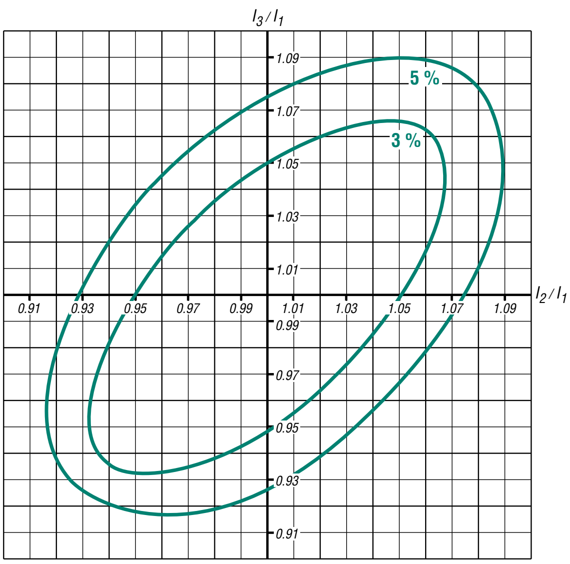


D2.2.6 - Phase current imbalance

Voltage imbalances induce current imbalances. Natural lack of symmetry due to manufacture also induces current imbalances.

The chart opposite shows the ratios in which the negative phase component is equal to 5% (and 3%) of the positive phase components in three-phase current supplies without zero components (neutral absent or not connected).

Inside the curve, the negative phase component is lower than 5% (and 3%).



D3 - Insulation class - Temperature rise and thermal reserve

Insulation class

The machines in this catalogue have been designed with a class F insulation system for the windings.

Class F allows for temperature rises of 105 K (measured by the resistance variation method) and maximum temperatures at the hot spots in the machine of 155 °C (Ref. IEC 60085 and IEC 60034-1).

Complete impregnation with tropicalized varnish of thermal class 180 °C gives protection against attacks from the environment, such as: 90% relative humidity, interference, etc.

For special constructions, the winding is class H and impregnated with special varnishes which enable it to operate in conditions of high temperatures with relative air humidity of up to 100%.

Temperature rise (ΔT*) and maximum temperatures at hot spots (T_{max}) for insulation classes (IEC 60034 - 1).

	ΔT*	T_{max}
Class B	80 K	130°C
Class F	105 K	155°C
Class H	125 K	180°C

* Measured using the winding resistance variation method.

The insulation of the windings is monitored in two ways:

a - Dielectric inspection which involves checking the leakage current, at an applied voltage of (2U + 1000) V, in conditions complying with standard IEC 60034-1 (systematic test).

b - Monitoring the insulation resistance between the windings and between the windings and the earth (sampling test) at a D.C. voltage of 500V or 1000V.

Temperature rise and thermal reserve

LEROY-SOMER motors are built to have a maximum winding temperature rise of 80 K under normal operating conditions (ambient temperature 40 °C, altitude below 1000 m, rated voltage and frequency, rated load).

Running at the voltage limit (± 10% of U_N) will induce overheating of less than 15 K.

In IEC 60034-1 and 60034-2, temperature rise ($\Delta\theta$) is calculated using the winding resistance variation method, with the formula:

$$\Delta T = \frac{R_2 - R_1}{R_1}(235 + T_1) + (T_1 - T_2)$$

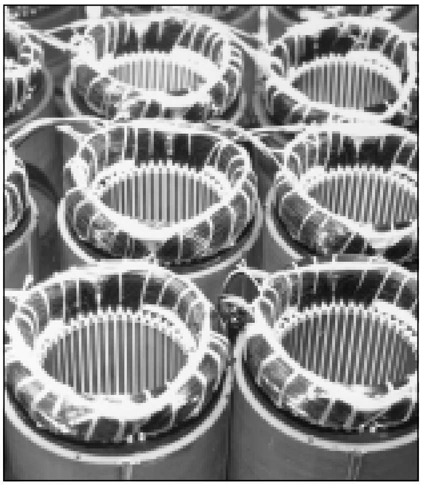
R_1 : cold resistance measured at ambient temperature T_1

R_2 : stabilized hot resistance measured at ambient temperature T_2

235 : coefficient for a copper winding (for an aluminium winding, the coefficient is 225)

The result is a thermal reserve linked to the following factors:

- **a difference of 25 K between the nominal temperature rise (Un, fn, Pn) and the permissible temperature rise (105 K) for class F insulation.**
- **a difference of over 20 K at the voltage limits (Un ± 10%) between the actual temperature rise and the permissible temperature rise.**



D

D4 - Power - Torque - Efficiency - Power Factor (Cos φ)

D4.1 - DEFINITIONS

The output power (Pu) at the motor shaft is linked to the torque (M) by the equation:

$$Pu = M.\omega$$

where Pu is in W, M is in N.m, ω is in rad/s and where ω is expressed as a function of the speed of rotation in min^{-1} by the equation:

$$\omega = 2\pi.N/60$$

The active power (P) drawn from the mains is expressed as a function of the apparent power (S) and the reactive power (Q) by the equation:

$$S = \sqrt{P^2 + Q^2}$$

(S in VA, P in W and Q in VAR)

The power P is linked to the output power Pu by the equation:

$$P = \frac{Pu}{\eta}$$

where η is the efficiency of the machine.

The output power Pu at the motor shaft is expressed as a function of the phase-to-phase mains voltage (U in Volts), of the line current absorbed (I in Amps) by the equation:

$$Pu = U.I.\ \sqrt{3}\ .\ \cos\varphi\ .\ \eta$$

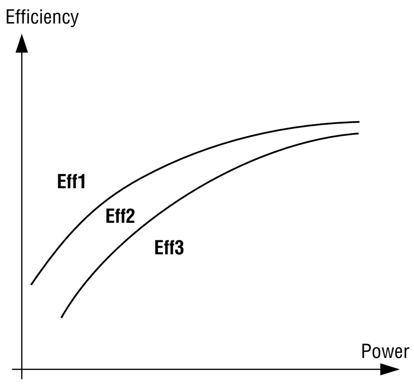
where cosφ is the power factor found from the ratio:

$$\cos\varphi = \frac{P}{S}$$

D4.2 - EFFICIENCY

In accordance with the agreements signed at the RIO and BUENOS AIRES INTERNATIONAL CONFERENCES, **the new generation of motors with aluminium or cast iron frame** has been designed to improve efficiency by reducing atmospheric pollution (carbon dioxide).

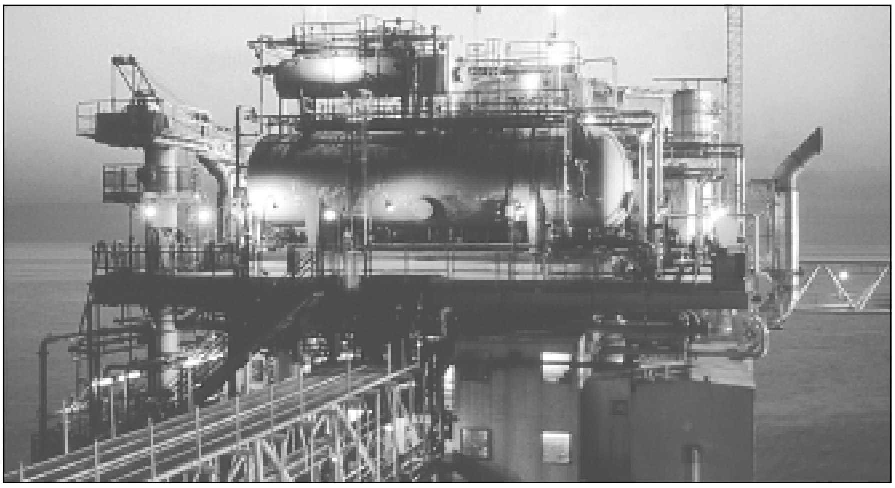
The improvement in efficiency of low voltage industrial motors (representing around 50% of installed power in industry) has had a large impact on energy consumption.



3 levels of efficiency Eff. 1-2-3 have been defined in a European agreement for 2 and 4-pole motors from 1.1 to 90 kW and this catalogue presents the reference range of FLS(C) Eff 2 motors.

Level Eff 3 in version FLS(C) has not been manufactured for some years now. **The Eff 1 level range is available on request.**

The European recommendation for measuring efficiency recommends testing using the separate losses method (in accordance with IEC 60034-2) on motors not fitted with bearing seals.



The advantages of improvement in efficiency:

Motor characteristics	Effects on the motor	Customer benefits
Increase in efficiency and in power factor.	Increase in specific output power.	Lower operating costs. Longer service life (x2 or 3). Better return on investment.
Noise reduction.		Improved working conditions.
Vibration reduction.		Quiet operation and longer service life of driven controls.
Temperature reduction.	Longer service life of fragile components (insulation system components, greased bearings).	Reduction in operating incidents and reduced maintenance costs.
	Increase in the capacity of instantaneous or extended overloads.	Wider field of applications (voltages, altitude, ambient temperature, etc).

D4.3 - INFLUENCE OF LOAD ON η AND POWER FACTOR COS φ

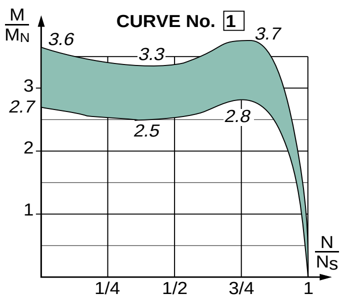
See the selection data in section E.

Overrating motors in a number of applications causes them to operate at about 3/4 load, resulting in optimum motor efficiency.

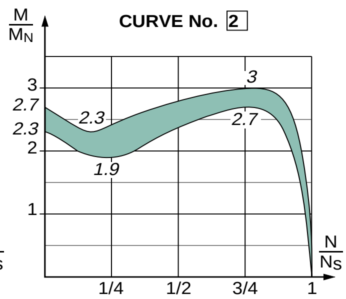
D4 - Power - Torque - Efficiency - Power Factor (Cos φ)

D4.4 - TORQUE-SPEED CHARACTERISTICS

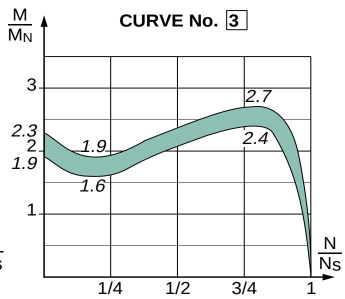
Below are torque/speed curves that correspond to a range of typical cases (different sizes of motor, no. of poles, etc).
M_{mot} is the average starting torque of the motor.
To find the accelerating torque, subtract the average load resistive torque from the average starting torque of the motor.
The curve numbers refer back to the electromagnetic characteristic selection tables in section E.



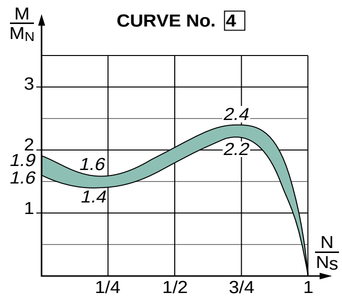
$$2,4 < \frac{M_{mot}}{M_N} < 3,1$$



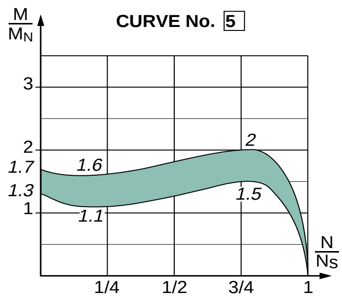
$$2,1 < \frac{M_{mot}}{M_N} < 2,4$$



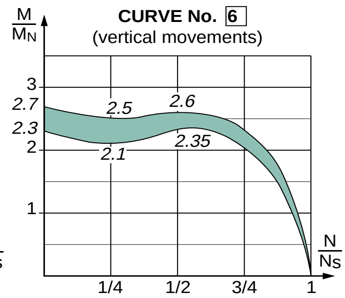
$$1,8 < \frac{M_{mot}}{M_N} < 2,1$$



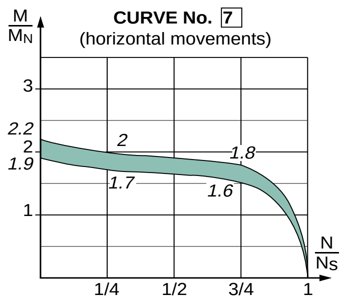
$$1,6 < \frac{M_{mot}}{M_N} < 1,8$$



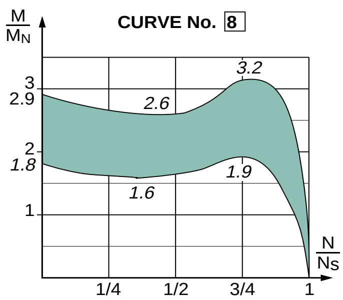
$$1,25 < \frac{M_{mot}}{M_N} < 1,65$$



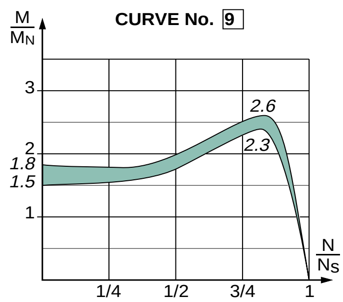
$$2 < \frac{M_{mot}}{M_N} < 2,3$$



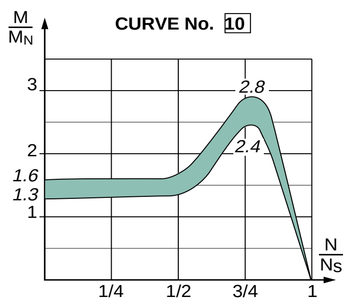
$$1,6 < \frac{M_{mot}}{M_N} < 1,8$$



$$1,6 < \frac{M_{mot}}{M_N} < 2,6$$



$$1,7 < \frac{M_{mot}}{M_N} < 1,9$$



$$1,6 < \frac{M_{mot}}{M_N} < 1,9$$

D4 - Power - Torque - Efficiency - Power Factor (Cos φ)

D4.5 - CALCULATION OF ACCELERATING TORQUE AND STARTING TIME

Acceleration time can be calculated using a simplified formula:

$$t_d = \frac{\pi}{30} \frac{N \cdot J_N}{M_a}$$, where:

t_d : is the acceleration time in seconds

J_N = moment of inertia in kg.m^2 of the motor plus the load corrected, if necessary, to the speed of the shaft that develops the torque M_a

N: speed to be achieved in min^{-1}

M_a or M_{acc} = the average accelerating torque in N.m (average torque developed by the motor during starting, reduced by the average resistive torque during the same period). In general, for centrifugal machines, a very good approximation can be written as follows:

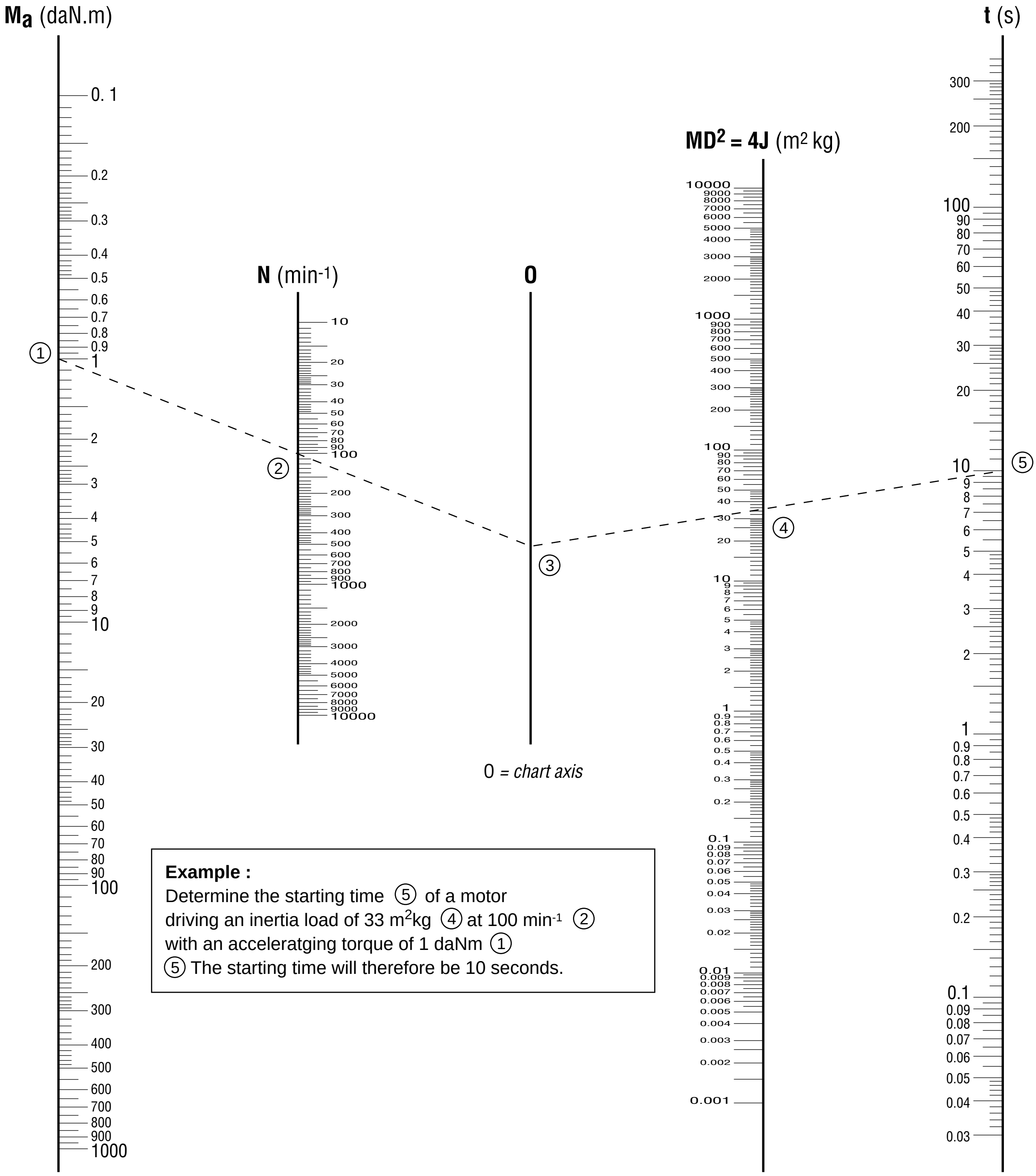
$$M_a = \frac{M_D + 2M_A + 2M_M + M_N}{6} - M_r$$

The chart below may also be used:

Here again is the formula by which the moment of inertia of the driven machine turning at speed N' is equalized with the speed N of the motor.

$$J_N = J_{N'} \cdot \left(\frac{N'}{N}\right)^2$$

▼ ***Starting time calculation chart***



Example :
Determine the starting time ⑤ of a motor driving an inertia load of 33 m^{2}kg ④ at 100 min^{-1} ② with an acceleratging torque of 1 daNm ①
⑤ The starting time will therefore be 10 seconds.

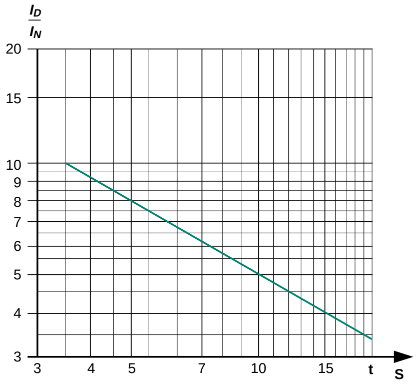
D4 - Power - Torque - Efficiency - Power Factor (Cos φ)

Permissible starting times and locked rotor time

The starting times calculated by using the chart on the previous page must remain within the limits opposite on condition that the number of starts per hour is 6 or less.

Three successive cold starts and two consecutive warm starts are allowed.

Permissible motor starting time for each motor in relation to the ratio I_D / I_N for 6 cold starts/hour. ▶



The table below gives locked rotor times at full voltage (e.g. incident on the transmission) for the motor when warm and when cold (ambient temperature: 40 °C):

Type	2 poles		4 poles		6 poles		8 poles	
	t (cold) s	t (warm) s	t (cold) s	t (warm) s	t (cold) s	t (warm) s	t (cold) s	t (warm) s
FLS 80	8	3	12	6	16	8	18	9
FLS 90	6	3	9	5	18	9	30	11
FLS 100	5	2.5	8	4	20	7	30	11
FLS 112	5	2.5	5	2.5	11	5	25	9
FLS 132	5	2.5	5	2.5	9	4	20	5
FLS 160 M	11	2	14	3	23	4.5	34	7
FLS 160 L	8	2	9	2	17	3.5	31	6
FLS 180 MR	6	1	12	2.5	-	-	-	-
FLS 180 L	-	-	13	2.5	7	1.5	33	6
FLS 200	14	3	15	3	14	2.5	42	8
FLS 225	12	2.5	16	3	20	4	25	5
FLS 250	21	7	15	5	23	7.5	23	7.5
FLS 280	15	5	12	4	16	5.5	23	7.5
FLS 315 ST	20	4	24	5	12	2.5	10	2
FLS 315 M	20	4	12	2.5	17	3.5	15	3
FLS 315 L	30	6	12	2.5	17	3.5	15	3
FLS 355 LA/LB	25	5	12	2.5	15	3	17	3.5
FLS 355 LC/LD	20	4	15	3	15	3	20	4
FLS 355 LK	-	-	30	6	20	4	20	4
FLS 400	-	-	30	6	20	4	20	4
FLS 450	-	-	30	6	20	4	20	4

D4 - Power - Torque - Efficiency - Power Factor (Cos φ)

D4.6 - RATED POWER Pn IN RELATION TO DUTY CYCLE

D4.6.1 - General rules for standard motors

$$P_n = \sqrt{\frac{n \times t_d \times [I_D/I_n \times P]^2 + (3600 - n \times t_d) P_u^2 \times fdm}{3600}}$$

Iterative calculation where:

- t_d(s) starting time of motor with power P(w)
- n number of (equivalent) starts per hour
- OF operating factor (decimal)
- I_D/I_n starting current of motor with power P
- P_u (w) output power of motor during the duty cycle using OF (in decimal), operating factor
- P (w) rated power of motor selected for the calculation

Note: n and OF are defined in section D4.6.2.
Sp = specification

S1	OF = 1; n ≤ 6
S2	; n = 1 length of operation determined by Sp
S3	OF according to Sp; n ~ 0 (temperature rise not affected by starting)
S4	OF according to Sp ; n according to Sp; t_d, P_u, P according to Sp (replace n with 4n in the above formula)
S5	OF according to Sp ; n = n starts + 3 n brakings = 4 n; t_d, P_u, P acc. to Sp (replace n with 4n in the above formula)
S6	$P = \sqrt{\frac{\Sigma(P_i^2 \cdot t_i)}{\Sigma t_i}}$
S7	same formula as S5 but OF = 1
S8	at high speed, same formula as S1 at low speed, same formula as S5
S9	S8 duty formula after complete description of cycle with OF on each speed
S10	same formula as S6

In addition, see the warning regarding precautions to be taken. Variations in voltage and/or frequency greater than standard should also be taken into account. The application should also be taken into account (general at constant torque, centrifugal at quadratic torque, etc).

D4.6.2 - Determination of the power in intermittent duty cycles for adapted motors

rms power in intermittent duty

This is the rated power absorbed by the driven machine, usually defined by the manufacturer.

If the power absorbed by the machine varies during a cycle, the rms power P is calculated using the equation:

$$P = \sqrt{\frac{\Sigma_1^n (P_i^2 \cdot t_i)}{\Sigma_1^n t_i}} = \sqrt{\frac{P_1^2 \cdot t_1 + P_2^2 \cdot t_2 \ldots + P_n^2 \cdot t_n}{t_1 + t_2 + \ldots t_n}}$$

if, during the working time the absorbed power is:

P_1 for period t_1
P_2 for period t_2
\- - - - - - -
P_n for period t_n

Power values lower than 0.5 P_N are replaced by 0.5 $P_N$in the calculation of rms power P (no-load operation is a special case).

Additionally, it is also necessary to check that for a particular motor of power P_N:

- the actual starting time is at most equal to 5 seconds
- the maximum output of the cycle does not exceed twice the rated output power P
- there is still sufficient accelerating torque during the starting period

Load factor (LF)
Expressed as a percentage, this is the ratio of the period of operating time with a load during the cycle to the total duration of the cycle where the motor is energized.

Operating factor (OF)
Expressed as a percentage, this is the ratio of the motor power-up time during the cycle to the total cycle time, provided that the total cycle time is less than 10 minutes.

Starting class
Class: $n = n_D + k.n_F + k'.n_i$
n_D is the number of complete starts per hour
n_F is the number of times electrical braking is applied per hour
"Electrical braking" means any braking directly involving the stator winding or the rotor winding:

- Regenerative braking (with frequency controller, multipole motor, etc)
- Reverse-current braking (the most commonly used)
- D.C. injection braking

ni is the number of impulses (incomplete starts up to one-third of maximum speed) per hour.
k and k' are constants determined as follows:

	k	k'
Cage induction motors	3	0.5

\- Reversing the direction of rotation involves braking (usually electrical) and starting.
\- Braking with LEROY-SOMER electro-mechanical brakes, as with any other brakes that are independent of the motor, does not constitute electrical braking in the sense described above.

Calculating derating

- Input criteria (load)
  - rms power during the cycle = P
  - Moment of inertia corrected to speed of motor = Je
  - Operating factor = OF
  - Class of starts per hour = n
  - Resistive torque during starting = Mr
- Selection in catalogue
  - Motor power rating P_N
  - Starting current I_d, $\cos\varphi_D$
  - Moment of inertia of rotor J_r
  - Average starting torque M_{mot}
  - Efficiency at $P_N(\eta_{PN})$ and at $P(\eta_P)$

Calculations
\- Starting time:

$$t_d = \frac{\pi}{30} \cdot N \cdot \frac{(J_e + J_r)}{M_{mot} - M_r}$$

\- Cumulative starting time per hour:
n x t_d
\- Energy to be dissipated per hour during starts = sum of the energy dissipated in the rotor (= inertia acceleration energy) and the energy dissipated in the stator during the cumulative starting time per hour:

$$E_d = \frac{1}{2}(J_e + J_r)\left(\frac{\pi \cdot N}{30}\right)^2 \times n + n \times t_d \sqrt{3} U I_d \cos\varphi_d$$

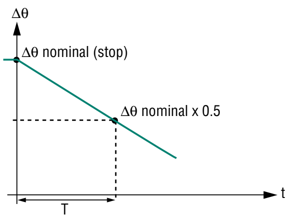
\- Energy to be dissipated during operation
$E_f = P. (1 - \eta_P) . (fdmx3600 - nxt_d)$
\- Energy that the motor can dissipate at rated power with the Operating Factor for Intermittent Duty.
$E_m = (OF)\ 3600 . P_N.(1 - \eta_{PN})$
(The heat dissipated when the motor is at rest can be ignored).
Dimensioning is correct if the following relationship is verified =

$$E_m \geq E_d + E_f$$

If the sum of $E_d + E_f$ is lower than 0.75 E_m check whether a motor with the next lowest power would be more suitable.

D4.6.3 - Equivalent thermal constant

The equivalent thermal constant enables the machine cooling time to be predetermined.



Thermal constant = $\frac{T}{\ln 2}$ = 1.44 T
Cooling curve Δθ = f(t)
where Δθ= temperature rise in S1 duty
T = time required for nominal temperature rise to reach half its value
t = time
ln = natural logarithm

D4.6.4 - Transient overload after operating in type S1 duty cycle

At rated voltage and frequency, the motors can withstand an overload of:
1.20 for an OF = 50 %
1.40 for an OF = 10%
However, it is necessary to ensure that the maximum torque is much greater than 1.5 times the rated torque corresponding to the overload.

LEROY SOMER

D5 - Speed of rotation

D5.1 - SINGLE FIXED SPEED MOTOR

The great majority of applications only require a single fixed speed. If this applies to you, you should opt for a 1500 min^{-1} or possibly 3000 min^{-1} motor (50 Hz supply) which are the ones most frequently used.
However, even with fixed speeds there are two types of application which fall outside the standard speed range of 750 to 3000 min^{-1}.

D5.1.1 - High-speed motor

High-speed motors, operating at speeds of over 3000 min^{-1}, obtained by using supplies with fixed frequencies other than 50 Hz, for example 100, 200 or 400 Hz: the motor will run at a synchronous speed N such that:

$$N = \frac{120}{p} \cdot f$$

(N is in min^{-1}; f is the frequency of the supply in Hz; p is the number of motor poles). Motors of this type have to be specially designed, taking into account the following important points:
- the wave form of the high frequency supply (type of harmonics and total harmonic distortion)
- increased magnetic losses in relation to frequency
- mechanical properties of rotors
- bearing properties, lubrication, lifetime, temperature rises
- ventilation, noise levels, vibrations
- starting current, motor torque, load inertia

It should also be noted that high speed applications are limited to smaller machines: the higher the speed, the smaller the machine must be.

D5.1.2 - Low-speed motor

Low-speed motors, running at under 750 min^{-1}. Low speeds are obtained either by using a supply with a fixed frequency of under 50 Hz, or by using more than 8 poles with a 50 Hz supply. Motors of this type also have to be specially designed to deal with the problems involved in this type of application, such as:
- resistive torque and driven inertia and in the manufacture:
- ventilation

The most widely used fixed frequency (50 Hz) low speeds are 500 min^{-1} (12-pole motor) and 375 min^{-1} (16-pole motor).

D5.2 - MULTIPLE FIXED SPEEDS MOTOR

Some applications require operation at two or three fixed speeds. These can be obtained by changing the poles in a multi-speed motor. There are a large number of solutions, but we shall only look at the following:

D5.2.1 - Motor with single winding

Motors with a single winding (Dahlander connection [speed ratio: 2:1]) or PAM (any speed ratio):
Internal connection of stator windings is used for specific applications:
centrifugal applications { Dahlander Y - Y or Δ - Δ ; PAM - Y
other applications - Dahlander Δ - Y

In general, these motors are designed for D.O.L. starting from the mains supply and are single-voltage.
The most common speed ratios are:
- 3000 / 1500 min^{-1} (2 / 4 poles)
- 1500 / 750 min^{-1} (4 / 8 poles)

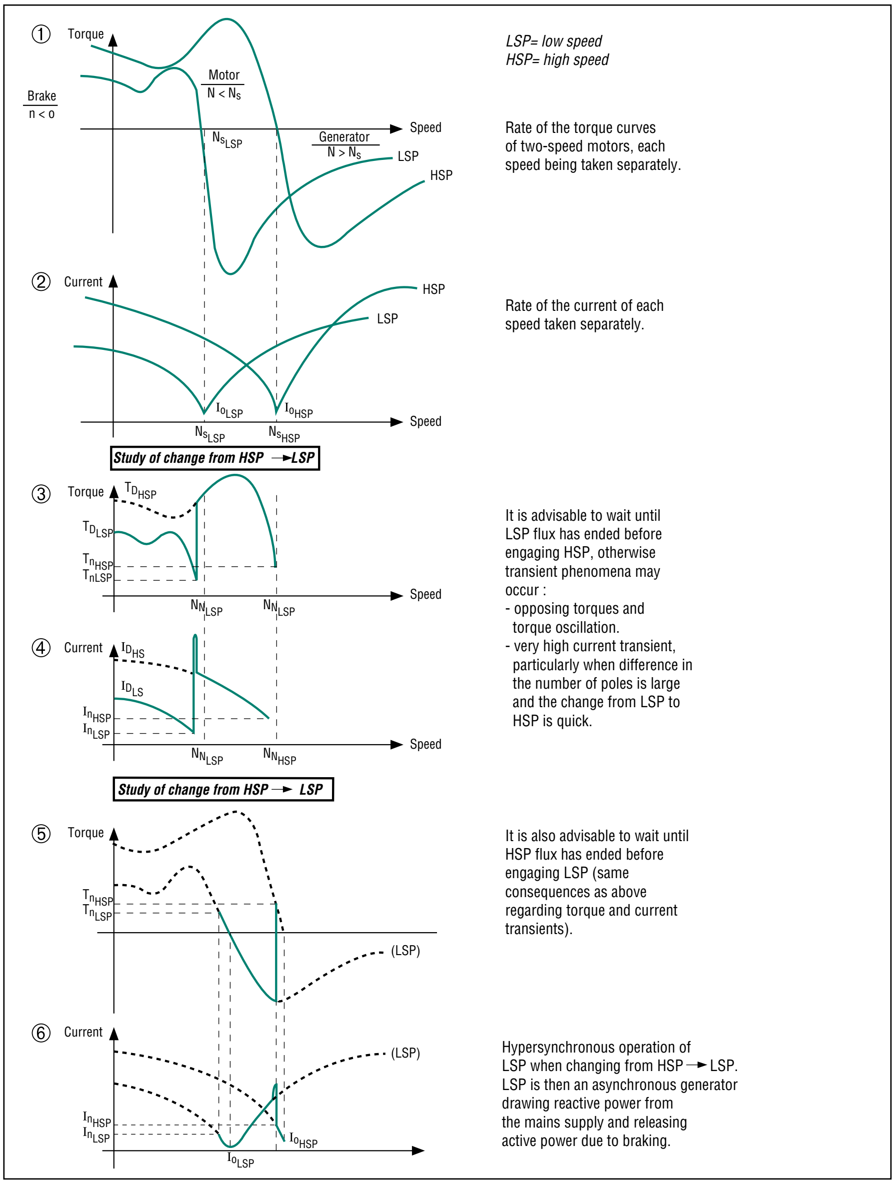
D5.2.2 - Motor with separate windings

Motors with two separate windings. Different starts are obtained depending on the winding connections on the terminal block:
2 x 3 terminals: Direct-On-Line (D.O.L.) starting
2 x 6 terminals: Y / Δ starting possible.

In the first case, these motors will be single-voltage; in the second, they may be either dual-voltage or Y / Δ starting single-voltage motors.
The most common speed ratios are:
- 1000 / 750 min^{-1} (6 / 8 poles)
- 1500 / 1000 min^{-1} (4 / 6 poles)

D5.2.3 - Behaviour of two-speed motors

Each speed of a multi-speed motor behaves like a complete motor (curves ① and ②) with operation as a brake, a motor and an asynchronous generator, depending on the quadrant.



The above curves ③ to ⑥ explain how the torques and currents develop when the motor changes from low speed to high speed and vice versa.

Note: The greater the difference between the number of poles, the more likelihood of:
- significant current peak at LSP
- long braking time and risk of temperature rise at LSP
- high level of hypersynchronous noise

Some of these phenomena can be aggravated if the driven inertia is high.
The rated power is determined according to the criteria in section D4.6.1 for each of the two speeds (see type S8 duty).
Manufacturers' recommendations should be followed regarding devices for connecting to the mains supply and protection, using equipment which has already been examined and for which the problems of transient current peaks have been resolved.

D5 - Speed of rotation

D5.2.4 - Operating rules

A few common-sense rules need to be applied to get the best out of a two-speed motor:

- Avoid large differences in the number of poles (for example 2/12p, 2/16p, 4/20p, etc): the torque drop at high speed occurs at a speed greater than the synchronous speed at low speed. The motor may start to "crawl" and never reach its higher speed rating.
- It is better to start the motor at the lower speed: this effectively eliminates the high speed torque drop, thus reducing the starting time. It will also limit current surge.
- As well as taking the precaution advised in the previous paragraph, current surge can be limited using the advice given in section D8 on "starting". Do bear in mind, though, that not all two-speed motors can be started using the suggested types of starting.
- An important precaution for motors with two separate windings, if the normal connection is a delta, is to "open" the delta for the speed not in use to avoid inducing circulating currents which can create opposing torques and harmful temperature rises.

D5.2.5 - Two-speed motors with connected windings

For ventilation applications, we manufacture two-speed motors by connecting the windings on a single-speed motor:

- High speed by delta connection at full voltage.
- Low speed by star connection at full voltage.

The second speed is obtained because the motor is seriously desaturated (voltage divided by 1.732 at the phase terminals) and the rotor is experiencing a great deal of slip: as a result, there is a significant rotor temperature rise – since all the Joule losses due to the slip are dissipated in it – and risks of significant overheating – by conduction – in the windings if essential derating precautions have not been taken.
In fact, equilibrium is achieved for both speed and temperature rise by means of the following principles:

- The power varies in the same way as the speed power three.
- The slip varies as a function of the output and the temperature rise.

The choice of alloy for the rotor squirrel cage depends on the required output speeds.
When the power absorbed by the fan varies for reasons not related to the selected operating principle – for example, dirt on the fan blades, temperature of the air flow, variation of power supply frequency or voltage, etc. – the temperature rise in the rotor varies and allows speed equilibrium to be regained without making any adjustments (unless the variations exceed the maximum motor torque in the relevant connection).
The immediate consequence of these random conditions is to define the motor according to its load (driven inertia, power, speeds, etc) and to optimize the choice using real tests. The number of poles chosen for these applications should be four poles or more, and the power rating less than 7.5 kW with 4 poles. We do not offer actual motor ranges, but will undertake development work in a technical partnership.

D5.2.6 - Special cases

Motors with more than two speeds have to be specially designed, as, in the majority of cases, the precise nature of the load must be specified.

D5.3 - VARIABLE SPEEDS

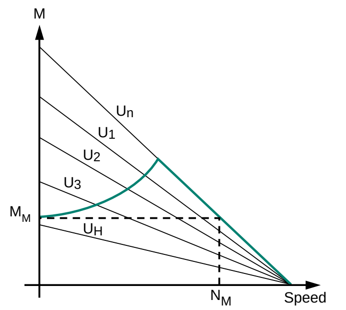
Improvements in manufacturing processes have led to the introduction of variable speed control.
Two different procedures can be used on motors:

- slip variation at fixed frequency
- supply frequency variation

D5.3.1 - Slip variation at fixed frequency

On a motor of a given build, slip other than the rated slip can be obtained by either increasing the load or decreasing the supply voltage.
As an increase in slip is accompanied by increased rotor losses, special rotors have now been designed for use in motors for very specific applications.
The most common application is the high-torque motor with a high-resistance rotor, used with variable voltage, providing constant torque within a specified range of speeds.
These motors have to be specially designed.
The family of curves below shows the variation in motor torque in relation to the supply voltage UN > U1 > U2, etc.
The green curve shows the maximum torque available in relation to speed for a maximum temperature rise for the insulation class in Type S1 duty (normally with forced ventilation).
The dotted curve shows the maximum constant torque available in Type S1 duty in the speed range 0 to NM.
The available powers and torques of these motors in Type S1 duty are much lower than those of standard motors of the same type.

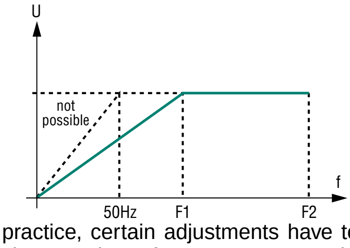
▼ ***Characteristic curves of a high-torque motor***



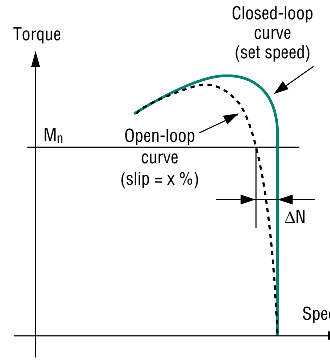
- Family of curves M = f(N) *at different voltages*
- Maximum use in S1 type duty
- M_M *maximum constant torque from 0 to* N_M *in S1 type duty*

D5.3.2 - Frequency variation

In induction motors, variations of speed within a wide range are obtained using a power supply with variable frequency and voltage.
As a general rule, the frequency inverter delivers a proportional voltage and frequency up to a value F_1, which depends on the manufacturer and/or the user, and a fixed voltage up to a maximum frequency value of F_2. In these conditions, the motor output is proportional to the frequency up to the value F_1 (F_1 = frequency where the U/f ratio changes), and then constant up to the value F F_2.



In practice, certain adjustments have to be made. At low frequency, to maintain significant torque, the inverter provides greater saturation of the motor (and thus a higher U value); the value of F1 is itself made variable so as to widen the range of use at constant torque (or at proportional power).
In addition, forced ventilation enhances motor cooling at low speeds and reduces noises levels at high speeds.
In applications where accurate speed regulation is required, the variable speed drive can be used with closed-loop feedback by fitting a speed detector (D.C. tacho, A.C. tacho or encoder) which will send a signal to the inverter to change its U/f ratio and so regulate the speed at the level required (see curve below).



Using induction motors at high speeds (over about 4000 min^{-1}) can be risky. The cage may be damaged, bearing life impaired, as well as vibration and high-frequency saturation leading to heavy losses and significant temperature rises, etc. An in-depth mechanical and electrical design exercise is needed for all high-power machines required to operate at speeds of over 4000 min^{-1} (see the table of mechanical speed limits at the end of this section).

D5 - Speed of rotation

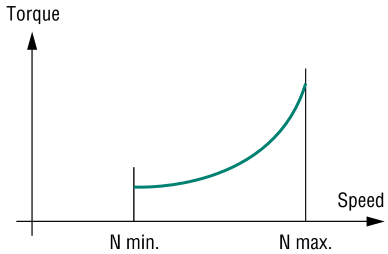
High-speed motors often need to be adapted to suit their application, and this work may include:
- fitting a speed detector
  (D.C. tacho, A.C. tacho or encoder)
- fitting forced ventilation
- fitting a brake or decelerator

Applications and choice of solutions

There are three main types of load:

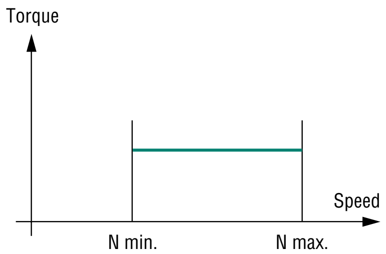
a - Centrifugal machines

The output torque varies as the square of the speed. The torque required for acceleration is low (about 20% of rated torque).



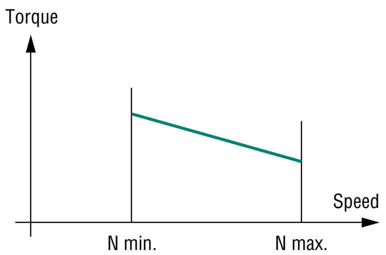
b - Constant torque applications

The output torque remains constant throughout the speed range. The torque required for acceleration may be high, depending on the machine (higher than the rated torque).



c - Constant power applications

The output torque decreases as the speed increases. The torque required for acceleration is at most equal to the rated torque.



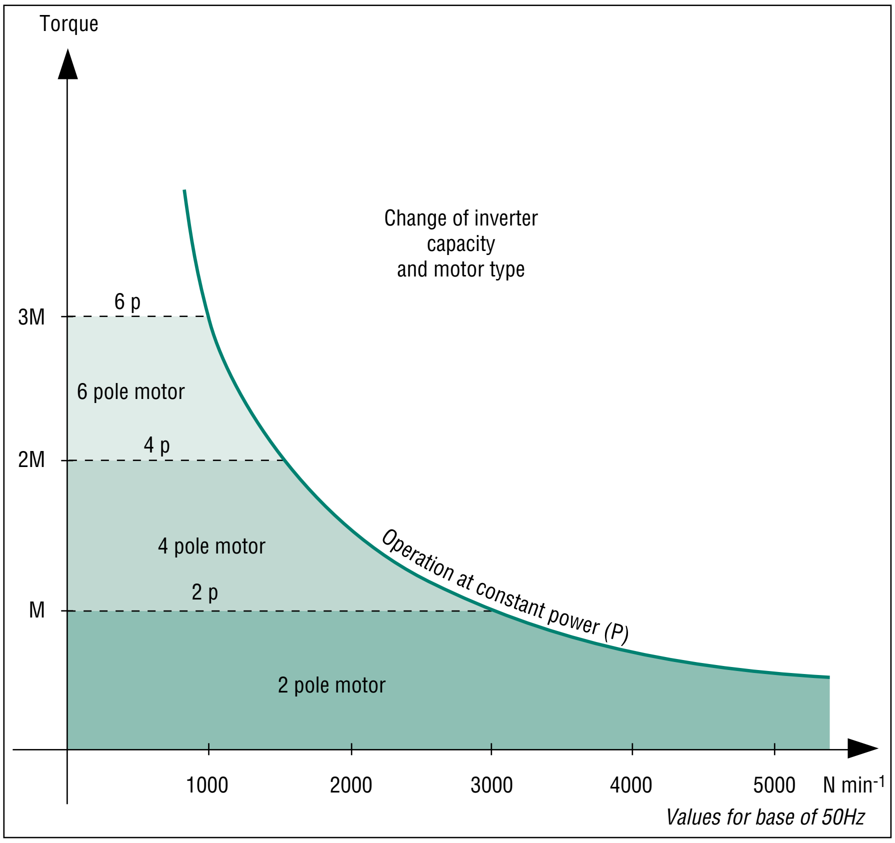
These applications involve a choice of motor-drives based on the following criteria:
- Centrifugal machines: torque or power at the maximum operating speed.
- Applications with constant torque: range of operating speeds and output torques.
- Applications with constant power: range of operating speeds and torque at the minimum operating speed.

Choice of inverter/motor combination

The curve below expresses the output torque of a 2, 4 or 6 pole motor supplied by a drive with power P where F_1 is 50 Hz (point at which U/f ratio changes).

For a frequency inverter with power P_N operating at a constant power P within a determined range of speeds, it is possible to optimize the choice of the motor and its number of poles to give a maximum amount of torque.

Example 1: the UMV - 3.5 T inverter (drive) can supply the following motors:
FLS 90 L - 2 p - 2.2 kW - 7.5 N.m
FLS 100 LK - 4 p - 2.2 kW - 15 N.m
FLS 112 M - 6 p - 2.2 kW - 22.5 N.m



The choice of the motor and inverter combination will therefore depend on the application.

D5 - Speed of rotation

D

Extreme operating conditions and other points

Transient overloads

Drives are designed to withstand transient overload peaks of 180% or overloads of 150% for 60 seconds (maximum once every ten minutes). If the overload is greater, the system will automatically shut down.

Starting torque and current

The specific U/f ratio (with Boost for frequencies lower than 25 Hz) means that the torque available when the motor is switched on can be adjusted to a value higher than the rated value.

Adjusting the switching frequency

This optimizes motor noise levels by adapting the wave form to the specific type of use.

Electrical protection

The system all have integrated features to protect them against:
- overload (over-current)
- under-voltage and over-voltage
- short-circuit
- earth fault

Note: All the above faults are shown on an LCD screen, as are settings, speed and current ranges, etc.

Mechanical speed limits for standard motors when the frequency is varied

With increasingly extensive frequency ranges, frequency inverters can, in theory, control a motor at a higher speed than its rated speed. However, the bearings and type of balancing of the standard rotor dictate a maximum mechanical speed which cannot be exceeded without endangering the service life of the motor.

The table opposite shows this critical speed for standard horizontal and vertical motors (for the 315 M and above, consult us for the vertical position).

Above these limits, please consult Leroy Somer.

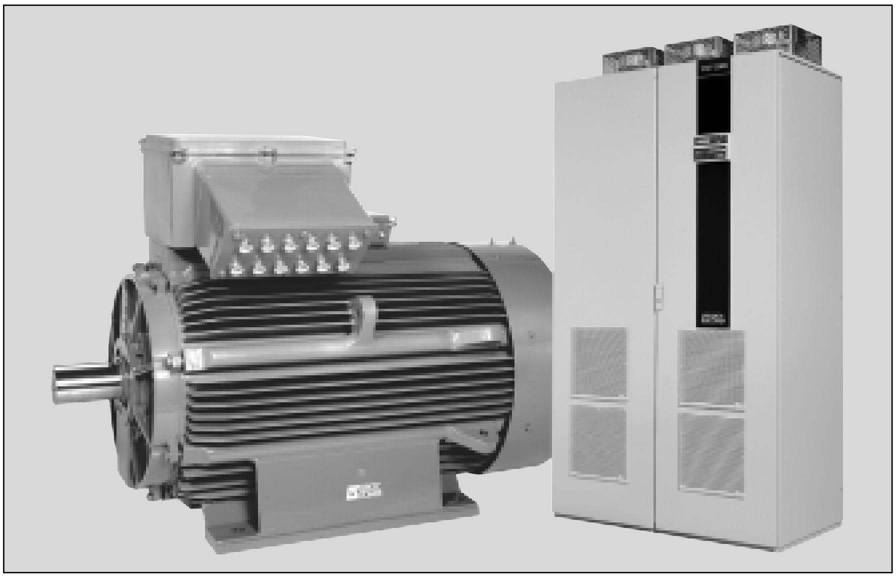
These speed limit values are given for motors coupled directly to the load (with no radial load).

The formula for calculating the greasing interval I'g at frequency f' is on average:

$$I'_g = \frac{25 x I_g}{f'}$$

I_g = greasing interval
(as indicated in section C3.4.2.2)

Type	2 poles	4 poles	6 poles
FLS 80	13000	13000	13000
FLS 90	10000	10000	10000
FLS 100	9000	9000	9000
FLS 112	9000	9000	9000
FLS 132	8000	8000	8000
FLS 160	5000	5000	5000
FLS 180	5000	5000	5000
FLS 200	4000	4000	4000
FLS 225 ST/MT	4000	4000	-
FLS 225 M	3600	3600	3600
FLS 250	3600	3600	3600
FLS 280	3600	3000	3000
FLS 315 ST	3600	3000	3000
FLS 315 M/L	3200	2500	2500
FLS 355 L	3200	2000	2000
FLS 355 LK	-	1800	1800
FLS 400	-	1800	1800
FLS 400 LK	-	1800	1800
FLS 450	-	1800	1800



Choice of motor

There are two possibilities:

a - The frequency inverter is not supplied by LEROY-SOMER

All the motors in this catalogue can be used with a frequency inverter. Depending on the application, motors will need to be derated by around 10% to maintain all the characteristics described in this catalogue.

To avoid changes in frame size due to derating within the standard range, LEROY-SOMER has developed a range of adapted motors with standardized dimensions. What is more, the improved efficiency of this range means that the motors can be used with an electronic drive without derating.

b - The frequency inverter is supplied by LEROY-SOMER

LEROY-SOMER has developed a range of optimized motors together with a range of frequency inverters.

As these two ranges have been specifically designed for use in combination, excellent performance is guaranteed.

There is a special catalogue devoted to this product line.

D6 - Noise and vibration

D6.1 - MOTOR NOISE LEVELS

D6.1.1 - Noise emitted by rotating machines

In a compressible medium, the mechanical vibrations of an elastic body create pressure waves which are characterized by their amplitude and frequency. The pressure waves constitute an audible noise if they have a frequency of between 16 and 16000 Hz.

Noise is measured by a microphone linked to a frequency analyser. Measurements are taken in an anechoic chamber on machines at no-load, and a sound pressure level Lp or a sound power level Lw can then be established. Measurement can also be carried out in situ on machines which may be on-load, using an acoustic intensity meter which can differentiate between sound sources and identify the sound emissions from the machine.

The concept of noise is linked to hearing. The auditory sensation is determined by integrating weighted frequency components with isosonic curves (giving a sensation of constant sound level) according to their intensity.

The weighting is carried out on sound meters using filters whose bandwidth takes into account, to a certain extent, the physiology of the human ear:

Filter A: *used for low and medium noise levels. High attenuation, narrow bandwidth.*

Filter B: *used for very high noise levels. Wide bandwidth.*

Filter C: *very low attenuation over the whole of the audible frequency range.*

Filter A is used most frequently for sound levels emitted by rotating machinery. It is this filter which has been used to establish the standardized characteristics.

A few basic definitions:

The unit of reference is the bel, and the sub-multiple decibel dB is used here.

Sound pressure level in dB

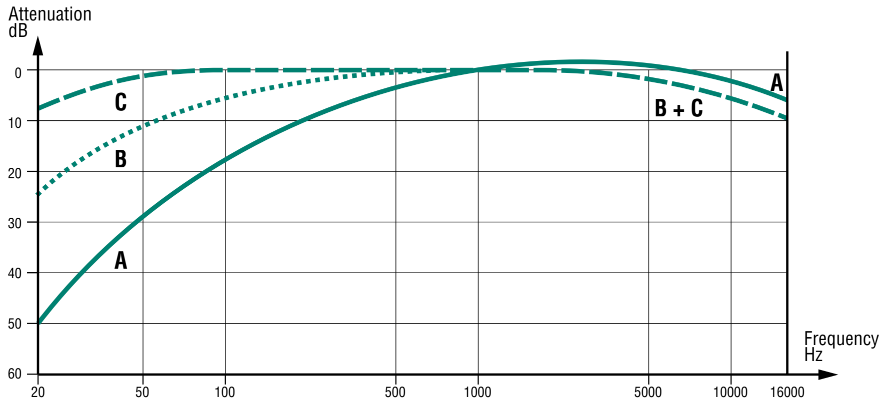
$L_p = 20\log_{10}\left(\frac{P}{P_0}\right)$ where $p_0 = 2.10^{-5}$ Pa

Sound power level in dB

$L_W = 10\log_{10}\left(\frac{P}{P_0}\right)$ where $p_0 = 10^{-12}$ W

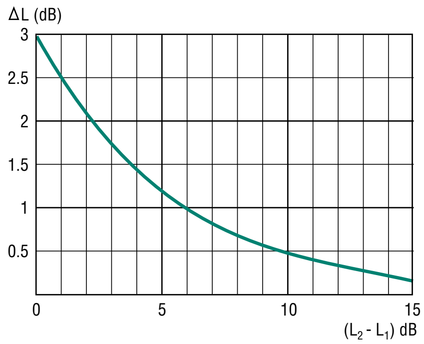
Sound intensity level in dB

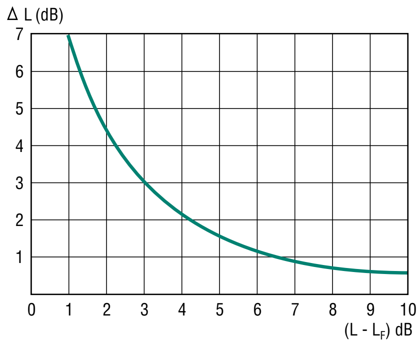
$L_W = 10\log_{10}\left(\frac{I}{I_0}\right)$ where $I_0 = 10^{-12}$ W/m^2



Correction of measurements

For differences of less than 10 dB between 2 sound sources or where there is background noise, corrections can be made by addition or subtraction using the rules below.





Addition of levels

If L_1 and L_2 are the separately measured levels ($L_2 \geq L_1$), the resulting sound level L_R will be obtained by the formula:

$$L_R = L_2 + \Delta L$$

ΔL is found by using the curve above ▲

Subtraction of levels*

This is most commonly used to eliminate background noise from measurements taken in a "noisy" environment.

If L is the measured level and L_F the background noise level, the actual sound level L_R will be obtained by the calculation:

$$L_R = L - \Delta L$$

ΔL is found by using the curve above ▲

**This method is the one normally used for measuring sound power and pressure levels. It is also an integral part of sound intensity measurement.*

D6 - Noise and vibration

Under IEC 60034-9, the guaranteed values are given for a machine operating at no-load under normal supply conditions (IEC 60034-1), in the actual operating position, or sometimes in the direction of rotation as specified in the design.

This being the case, standardized sound power level limits are shown for the values obtained for the machines described in this catalogue. (Measurements were taken in conformity with standard ISO 1680).

Weighted sound level [dB(A)] of motors (with a 50 Hz supply) in position IM 1001

Expressed as sound power level (Lw) according to the standard, the level of sound is also shown as sound pressure level (Lp) in the table below:

Motor type	2 poles			4 poles			6 poles			8 poles		
	IEC 60034-	FLS	FLS	IEC 60034-	FLS	FLS	IEC 60034-	FLS	FLS	IEC 60034-	FLS	FLS
	Power LwA		Pressure LpA	Power LwA		Pressure LpA	Power LwA		Pressure LpA	Power LwA		Pressure LpA
FLS 80 L	81	67	68	-	53	44	-	49	40	-	49	40
FLS 90 S	81	73	64	71	59	50	-	54	45	-	54	45
FLS 90 L	81	73	64	71	59	50	71	54	45	-	54	45
FLS 100 LK	86	75	66	76	61	52	71	57	48	71	51	46
FLS 112 M/MR	86	78	69	76	61	52	71	57	48	71	58	49
FLS 132 S	91	81	72	76	68	59	76	64	55	71	63	54
FLS 132 M	91	81	72	81	68	59	76	64	55	76	63	54
FLS 160 M	91	84	74	81	73	63	80	66	56	76	66	56
FLS 160 L	94	84	74	88	73	63	80	66	56	80	66	56
FLS 180 MR	96	85	75	88	73	63	-	-	-	-	-	-
FLS 180 L	-	-	-	88	75	64	84	74	63	80	72	62
FLS 200 L	96	86	76	91	76	66	84	76	65	84	73	62
FLS 225 ST	-	-	-	91	79	66	-	-	-	84	75	62
FLS 225 M/MT	98	87	76	94	79	68	87	83	72	84	76	65
FLS 250 M	98	88	77	94	79	68	87	83	72	89	76	66
FLS 280 S	100	88	77	97	79	68	90	83	72	89	76	65
FLS 280 M	100	88	77	97	79	68	90	83	72	89	76	65
FLS 315 ST	100	89	77	97	82	70	94	87	75	89	86	75
FLS 315 M/LA	103	96	84	101	85	73	94	88	78	92	90	78
FLS 315 LB	103	96	84	101	85	73	98	88	78	92	90	78
FLS 355 LA/LB/LC	107	96	84	105	92	80	98	90	78	92	90	78
FLS 355 LD	107	96	84	105	92	80	101	90	78	92	90	78
FLS 355 LKA	-	-	-	-	-	-	-	-	-	98	90	78
FLS 355 LKB	-	-	-	105	94	82	101	90	78	98	90	78
FLS 400 LA/LB	-	-	-	105	94	82	101	90	78	98	90	78
FLS 400 LVB	-	-	-	108	97	85	-	-	-	-	-	-
FLS 400 LKA/LKB	-	-	-	-	-	-	105	93	80	98	90	78
FLS 450 LA/LB	-	-	-	108	95	82	105	93	80	98	90	78
FLS 450 LVA/LVB	-	-	-	111	97	85	-	-	-	-	-	-

The maximum tolerance for these values is + 3 dB(A).

In compliance with standards IEC 60034-9 and NFEN ISO 4871, uncertainty on machine installations is established using the formula:

$L_p = L + k$

where 1.5 < k < 6 dB depending on whether laboratory or control measurements are being used.

D6.1.2 - Noise levels for machines at full load

Sound power levels, when at full load, are usually higher than those when at no-load. The maximum increase at full load to be added to the declared values at no-load is between 2 and 8 dB(A). (Addition to standard IEC 60034.9).

D6 - Noise and vibrations

The FLS machines in this catalogue are classed N

D6.2 - VIBRATION LEVELS - BALANCING

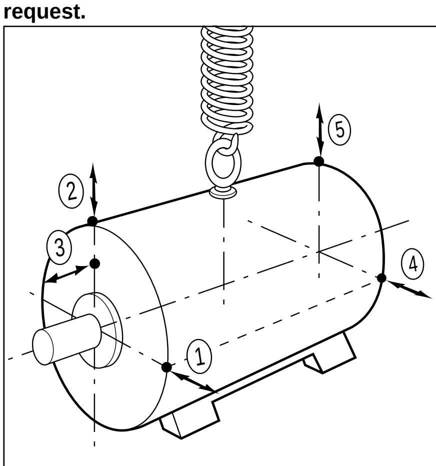
Inaccuracies due to construction (magnetic, mechanical and air-flow) lead to sinusoidal (or pseudo sinusoidal) vibrations over a wide range of frequencies. Other sources of vibration can also affect motor operation: such as poor mounting, incorrect drive coupling, end shield misalignment, etc.

We shall first of all look at the vibrations emitted at the operating frequency, corresponding to an unbalanced load whose amplitude swamps all other frequencies and on which the dynamic balancing of the mass in rotation has a decisive effect.

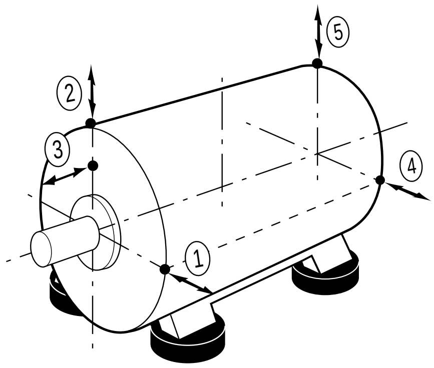
Under standard ISO 8821, rotating machines can be balanced with or without a key or with a half-key on the shaft extension. Standard ISO 8821 requires the balancing method to be marked on the shaft extension as follows:

- half-key balancing: letter H
- full key balancing: letter F
- no-key balancing: letter N

The machines in this catalogue are classed N - Classes R and S are available on request.



▲ *Measuring system for suspended machines*



▲ *Measuring system for machines on flexible mountings*

The measurement points quoted in the standards are the ones indicated in the drawings above.

At each point, the results should be lower than those given in the tables below for each balancing class and only the highest value is to be taken as the "vibration level".

Measured parameters

The vibration speed can be chosen as the variable to be measured. This is the speed at which the machine moves either side of its static position. It is measured in mm/s.

As the vibratory movements are complex and non-harmonic, it is the quadratic average (rms value) of the speed of vibration which is used to express the vibration level.

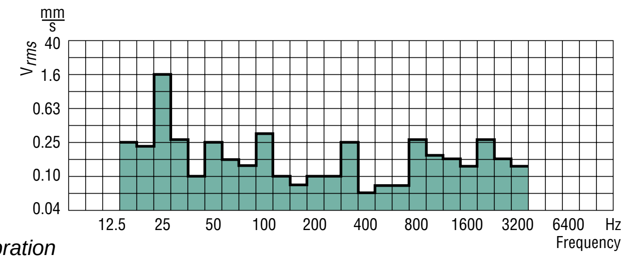
Other variables that could also be measured are the vibratory displacement amplitude (in µm) or vibratory acceleration (in m/s²).

If the vibratory displacement is measured against frequency, the measured value decreases with the frequency: high-frequency vibrations are not taken into account.

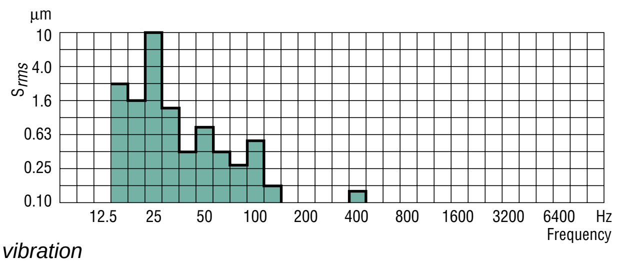
If the vibratory acceleration is measured, the measured value increases with the frequency: low-frequency vibrations (unbalanced loads) cannot be measured.

The rms speed of vibration is the variable chosen by the standards.

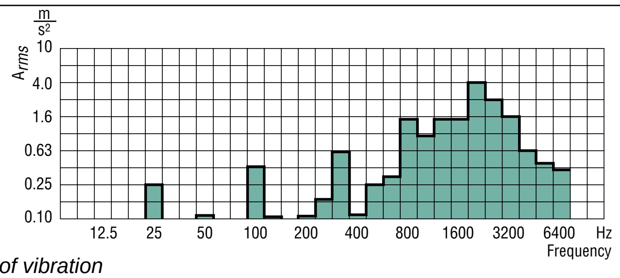
However, if preferred, the table of vibration amplitudes may still be used (for measuring sinusoidal and similar vibrations).



Speed of vibration



Amplitude of vibration



Acceleration of vibration

D6 - Noise and vibration

Maximum value of rms speed of vibration expressed in mm/s (IEC 60034-14) (machine tested when freely suspended)

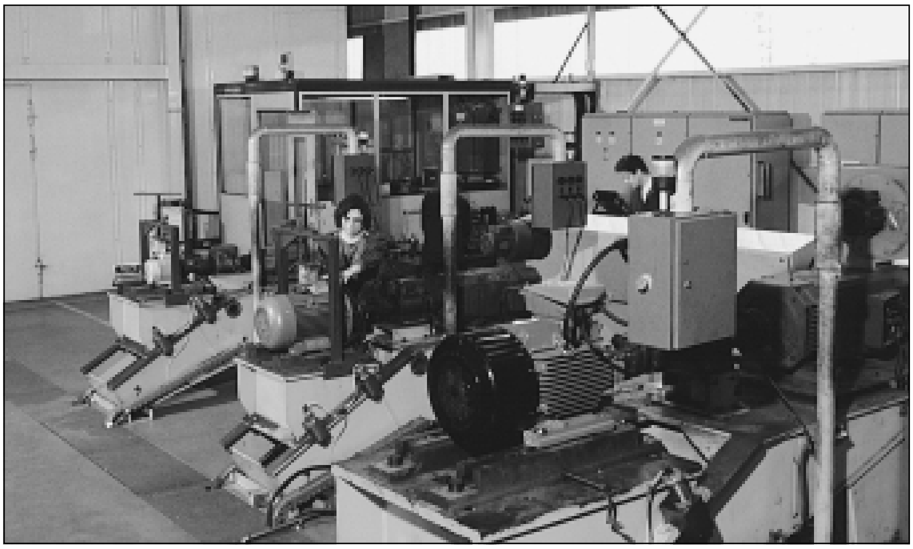
Class	Speed N (min^{-1})	Frame size H (mm)			
		$80 \leq H \leq 132$	$132 < H \leq 225$	$225 < H \leq 400$	$H > 400$
N (normal)	$600 < N \leq 3600$	1.8	2.8	3.5	3.5
R (reduced)	$600 < N \leq 1.800$ $1\,800 < N \leq 3600$	0.71 1.12	1.12 1.8	1.8 2.8	2.8 2.8
S (special)	$600 < N \leq 1.800$ $1\,800 < N \leq 3600$	0.45 0.71	0.71 1.12	1.12 1.8	- -

Maximum value of the simple displacement amplitude expressed in µm (for sinusoidal vibrations only)

Class	Speed N (min^{-1})	Frame size H (mm)		
		$80 \leq H \leq 132$	$132 < H \leq 225$	$225 < H \leq 400$
N (normal)	1 000 1 500 3 000	24 16 8	38 25 12.5	48 32 16
R (reduced)	1 000 1 500 3 000	9 6.3 5	16 10 8	24 16 12.5
S (special)	1 000 1 500 3 000	6.3 4 3.15	9 6.3 5	16 10 8

For motors with a frame size larger than 400, look up the values given for class N of the 400.
For lower values, please consult us.

For large machines and special requirements with regard to vibration, balancing can be carried out *in situ* (finished assembly).
Prior consultation is essential, as the machine dimensions may be modified by the addition to the drive ends of the balancing disks required in this situation.



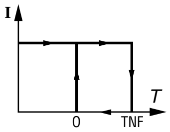
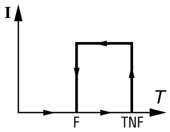
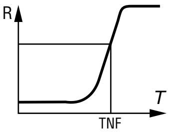
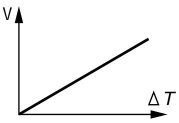
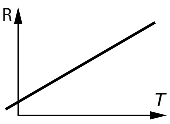
D7 - Performance

D7.1 - THERMAL PROTECTION

Motors are protected by a manual or automatic overcurrent relay, placed between the isolating switch and the motor. This relay may in turn be protected by fuses.

These protection devices provide total protection of the motor against non-transient overloads. If a shorter reaction time is required, or if you want to detect transient overloads, or to monitor temperature rises at "hot spots" in the motor or at strategic points in the installation for maintenance purposes, it would be advisable to install heat sensors placed at sensitive points. The various types are shown in the table below, with a description of each. It must be emphasized that sensors cannot be used to carry out direct adjustments to the motor operating cycles.

Built-in indirect thermal protection

Type	Symbol	Operating principle	Operating curve	Cut-off (A)	Protection provided	Number of devices
Normally closed thermostat (closed when de-energized)	PTO	bimetallic strip, indirectly heated, with normally closed (NC) contact		2.5 A at 250 V with cos φ 0.4	general surveillance for non-transient overloads	2 or 3 in series
Normally open thermostat (open when de-energized)	PTF	bimetallic strip, indirectly heated, with normally open (NO) contact		2.5 A at 250 V with cos φ 0.4	general surveillance for non-transient overloads	2 or 3 in parallel
Positive temperature coefficient thermistor	PTC	Variable non-linear resistor with indirect heating		0	general surveillance for transient overloads	3 in series
Thermocouples	*T* (*T* < 150 °C) Copper Constantan K (*T* < 1000 °C) Copper Copper-Nickel	Peltier effect		0	continuous surveillance at hot spots	1 per hot spot
Platinum resistance thermometer	PT 100	Variable linear resistor with indirect heating		0	high accuracy continuous surveillance at key hot spots	1 per hot spot

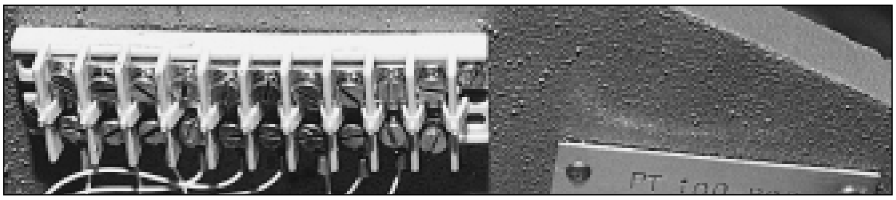
- NRT: nominal running temperature
- The NRTs are chosen according to the position of the sensor in the motor and the temperature rise class.

Fitting thermal protection
- PTO or PTF, in the control circuits
- PTC, with relay, in the control circuits
- PT 100 or thermocouples, with reading equipment or recorder, in the control board of the installation for continuous surveillance.

Alarm and early warning
All protective equipment may be backed up by another type of protection (with different NRTs). The first device will then act as an "early warning" (light or sound signals given without shutting down the power circuits), and the second device will be the actual alarm (shutting down the power circuits).

Built-in direct thermal protection

For low rated currents, bimetallic strip-type protection may be used. The line current passes through the strip, which shuts down or restores the supply circuit as necessary. The design of this type of protection allows for manual or automatic reset.



D7 - Performance

D7.2 - POWER FACTOR (COS φ) CORRECTION

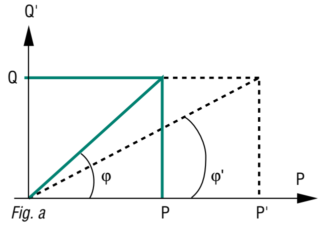
To help improve current supply in the power lines, electricity supply distributors now ask their customers to have loads with a power factor (cos φ) as near as possible to 1 or at least higher than 0.93.

To create the magnetic field, induction motors absorb reactive power (Q) and introduce a power factor which may be quite different from the one recommended by electricity supply distributors.

There are, however, several ways of correcting the power factor:

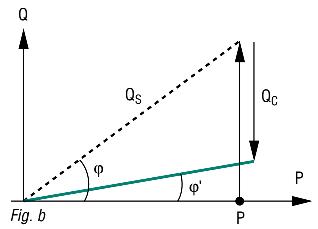
a/ by changing the active power

- increase active energy consumption (space heaters, lighting, etc)
- use synchronous machines (cos φ = 1). *Fig. a*



b/ by changing the reactive power

- provide capacitive reactive compensation for the generally inductive reactive drop in the installation (power lines and induction motors). *Fig. b*



The need for power factor correction is not linked to faults in design or manufacture. Instead of the two procedures outlined above, it may be easier to use the chart opposite to calculate the compensating reactive power.

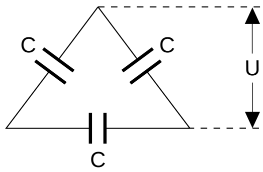
• **Calculating the reactive power compensation**

$$Q = \frac{Pu}{\eta}(tg\varphi - tg\varphi')$$

where Pu active output power
η motor efficiency

tg φ and tg φ' phase angle error before and after connection

• **Connection of capacitors**



The capacitor values are given by the following formula (in three-phase):

$Q = U^2 C\omega \cdot \sqrt{3}$

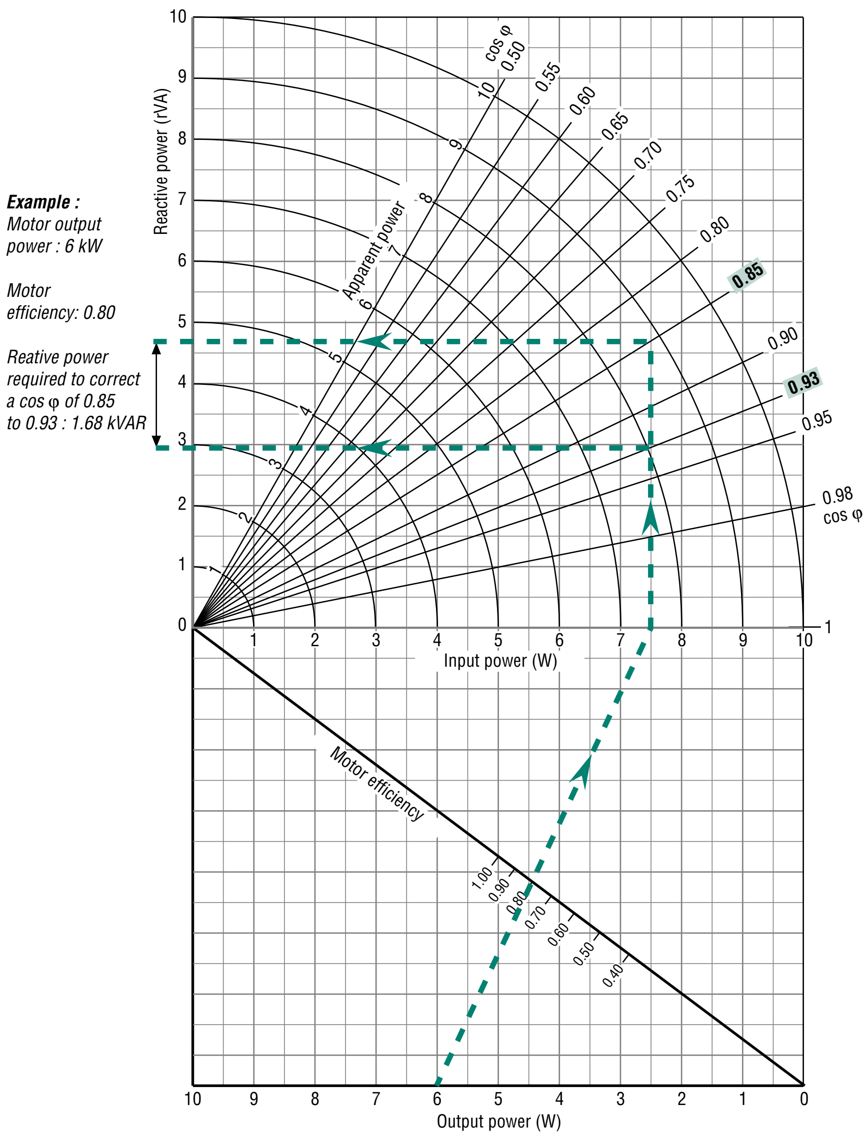
U voltage of the mains with an angular velocity of the phases:

ω ($\omega = 2\pi \cdot f$)

IMPORTANT:

The use of capacitors on motor terminals can cause certain problems:

- in hypersynchronous braking, the motor operates as a self-excited generator and high peak voltages will occur across the mains connected terminals
- in the event of micro-cuts, reactive energy is released which will excite the motor. When the supply is restored, high transient voltages may occur.



For increased accuracy when using the chart, multiply the horizontal scale and the vertical scale by the same factor. The result should be divided by the same factor.

▲ **Chart for finding the reactive power required for power factor improvement.**

D7 - Performance

D7.3 - MOTORS OPERATING IN PARALLEL

Motors connected to the same mechanical shaft

A mechanical shaft can be operated by two or more separate motors:

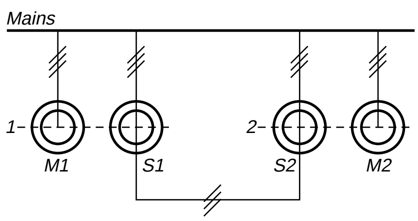
a) If the motors are of the same type, the total power consumption on the line is equally distributed between the motors (to within the different slip variations).

b) If the motors are of different types, the power is distributed according to the steady speed of the whole unit. So, a small motor with high slip, placed on the same line as a large motor with minimal slip, will run at more or less the same speed as the large motor and therefore only provide a small proportion of the rated power.

Motors coupled to independent shafts which must rotate at the same speed:
electrical shaft

To avoid deformation problems in large machines (gantry cranes, for example), separately sited mechanical shafts have to be synchronized to rotate at the same speed, whatever their loads.

We can then draw the follow diagram, called an electrical shaft:



1 - 2 : mechanical shafts to be synchronized

M1 - M2: drive motors, normally cage induction motors, providing the average torque on each line.

S1 - S2: synchronizing slipring motors, coupled to the drive motors M1 and M2, whose rotor circuits are linked phase-to-phase. These motors have the dimensions required for providing the synchronization power defined in the application specification.

Note: There is a simplified version of this diagram, in which motors M1 and M2 are absent and motors S1 and S2 carry out both functions. In this case both rotors output into a single rheostat for minimum slip operation, which will enable any desynchronization (out-of-step) to be detected and the necessary speed compensation to be made.

For a given power, machine dimensions will have to be large enough to be able to supply sufficient motor and synchronization torque, and minimize losses due to rotor slip.

Motors in parallel on the same supply controlled by a single switch

Example: drying tunnel with several fans.

As manufacturing inaccuracies in the windings can occur, it is best to check the order of the motor and line phases before starting, and not to use motors with different internal connections so as to avoid circulating currents which might destroy complete installations.

All equipotential neutral connections must be excluded.

D8 - Starting methods for cage induction motors

The two essential parameters for starting cage induction motors are:

- starting torque
- starting current

These two parameters and the resistive torque determine the starting time.

These three characteristics arise from the construction of cage induction motors. Depending on the driven load, it may be necessary to adjust these values to avoid torque impulse on the load or current surges in the supply. There are essentially five different types of supply, which are:

- D.O.L. starting
- star/delta starting
- soft starting with auto-transformer
- soft starting with resistors
- electronic starting

The tables on the next few pages give the electrical outline diagrams, the effect on the characteristic curves, and a comparison of the respective advantages of each mode.

D8.1 - MOTORS WITH ASSOCIATED ELECTRONICS

"Electronic" starting modes control the voltage at the motor terminals throughout the entire starting phase, giving very gradual smooth starting.

• "Unistart" electronic soft starter

This electronic starter enables three-phase induction motors to be started smoothly by controlling their acceleration.

Characteristics:

- P < 2.2 kW 380V-415V 50/60 Hz
- P < 1.5 kW 230V 50/60 Hz
- Ramp from 0.5 to 10 s
- Starting torque adjustable from 0 to 100%.

• "Digistart" electronic soft starter

- 10 models from 9 to 500 kW
- Supply: 220 to 690 V - 50/60 Hz

- Advantages:

• Protects both itself and the motor over the whole power range.

• Can be used on all motors without derating

• Fault signalling

• Simple digital programming

• Keypad or remote control

• Hyper control

Hyper Control is an electronic system which is placed between the multi-speed motor and the low-speed power supply contactor, and is used to manage torque when changing from one speed to another.

6 power ratings

RATINGS	HC.1.22.400	HC.3.22.400	HC.4.8.9.400
Low-speed motor power	0.06 to 3.9 kW		
Three-phase mains supply voltage	400 V +10% -10%		

RATINGS	HC.1.22.230	HC.3.22.230	HC.4.8.9.230
Low-speed motor power	0.035 to 2.25 kW		
Three-phase mains supply voltage	230 V +10% -10%		

Mains frequency	50 / 60 Hz ±5%
Protection	IP 20
Housing in composite material	

D8.2 - VARIABLE SPEED MOTOR

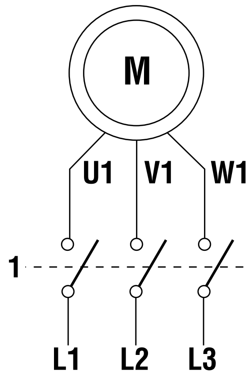
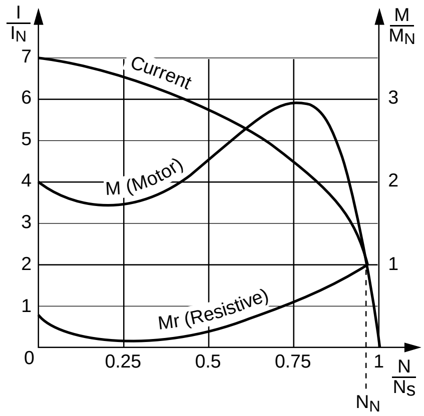
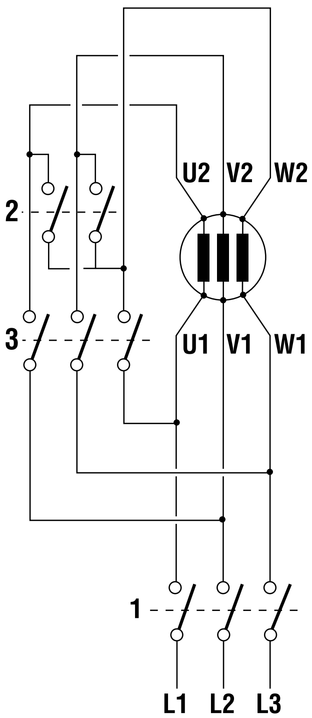
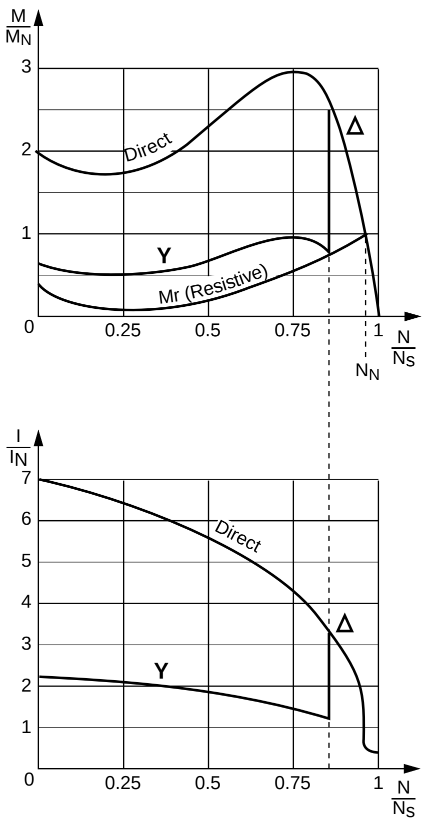
• Starting on variable speed drive

One of the advantages of variable speed drives is that loads can be started without a current surge on the mains supply, since starting is always performed with no voltage or frequency at the motor terminals.

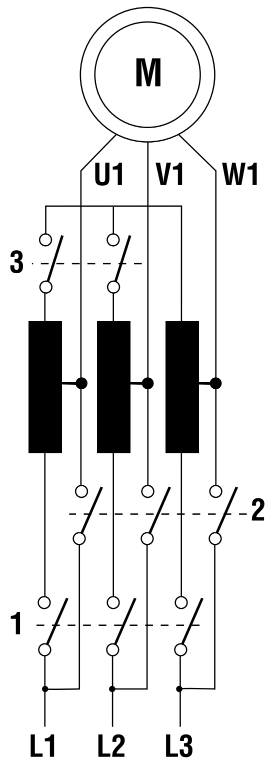
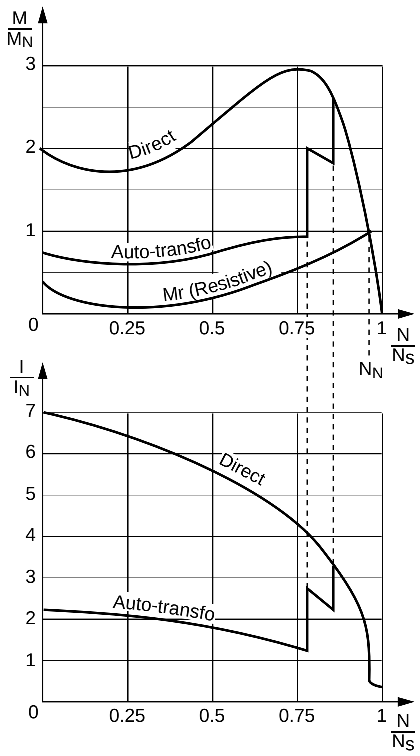
UNISTART

DIGISTART

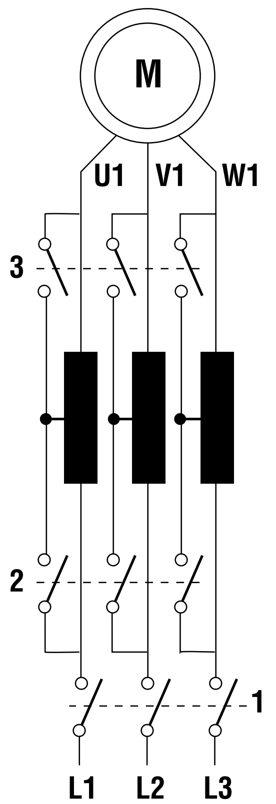
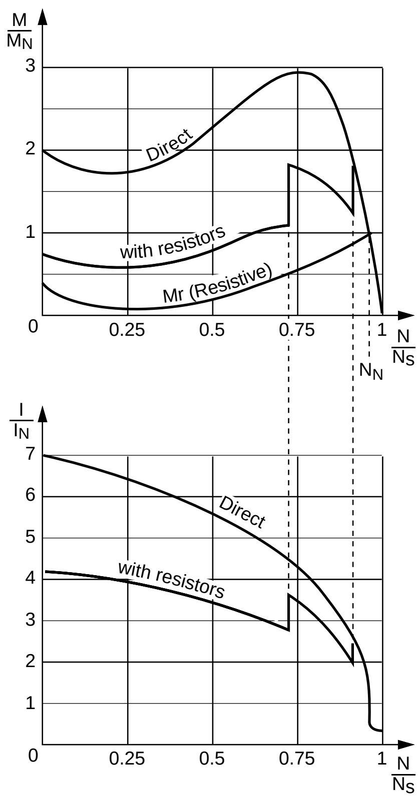
D8 - Starting methods for cage induction motors

Mode	Outline diagram	Characteristic curves	Number of steps	Starting torque	Starting current	Advantages
D.O.L.			1	M_D	I_D	Simple equipment High torque Minimum starting time
Star Delta			2	M_D / 3	I_D / 3	Current requirement cut by two-thirds Simple equipment 3 contactors including one 2-pole

D8 - Starting methods for cage induction motors

<table>
<tr><th>Mode</th><th>Outline diagram</th><th>Characteristic curves</th><th>Number of steps</th><th>Starting torque</th><th>Starting current</th><th>Advantages</th></tr>
<tr><td>Soft start with auto transformer</td><td>
</td><td>
</td><td>$n \geq 3$</td><td>$K^2.M_D$
$K = \frac{U_{starting}}{U_n}$</td><td>$K^2.I_D$</td><td>Choice of torque level

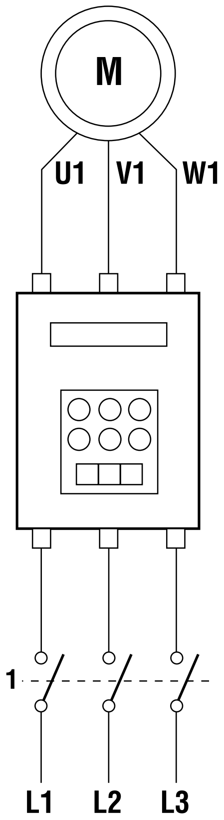
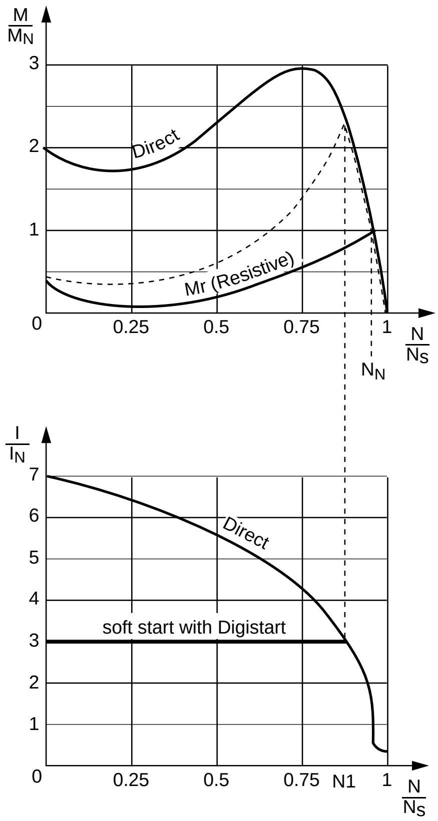
Reduction of current proportional to that of the torque

Current is not cut off</td></tr>
<tr><td>Soft start with resistors</td><td>
</td><td>
</td><td>n</td><td>$K^2.M_D$
$K = \frac{U_{starting}}{U_n}$</td><td>$K.I_D$</td><td>Enables choice of torque or current

Current is not cut off

Fairly inexpensive (1 contactor per position)</td></tr>
</table>

D8 - Starting methods for cage induction motors

Mode	Outline diagram	Characteristic curves	Number of steps	Starting torque	Starting current	Advantages
DIGISTART				K^2M_D $K = \frac{U_{starting}}{U_n}$	KI_D	Adjustable on site Choice of torque and of current Current is not cut off Smooth starting Less space required No maintenance Higher number of starts Digital Integrated motor and machine protection Serial link

D9 - Braking methods

General information

The braking torque is equal to the torque produced by the motor increased by the resistive torque of the driven machine.

$$C_f = C_m + C_r$$

C_f= braking torque

C_m= motor torque

C_r= resistive torque

Braking time, i.e. the time required for an induction motor to change from speed N to stop, is calculated by the formula:

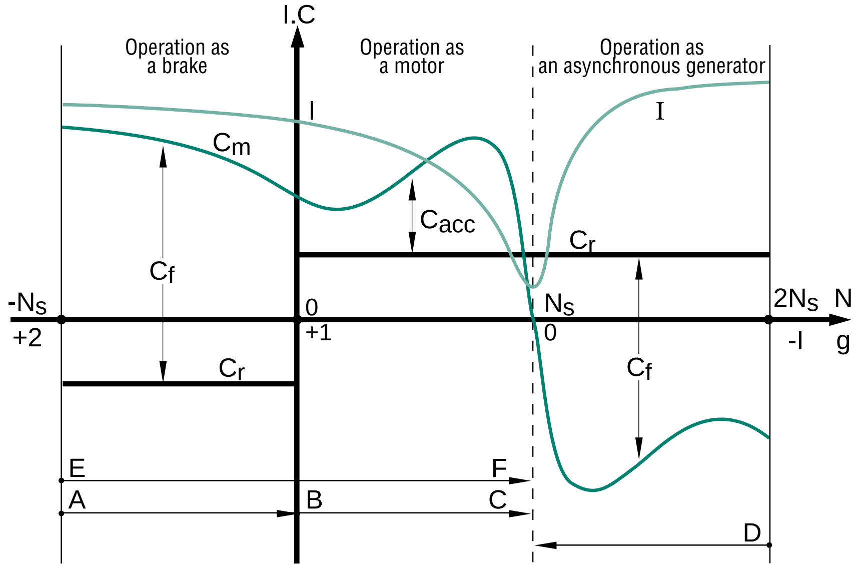
$$T_f = \frac{\Pi \cdot J \cdot N}{30 \cdot C_f(av)}$$

T_f (in s) = braking time

J (in kgm^2) = moment of inertia

N (in min^{-1}) = speed of rotation

C_f (av) (in N.m) = average braking torque during the time period



Curves I = f(N), C_m = f (N), C_r = f(N), in the motor starting and braking zones.

I = *current absorbed*

C = *torque value*

C_f = *braking torque*

C_r = *resistive torque*

C_m = *motor torque*

N = *speed of rotation*

g = *slip*

N_s = *synchronous speed*

AB = *reverse-current braking*

BC = *starting, acceleration*

DC = *braking as asynchronous generator*

EF = *reverse*

Reverse-current braking

This method of braking is obtained by reversing two of the phases.

In general, an isolator disconnects the motor from the supply at the time the speed changes to N=0.

In cage induction motors, the average braking torque is generally greater than the starting torque.

Braking torque varies in different types of machine, as it depends on the rotor cage construction.

This method of braking involves a large amount of absorbed current, more or less constant and slightly higher than the starting current.

Thermal stresses during braking are three times higher than during acceleration.

Accurate calculations are required for repetitive braking.

Note: The direction of rotation of a motor is changed by reverse-current braking and restarting.

Thermically, one reversal is the equivalent of 4 starts. Care must therefore be taken when choosing a machine.

D.C. injection braking

Operating stability can be a problem when reverse-current braking is used, due to the flattening out of the braking torque curve in the speed interval (O, — N_S).

There is no such problem with D.C. injection braking: this can be used on both cage induction and slipring motors.

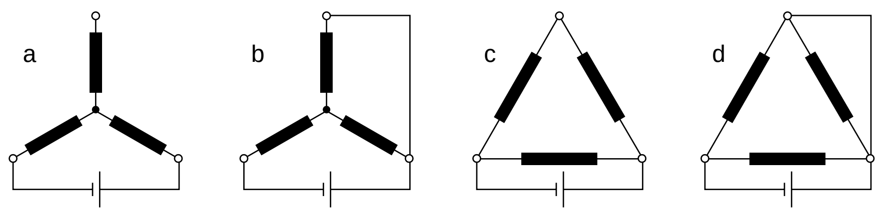
With this braking method, the induction motor is connected to the mains and braking occurs when the A.C. voltage is cut off and D.C. voltage is applied to the stator.

There are four different ways of connecting the windings up to direct current.

The D.C. applied to the stator is usually supplied by a rectifier plugged into the mains.

Thermal stresses are approximately three times lower than for reverse-current braking.

The shape of the braking torque curve in the speed interval (0, — N_S) is similar to that of the curve Cm = f (N) and is obtained by changing the abscissa variable to $N_f = N_S$ — N.



▲ **Motor winding connections for direct current**

D9 - Braking methods

The braking current is calculated using the formula:

$$I_f = k1_i \times I_d \sqrt{\frac{C_f - C_{fe}}{k_2 \cdot Cd}}$$

The values of k1 for each of the four connections are:

$k1_a = 1.225$ $k1_c = 2.12$

$k1_b = 1.41$ $k1_d = 2.45$

The braking torque can be found by the formula:

$$C_f = \frac{\Pi \cdot J \cdot N}{30 \cdot T_f}$$

In the formulae above:

I_f (in A) = direct current for braking

I_d (in A) = starting current in the phase

= $\frac{1}{\sqrt{3}}$ I_d given in catalogue (for Δ connection)

C_f (in N.m) = average braking torque in the interval (N_S, N)

C_{fe} (in N.m) = external braking torque

C_d (in N.m) = starting torque

J (en kgm^2) = total moment of inertia on the drive shaft

N (in min^{-1}) = speed of rotation

T_f (in s) = braking time

$k1_i$ = numerical factors for connections a, b, c and d (see diagram)

k2 = numerical factors taking into account the average braking torque (k2 = 1.7)

The direct current to be applied to the windings is calculated by:

$U_f = k3_i . k4 . I_f . R_1$

k3 values for the four diagrams are as follows:

$k3_a = 2$

$k3_b = 1.5$

$k3_c = 0.66$

$k3_d = 0.5$

U_f (in V) = voltage for braking

I_f (in A) = direct current for braking

R_1 (en Ω) = stator phase resistance at 20° C

$k3_i$ = numerical factors for connections a, b, c and d (see diagrams)

k4 = numerical factor taking into account the temperature rise of the motor (k4 = 1.3)

Regenerative braking

This is the braking method applied to multi-speed motors when changing down to lower speeds. This procedure cannot be used to stop the motor.

Thermal stresses are approximately equal to those occurring when motors with Dahlander connections are started at the lower rated speed (speed ratio 1 : 2).

With the motor at the lower speed, working as a generator, it develops very high braking torque in the speed interval ($2N_S$, N_S).

The maximum braking torque is slightly higher than the starting torque of the motor at the lower speed.

Mechanical braking

Electromechanical brakes (D.C. or A.C field excitation) can be fitted at the rear of the motor.

For further details, see our "Brake motors" catalogue.

D10 - Operation as an asynchronous generator

D10.1 - GENERAL

The motor operates as an asynchronous generator each time the load becomes a driving load and the rotor speed exceeds the synchronous speed (N_s).

This can be induced either voluntarily, as in the case of electric power stations (water or wind power, etc) or involuntarily, caused by factors linked to the application (downward movement of crane hooks or blocks, inclined conveyors, etc).

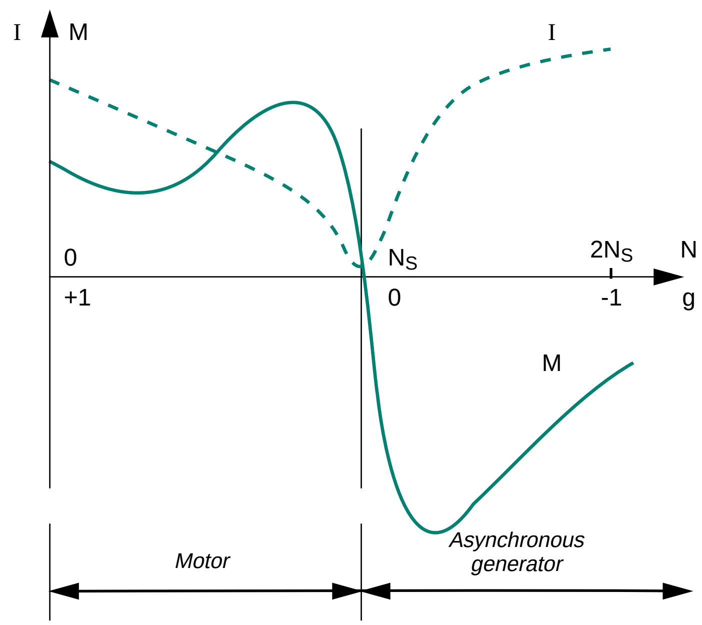
D10.2 - OPERATING CHARACTERISTICS

The diagram opposite shows the various operations of an asynchronous machine in relation to its slip (g) or its speed (N).

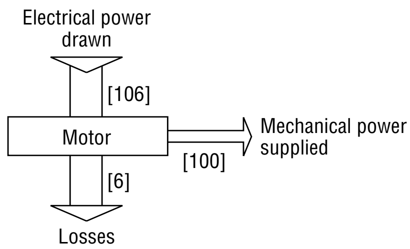
Example: let us consider an induction motor of 45 kW, 4 poles, 50 Hz at 400V. As a rough estimate, its characteristics as an asynchronous generator can be deduced from its rated characteristics as a motor, by applying the rules of symmetry.

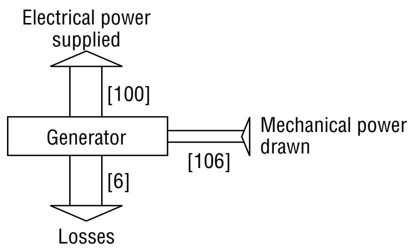
If more precise values are required, the manufacturer should be consulted.

In practice, it can be checked that the same machine, operating as a motor and as a generator with the same slip, has approximately the same losses in both cases, and therefore virtually the same efficiency. It can be deduced from this that the rated electrical power supplied by the asynchronous generator will be virtually the same as the motor output power.

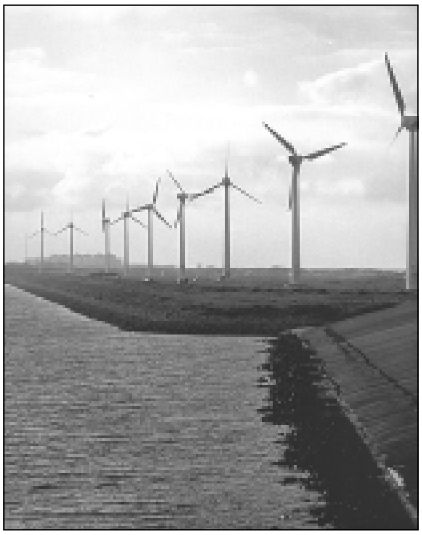


Characteristics	Motor	GA
Synchronous speed................ (min^{-1})	1500	1500
Rated speed .... (min^{-1})	1465	1535
Rated torque............................ (m.N)	+ 287	- 287
Rated current at 400V............. (A)	87 A (absorbed)	87 A (supplied)





D10 - Operation as an asynchronous generator



D10.3 - CONNECTION TO A POWERFUL MAINS SUPPLY

It is assumed that the machine stator is connected to a powerful electrical mains supply (usually the national grid), ie. a mains supply provided by a generator which regulates the power to at least twice that of the asynchronous generator.

Under these conditions, the mains supply imposes its own voltage and frequency on the asynchronous generator. Furthermore, it supplies it automatically with the reactive energy necessary for all its operating conditions.

D10.3.1 - Connection - Disconnection

Before connecting the asynchronous generator to the mains supply, it is necessary to ensure that the direction of phase rotation of the asynchronous generator and the mains supply are in the same order.

• To connect an asynchronous generator to the mains supply, it should be accelerated gradually until it reaches its synchronous speed Ns. At this speed, the machine torque is zero and the current is minimal.

This is an important advantage of asynchronous generators: as the rotor is not polarised until the stator is powered up, it is not necessary to synchronise the mains supply and the machine when they are connected.

However, there is a phenomenon affecting the connection of asynchronous generators which, in some cases, can be a nuisance: the rotor of the asynchronous generator, although not energized, still has some residual magnetism.

On connection, when the magnetic flux created by the mains supply and that caused by the residual magnetism of the rotor are not in phase, the stator experiences a very brief current peak (one or two half-waves), combined with an instantaneous overtorque of the same duration.

It is advisable to use connecting stator resistances to limit this phenomenon.

• Disconnecting the asynchronous generator from the mains supply does not pose any particular problem.

As soon as the machine is disconnected, it becomes electrically inert since it is no longer energized by the mains supply. It no longer brakes the driving machine, which should therefore be stopped to avoid reaching overspeed.

D10.3.1.1 - Reactive power compensation

To limit the current in the lines and the transformer, the asynchronous generator can be compensated by restoring the power factor of the installation to the unit, using a bank of capacitors.

In this case, the capacitors are only inserted at the terminals of the asynchronous generator once it has been connected, to avoid self-energization of the machine due to the residual magnetism during speed pick-up. For a 3-phase low voltage asynchronous generator, 3-phase or single-phase capacitors in delta connection are used.

D10.3.1.2 - Electrical protection and safety

There are two protection and safety categories:

- those which relate to the mains
- those which relate to the set and its generator

The major mains protection devices monitor:

- maximum-minimum voltage
- maximum-minimum frequency
- minimum power or energy feedback (operating as a motor)
- generator connection fault

The protection devices for the set are:

- stop on detection of racing start
- lubrication faults
- thermal magnetic protection of the generator, usually with probes in the winding.

D10.4 - POWER SUPPLY FOR AN ISOLATED NETWORK

This concerns the supply of a consuming network which does not have another generator of sufficient power to impose its voltage and frequency on the asynchronous generator.

D10.4.1 - Reactive power compensation

In the most common case, reactive energy must be supplied:

- to the asynchronous generator
- to the user loads which consume it

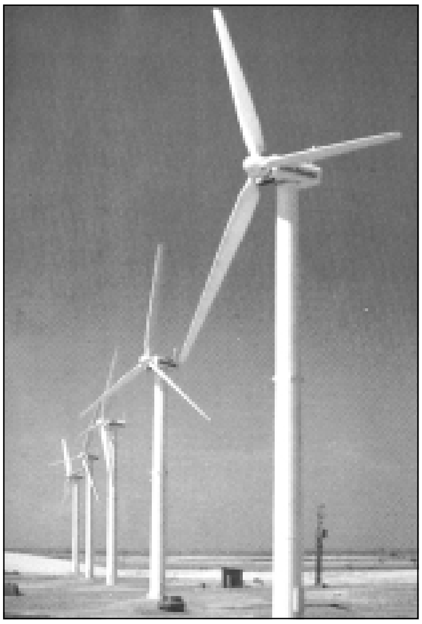
To supply both of these consumption types with reactive energy, use a reactive energy source of suitable power connected in parallel on the circuit. This is usually a bank of capacitors with one or more stages which may be fixed, manually adjusted (using notches) or automatically adjusted. Synchronous capacitors are now rarely used.

Example: in an isolated network with power consumption of 50 kW where cos φ = 0.9 (and tan φ = 0.49), supplied by an asynchronous generator with cos φ of 0.8 at 50 kW (and tan φ = 0.75), it is necessary to use a bank of capacitors which supplies:

(50 x 0.49) + (50 x 0.75) = 62 kvar

D

D10 - Operation as an asynchronous generator



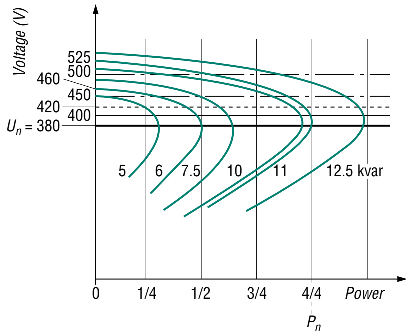
D10.4.2 - Characteristic curves

At rated frequency, an asynchronous generator supplies a voltage which depends on the active power supplied and the value of the energization capacitors.

For each asynchronous generator, it is possible to plot a network of curves such as those shown below.

In conclusion, to maintain a constant voltage, the reactive power must be adapted to the active power required.

Adjusting the load and the capacitors does not present any special difficulties. The table below shows how these parameters should be modified.



Example of a13 kW and 6-pole machine

Direction of adjustment for load and capacitors

Problem		Action
Frequency	**Voltage**	
Too high	Too high	Increase the active load or reduce the speed or mechanical power
Too high	Too low	Increase the capacitor bank capacity
Too low	Too high	Decrease the capacitor bank capacity
Too low	Too low	Reduce the active load or increase the speed

D10.4.3 - Regulation

When the power consumed by the user or the power supplied by the driving machine vary but the frequency and voltage are to be maintained within narrow limits, a regulation device must be provided. This device is designed to maintain the correct electrical characteristics by adjusting one or more parameters:

- active power supplied (driving machine)
- active power consumed (loads on the circuit in use)
- reactive power supplied (usually capacitors).

D10.4.4 - Control and protection

The installation comprises an electrical measuring, control and protection enclosure.

The only special devices are:

- time delay on connection of the load circuit to avoid de-energization of the machine on starting
- control of the energization capacitors, manually or automatically as required

The rest of the electrical equipment is completely standard.

D10.5 - PERFORMANCE OF MOTORS USED AS AG

- Preference should be given to 4 - 6 or 8-pole versions for power ratings above 5.5 kW depending on the speeds of the driven machines.
- For small generators (P ≤ 4 kW), the most common application uses 2 poles.
- For standard motors, the no-load voltages of asynchronous generators are very high and the voltage drop for the rated power is around 15% (power ratings below the rated power should not be used).
- Remember that asynchronous generators consume the reactive power required for their energization and supply active power to the mains (isolated or non-isolated) and that the reactive power of the loads should be compensated.

3-phase TEFV induction motors
FLS cast iron
Electrical characteristics

PAGES

E1 - Selection data: single-speed

E

E2 - Selection data: two-speed

The characteristics described in the following pages also apply to the FLSC range

For dimensions, see section F
page 99

3-phase TEFV induction motors
FLS cast iron
Electrical characteristics

E1 - Selection data: single-speed

2 poles
3000 min^{-1}

IP 55
Cl. F - ΔT 80 K
400 V +/- 10%

EFF 2

MAINS SUPPLY Δ 230 / Y 400 V or Δ 400 V **50 Hz**

Type	Power at 50 Hz	Rated speed	Rated torque	Rated current	Power factor			Efficiency			I_d / I_n	C_d / C_n	C_m / C_n	Apparent power	Torque curve	Moment of inertia	Weight
	kW	min^{-1}	N.m	A	50 %	75 %	100 %	50 %	75 %	100 %				kVA	N°	kg.m^2	kg
FLS 80 L	0.75	2840	2.5	1.6	0.76	0.80	0.86	73	77.4	76.9	5.9	2.4	2.2	1.1	1	0.0007	15
FLS 80 L	1.1	2837	3.7	2.4	0.65	0.77	0.84	76.6	78.5	79.5	5.6	2.7	2.4	1.6	6	0.0009	18
FLS 90 S	1.5	2870	5	3.3	0.64	0.75	0.81	79	81	82	7.3	3	3.1	2.3	5	0.0014	21
FLS 90 L	2.2	2862	7.5	4.3	0.71	0.82	0.88	82.5	84.2	84.5	8.1	3.7	3.5	3	5	0.0021	26
FLS 100 LK	3	2925	10	5.5	0.85	0.89	0.91	83	84	86	8.4	2.4	3	3.8	4	0.0069	42
FLS 112 M	4	2940	13.6	7.5	0.81	0.87	0.89	84	86	86.5	8.7	2.9	3.3	5.2	1	0.0084	48
FLS 132 S	5.5	2940	18.7	10.6	0.79	0.84	0.86	84	85.5	87	7.6	2.3	2.9	7.4	2	0.0168	67
FLS 132 S	7.5	2950	25	14.1	0.81	0.85	0.87	87	88	88	8.9	2.6	3.4	9.8	4	0.0236	70
FLS 160 MA	11	2935	35.8	20	0.82	0.86	0.88	85.3	87.3	88.4	8.6	2.8	3.2	14.1	2	0.037	97
FLS 160 MB	15	2935	48.8	27	0.82	0.86	0.88	87	89.1	89.7	8.6	2.8	3.2	19	2	0.043	108
FLS 160 L	18.5	2940	60	33	0.84	0.88	0.90	88.1	90.2	90.8	8.4	2.7	3.1	22.6	2	0.057	126
FLS 180 MR	22	2940	71	39	0.83	0.87	0.89	88.3	90.4	91	8.5	2.8	3.1	27.2	2	0.065	135
FLS 200 LA	30	2950	97	51	0.85	0.90	0.91	90.2	91.9	92.4	7.7	2.4	2.8	35.7	3	0.13	245
FLS 200 LB*	37	2959	120	63	0.84	0.89	0.9	91.3	93	93.5	8.3	3	3.4	44.4	8	0.16	265
FLS 225 MT*	45	2958	145	78	0.83	0.88	0.89	91.6	93.3	93.8	8.3	2.8	3.2	54	8	0.19	290
FLS 250 M*	55	2966	177	94	0.81	0.87	0.89	92.2	94	94.6	7.9	2.5	3.5	65	8	0.44	405
FLS 280 S*	75	2965	241	127	0.82	0.88	0.90	93	94.2	94.6	8	2.7	3.8	88	8	0.47	505
FLS 280 M*	90	2962	290	149	0.83	0.89	0.91	91.6	95.1	95.5	7.7	2.6	3.7	104	8	0.53	560
FLS 315 ST	110	2975	356	178	0.89	0.92	0.93	95	95.7	95.8	8.2	2.8	3.3	123	8	1.08	850
FLS 315 M	132	2962	427	221	0.86	0.89	0.90	93.8	95.4	96	7.5	1.8	2.7	153	9	1.71	1000
FLS 315 LA	160	2969	517	272	0.82	0.87	0.89	92.8	94.9	95.5	7.5	2	3	188	9	1.71	1050
FLS 315 LB	200	2967	647	342	0.81	0.86	0.88	93.9	95.4	96	7.7	2.3	3.4	237	8	1.99	1150
FLS 355 LA	250	2978	808	424	0.84	0.88	0.89	94	95.2	95.6	7.2	2.1	2.6	294	3	3.39	1400
FLS 355 LB	275	2980	881	464	0.84	0.88	0.89	95	96	96.2	8.4	2.3	2.9	322	10	3.39	1500
FLS 355 LB ●	315	2976	1016	525	0.85	0.89	0.90	94.9	95.9	96.2	7.2	1.8	2.5	364	10	3.39	1500
FLS 355 LC	330	2980	1057	560	0.81	0.86	0.88	95.4	96.3	96.6	7.9	1.9	2.6	388	3	3.39	1915
FLS 355 LC	355	2979	1137	588	0.83	0.88	0.90	95.6	96.5	96.8	8.2	2.3	3.1	407	3	4.03	1915
FLS 355 LD ●	400	2977	1284	673	0.82	0.87	0.89	95.2	96.1	96.4	7.8	2	2.7	466	3	4.03	1915

* Motors EFF1

● Class F temperature rise

For power ratings above 400 kW, please consult Leroy-Somer.

* Torque curve	Noise level
section D4.4 - page 63	section D6.1 - page 71

LEROY SOMER

3-phase TEFV induction motors
FLS cast iron
Electrical characteristics

E1 - Selection data: single-speed

Voltage and frequency	MAINS SUPPLY 380 V 50 Hz					MAINS SUPPLY 415 V 50 Hz				MAINS SUPPLY 460 V can be used from 440V to 480V 60 Hz				
	Power at 50 Hz	Rated speed	Rated current	Power factor	Efficiency	Rated speed	Rated current	Power factor	Efficiency	Power at 60 Hz	Rated speed	Rated current	Power factor	Efficiency
Type	kW	min^{-1}	A		%	min^{-1}	A		%	kW	min^{-1}	A		%
FLS 80 L	0.75	2802	1.8	0.85	74.5	2846	1.8	0.78	74.1	0.9	3420	1.8	0.83	76.3
FLS 80 L	1.1	2819	2.4	0.89	77.1	2859	2.4	0.84	75.5	1.3	3442	2.4	0.88	78.8
FLS 90 S	1.5	2853	3.2	0.87	81	2885	3	0.82	84	1.8	3485	3.1	0.87	83
FLS 90 L	2.2	2880	4.8	0.84	83	2904	4.6	0.81	82.5	2.7	3490	4.6	0.88	84.5
FLS 100 LK	3	2910	5.8	0.93	84	2930	5.5	0.9	84	3.6	3510	5.8	0.92	84
FLS 112 M	4	2925	7.9	0.91	85	2945	7.5	0.88	84.5	4.8	3530	7.8	0.91	85
FLS 132 S	5.5	2930	10.9	0.9	85.5	2940	10.3	0.87	85.4	6.6	3525	10.9	0.90	84.6
FLS 132 S	7.5	2935	14.2	0.92	87.5	2955	13.4	0.89	87.8	9	3530	14.2	0.91	87.4
FLS 160 MA	11	2929	21	0.89	88.2	2939	20	0.87	88.4	13.2	3535	21	0.88	88.1
FLS 160 MB	15	2929	29	0.89	89.5	2939	27	0.87	89.7	18	3535	29	0.88	89.4
FLS 160 L	18.5	2933	34	0.91	90.6	2944	32	0.89	90.8	22	3540	34	0.90	90.5
FLS 180 MR	22	2933	41	0.90	90.8	2944	38	0.88	91	25	3533	39	0.90	90.5
FLS 200 LA	30	2946	54	0.92	92.3	2967	50	0.90	93	34.5	3546	51	0.92	92.1
FLS 200 LB	37	2955	65	0.92	93.6	2963	62	0.89	93.9	42.5	3555	62	0.92	93.4
FLS 225 MT	45	2946	81	0.9	93.7	2956	75	0.89	93.7	52	3546	78	0.90	93.5
FLS 250 M	55	2962	98	0.90	94.5	2970	91	0.89	94.6	63	3562	93	0.90	94.3
FLS 280 S	75	2966	134	0.90	94.5	2967	124	0.89	94.6	86	3566	127	0.90	94.3
FLS 280 M	90	2953	158	0.91	95.3	2967	146	0.90	95.5	103	3567	151	0.90	95.3
FLS 315 ST	110	2971	188	0.93	95.7	2976	172	0.93	95.7	126	3571	178	0.93	95.5
FLS 315 M	132	2957	230	0.91	96	2963	213	0.90	96	150	3557	216	0.91	95.8
FLS 315 LA	160	2963	283	0.90	95.3	2972	265	0.88	95.3	180	3563	264	0.90	95.1
FLS 315 LB	200	2956	358	0.89	95.3	2968	338	0.86	95.6	230	3556	341	0.89	95.1
FLS 355 LA	250	2974	442	0.90	95.4	2978	409	0.89	95.5	280	3574	410	0.90	95.2
FLS 355 LB	275	2973	482	0.90	96.3	2980	451	0.88	96.5	315	3576	457	0.90	96.2
FLS 355 LB	315	2970	552	0.90	96.3	2976	516	0.88	96.5	330	3571	484	0.89	96.1
FLS 355 LC	330	2980	590	0.88	96.6	2980	561	0.85	96.2	380	3576	567	0.88	95.6
FLS 355 LC	355	2978	619	0.90	96.8	2983	589	0.87	96.4	410	3578	597	0.90	95.8
FLS 355 LD	400	2976	709	0.89	96.3	2981	647	0.89	96.6	440	3576	657	0.88	95.5

For power ratings above 400 kW, please consult Leroy-Somer.

E

3-phase TEFV induction motors
FLS cast iron
Electrical characteristics

E1 - Selection data: single-speed

4 poles
1500 min^{-1}

IP 55
Cl. F - ΔT 80 K
400 V +/- 10%

EFF 2

MAINS SUPPLY Δ 230 / Y 400 V or Δ 400 V **50 Hz**

Type	Power at 50 Hz	Rated speed	Rated torque	Rated current	Power factor			Efficiency			I_d / I_n	C_d / C_n	C_m / C_n	Apparent power	Torque curve	Moment of inertia	Weight
	kW	min^{-1}	N.m	A	50 %	75 %	100 %	50 %	75 %	100 %				kVA	N°	$kg.m^2$	kg
FLS 80 L	0.55	1410	3.7	1.6	0.56	0.69	0.74	65	69.4	69.2	4.4	2.1	2.3	1.1	3	0.0013	15
FLS 80 L	0.75	1425	5	2	0.58	0.70	0.75	70	73	72.5	5.7	3	2.8	1.4	1	0.0024	17
FLS 90 S	1.1	1429	7.5	2.5	0.68	0.77	0.83	76	78.4	78	4.9	1.6	2	1.7	5	0.0026	19
FLS 90 L	1.5	1428	10	3.3	0.62	0.74	0.82	77	79.4	79.5	5.3	1.8	2.3	2.3	4	0.0032	21
FLS 90 L	1.8	1438	12.3	4	0.63	0.75	0.82	79	80.8	80.1	5.9	2.1	3.2	2.7	2	0.0037	23
FLS 100 LK	2.2	1457	15	4.6	0.67	0.77	0.83	82.2	84.4	83.8	6.3	1.9	2.4	3.2	3	0.0077	41
FLS 100 LK	3	1454	20	6.2	0.64	0.76	0.82	83.4	84.9	84.7	6.5	2.1	2.6	4.3	2	0.0094	44
FLS 112 M	4	1462	27.5	8.4	0.62	0.74	0.81	82.2	84.9	85.1	7.4	2.5	2.9	5.8	2	0.012	48
FLS 132 S	5.5	1467	37	10.9	0.66	0.78	0.84	86	87.1	87	8	2.7	3.7	7.7	1	0.0154	65
FLS 132 M	7.5	1450	50	14.3	0.75	0.82	0.87	85.5	87.2	87	7.3	1.9	2.9	10.5	2	0.0192	70
FLS 132 M	9	1449	61	16.8	0.72	0.84	0.88	86.5	88.4	87.7	7.6	2.8	2.9	11.6	2	0.023	75
FLS 160 M	11	1455	72.2	21	0.72	0.81	0.86	87	88.4	88.5	7.8	2.6	3.3	15	2	0.06	103
FLS 160 L	15	1455	98.5	28	0.72	0.81	0.86	88	89.4	89.5	7.8	2.6	3.3	20	2	0.079	120
FLS 180 MR	18.5	1465	120.5	35	0.72	0.81	0.86	88.5	89.9	90	7.8	2.6	3.3	24	2	0.095	135
FLS 180 L	22	1465	143	41	0.73	0.82	0.86	89.7	91.2	91.4	7.4	2.6	2.4	28	6	0.137	184
FLS 200 L	30	1471	195	56	0.73	0.82	0.85	91	92	91.9	6.5	2.5	2.3	39	6	0.24	260
FLS 225 ST*	37	1476	240	70	0.66	0.77	0.82	91.6	93.3	93.6	7	2.6	2.4	49	6	0.28	290
FLS 225 M*	45	1483	290	79	0.76	0.84	0.87	93.2	94.3	94.5	7	2.5	2.6	55	6	0.7	388
FLS 250 M*	55	1479	355	101	0.70	0.80	0.84	93.9	94.6	94.5	6.5	2.4	2.5	70	6	0.7	395
FLS 280 S*	75	1483	484	137	0.68	0.79	0.84	93	94.8	94.9	7.7	2.9	3	95	6	0.815	475
FLS 280 M*	90	1478	581	162	0.73	0.82	0.85	94.2	95	95	7.6	3	3.1	112	6	1.015	565
FLS 315 ST	110	1482	710	203	0.71	0.80	0.83	93.7	94.5	94.8	7.3	2.9	2.7	141	8	1.83	850
FLS 315 M	132	1489	850	249	0.68	0.77	0.81	92.7	94.3	95	8	2.8	2.6	172	8	2.91	1000
FLS 315 LA	160	1486	1032	285	0.73	0.82	0.85	94.6	95.6	95.8	7.5	2.2	2.4	198	3	3.4	1050
FLS 315 LB	200	1487	1291	369	0.68	0.78	0.82	95.1	95.9	96	8	2.2	2.3	255	3	3.4	1150
FLS 355 LA	250	1487	1611	427	0.81	0.86	0.88	95.5	96.3	96.5	7.4	1.7	2.3	296	9	6.2	1510
FLS 355 LB	300	1489	1930	520	0.79	0.85	0.87	95.5	96.1	96.3	6.5	1.6	1.6	360	5	6.2	1550
FLS 355 LC	315	1490	2019	557	0.76	0.82	0.85	95.5	96.3	96.5	7.4	2.2	2.2	386	5	6.5	1800
FLS 355 LC	355	1489	2279	619	0.77	0.83	0.86	95.8	96.6	96.8	6.6	1.9	1.9	429	5	6.5	1800
FLS 355 LD	400	1489	2564	689	0.77	0.84	0.87	95.7	96.6	96.8	7.4	2.1	2.1	477	6	7.4	1930
FLS 400 LB	400	1491	2559	691	0.78	0.85	0.87	95.4	96.3	96.6	8	2	2.6	478	4	11.7	2350
FLS 355 LKB	450	1490	2880	767	0.79	0.86	0.88	95.5	96.4	96.7	7.6	1.8	2.3	532	4	11.7	2320
FLS 400 LB	450	1490	2880	767	0.79	0.86	0.88	95.5	96.4	96.7	7.6	1.8	2.3	532	4	11.7	2350
FLS 355 LKB ●	500	1490	3200	854	0.79	0.86	0.88	96	96.1	96.5	6.5	1.7	2.2	592	4	11.7	2320
FLS 400 LVB	500	1490	3200	864	0.77	0.84	0.87	96	96.1	96.5	6.5	1.7	2.2	599	4	11.7	2350
FLS 450 LA	500	1492	3200	864	0.77	0.84	0.87	96	96.1	96.5	8	1.6	2.2	599	5	21	3100
FLS 450 LVA	550	1491	3525	940	0.78	0.85	0.88	96	96.1	96.5	7.9	1.5	2.1	651	5	21	3100
FLS 450 LB	630	1493	4030	1089	0.77	0.84	0.87	96	96.1	96.5	8.2	1.5	2.1	754	5	24	3450
FLS 450 LVB ●	675	1491	4326	1164	0.77	0.84	0.87	96	96.3	96.7	8	1.4	1.9	807	5	24	3450

* Motors EFF1

● Class F temperature rise

For power ratings above 675 kW, please consult Leroy-Somer.

* Torque curve	Noise level
section D4.4 - page 63	section D6.1 - page 71

3-phase TEFV induction motors
FLS cast iron
Electrical characteristics

E1 - Selection data: single-speed

Voltage and frequency	MAINS SUPPLY 380 V 50 Hz					MAINS SUPPLY 415 V 50 Hz				MAINS SUPPLY 460 V 60 Hz can be used from 440V to 480V				
	Power at 50 Hz	Rated speed	Rated current	Power factor	Efficiency	Rated speed	Rated current	Power factor	Efficiency	Power at 60 Hz	Rated speed	Rated current	Power factor	Efficiency
Type	kW	min^{-1}	A		%	min^{-1}	A		%	kW	min^{-1}	A		%
FLS 80 L	0.55	1390	1.6	0.78	69	1415	1.6	0.70	68	0.66	1705	1.55	0.75	72
FLS 80 L	0.75	1415	2	0.78	72.6	1430	2.1	0.71	71.2	0.9	1730	2	0.75	74.4
FLS 90 S	1.1	1416	2.6	0.86	75.5	1437	2.5	0.81	77.2	1.3	1726	2.5	0.84	78.9
FLS 90 L	1.5	1417	3.4	0.86	77.9	1436	3.4	0.79	78.4	1.8	1722	3.3	0.84	80.4
FLS 90 L	1.8	1427	4.1	0.84	79.4	1443	4	0.78	80.1	2.2	1733	4.1	0.82	81
FLS 100 LK	2.2	1450	4.7	0.85	83.2	1462	4.5	0.81	83.9	2.6	1755	4.6	0.84	84.8
FLS 100 LK	3	1448	6.4	0.85	84.3	1460	6.2	0.80	84.7	3.6	1752	6.3	0.83	85.9
FLS 112 M	4	1455	8.5	0.84	85	1464	8.4	0.78	84.7	4.8	1753	8.4	0.83	86.1
FLS 132 S	5.5	1444	11.4	0.85	86.5	1455	11	0.81	86	6.6	1750	11.2	0.85	87
FLS 132 M	7.5	1445	15.8	0.85	85	1455	15	0.82	85	9	1750	15.5	0.85	87
FLS 132 M	9	1440	17.4	0.90	86.9	1455	16.6	0.88	87.9	11	1750	17	0.88	88.7
FLS 160 M	11	1447	21.6	0.88	88	1459	21	0.84	88.7	12.6	1747	20	0.88	87.8
FLS 160 L	15	1447	29.1	0.88	89	1459	28	0.84	89.7	17.2	1747	28	0.88	88.8
FLS 180 MR	18.5	1457	36.1	0.88	88.5	1469	34	0.84	90.2	21	1757	34	0.88	88.3
FLS 180 L	22	1460	41.7	0.88	91.1	1465	40	0.84	91.5	25	1760	39	0.88	90.9
FLS 200 L	30	1467	58	0.86	91.4	1472	55	0.83	91.6	34.5	1767	55	0.86	91.2
FLS 225 ST	37	1472	70	0.86	93.4	1477	69	0.80	93	42.4	1773	66	0.86	93.2
FLS 225 M	45	1478	82	0.88	94.2	1483	78	0.85	94.4	52	1783	82	0.85	94.2
FLS 250 M	55	1476	102	0.87	94.6	1481	100	0.81	94.3	63	1776	96	0.87	94.4
FLS 280 S	75	1480	140	0.86	94.8	1484	136	0.81	94.4	86	1780	133	0.86	94.5
FLS 280 M	90	1477	167	0.86	95.4	1481	158	0.83	95.4	103	1777	158	0.86	95.2
FLS 315 ST	110	1479	207	0.85	94.8	1487	194	0.83	95.1	125	1779	195	0.85	94.6
FLS 315 M	132	1487	254	0.83	95.1	1488	249	0.78	94.4	150	1787	239	0.83	94.9
FLS 315 LA	160	1485	291	0.87	95.9	1487	284	0.82	95.7	185	1785	279	0.87	95.7
FLS 315 LB	200	1486	362	0.87	96.4	1492	357	0.81	96.1	230	1786	344	0.87	96.4
FLS 355 LA	250	1485	443	0.89	96.4	1488	415	0.87	96.4	285	1785	417	0.89	96.4
FLS 355 LB	300	1487	545	0.87	96.1	1490	498	0.87	96.3	345	1787	519	0.87	95.9
FLS 355 LC	315	1488	577	0.86	96.4	1491	548	0.83	96.4	360	1780	546	0.86	96.2
FLS 355 LC	355	1487	641	0.87	96.7	1490	608	0.84	96.7	405	1787	605	0.87	96.5
FLS 355 LD	400	1488	722	0.87	96.7	1490	685	0.84	96.7	460	1788	688	0.87	96.5
FLS 400 LB	400	1490	707	0.89	96.6	1492	672	0.86	96.3	460	1790	681	0.88	96.3
FLS 355 LKB	450	1489	795	0.89	96.6	1491	748	0.87	96.2	515	1789	763	0.88	96.3
FLS 400 LB	450	1489	795	0.89	96.6	1491	748	0.87	96.2	515	1789	763	0.88	96.3
FLS 355 LKB	500	1489	892	0.88	96.8	1491	833	0.87	96	575	1792	860	0.87	96.5
FLS 400 LVB	500	1489	892	0.88	96.8	1491	833	0.87	96	575	1792	860	0.87	96.5
FLS 450 LA	500	1492	895	0.88	96.5	1491	840	0.86	96.3	575	1791	862	0.87	96.2
FLS 450 LVA	550	1491	973	0.89	96.5	1490	913	0.87	96.3	630	1791	934	0.88	96.2
FLS 450 LB	630	1493	1132	0.88	96.1	1492	1063	0.86	95.9	725	1793	1092	0.87	95.8
FLS 450 LVB	675	1491	1205	0.88	96.7	1490	1132	0.86	96.5	775	1791	1160	0.87	96.4

For power ratings above 675 kW, please consult Leroy-Somer.

3-phase TEFV induction motors
FLS cast iron
Electrical characteristics

E1 - Selection data: single-speed

6 poles
1000 min⁻¹

IP 55
Cl. F - ΔT 80 K
400 V +/- 10%

MAINS SUPPLY Δ 230 / Y 400 V or Δ 400 V **50 Hz**

Type	Power at 50 Hz	Rated speed	Rated torque	Rated current	Power factor			Efficiency			I_d / I_n	C_d / C_n	C_m / C_n	Apparent power	Torque curve	Moment of inertia	Weight
	kW	min^{-1}	N.m	A	50 %	75 %	100 %	50 %	75 %	100 %				kVA	N°	$kg.m^2$	kg
FLS 80 L	0.25	950	2.5	0.8	0.55	0.68	0.74	54	58	60.3	3.6	2	1.9	0.6	3	0.0024	14
FLS 80 L	0.37	940	3.7	1.2	0.55	0.68	0.74	55	59	61	3.8	1.9	2.1	0.8	4	0.0032	15
FLS 80 L	0.55	955	5.5	1.8	0.46	0.59	0.67	60	64	65	4.4	2.5	2.6	1.3	2	0.0042	16
FLS 90 S	0.75	940	7.5	2.1	0.65	0.75	0.8	60	64	65.2	3.5	2	2.2	1.4	3	0.0039	21
FLS 90 L	1.1	940	11	2.7	0.66	0.76	0.81	70	73	73.5	4.8	1.8	2.2	1.8	4	0.0048	23
FLS 100 LK	1.5	955	15	3.5	0.61	0.72	0.78	76	78	78.3	6.3	2.2	2.8	2.5	2	0.0134	41
FLS 112 M	2.2	960	22	5.2	0.59	0.71	0.77	79	80	80	5.5	2.3	2.4	3.6	3	0.015	45
FLS 132 S	3	953	30	6.9	0.63	0.71	0.76	80	82.2	81.9	5.3	2.2	2.4	4.7	2	0.0376	71
FLS 132 M	4	970	40	9	0.61	0.72	0.78	81	82	82.1	6.7	2.8	2.7	6.2	1	0.0517	76
FLS 132 MU	5.5	970	54	12.2	0.63	0.74	0.79	81	82	82.1	7.1	3.2	2.7	8.5	1	0.0595	88
FLS 160 M	7.5	968	74	16	0.65	0.75	0.80	84.9	86.4	86	5	1.5	2.4	11	5	0.085	100
FLS 160 L	11	966	109	23	0.66	0.76	0.81	85.9	87.4	87	5	1.5	2.4	16	5	0.12	128
FLS 180 L	15	974	147	30	0.67	0.77	0.82	88.3	89.7	89.5	7.1	2.1	3.1	21	2	0.2	170
FLS 200 LA	18.5	975	181	36	0.68	0.78	0.83	88.9	90.5	90.7	7	2.2	3.3	25	2	0.29	240
FLS 200 LB	22	973	216	43	0.66	0.76	0.81	89.7	91.3	91.5	7	2.2	3.3	30	2	0.31	260
FLS 225 M	30	978	293	59	0.64	0.74	0.80	92.3	93.3	92	6	2	2.4	41	3	0.94	392
FLS 250 M	37	977	362	73	0.66	0.76	0.80	91.6	92.6	92.5	6.2	2.2	2.6	50	3	0.94	394
FLS 280 S	45	971	440	84	0.7	0.80	0.84	92	93.1	93	6	1.9	2.3	58	3	1.13	455
FLS 280 M	55	977	538	109	0.65	0.75	0.79	92	93.1	93	6.9	2.8	3.3	75	2	1.26	532
FLS 315 ST	75	987	731	133	0.77	0.84	0.86	94.2	94.9	94.8	6.5	2.3	2.1	92	6	1.8	850
FLS 315 M	90	987	875	161	0.76	0.83	0.85	95	95.7	95.6	6.7	1.7	1.5	111	7	2.6	1000
FLS 315 LA	110	983	1067	199	0.76	0.83	0.85	93.9	94.6	94.5	6	1.5	1.3	138	7	2.6	1050
FLS 315 LB	132	988	1280	241	0.74	0.81	0.83	95.3	96	95.9	7.4	2	1.8	167	7	3.5	1125
FLS 315 LB	150	986	1454	277	0.76	0.81	0.82	95.7	96.1	95.8	6.6	1.5	2.5	192	9	3.5	1125
FLS 355 LA	185	987	1783	346	0.68	0.77	0.81	94.8	95.7	95.8	7.5	2	3.3	240	3	5.4	1415
FLS 355 LB	220	988	2129	412	0.68	0.77	0.81	94.5	95.5	95.6	7.4	1.9	3.1	286	3	6.3	1535
FLS 355 LD	250	993	2406	459	0.72	0.79	0.82	95.3	95.8	95.8	7.8	2.1	2.3	317	5	8.6	1935
FLS 355 LD	300	992	2885	558	0.72	0.79	0.82	94.7	95.2	95.2	6.8	1.65	1.8	386	5	8.6	1935
FLS 355 LKB	350	994	3376	637	0.73	0.80	0.83	94.8	95.8	96	6.5	1.7	1.6	442	5	17	2350
FLS 400 LB	350	994	3376	637	0.73	0.80	0.83	94.8	95.8	96	6.5	1.7	1.6	442	5	17	2400
FLS 450 LA	400	996	3851	773	0.61	0.72	0.78	94.4	95.7	96.3	8	2	2.2	535	5	33	3230
FLS 400 LKB	500	996	4809	952	0.62	0.73	0.79	94.6	95.9	96.5	8	2	2.2	659	5	35	3350
FLS 450 LB	500	996	4809	952	0.62	0.73	0.79	94.6	95.9	96.5	8	2	2.2	659	5	35	3400
FLS 450 LB	550	996	5273	1034	0.63	0.74	0.8	94.6	95.9	96.5	7.5	1.8	1.9	716	5	35	3400

For power ratings above 550 kW, please consult Leroy-Somer.

* Torque curve	Noise level
section D4.4 - page 63	section D6.1 - page 71

3-phase TEFV induction motors
FLS cast iron
Electrical characteristics

E1 - Selection data: single-speed

Voltage and frequency	MAINS SUPPLY 380 V 50 Hz					MAINS SUPPLY 415 V 50 Hz				MAINS SUPPLY 460 V 60 Hz can be used from 440V to 480V				
	Power at 50 Hz	Rated speed	Rated current	Power factor	Efficiency	Rated speed	Rated current	Power factor	Efficiency	Power at 60 Hz	Rated speed	Rated current	Power factor	Efficiency
Type	kW	min^{-1}	A		%	min^{-1}	A		%	kW	min^{-1}	A		%
FLS 80 L	0.25	940	0.8	0.78	60.4	950	0.8	0.71	60	0.3	1145	0.8	0.74	64.2
FLS 80 L	0.37	940	1.2	0.77	63.5	955	1.2	0.7	64	0.45	1145	1.2	0.76	63.5
FLS 80 L	0.55	945	1.8	0.72	66.3	960	1.8	0.65	64	0.66	1150	1.8	0.68	68.8
FLS 90 S	0.75	930	2.1	0.83	66.3	945	2	0.79	64.6	0.9	1140	2	0.78	73.6
FLS 90 L	1.1	935	2.8	0.83	72.9	950	2.7	0.78	73.5	1.3	1145	2.6	0.81	76.2
FLS 100 LK	1.5	950	3.7	0.8	78	960	3.5	0.76	78.1	1.8	1160	3.6	0.78	80.3
FLS 112 M	2.2	950	5.3	0.8	78.5	965	5.1	0.75	79.5	2.6	1155	5.1	0.78	81.3
FLS 132 S	3	943	7.1	0.79	81.1	957	6.9	0.74	81.7	3.6	1145	7	0.78	82.7
FLS 132 M	4	965	9.3	0.8	81.9	970	9.1	0.75	82	4.8	1170	9	0.8	83.7
FLS 132 MU	5.5	965	11.2	0.81	92.1	975	12.3	0.76	81.9	6.6	1160	12.3	0.81	83.1
FLS 160 M	7.5	959	16.4	0.82	84.9	970	15.9	0.77	85.2	8.6	1159	15.6	0.82	84.7
FLS 160 L	11	960	23	0.84	87.2	969	22	0.79	87	12.6	1169	23	0.79	87
FLS 180 L	15	970	30	0.86	89	977	29	0.81	89.6	17	1170	28	0.86	88.8
FLS 200 LA	18.5	971	37	0.85	90.7	976	35	0.82	90.7	21	1171	34	0.85	90.5
FLS 200 LB	22	970	45	0.82	91.4	977	43	0.78	91.3	25	1170	42	0.82	91.2
FLS 225 M	30	974	61	0.82	91.6	980	58	0.78	92	34.5	1174	58	0.82	91.4
FLS 250 M	37	973	75	0.81	92.4	979	72	0.78	92.1	42	1173	71	0.81	92.2
FLS 280 S	45	967	87	0.85	92.6	972	83	0.82	92.6	52	1167	85	0.84	91.9
FLS 280 M	55	973	110	0.82	92.6	978	107	0.77	93	63	1173	104	0.82	92.4
FLS 315 ST	75	986	137	0.88	94.6	988	128	0.86	94.8	85	1188	131	0.86	94.6
FLS 315 M	90	985	165	0.87	95.5	988	156	0.84	95.5	105	1185	159	0.87	95.3
FLS 315 LA	110	981	206	0.86	94.6	985	198	0.82	94.6	125	1185	203	0.82	94.4
FLS 315 LB	132	986	250	0.84	95.8	989	243	0.79	95.7	150	1186	235	0.84	95.6
FLS 315 LB	150	988	284	0.84	95.8	990	277	0.79	95.6	170	1188	266	0.84	95.6
FLS 355 LA	185	983	345	0.85	96	988	357	0.76	95.1	210	1184	328	0.84	95.8
FLS 355 LB	220	985	418	0.84	95.4	988	413	0.78	95.1	250	1185	393	0.84	95.2
FLS 355 LD	250	991	477	0.83	95.8	994	450	0.8	96.7	287	1191	450	0.83	96.5
FLS 355 LD	300	990	571	0.84	95.1	993	549	0.8	95.2	345	1190	544	0.84	94.9
FLS 355 LKB	350	993	676	0.82	96	995	669	0.76	95.9	400	1193	648	0.81	95.7
FLS 400 LB	350	993	676	0.82	96	995	669	0.76	95.9	400	1193	648	0.81	95.7
FLS 450 LA	400	995	778	0.81	96.5	996	784	0.74	96	460	1195	751	0.80	96.2
FLS 400 LKB	500	995	961	0.82	96.5	996	955	0.76	96	575	1195	927	0.81	96.2
FLS 450 LB	500	995	961	0.82	96.5	996	955	0.76	96	575	1195	927	0.81	96.2
FLS 450 LB	550	995	1045	0.83	96.5	996	1036	0.77	96	632	1195	1007	0.82	96.2

For power ratings above 550 kW, please consult Leroy-Somer.

E

3-phase TEFV induction motors
FLS cast iron
Electrical characteristics

E1 - Selection data: single-speed

8 poles
750 min^{-1}

IP 55
Cl. F - ΔT 80 K
400 V +/- 10%

MAINS SUPPLY Δ 230 / Y 400 V or Δ 400 V **50 Hz**

Type	Power at 50 Hz	Rated speed	Rated torque	Rated current	Power factor			Efficiency			I_d / I_n	C_d / C_n	C_m / C_n	Apparent power	Torque curve	Moment of inertia	Weight
	kW	min^{-1}	N.m	A	50 %	75 %	100 %	50 %	75 %	100 %				kVA	N°	kg.m^2	kg
FLS 80 L	0.18	710	2.5	0.8	0.46	0.58	0.64	45	51	52.3	3	1.6	1.6	0.5	5	0.0031	14
FLS 80 L	0.25	720	3.4	1.1	0.44	0.55	0.6	46	54	54.5	3.2	2	2.3	0.8	4	0.0041	16
FLS 90 S	0.37	685	5	1.2	0.46	0.63	0.71	59	63	64	3.5	1.7	1.7	0.9	8	0.0038	21
FLS 90 L	0.55	695	7.5	1.7	0.46	0.63	0.72	54	63.7	63	3.3	1.8	1.8	1.2	8	0.0047	23
FLS 100 LK	0.75	720	10	2.3	0.47	0.6	0.68	66	70	70.9	4.1	1.9	1.9	1.6	8	0.0085	41
FLS 100 LK	1.1	720	15	3.8	0.44	0.56	0.62	60	66	68	4.1	1.8	2.3	2.6	8	0.0117	43
FLS 112 M	1.5	725	20	4.8	0.45	0.57	0.63	68	72	72.5	4	2.1	2.2	3.3	8	0.015	45
FLS 132 S	2.2	715	30	7.2	0.44	0.55	0.6	72	74	74	3.2	1.4	1.8	5	5	0.0253	71
FLS 132 M	3	705	40	9.1	0.46	0.57	0.63	73	76	76	3.1	1.3	1.9	6.3	5	0.0334	81
FLS 160 MA	4	710	54	11.3	0.44	0.56	0.63	80.1	82	81.5	3.8	1.4	1.7	7.8	5	0.062	105
FLS 160 MB	5.5	710	74	15	0.46	0.58	0.65	80.6	82.5	82	3.8	1.4	1.7	10.4	5	0.071	111
FLS 160 L	7.5	715	100	20	0.46	0.58	0.65	81.6	93.5	83	3.8	1.5	1.8	14	5	0.086	128
FLS 180 L	11	724	147	27	0.51	0.63	0.7	82.4	84.9	85.1	3.9	1.4	1.7	19	5	0.21	175
FLS 200 L	15	729	196	34	0.53	0.66	0.72	86.2	88	88.1	5	1.8	2.6	24	9	0.32	265
FLS 225 ST	18.5	727	242	41	0.54	0.67	0.73	87.1	88.9	89	5	1.6	2.3	29	9	0.38	285
FLS 225 M	22	732	288	48	0.58	0.68	0.72	91.7	92.6	92.1	5.9	1.8	2.5	33	9	0.83	388
FLS 250 M	30	729	393	61	0.64	0.74	0.78	90.8	91.7	91.2	6.2	1.8	2.5	42	9	0.83	393
FLS 280 S	37	723	487	75	0.64	0.74	0.78	91	92.1	92	4.5	1.3	1.8	52	5	1.4	472
FLS 280 M	45	730	592	102	0.55	0.66	0.7	90.7	91.8	91.7	6	2.3	3.2	70	3	1.75	563
FLS 315 ST	55	738	715	102	0.71	0.8	0.83	94	94.5	94.2	7.4	2.1	3	71	3	2.7	850
FLS 315 M	75	743	972	147	0.68	0.76	0.78	94.3	95	94.8	7.4	2	2.2	102	4	3.1	1000
FLS 315 LA	90	742	1169	177	0.68	0.76	0.78	94.2	94.9	94.7	6.7	1.9	2.1	122	4	4.2	1030
FLS 315 LB	110	742	1420	222	0.66	0.74	0.76	94.3	95	94.8	7.2	2	2.2	153	4	5.1	1125
FLS 355 LA	132	741	1704	258	0.68	0.75	0.78	94.2	95.2	95.3	6.7	2	2.2	179	4	5.5	1415
FLS 355 LB	160	741	2065	312	0.68	0.75	0.78	94.2	95.2	95.3	6.9	2	2.2	216	4	6	1535
FLS 355 LD	200	741	2581	364	0.74	0.81	0.84	93.9	94.9	95	6.7	1.6	1.7	252	4	6.5	1935
FLS 355 LKA	250	743	3235	464	0.67	0.77	0.82	94.2	95.1	95.3	6.8	1.6	2.2	322	5	18.5	2170
FLS 400 LA	250	743	3235	464	0.67	0.77	0.82	94.2	95.1	95.3	6.8	1.6	2.2	322	5	18.5	2200
FLS 355 LKB	300	741	3882	552	0.68	0.78	0.83	94	94.8	95	6	1.1	1.5	382	5	21.6	2370
FLS 400 LB	300	741	3882	552	0.68	0.78	0.83	94	94.8	95	6	1.1	1.5	382	5	21.6	2400
FLS 400 LKA	350	746	4500	652	0.69	0.78	0.81	95	95.9	96.2	6.2	1.7	1.4	452	7	40	3100
FLS 450 LA	350	746	4500	652	0.69	0.78	0.81	95	95.9	96.2	6.2	1.7	1.4	452	7	40	3150
FLS 400 LKB	400	746	5148	737	0.71	0.79	0.82	94.9	95.8	96.1	6.7	1.9	1.6	510	7	47	3420
FLS 450 LB	400	746	5148	737	0.71	0.79	0.82	94.9	95.8	96.1	6.7	1.9	1.6	510	7	47	3470

For power ratings above 400 kW, please consult Leroy-Somer.

* Torque curve	Noise level
section D4.4 - page 63	section D6.1 - page 71

3-phase TEFV induction motors
FLS cast iron
Electrical characteristics

E1 - Selection data: single-speed

Voltage and frequency	MAINS SUPPLY 380 V 50 Hz					MAINS SUPPLY 415 V 50 Hz				MAINS SUPPLY 460 V 60 Hz can be used from 440V to 480V				
	Power at 50 Hz	Rated speed	Rated current	Power factor	Efficiency	Rated speed	Rated current	Power factor	Efficiency	Power at 60 Hz	Rated speed	Rated current	Power factor	Efficiency
Type	kW	min^{-1}	A		%	min^{-1}	A		%	kW	min^{-1}	A		%
FLS 80 L	0.18	700	0.8	0.66	53	710	0.8	0.61	52	0.22	860	0.8	0.62	56.2
FLS 80 L	0.25	710	1.1	0.63	56	720	1.2	0.57	53.1	0.3	870	1.1	0.59	58.8
FLS 90 S	0.37	670	1.2	0.75	63	700	1.2	0.69	62	0.45	835	1.2	0.71	66.5
FLS 90 L	0.55	680	1.8	0.74	62	700	1.8	0.67	64	0.66	810	1.8	0.71	66.5
FLS 100 LK	0.75	715	2.3	0.71	70.6	720	2.3	0.66	69.9	0.9	870	2.2	0.7	72.6
FLS 100 LK	1.1	710	3.6	0.68	68	720	3.9	0.6	65	1.3	870	3.6	0.64	71.5
FLS 112 M	1.5	715	4.7	0.67	72.3	725	4.9	0.6	70.9	1.8	870	4.7	0.65	74.3
FLS 132 S	2.2	710	7.6	0.6	73.5	720	8.0	0.53	72	2.6	855	7.3	0.59	75.5
FLS 132 M	3	695	9.5	0.64	75	710	9.8	0.57	75	3.6	850	10.2	0.59	75
FLS 160 MA	4	706	11.4	0.65	81.8	714	11.1	0.61	82.1	4.6	851	10.9	0.64	83.1
FLS 160 MB	5.5	706	16	0.67	79.4	714	16	0.62	79.7	6.3	857	15	0.66	82.2
FLS 160 L	7.5	707	21	0.67	82.4	718	20	0.62	82.4	8.6	859	19	0.66	84.1
FLS 180 L	11	720	27	0.73	85.1	726	28	0.66	84.4	12.5	870	25	0.73	84.9
FLS 200 L	15	729	34	0.76	88.6	730	35	0.68	87.7	17	879	32	0.76	87.6
FLS 225 ST	18.5	723	41	0.76	89.5	729	42	0.69	89.9	21	876	40	0.73	90.9
FLS 225 M	22	731	47	0.77	92.2	734	47	0.71	92.1	25	881	44	0.77	92
FLS 250 M	30	725	63	0.8	90.5	731	61	0.75	90.8	34	875	59	0.80	90.3
FLS 280 S	37	716	78	0.79	91.4	725	72	0.78	92.1	42	866	73	0.79	91.2
FLS 280 M	45	727	101	0.74	91.8	734	97	0.70	91.9	52	879	97	0.73	92.3
FLS 315 ST	55	737	104	0.85	94.2	740	100	0.82	93.8	65	884	100	0.87	93.8
FLS 315 M	75	742	149	0.81	94.8	743	146	0.76	94.1	85	892	139	0.81	94.6
FLS 315 LA	90	741	178	0.81	94.8	743	174	0.76	94.7	105	891	172	0.81	94.9
FLS 315 LB	110	741	223	0.79	94.9	743	218	0.74	94.9	125	891	210	0.79	94.7
FLS 355 LA	132	740	267	0.79	95.3	743	253	0.76	95.5	150	890	251	0.79	95.1
FLS 355 LB	160	740	323	0.79	95.3	743	307	0.76	95.5	185	889	310	0.79	94.9
FLS 355 LD	200	740	377	0.85	95	743	356	0.82	95.3	230	890	359	0.85	94.8
FLS 355 LKA	250	742	470	0.85	95.2	744	463	0.79	95.2	285	892	444	0.85	94.9
FLS 400 LA	250	742	470	0.85	95.2	744	463	0.79	95.2	285	892	444	0.85	94.9
FLS 355 LKB	300	740	566	0.85	94.9	742	575	0.77	94.4	345	890	546	0.84	94.5
FLS 400 LB	300	740	566	0.85	94.9	742	575	0.77	94.4	345	890	546	0.84	94.5
FLS 400 LKA	350	745	660	0.84	96.1	746	626	0.81	96.1	400	895	632	0.83	95.8
FLS 450 LA	350	745	660	0.84	96.1	746	626	0.81	96.1	400	895	632	0.83	95.8
FLS 400 LKB	400	746	753	0.84	96.2	747	725	0.80	96.1	460	896	726	0.83	95.9
FLS 450 LB	400	746	753	0.84	96.2	747	725	0.8	96.1	460	896	726	0.83	95.9

For power ratings above 400 kW, please consult Leroy-Somer.

E2 - Selection data: two-speed

IP 55 - Cl. F
Centrifugal applications

MAINS SUPPLY Δ 400 V 50 Hz

Type	2/4 Poles Dahlander	4/6 Poles PAM* or 2 windings	4/8 Poles Dahlander	6/8 Poles PAM* or 2 windings
	P_N kW	P_N kW	P_N kW	P_N kW
FLS 80 L	0.75 / 0.18	0.55 / 0.18	0.75 / 0.12	0.37 / 0.18
FLS 90 S	1.1 / 0.22	0.75 / 0.25	1.1 / 0.18	0.55 / 0.27
FLS 90 L	1.5 / 0.3	1.1 / 0.37	1.5 / 0.25	0.75 / 0.37
FLS 100 LK	2.2 / 0.37	1.5 / 0.55	2.2 / 0.37	-
FLS 100 LK	3 / 0.55	2.2 / 0.75	3 / 0.55	1.1 / 0.55
FLS 112 M	-	3 / 1.1	-	1.5 / 0.75
FLS 112 MU	4 / 0.75	4 / 1.5	4 / 0.75	2.2 / 1.1
FLS 132 M	5.5 / 1.1	5.5 / 1.8	5.5 / 1.1	3 / 1.5
FLS 132 M	7.5 / 1.5	-	7.5 / 1.5	-
FLS 160 MA	-	7.3 / 2.4	-	5 / 1.7
FLS 160 MB	11 / 2.7	-	10 / 2.5	-
FLS 160 L	15 / 3.7	10 / 3.3	14 / 3	7.3 / 2.4
FLS 180 M	18.5 / 4.5	12.5 / 4	18.5 / 4.5	-
FLS 180 L	22 / 5.5	14.5 / 5	22 / 4.8	10 / 3.3
FLS 200 LA	-	20 / 6	-	12.5 / 4
FLS 200 LB	30 / 7.5	-	30 / 6.5	15 / 5
FLS 225 ST	-	25 / 8.2	-	-
FLS 225 MT	37 / 9	-	37 / 8	-
FLS 225 M	42 / 10.5	30 / 10	42 / 8.5	20 / 6.7
FLS 250 M	45 / 11	37 / 12.2	45 / 9	25 / 8.2
FLS 280 S	55 / 13.7	50 / 16.7	55 / 11	30 / 10
FLS 280 M	75 / 18.7	60 / 20	75 / 15	37 / 12.2
FLS 315 ST	90 / 27.5	72.5 / 25	90 / 18	50 / 16.7
FLS 315 M	-	88.5 / 29	-	60 / 20
FLS 315 LA	-	107.5 / 35	110 / 22	75.5 / 25
FLS 315 LB	-	132 /45	-	100 / 39
FLS 355 LA	-	167 / 55	160 / 32	123 / 41
FLS 355 LB	-	200 / 66	200 / 40	147 / 49
FLS 355 LD	-	270 / 88	220 / 44	200 / 67
FLS 400 LA	-	300 / 100	300 / 60	230 / 78
FLS 400 LB	-	335 / 110	450 / 90	250 / 85
FLS 450 LA	-	370 / 120	500 / 100	300 / 100
FLS 450 LB	-	450 / 150	550 / 110	330 / 110

* (PAM up to 132)

The specific electrical characteristics for these motors are available on request.

E2 - Selection data: two-speed

IP 55 - Cl. F
General

MAINS SUPPLY Δ 400 V 50 Hz

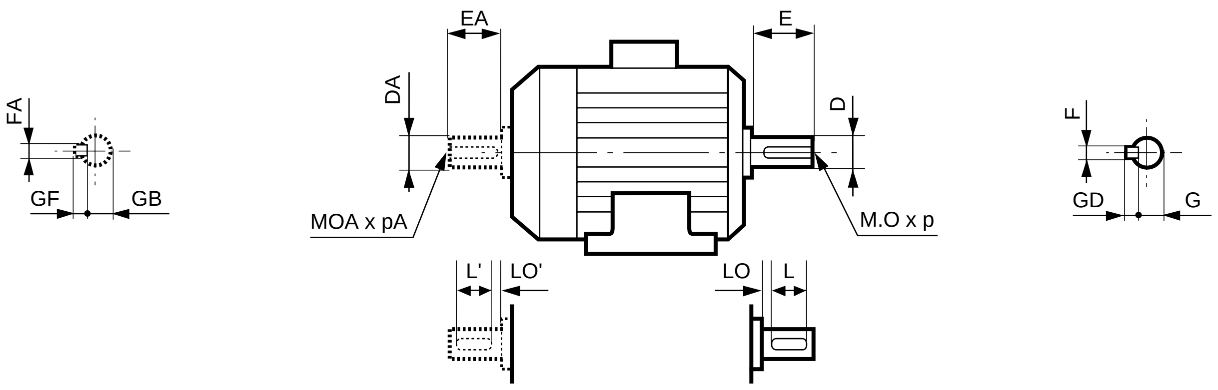
Type	2/4 Poles Dahlander	4/6 Poles 2 windings	4/8 Poles Dahlander	6/8 Poles 2 windings
	P_N kW	P_N kW	P_N kW	P_N kW
FLS 80 L	0.75 / 0.55	-	0.5 / 0.22	-
FLS 90 S	1.1 / 0.75	0.55 / 0.37	0.75 / 0.4	-
FLS 90 L	1.5 / 1.1	0.75 / 0.55	1.1 / 0.5	-
FLS 100 LK	2.2 / 1.5	1.1 / 0.75	-	-
FLS 100 LK	3 / 2.2	1.5 / 1.1	1.5 / 0.75	-
FLS 112 M	-	2.2 / 1.5	2.2 / 1.1	-
FLS 112 MU	4.5 / 3.7	2.8 / 1.8	3 / 1.5	-
FLS 132 M	6 / 4.5	4 / 2.5	5.5 / 3	-
FLS 132 M	7.5 / 5.5	5.5 / 3.7	7.5 / 4	-
FLS 160 MA	-	5.5 / 3.7	-	3.75 / 2.5
FLS 160 MB	11 / 9	-	-	-
FLS 160 L	15 / 11	7.5 / 5	12 / 6	5.5 / 3.7
FLS 180 L	18.5 / 15.5	9 / 6.2	13 / 7.5	-
FLS 180 L	22 / 16	11 / 7.3	15 / 9	7.5 / 5
FLS 200 LA	-	15 / 10	18 / 11	9 / 6
FLS 200 LB	30 / 22.5	-	22 / 15	11.5 / 7.7
FLS 225 ST	-	18.5 / 12.3	27 / 18	-
FLS 225 MT	37 / 27.5	-	-	-
FLS 225 M	42 / 31	22.5 / 15	30 / 20	15 / 10
FLS 250 M	45 / 33.5	27 / 15	37 / 25	18.5 / 12.5
FLS 280 S	55 / 41	37 / 25	45 / 30	22.5 / 15
FLS 280 M	75 / 55	45 / 30	55 / 37	27.5 / 18
FLS 315 ST	90 / 67	55 / 37	68 / 45	37.5 / 25
FLS 315 M	-	66 / 44	83 / 55	45 / 30
FLS 315 LA	-	80 / 53	110 / 75	55 / 37
FLS 315 LB	-	100 / 67	136 / 90	75 / 50
FLS 355 LA	-	125 / 83	166 / 110	90 / 60
FLS 355 LB	-	150 / 100	200 / 132	110 / 75
FLS 355 LD	-	200 / 132	240 / 160	150 / 100
FLS 400 LA	-	225 / 150	-	175 / 110
FLS 400 LB	-	250 / 165	300 / 200	200 / 132
FLS 450 LA	-	275 / 180	375 / 250	225 / 150
FLS 450 LB	-	330 / 225	475 / 315	250 / 160

3-phase TEFV induction motors
FLS cast iron
Dimensions

3-phase TEFV induction motors
FLS cast iron
Dimensions

F1 - Dimensions of shaft extensions

Dimensions in millimetres



Main shaft extensions

Type	4, 6 and 8 poles									2 poles								
	F	GD	D	G	E	O	p	L	LO	F	GD	D	G	E	O	p	L	LO
FLS 80 L	6	6	19j6	15.5	40	6	16	30	6	6	6	19j6	15.5	40	6	16	30	6
FLS 90 S/L	8	7	24j6	20	50	8	19	40	6	8	7	24j6	20	50	8	19	40	6
FLS 100 LK	8	7	28j6	24	60	10	22	50	6	8	7	28j6	24	60	10	22	50	6
FLS 112 M	8	7	28j6	24	60	10	22	50	6	8	7	28j6	24	60	10	22	50	6
FLS 132 S/M/MU	10	8	38k6	33	80	12	28	63	10	10	8	38k6	33	80	12	28	63	10
FLS 160 M/L	12	8	42k6	37	110	16	36	90	20	12	8	42k6	37	110	16	36	90	20
FLS 180 MR/L	14	9	48k6	42.5	110	16	36	90	20	14	9	48k6	42.5	110	16	36	90	20
FLS 200 L	16	10	55m6	49	110	20	42	90	20	16	10	55m6	49	110	20	42	90	20
FLS 225 ST/MT/M	18	11	60m6	53	140	20	42	125	15	16	10	55m6	49	110	20	42	90	20
FLS 250 M	18	11	65m6	58	140	20	42	125	15	18	11	60m6	53	140	20	42	125	15
FLS 280 S/M	20	12	75m6	67.5	140	20	42	125	15	18	11	65m6	58	140	20	42	125	15
FLS 315 ST	22	14	80m6	71	170	20	42	140	30	18	11	65m6	58	140	20	42	125	15
FLS 315 M	22	14	80m6	71	170	20	42	140	30	18	11	65m6	58	140	20	42	125	15
FLS 315 L	25	14	90m6	81	170	24	50	140	30	20	12	70m6	62.5	140	20	42	125	15
FLS 355 L/LK	28	16	100m6	90	210	24	50	180	30	22	14	80m6	71	170	20	42	140	30
FLS 400 L/LK/LV	28	16	110m6	100	210	24	50	180	30	-	-	-	-	-	-	-	-	-
FLS 450 L/LV	32	18	120m6	109	210	24	50	180	30	-	-	-	-	-	-	-	-	-

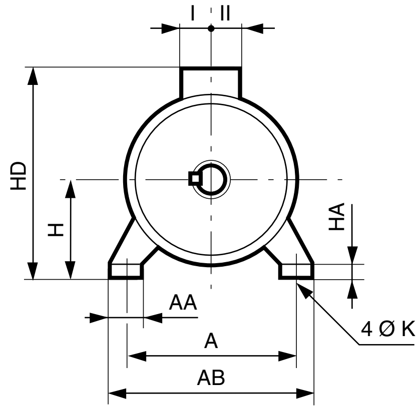
Secondary shaft extensions

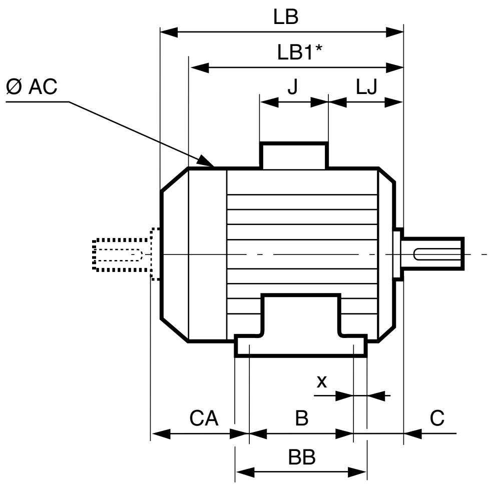
Type	4, 6 and 8 poles									2 poles								
	FA	GF	DA	GB	EA	OA	pA	L'	LO'	FA	GF	DA	GB	EA	OA	pA	L'	LO'
FLS 80 L	5	5	14j6	11	30	5	15	25	3.5	5	5	14j6	11	30	5	15	25	3.5
FLS 90 S/L	6	6	19j6	15.5	40	6	16	30	6	6	6	19j6	15.5	40	6	16	30	6
FLS 100 LK	8	7	24j6	20	50	8	19	40	6	8	7	24j6	20	50	8	19	40	6
FLS 112 M	8	7	24j6	20	50	8	19	40	6	8	7	24j6	20	50	8	19	40	6
FLS 132 S/M/MU	8	7	28j6	24	60	10	22	50	6	8	7	28j6	24	60	10	22	50	6
FLS 160 M/L	12	8	42k6	37	110	16	36	90	20	12	8	42k6	37	110	16	36	90	20
FLS 180 MR/L	14	9	48k6	42.5	110	16	36	90	20	14	9	48k6	42.5	110	16	36	90	20
FLS 200 L	16	10	55m6	49	110	20	42	90	20	16	10	55m6	49	110	20	42	90	20
FLS 225 ST/MT/M	18	11	60m6	53	140	20	42	125	15	16	10	55m6	49	110	20	42	90	20
FLS 250 M	18	11	60m6	53	140	20	42	125	15	18	11	60m6	53	140	20	42	125	15
FLS 280 S/M	20	12	60m6	53	140	20	42	125	15	18	11	60m6	53	140	20	42	125	15
FLS 315 ST	22	14	80m6	71	170	20	42	140	30	18	11	65m6	58	140	20	42	125	15
FLS 315 M	22	14	80m6	71	170	20	42	140	30	18	11	65m6	58	140	20	42	125	15
FLS 315 L	25	14	90m6	81	170	24	50	140	30	20	12	70m6	62.5	140	20	42	125	15
FLS 355 L/LK	28	16	100m6	90	210	24	50	180	30	22	14	80m6	71	170	20	42	140	30
FLS 400 L/LK/LV	28	16	110m6	100	210	24	50	180	30	-	-	-	-	-	-	-	-	-
FLS 450 L/LV	32	18	120m6	109	210	24	50	180	30	-	-	-	-	-	-	-	-	-

3-phase TEFV induction motors
FLS cast iron
Dimensions

F2 - Foot-mounted IM B3 (IM 1001)

Dimensions in millimetres





Main dimensions

Type	A	AB	B	BB	C	X	AA	K	HA	H	AC	LB	LB1*	CA	FLS					FLSC				
															HD	LJ	J	I	II	HD	LJ	J	I	II
FLS 80 L	125	157	100	130	50	20	32	9	10	80	160	214	178	68	222	33	114	57	57	230	27	126	63	63
FLS 90 S	140	172	100	160	56	22	34	9	11	90	185	243	204	93	247	28	114	57	57	250	22	126	63	63
FLS 90 L	140	172	125	160	56	22	34	9	11	90	185	243	204	68	247	28	114	57	57	250	22	126	63	63
FLS 100 LK	160	200	140	174	63	22	42	12	12	100	226	323	276	125	276	55	114	57	57	293	37	150	75	75
FLS 112 M	190	230	140	174	70	22	45	12	12	112	226	323	276	119	288	55	114	57	57	305	37	150	75	75
FLS 132 S	216	255	140	223	89	31	58	12	15	132	264	387	328	164	323	46	114	57	57	345	28	150	75	75
FLS 132 M	216	255	178	223	89	31	58	12	15	132	264	387	328	126	323	46	114	57	57	345	28	150	75	75
FLS 132 MU	216	255	178	223	89	31	58	12	15	132	264	410	352	149	323	46	114	57	57	345	28	150	75	75
FLS 160 M	254	294	210	294	108	20	65	14	20	160	310	495	435	182	385	50	160	80	80	385	50	160	80	80
FLS 160 L	254	294	254	294	108	20	65	14	20	160	310	495	435	138	385	50	160	80	80	385	50	160	80	80
FLS 180 MR	279	324	241	295	121	25	80	14	25	180	310	515	450	158	405	50	160	80	80	405	50	160	80	80
FLS 180 L	279	330	279	335	121	28	70	14	28	180	350	555	480	160	468	55	220	128	128	468	55	220	128	128
FLS 200 L	318	374	305	361	133	28	80	18	44	200	394	681	595	248	515	65	220	128	128	515	65	220	128	128
FLS 225 ST	356	420	286	367	149	28	100	18	35	225	394	681	595	251	540	65	220	128	128	540	65	220	128	128
FLS 225 MT	356	420	311	367	149	28	100	18	35	225	394	681	595	226	540	65	220	128	128	540	65	220	128	128
FLS 225 M	356	426	311	375	149	32	80	18	27	225	540	780	630	326	656	70	352	173	210	656	70	352	173	210
FLS 250 M	406	476	349	413	168	32	80	22	27	250	540	780	630	269	681	70	352	173	210	681	70	352	173	210
FLS 280 S	457	527	368	432	190	32	80	22	27	280	540	860	710	302	711	70	352	173	210	711	70	352	173	210
FLS 280 M	457	527	419	483	190	32	80	22	27	280	540	960	810	357	711	70	352	173	210	711	70	352	173	210
FLS 315 ST	508	598	406	547	216	45	90	27	45	315	556	1068	910	452	761	68	352	173	210	761	68	352	173	210
FLS 315 M	508	600	457	598	216	45	100	27	45	315	624	1203	1030	536	835	70	452	217	269	835	70	452	217	269
FLS 315 L	508	600	508	598	216	45	100	27	45	315	632	1203	1030	485	835	70	452	217	269	835	70	452	217	269
FLS 355 LA/LB	610	710	630	710	254	40	110	27	35	355	700	1305	1118	427	910	61	452	217	269	910	61	452	217	269
FLS 355 LC/LD	610	710	630	710	254	40	110	27	35	355	700	1430	1242	552	910	61	452	217	269	910	61	452	217	269
FLS 355 LK	610	750	630	815	254	40	128	27	45	355	787	1687	1430	813	1117	52	700	224	396	1117	52	700	224	396
FLS 400 L/LV	686	800	710	815	280	65	128	35	45	400	787	1687	1430	707	1162	52	700	224	396	1162	52	700	224	396
FLS 400 LKA/LKB	686	824	800	950	280	59	140	35	45	400	877	1835	1550	765	1210	68	700	224	396	1210	68	700	224	396
FLS 450 L/LV	750	890	800	950	315	94	140	35	45	450	877	1835	1550	730	1260	68	700	224	396	1260	68	700	224	396

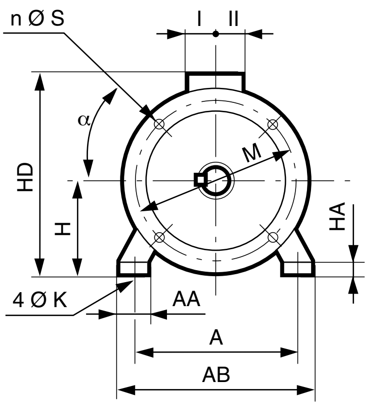
* LB1 : non-ventilated motor

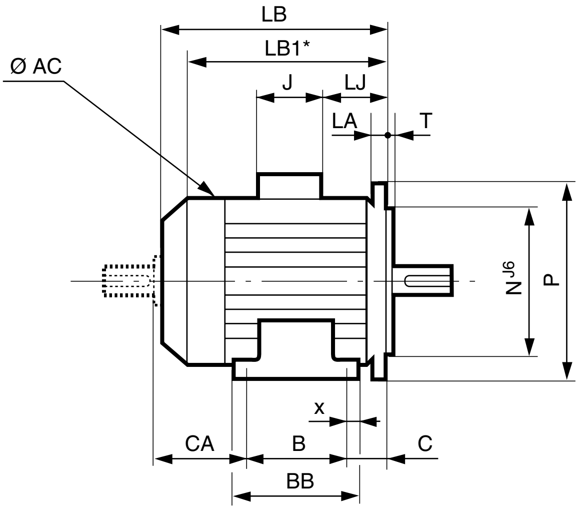
F

3-phase TEFV induction motors
FLS cast iron
Dimensions

F3 - Foot and flange-mounted IM B35 (IM 2001)

Dimensions in millimetres





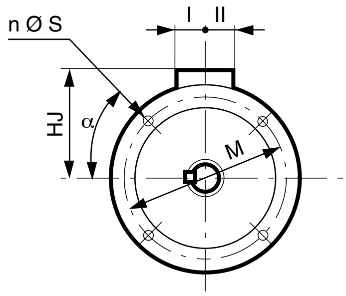
Type	Main dimensions																									
	A	AB	B	BB	C	X	AA	K	HA	H	AC	LB	LB1*	FLS						FLSC						Sym.
														HD	HJ	LJ	J	I	II	HD	HJ	LJ	J	I	II	
FLS 80 L	125	157	100	130	50	20	32	9	10	80	160	214	178	222	142	33	114	57	57	230	150	27	126	63	63	FF 165
FLS 90 S	140	172	100	160	76	22	34	9	11	90	185	263	224	247	153	48	114	57	57	250	162	22	126	63	63	FF 165
FLS 90 L	140	172	125	160	76	22	34	9	11	90	185	263	224	247	153	48	114	57	57	250	162	22	126	63	63	FF 165
FLS 100 LK	160	200	140	174	63	22	42	12	12	100	226	323	276	276	176	55	114	57	57	293	193	37	150	75	75	FF 215
FLS 112 M	190	230	140	174	70	22	45	12	12	112	226	323	276	288	176	55	114	57	57	305	193	37	150	75	75	FF 215
FLS 132 S	216	255	140	223	89	31	58	12	15	132	264	387	328	323	195	46	114	57	57	345	213	28	150	75	75	FF 265
FLS 132 M	216	255	178	223	89	31	58	12	15	132	264	387	328	323	195	46	114	57	57	345	213	28	150	75	75	FF 265
FLS 132 MU	216	255	178	223	89	31	58	12	15	132	264	410	352	323	195	46	114	57	57	345	213	28	150	75	75	FF 265
FLS 160 M	254	294	210	294	108	20	65	14	20	160	310	495	435	385	225	50	160	80	80	385	225	50	160	80	80	FF 300
FLS 160 L	254	294	254	294	108	20	65	14	20	160	310	495	435	385	225	50	160	80	80	385	225	50	160	80	80	FF 300
FLS 180 MR	279	324	241	295	121	25	80	14	25	180	310	515	450	405	225	50	160	80	80	405	225	50	160	80	80	FF 300
FLS 180 L	279	330	279	335	121	28	70	14	28	180	350	555	480	468	280	55	220	128	128	468	280	55	220	128	128	FF 300
FLS 200 L	318	374	305	361	133	28	80	18	44	200	394	681	595	515	315	65	220	128	128	515	315	65	220	128	128	FF 350
FLS 225 ST	356	420	286	367	149	28	100	18	35	225	394	681	595	540	315	65	220	128	128	540	315	65	220	128	128	FF 400
FLS 225 MT	356	420	311	367	149	28	100	18	35	225	394	681	595	540	315	65	220	128	128	540	315	65	220	128	128	FF 400
FLS 225 M	356	426	311	375	149	32	80	18	27	225	540	780	630	656	431	70	352	173	210	656	431	70	352	173	210	FF 400
FLS 250 M	406	476	349	413	168	32	80	22	27	250	540	780	630	681	431	70	352	173	210	681	431	70	352	173	210	FF 500
FLS 280 S	457	527	368	432	190	32	80	22	27	280	540	860	710	711	431	70	352	173	210	711	431	70	352	173	210	FF 500
FLS 280 M	457	527	419	483	190	32	80	22	27	280	540	960	810	711	431	70	352	173	210	711	431	70	352	173	210	FF 500
FLS 315 ST	508	598	406	547	216	45	90	27	45	315	556	1068	910	761	446	68	352	173	210	761	446	68	352	173	210	FF 600
FLS 315 M	508	600	457	598	216	45	100	27	45	315	624	1203	1030	835	520	70	452	217	269	835	520	70	452	217	269	FF 600
FLS 315 L	508	600	508	598	216	45	100	27	45	315	632	1203	1030	835	520	70	452	217	269	835	520	70	452	217	269	FF 600
FLS 355 LA/LB	610	710	630	710	254	40	110	27	35	355	700	1305	1118	910	555	61	452	217	269	910	555	61	452	217	269	FF 740
FLS 355 LC/LD	610	710	630	710	254	40	110	27	35	355	700	1430	1242	910	555	61	452	217	269	910	555	61	452	217	269	FF 740
FLS 355 LK	610	750	630	815	254	40	128	27	45	355	787	1687	1430	1117	762	52	700	224	396	1117	762	52	700	224	396	FF 740
FLS 400 L/LV	686	800	710	815	280	65	128	35	45	400	787	1687	1430	1162	762	52	700	224	396	1162	762	52	700	224	396	FF 940
FLS 400 LKA/LKB	686	824	800	950	280	59	140	35	45	400	877	1835	1550	1210	810	68	700	224	396	1210	810	68	700	224	396	FF 940
FLS 450 L/LV	750	890	800	950	315	94	140	35	45	450	877	1835	1550	1260	810	68	700	224	396	1260	810	68	700	224	396	FF 1080

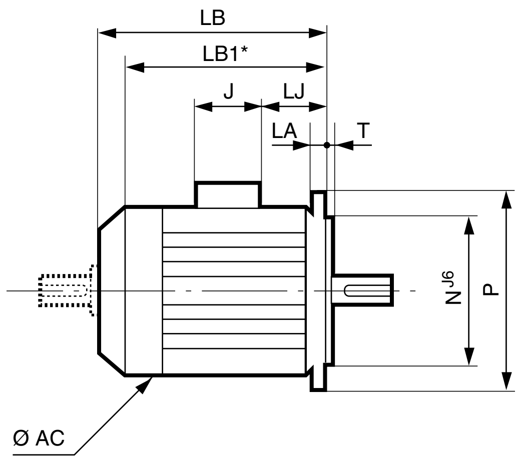
* LB1 : non-ventilated motor

3-phase TEFV induction motors
FLS cast iron
Dimensions

F4 - Flange-mounted IM B5 (IM 3001)

Dimensions in millimetres





IEC Symbol	Faceplate dimensions						
	M	N	P	T	n	S	LA
FF 165	165	130	200	3.5	4	12	10
FF 165	165	130	200	3.5	4	12	10
FF 165	165	130	200	3.5	4	12	10
FF 215	215	180	250	4	4	15	12
FF 215	215	180	250	4	4	15	12
FF 265	265	230	300	4	4	14,5	14
FF 265	265	230	300	4	4	14,5	14
FF 265	265	230	300	4	4	14,5	14
FF 300	300	250	350	5	4	18,5	15
FF 300	300	250	350	5	4	18,5	15
FF 300	300	250	350	5	4	18,5	15
FF 300	300	250	350	5	4	18,5	15
FF 350	350	300	400	5	4	18	15
FF 400	400	350	450	5	8	18	16
FF 400	400	350	450	5	8	18	16
FF 400	400	350	450	5	8	18	16
FF 500	500	450	550	5	8	18	18
FF 500	500	450	550	5	8	18	18
FF 500	500	450	550	5	8	18	18
FF 600	600	550	660	6	8	22	25
FF 600	600	550	660	6	8	22	25
FF 600	600	550	660	6	8	22	25
FF 740	740	680	800	6	8	22	25
FF 740	740	680	800	6	8	22	25
FF 740	740	680	800	6	8	22	25
FF 940	940	880	1000	6	8	28	28
FF 940	940	880	1000	6	8	28	28
FF 1080	1080	1000	1150	6	8	28	30

Type	Main dimensions							
	AC	LB	LB1	HJ	LJ	J	I	II
FLS 80 L	160	214	178	142	33	114	57	57
FLS 90 S	185	263	224	153	48	114	57	57
FLS 90 L	185	263	224	153	48	114	57	57
FLS 100 LK	226	323	276	176	55	114	57	57
FLS 112 M	226	323	276	176	55	114	57	57
FLS 132 S	264	387	328	195	46	114	57	57
FLS 132 M	264	387	328	195	46	114	57	57
FLS 132 MU	264	410	352	195	46	114	57	57
FLS 160 M	310	495	435	225	50	160	80	80
FLS 160 L	310	495	435	225	50	160	80	80
FLS 180 MR	310	515	450	225	50	160	80	80
FLS 180 L	350	555	480	280	55	220	128	128
FLS 200 L	394	681	595	315	65	220	128	128
FLS 225 ST	394	681	595	315	65	220	128	128
FLS 225 MT	394	681	595	315	65	220	128	128
FLS 225 M	540	780	630	431	70	352	173	210
FLS 250 M	540	780	630	431	70	352	173	210
FLS 280 S	540	860	710	431	70	352	173	210
FLS 280 M	540	960	810	431	70	352	173	210
FLS 315 ST	556	1068	910	446	68	352	173	210
FLS 315 M	624	1203	1030	520	70	452	217	269
FLS 315 L	632	1203	1030	520	70	452	217	269
FLS 355 LA/LB	700	1305	1118	555	61	452	217	269
FLS 355 LC/LD	700	1305	1242	555	61	452	217	269
FLS 355 LK	787	1687	1430	762	52	700	224	396
FLS 400 L/LV	787	1687	1430	762	52	700	224	396
FLS 400 LKA/LKB	877	1835	1550	810	68	700	224	396
FLS 450 L/LV	877	1835	1550	810	68	700	224	396

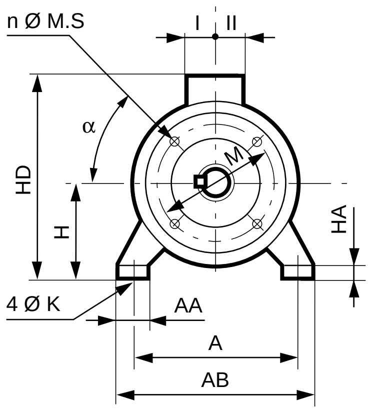
* LB1 : non-ventilated motor

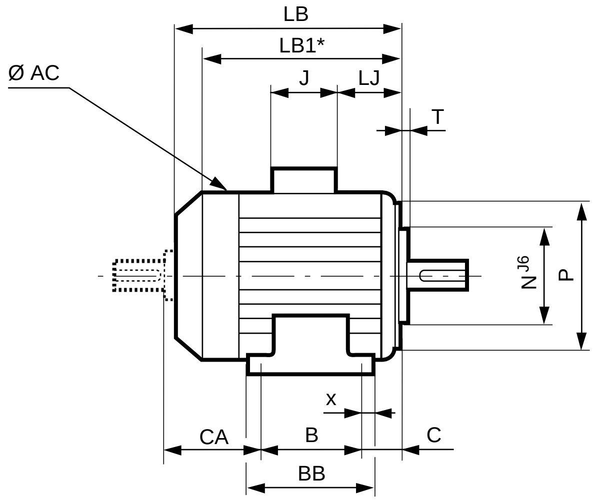
Flange-mounted motors in position IM 3001 (IM B5) are only available up to frame size 225. See section C1 for mounting arrangements.

3-phase TEFV induction motors
FLS cast iron
Dimensions

F5 - Foot and face-mounted IM B34 (IM 2101)

Dimensions in millimetres





Type	Main dimensions																									
	A	AB	B	BB	C	X	AA	K	HA	H	AC	LB	LB1*	FLS						FLSC						Sym.
														HD	HJ	LJ	J	I	II	HD	HJ	LJ	J	I	II	
FLS 80 L	125	157	100	130	50	20	32	9	10	80	160	214	178	222	142	33	114	57	57	230	150	27	126	63	63	FT 100
FLS 90 S	140	172	100	160	56	22	34	9	11	90	185	243	204	247	153	28	114	57	57	250	162	22	126	63	63	FT 115
FLS 90 L	140	172	125	160	56	22	34	9	11	90	185	243	204	247	153	28	114	57	57	250	162	22	126	63	63	FT 115
FLS 100 LK	160	200	140	174	63	22	42	12	12	100	226	323	276	276	176	55	114	57	57	293	193	37	150	75	75	FT 130
FLS 112 M	190	230	140	174	70	22	45	12	12	112	226	323	276	288	176	55	114	57	57	305	193	37	150	75	75	FT 130
FLS 132 S	216	255	140	223	89	31	58	12	15	132	264	387	328	323	195	46	114	57	57	345	213	28	150	75	75	FT 215
FLS 132 M	216	255	178	223	89	31	58	12	15	132	264	387	328	323	195	46	114	57	57	345	213	28	150	75	75	FT 215
FLS 132 MU	216	255	178	223	89	31	58	12	15	132	264	410	352	323	195	46	114	57	57	345	213	28	150	75	75	FT 215

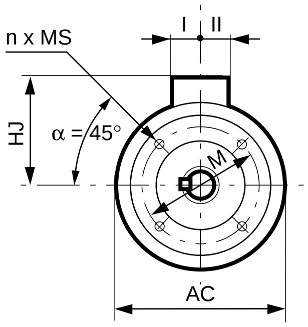
* LB1 : non-ventilated motor

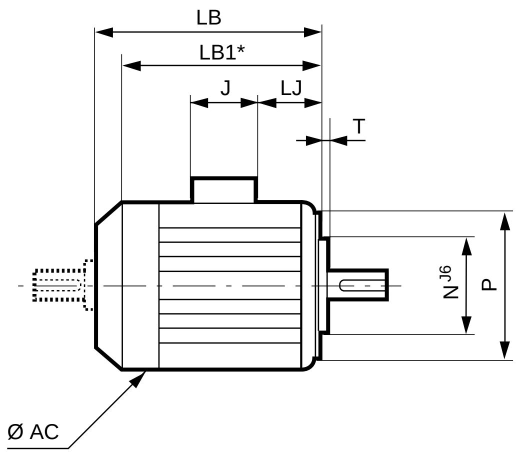
F

3-phase TEFV induction motors
FLS cast iron
Dimensions

F6 - Face-mounted **IM B14 (IM 3601)**

Dimensions in millimetres





IEC Symbol	Flange dimensions					
	M	N	P	T	n	MS
FT 100	100	80	120	3	4	M6
FT 115	115	95	140	3	4	M8
FT 115	115	95	140	3	4	M8
FT 130	130	110	160	3.5	4	M8
FT 130	130	110	160	3.5	4	M8
FT 215	215	180	250	4	4	M12
FT 215	215	180	250	4	4	M12
FT 215	215	180	250	4	4	M12

* LB1: non-ventilated motor

Type	Main dimensions														
	AC	LB	LB1*	FLS						FLSC					
				HD	HJ	LJ	J	I	II	HD	HJ	LJ	J	I	II
FLS 80 L	160	214	178	222	142	33	114	57	57	230	150	27	126	63	63
FLS 90 S	185	243	204	247	153	28	114	57	57	250	162	22	126	63	63
FLS 90 L	185	243	204	247	153	28	114	57	57	250	162	22	126	63	63
FLS 100 LK	226	323	276	276	176	55	114	57	57	293	193	37	150	75	75
FLS 112 M	226	323	276	288	176	55	114	57	57	305	193	37	150	75	75
FLS 132 S	264	387	328	323	195	46	114	57	57	345	213	28	150	75	75
FLS 132 M	264	387	328	323	195	46	114	57	57	345	213	28	150	75	75
FLS 132 MU	264	410	352	323	195	46	114	57	57	345	213	28	150	75	75

G1 - Non-standard flanges

As an option, LEROY-SOMER motors can be fitted with flanges and faceplates that are larger or smaller than standard. This means that motors can be adapted to all types of situation without the need for costly and time-consuming modifications.

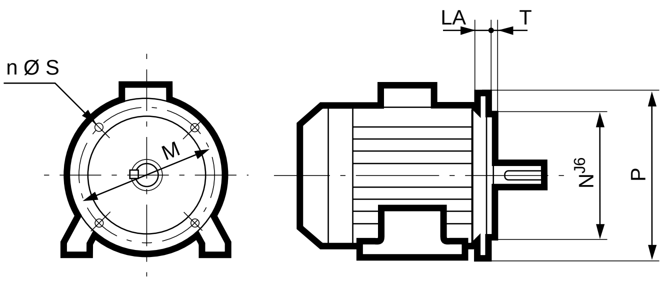
The tables below give flange and faceplate dimensions and flange/motor compatibility.

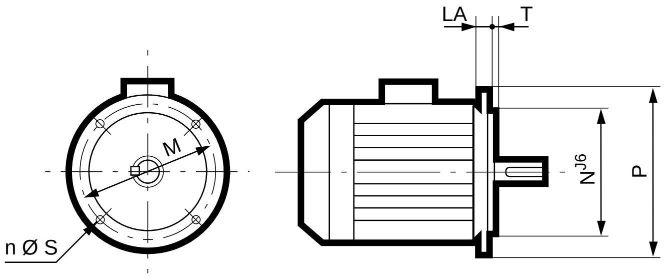
The bearing and shaft extension for each frame size remain standard.

MAIN FLANGE DIMENSIONS

Flange-mounted (FF)

Dimensions in millimetres



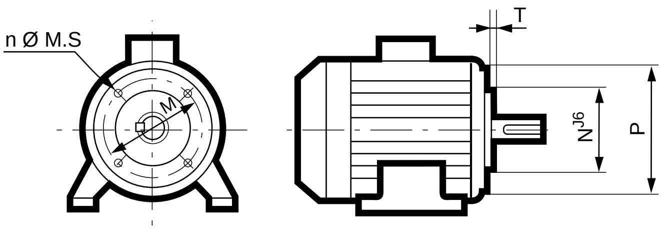


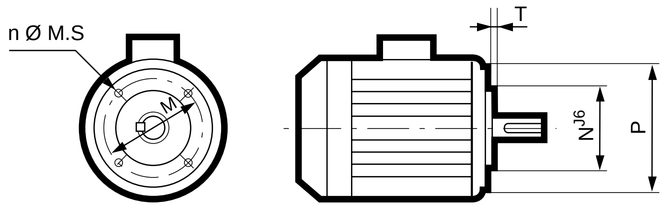
IEC symbol	Flange dimensions						
	M	N	P	T	n	S	LA
FF 115	115	95	140	3	4	10	10
FF 130	130	110	160	3.5	4	10	10
FF 165	165	130	200	3.5	4	12	10
FF 215	215	180	250	4	4	15	12
FF 265	265	230	300	4	4	15	14
FF 300	300	250	350	5	4	18	15
FF 350	350	300	400	5	4	18	15
FF 400	400	350	450	5	8	18	16
FF 500	500	450	550	5	8	18	18**
FF 600	600	550*	660	6	8	22	25
FF 740	740	680*	800	6	8	22	25
FF 940	940	880*	1000	6	8	28	28
FF 1080	1080	1000*	1150	6	8	28	30

* Tolerance Njs^{6} from FF 600 upwards
** LA = 22 for frame sizes ≥ 280

Face-mounted (FT)

Dimensions in millimetres



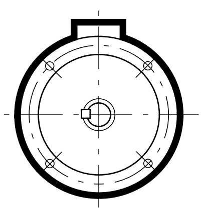


Symbol IEC	Faceplate dimensions					
	M	N	P	T	n	M.S
FT 85	85	70	105	2.5	4	M6
FT 100	100	80	120	3	4	M6
FT 115	115	95	140	3	4	M8
FT 130	130	110	160	3.5	4	M8
FT 165	165	130	200	3.5	4	M10
FT 215	215	180	250	4	4	M12
FT 265	265	230	300	4	4	M12

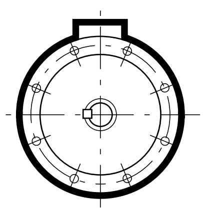
G1 - Non-standard flanges

	Flange-mounted (FF)													Face-mounted (FT)						
Motor type \ Flange type	FF 115	FF 130	FF 165	FF 215	FF 265	FF 300	FF 350	FF 400	FF 500	FF 600	FF 740	FF 940	FF 1080	FT 85	FT 100	FT 115	FT 130	FT 165	FT 215	FT 265
FLS 80 L	❍	❍	●	✶										✶	●	✶	✶	✶		
FLS 90	✶	✶	●	✶											✶	●	✶	❍		
FLS 90 (Foot)	❍	❍	❍	❍											✶	●	✶	❍		
FLS 100 LK	❍	❍	❍	●												✶	●	❍	✶	
FLS 112 M	❍	❍	❍	●												✶	●	❍	✶	
FLS 112 MR		❍	❍	●	✶											✶	●	✶	✶	
FLS 132 S/M/MU			❍	❍	●	❍												✶	●	✶
FLS 160 M/L				✶	✶	●	✶													
FLS 180 MR						●	✶													
FLS 180 L						●	✶													
FLS 200 L							●	✶												
FLS 225 ST/MT							✶	●												
FLS 225 S/M								●	✶											
FLS 250 M								✶	●											
FLS 280 S									●											
FLS 280 M									●											
FLS 315 S									✶	●										
FLS 315 M/L										●										
FLS 355 L											●									
FLS 355 LK											●	✶								
FLS 400											✶	●								
FLS 400 LK												●	✶							
FLS 450												✶	●							

● Standard ❍ Adapted shaft ✶ Adaptable without shaft modifications



NOTE: for flanges up to FF 350, the flange is drilled with 4 holes at an angle of 45° in relation to the axis of the terminal box.



NOTE: from flange FF 400 upwards, the flange is drilled with 8 holes at an angle of 22°30 in relation to the axes.

G2 - Variable speed options

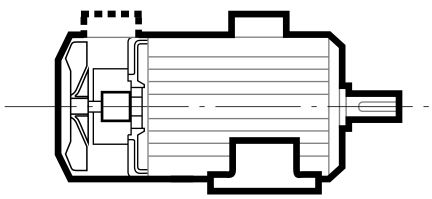
The induction motors described in this catalogue are easily integrated into controlled systems and control applications that use frequency inverters.

For these kinds of application, accessories are often required to make operation easier. These accessories include:

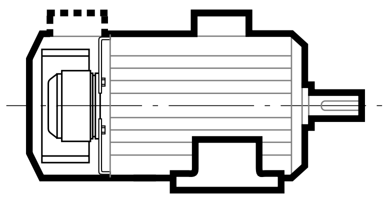
- D.C. tachogenerators, which give perfect synchronization of motor speed by slip compensation.
- A.C. tachogenerators for speed measurement.
- Forced ventilation for motors used at high or low speeds (see section C4.2).
- Holding brakes for maintaining the rotor in the stop position without needing to leave the motor switched on.
- Encoders which provide digital information for accurate speed maintenance and position control.

These options can be used singly or in combination as shown in the table opposite.

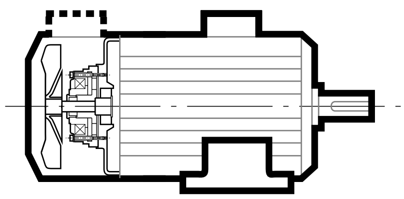
D.C. tachogenerator or A.C. tachogenerator or encoder



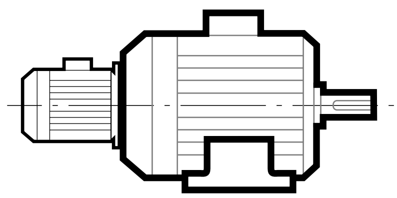
Forced ventilation



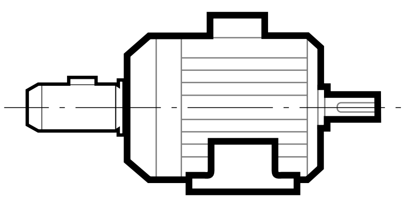
Brake



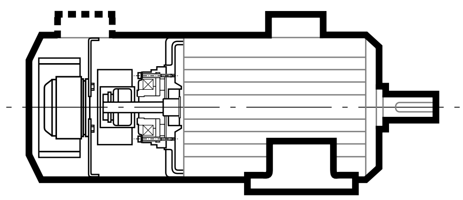
Forced exial or radial ventilation*



D.C. tachogenerator*



Forced ventilation, brake (D.C. tacho or A.C. tacho or encoder)



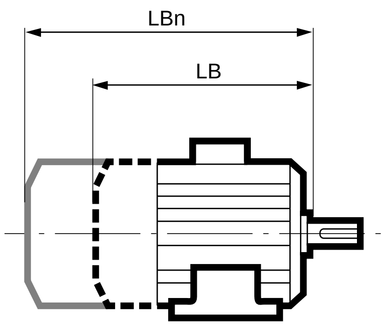
** For frame sizes 160 and above*

3-phase TEFV induction motors
FLS cast iron
Optional features

G2 - Variable speed options

Options	Option combinations										
	LB1	LB2	LB3	LB4	LB5	LB6	LB7	LB9	LB10	LB12	LB16
D.C. tachogenerator	●		●		●		●				●
A.C. tachogenerator								●	●		
Encoder										●	●
Forced axial ventilation		●	●			●	●	●			
Brake				●	●	●	●		●		

Type	Main dimensions LBn										
	LB1	LB2	LB3	LB4	LB5	LB6	LB7	LB9	LB10	LB12	LB16
FLS 80	LB + 39	LB + 100	LB + 100	LB + 36	-	LB + 125	LB + 200	-	LB + 125	-	-
FLS 90	LB + 45	LB + 93	LB + 93	LB + 35	-	LB + 117	LB + 193	-	LB + 117	-	-
FLS 100	LB + 36	LB + 90	LB + 90	LB + 79	-	LB + 140	LB + 218	-	LB + 105	-	-
FLS 112	LB + 36	LB + 90	LB + 90	LB + 79	-	LB + 140	LB + 218	-	LB + 140	-	-
FLS 132	LB + 45	LB + 75	LB + 75	LB + 62	-	LB + 95	LB + 165	-	LB + 95	-	-
FLS 160	LB + 230	LB + 190	LB + 130	-	-	-	-	LB + 130	-	LB + 80	LB + 310
FLS 180	LB + 230	LB + 235	LB + 130	-	-	-	-	LB + 130	-	LB + 80	LB + 310
FLS 200	LB + 230	LB + 235	LB + 110	-	-	-	-	LB + 110	-	LB + 80	LB + 310
FLS 225 ST/MT	LB + 230	LB + 235	-	-	-	-	-	-	-	LB + 80	LB + 310
FLS 225 M	LB + 230	LB + 150	-	-	-	-	-	-	-	LB + 80	LB + 310
FLS 250	LB + 230	LB + 150	-	-	-	-	-	-	-	LB + 80	LB + 310
FLS 280	LB + 230	LB + 150	-	-	-	-	-	-	-	LB + 80	LB + 310
FLS 315	LB + 230	LB + 265	-	-	-	-	-	-	-	LB + 80	LB + 310
FLS 355	LB + 230	LB + 370	-	-	-	-	-	-	-	LB + 80	LB + 310
FLS 400	LB + 230	LB + 370	-	-	-	-	-	-	-	LB + 80	LB + 310
FLS 450	LB + 230	LB + 410	-	-	-	-	-	-	-	LB + 80	LB + 310



3-phase TEFV induction motors
FLS cast iron
Optional features

G3 - Mechanical options

G3.1 - ADAPTORS FOR VIBRATION SENSOR

On request, our motors can be fitted with adaptors (SPM type) on flanges, in order to fit vibration sensors (not provided).

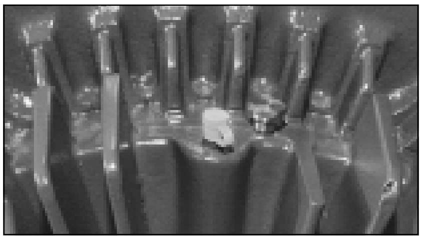
The adaptors form a connection with the snap-on transmitter.

Being specially designed for harsh environments, they are fitted with a PVC seal after undergoing the following surface treatments:

1 - zinc : 15 µm Zn

2 - silver for very corrosive environments

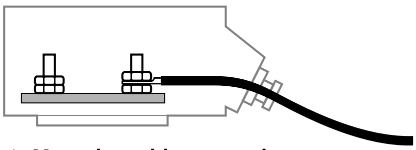
: 2 µm Cu + 30 µm Ag



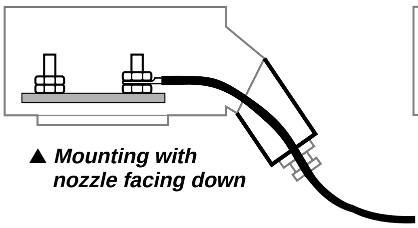
G3.2 - TERMINAL BOX NOZZLES

The terminal box nozzle facilitates connection of the power cables to the motor, when using cables with large cross-sections on which a small radius of curvature is impossible.

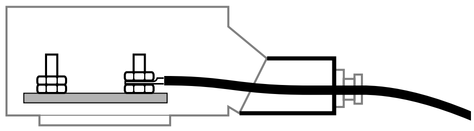
The three possible methods of mounting are shown below for a horizontal motor, frame size ≥ 225 M, with the terminal box on top of the motor.



▲ *Mounting without nozzle*

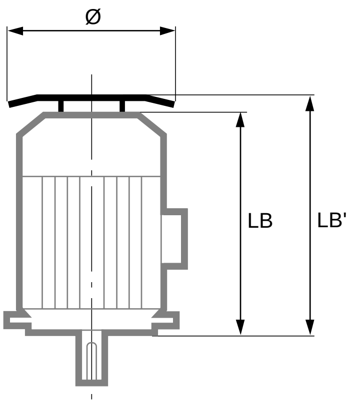


▲ *Mounting with nozzle facing down*



▲ *Mounting with nozzle in horizontal position*

G3.3 - DRIP COVERS



Drip cover for operation in vertical position, shaft end facing down

Type	LB'	Ø
FLS 80	LB + 20	145
FLS 90 and FLS 100	LB + 20	185
FLS 112 M	LB + 20	185
FLS 112 MU	LB + 25	210
FLS 132	LB + 30	240
FLS 160 and 180 MR	LB + 60	320
FLS 180 L	LB + 60	360
FLS 200 L	LB + 75	400
FLS 225 ST/MT	LB + 75	400
FLS 225 M and FLS 250 M	LB + 130	420
FLS 280 and FLS 315	LB + 130	420
FLS 355 L	LB + 135	500
FLS 355 LK	LB + 160	650
FLS 400	LB + 160	650
FLS 450	LB + 160	650

G3.4 - UNIVERSAL MOUNTING

This enables motors in this range (IEC flange and shaft extension) to be connected to LEROY-SOMER gearboxes:

- Compabloc 2000 (parallel gears)
- Orthobloc 2000 (helical bevel and parallel gears)

Details of this option and of the gearboxes are given in the Leroy-Somer catalogues “Cb 2000 concentric shaft geared motors” and “Ot 2000 helical bevel geared motors and gear units”.

H1 - Voltage drop along cables (standard NFC 15.100)

Voltage drops are calculated using the formula:

$$u = b\,(\rho_1 \frac{L}{S} \cos\varphi + \lambda L \sin\varphi)\, I_s$$

where u = voltage drop

b = factor equal to 1 for three-phase circuits, and equal to 2 for single-phase circuits

Note: Three-phase circuits with a neutral that is completely out of balance (loss of two phases) are treated as single-phase circuits.

ρ_1 = resistivity of the conductors in normal duty taken as being equal to the resistivity at the normal duty temperature, ie. 1.25 times the resistivity at 20°C, giving 0.0225 $\Omega mm^2/m$ for copper and 0.036 $\Omega mm^2/m$ for aluminium.

L = length of cabling conduits in metres

S = cross-section of conductors in mm^2

cos φ = power factor: if the exact figure is not available, the PF is taken as being 0.8 (sin φ = 0.6)

λ = linear reactance of conductors, taken as being equal to 0.08 mΩ/m if the exact figure is not available

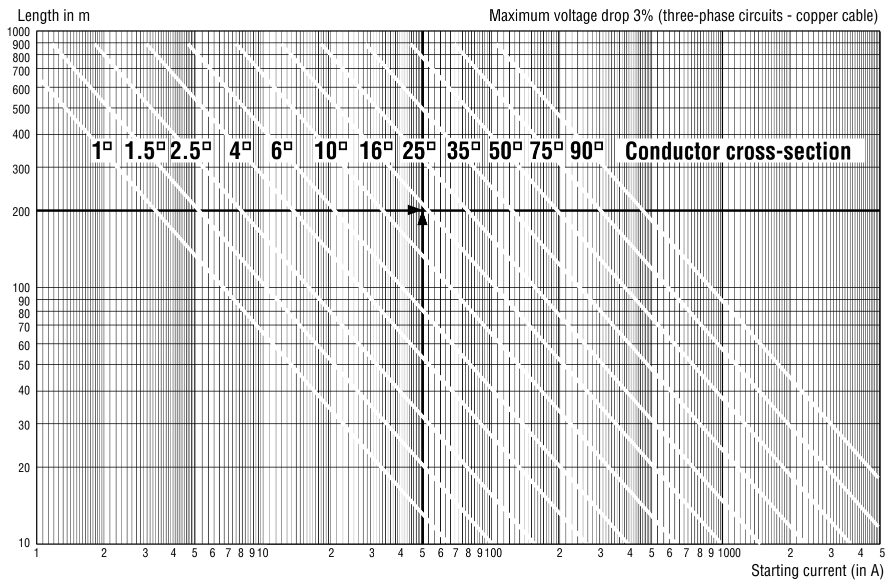
I_s = current in use, in amps

The higher the current, the greater the voltage drop will be. The voltage drop should therefore be calculated for the starting current to see if this is suitable for the application. If the most important criterion is the starting torque (or starting time), the voltage drop should be limited to 3% maximum* (the equivalent of a loss of torque of around 6 to 8%).

* the relative voltage drop (as a %) equals:

$$\Delta u = 100\,\frac{u}{U_0}$$

U_0 = voltage between phase and neutral



Maximum power for D.O.L. motors

(See table opposite)

The table opposite shows maximum kW ratings for D.O.L. motors connected to the mains supply.

Minimizing motor starting problems

For the installation to remain in good working order, it is necessary to avoid any significant temperature rise in the cabling conduits, while making sure that the protection devices do not interrupt starting.

Operating problems in other equipment connected to the same supply are due to the voltage drop caused by the current demand on starting, which can be many times greater than the current absorbed by the motor at full load.

▼ ***Maximum power for D.O.L. motors (kW)***

Type of motor		Three-phase 380/400V	
Type of premises		**Full power D.O.L.**	**other starting methods**
Residential areas		5.5	11
Other premises	*Overhead power line*	11	22
	underground pwr line	22	45

"Other premises" includes the service sector, the industrial sector, general housing services, the agricultural sector, etc.

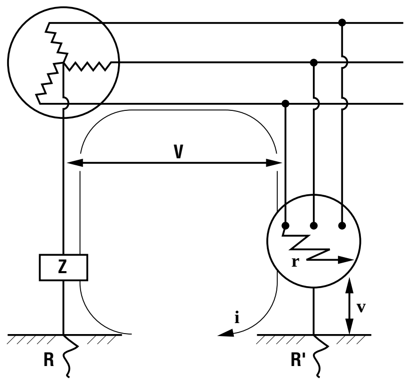
For motors driving a high inertia machine, motors with long starting times, brake motors or change of direction by current reversal, the electricity supply company must carry out all the necessary checks before installation.

H2 - Earthing impedance

French government decree 62.1454 of 14 November 1962 concerning the protection of operatives in workplaces in which electrical currents are used, requires that when the neutral is connected to the earth by a limiting impedance, the rms value of the fault current multiplied by the resistance of the earth terminal of the mass in which the fault occurs must not exceed:

- 24 V in highly conductive workplaces
- 50 V in other cases

(Ref. standard UTE C 12.100 - page 12, Article 32)



V : phase voltage
Z : limiting impedance
R : resistance of neutral earth
R' : resistance of the earth of the mass where the fault occurs
r : internal fault resistance
i : fault current
v : potential of the mass in relation to the earth
v_L : maximum value imposed for that potential

This may be written:

$v = R'i$

and $V = (Z + R + R' + r)\,i$

whence $Z = R' \frac{V}{v} - (R + R' + r)$

and consequently:

$$Z \geq R' \frac{V}{v_L} - (R + R' + r)$$

Example 1

Highly conductive premises where:

R = 3 Ω
R' = 20 Ω
r = 10 Ω
V = 220 V

$Z \geq 20 \times \frac{220}{24} - (3 + 20 + 10) = 150\ \Omega$

Example 2

Other cases:

R = 6 Ω
R' = 10 Ω
r = 0 Ω
V = 380 V

$Z \geq 10 \times \frac{380}{50} - (6 + 10 + 0) = 60\ \Omega$

H3 - Packaging weights and dimensions

Dimensions in millimetres

Frame size	ROAD TRANSPORT			
	IM 1001		IM 3001 - IM 3011	
	Tare (kg)	Dimensions in mm (L x W x H)	Tare (kg)	Dimensions in mm (L x W x H)
Cardboard boxes				
80	1.5	380 x 215 x 280	1.5	380 x 215 x 280
90	2	475 x 240 x 320	2	475 x 240 x 320
100	2	455 x 280 x 360	2	455 x 280 x 360
112	2	455 x 280 x 360	2	455 x 280 x 360
132	3	565 x 325 x 410	3	565 x 325 x 410
Pallets				
160 / 180	5	780 x 430	5	780 x 430
200 - 225 ST /MT	6	900 x 460	6	900 x 460
225 M - 250	13	1150 x 500	13	1150 x 500
280 - 315	18	1850 x 700	18	1850 x 700*
355	18	2100 x 840	18	2100 x 840*
355 LK to 450	28	2300 x 950	28	2300 x 950

** motors in IM 3011, pallet of 850 x 850 with floor dimensions of 1100 x 1000*

Frame size	SEA TRANSPORT			
	IM 1001		IM 3001 - IM 3011	
	Tare (kg)	Dimensions in mm (L x W x H)	Tare (kg)	Dimensions in mm (L x W x H)
Plywood crates				
80	on request		on request	
90	on request		on request	
100	21	740 x 480 x 610	24	740 x 480 x 610
112	21	740 x 480 x 610	24	740 x 480 x 610
132	21	740 x 480 x 610	24	740 x 480 x 610
160	45	900 x 540 x 620	50	900 x 550 x 700
180 MR	45	900 x 560 x 640	45	900 x 550 x 650
180 L	50	950 x 580 x 690	50	950 x 580 x 690
200 L	60	1100 x 630 x 750	60	1100 x 600 x 750
225 ST/MT	70	1150 x 650 x 770	70	1150 x 650 x 770
225 M	80	1250 x 700 x 810	80	1250 x 700 x 840
250 M	80	1250 x 700 x 860	100	1250 x 750 x 950
280 S/M	120	1550 x 790 x 1050	120	1550 x 790 x 1050
315 ST	130	1600 x 830 x 1090	140	1600 x 860 x 1170
315 M/L	145	1750 x 860 x 1160	150	1750 x 860 x 1230
355 LA/LB	170	1900 x 940 x 1230	190	1900 x 1000 x 1370
355 LC/LD	180	2050 x 940 x 1230	200	2050 x 1000 x 1370
355 LK	230	2300 x 1020 x 1470	245	2300 x 1000 x 1620
400 L/LV	240	2300 x 1030 x 1510	290	2300 x 1200 x 1800
400 LK	270	2450 x 1120 x 1610	305	2450 x 1200 x 1800
450 L/LV	270	2450 x 1120 x 1610	335	2450 x 1350 x 1900

- These values are given for individual packages
- Frame sizes up to 132 grouped in cardboard containers on a standard 1200 x 800 pallet

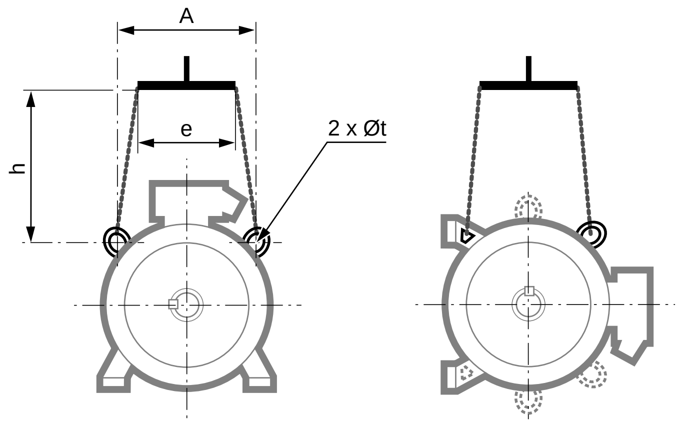
H4 - Position of lifting rings

Position of lifting rings for lifting the motor only (not connected to the machine)

The positions of the lifting rings and the minimum dimensions of the loading bars are given below in order to help with preparation for handling the motors. If these precautions are not followed, there is a risk of warping or crushing some equipment such as the terminal box, protective cover or drip cover.

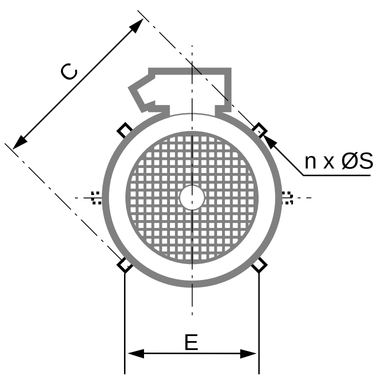
Important: Motors intended for use in the vertical position may be delivered on a pallet in the horizontal position. When the motor is pivoted, the shaft must under no circumstances be allowed to touch the ground, as the bearings may be irreparably damaged.

- horizontal position

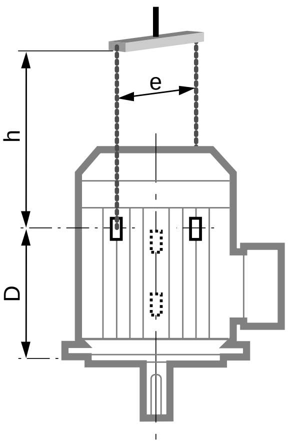


Type	Horizontal position			
	A	e min	h min	t
FLS 100	120	200	150	9
FLS 112	120	200	150	9
FLS 132	160	200	150	9
FLS 160	200	160	110	14
FLS 180 MR	200	160	110	14
FLS 180 L	200	260	150	14
FLS 200	270	260	165	14
FLS 225 ST/MT	270	260	150	14
FLS 225 M	360	265	200	30
FLS 250	360	380	200	30
FLS 280	360	380	500	30
FLS 315 ST	310	380	500	17
FLS 315 M/L	360	380	500	23
FLS 355	310	380	500	23
FLS 400	735	710	500	30
FLS 450	730	710	500	30

- vertical position



View from above**



Side view

Type	Vertical position						
	C	E	D	n**	S	e min*	h min
FLS 160	320	200	230	2	14	320	350
FLS 180 MR	320	200	230	2	14	320	270
FLS 180 L	390	265	290	2	14	390	320
FLS 200	410	300	295	2	14	410	450
FLS 225 ST/MT	410	300	295	2	14	410	450
FLS 225 M	480	360	405	4	30	540	350
FLS 250	480	360	405	4	30	540	350
FLS 280 S	480	360	485	4	30	590	550
FLS 280 M	480	360	585	4	30	590	550
FLS 315 ST	590	-	590	2	17	630	550
FLS 315 M/L	695	-	765	2	24	695	550
FLS 355	755	-	835	2	24	755	550
FLS 400	810	350	1135	4	30	810	600
FLS 450	960	400	1170	4	30	960	750

** : if the motor is fitted with a drip cover, allow an additional 50 to 100 mm to avoid damaging it when the load is swung.*

*** : if n = 2, the lifting rings form an angle of 90° with respect to the terminal box axis*
if n = 4, this angle becomes 45°

3-phase TEFV induction motors
FLS cast iron
Installation and Maintenance

H5 - Identification, exploded views and parts list

H5.1 - NAMEPLATES

*LEROY SOMER MOT. 3∿ FLSC 90L TR
N° 999999 JJ0001
CE

IP55 IK08 cl.F 40°C S.S1 kg 21

V	Hz	min -1	kW	cos	A
⅄ 380	50	1420	1.50	0.86	3.4
Δ 230	50	1428	1.50	0.82	5.7
⅄ 400	50	1428	1.50	0.82	3.3
⅄ 415	50	1435	1.50	0.79	3.4
⅄ 440	60	1710	1.80	0.85	3.6
⅄ 460	60	1720	1.80	0.84	3.3

EFF 2

*Other logos may be used as an option, but only by agreement BEFORE ordering.

LEROY SOMER MOT. 3 ∿ FLS 200 L4
N° 685702 JJ001 kg : 260
CE EFF 2

IP55 IK08	I cl.F	40°C	S1	%	d/h
V	Hz	min-1	kW	cos φ	A
Δ 380	50	1467	30	0.86	58
Δ 400	-	1471	-	0.85	56
Y 690	-	-	-	-	33
Δ 415	-	1472	-	0.83	55
Δ 440	60	1762	34.5	0.86	58
Δ 460	-	1767	-	-	55

GRAISSE ESSO UNIREX N3			
DE	6313 C3	23 cm³	9000 / 7000 H 50/60 Hz
NDE	6313 C3	23 cm³	9000 / 7000 H 50/60 Hz

▼ ***Definition of symbols used on nameplates***

CE **Legal mark indicating that the equipment conforms to the requirements of European Directives.**

MOT 3 ~ : Three-phase A.C. motor
FLS : FLS range
FLSC : FLS range Corrobloc finish
90 : Frame size
L : Housing symbol
TR : Impregnation index

Motor no.
N° : Serial number
J : Year of production
J : Month of production
001 : Batch number
EFF 2 : Efficiency indicator

IP55 IK08: Index of protection
I cl. F : Insulation class F
40°C : Max. ambient operating temperature (IEC 34-1)
S...% : Duty - Duty (operating) factor
...d/h : Number of cycles per hour
kg : Weight
V : Supply voltage
Hz : Supply frequency
min-1 : Revolutions per minute (rpm)
kW : Rated output power
cos φ : Power factor
A : Rated current
Δ : Delta connection
Y : Star connection

Bearings

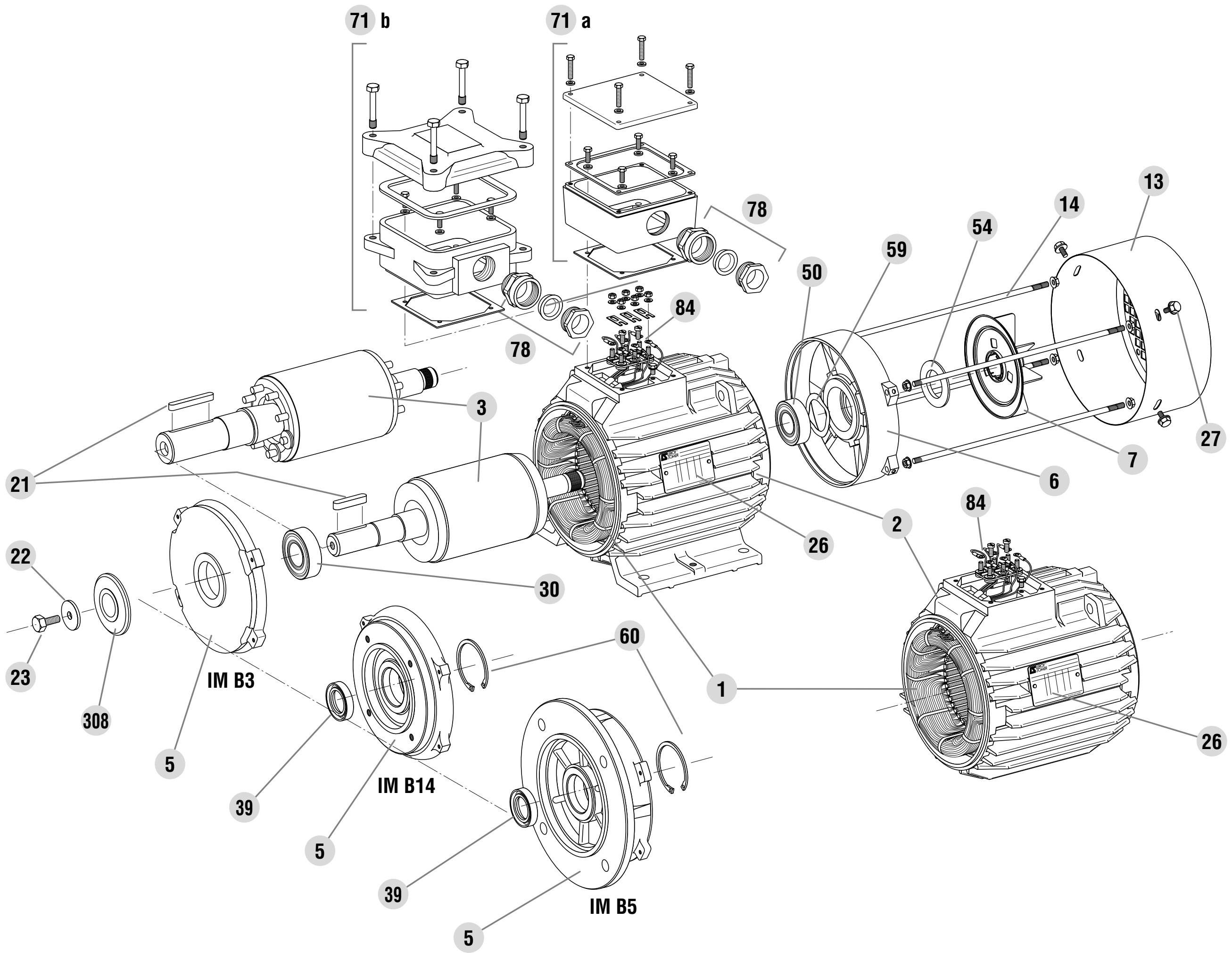
DE : Drive end bearing
NDE : Non drive end bearing
23 cm³: Amount of grease at each regreasing (in cm³)
9000/7000 H : Interval (regreasing in hours) for θ amb 40°C at frequency 50 Hz/60 Hz
ESSO UNIREX N3 : Type of grease

Please quote when ordering spare parts

H

H5 - Identification, exploded views and parts list

H5.2 - FRAME SIZE: 80 to 132

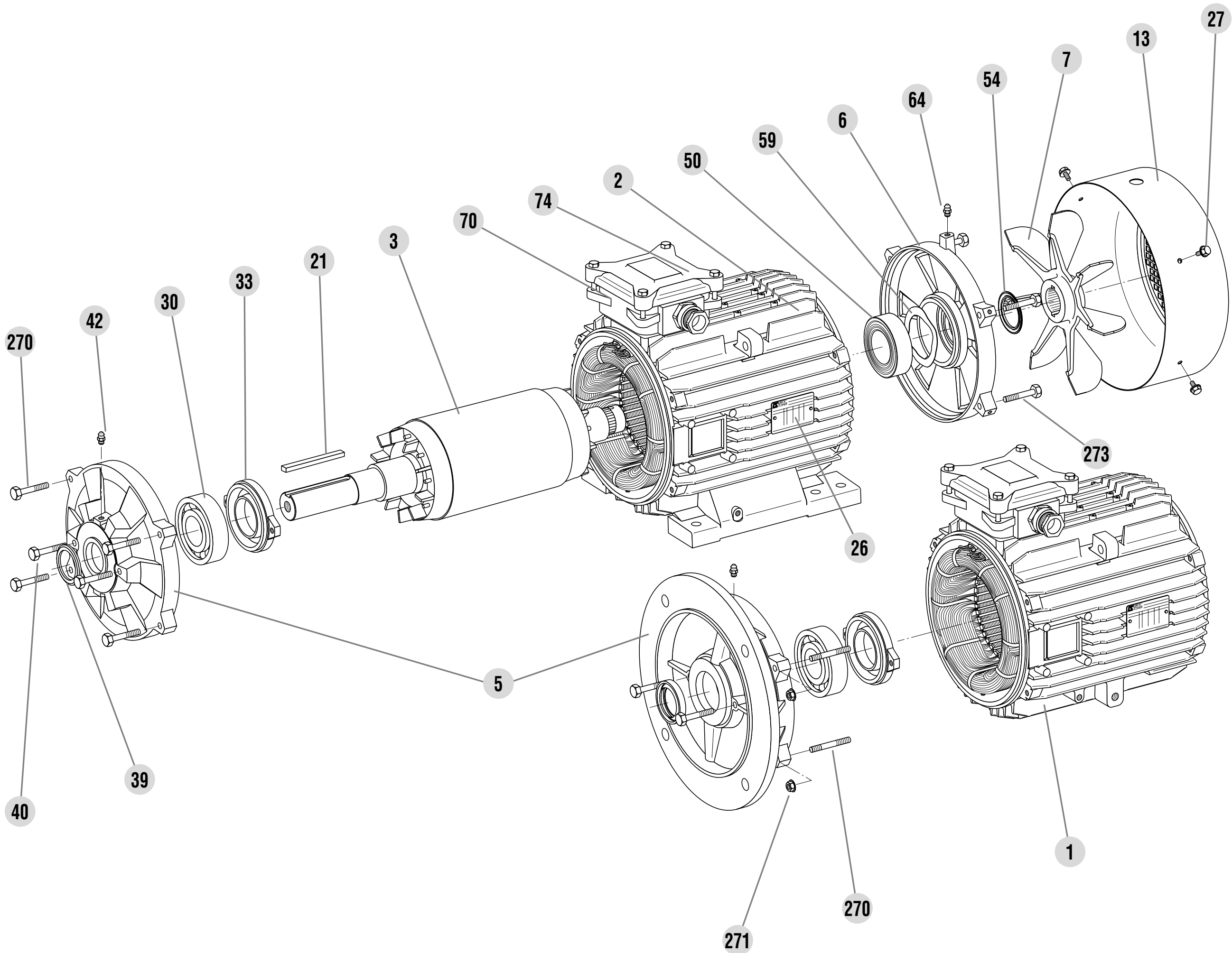


Frame size: 80 to 132					
Ref.	**Description**	**Ref.**	**Description**	**Ref.**	**Description**
1	Wound stator	21	Shaft extension key	54	Non drive end seal
2	Housing	22	Shaft extension washer	59	Preloading (wavy) washer
3	Rotor	23	Shaft extension screw	60	Circlip
5	Drive end shield (DE)	26	Nameplate	71a	FLS terminal box
6	Non-drive end shield (NDE)	27	Fan cover screw	71b	FLSC terminal box
7	Fan	30	Drive end bearing	78	Cable gland
13	Fan cover	39	Drive end seal	84	Terminal block
14	Tie rods	50	Non drive end bearing	308	Labyrinth seal

Note: The above illustration of parts does not necessarily show details, forms and volumes accurately.

H5 - Identification, exploded views and parts list

H5.3 - FRAME SIZE: 160 - 180

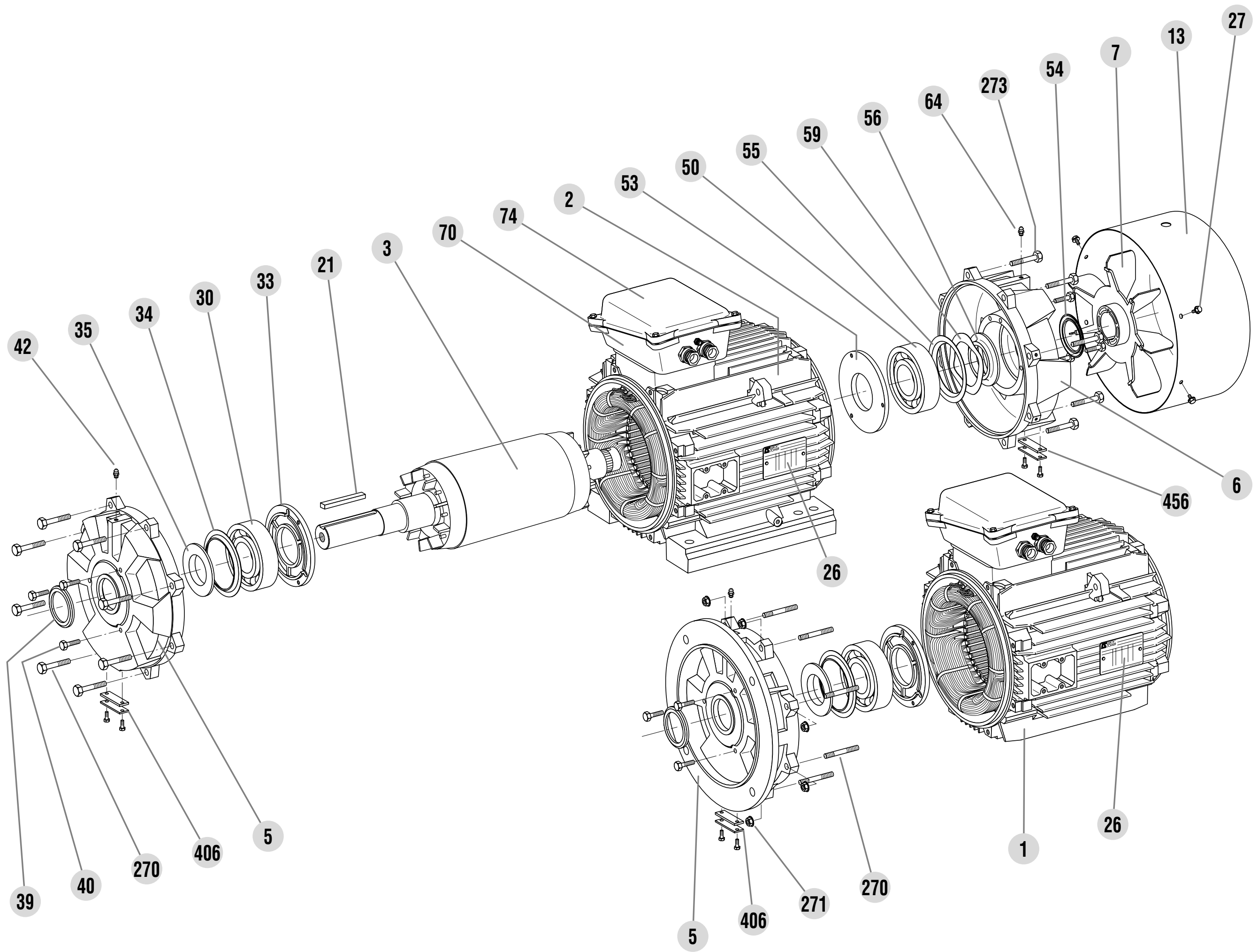


Frame size: 160 - 180					
No.	**Description**	**No.**	**Description**	**No.**	**Description**
1	Wound stator	26	Nameplate	54	NDE seal
2	Housing	27	Fan cover screw	59	NDE preloading (wavy) washer
3	Rotor	30	Drive end bearing	64	NDE grease nipple (rear)
5	Drive end shield (DE)	33	DE internal cover (front)	70	Stator terminal box
6	Non-drive end shield (NDE)	39	DE seal	74	Terminal box lid
7	Fan	40	Cover fixing screw	270	DE shield fixing screw
13	Fan cover	42	DE grease nipple (front)	271	DE shield fixing nut
21	Shaft extension key	50	NDE bearing (rear)	273	NDE shield fixing screw

Note: The above illustration of parts does not necessarily show details, forms and volumes accurately.

H5 - Identification, exploded views and parts list

H5.4 - FRAME SIZE: 200 to 225 MT

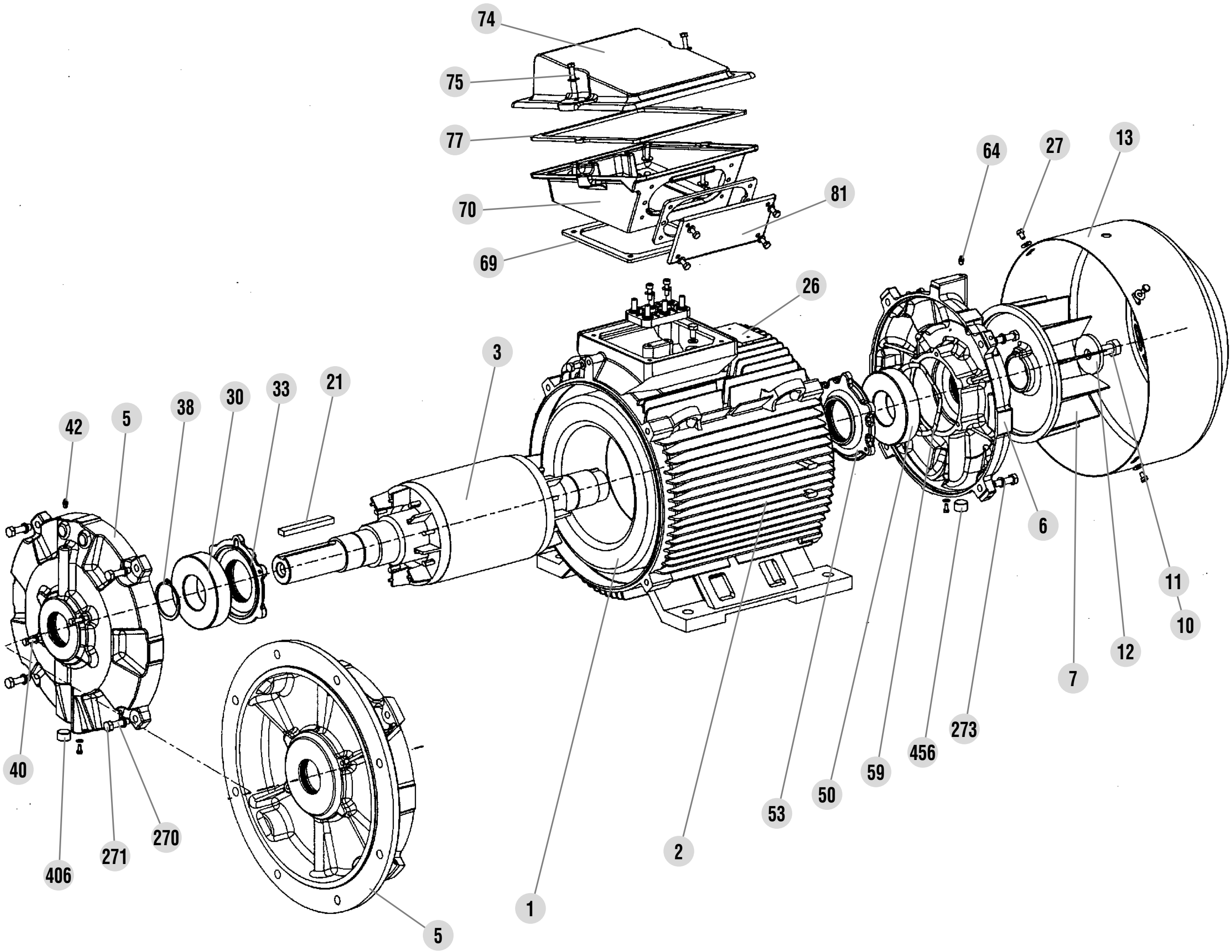


Frame size: 200 to 225 MT					
No.	**Description**	**No.**	**Description**	**No.**	**Description**
1	Wound stator	33	DE internal cover (front)	59	NDE preloading (wavy) washer
2	Housing	34	Fixed part of DE grease valve (front)	64	NDE grease nipple (rear)
3	Rotor	35	Moving part of DE grease valve (front)	70	Stator terminal box
5	Drive end shield (DE)	39	DE seal	74	Stator terminal box lid
6	Non-drive end shield (NDE)	40	Cover fixing screw	270	DE shield fixing screw
7	Fan	42	DE grease nipple (front)	271	DE shield fixing nut
13	Fan cover	50	NDE bearing (rear)	273	NDE shield fixing screw
21	Shaft extension key	53	NDE internal cover (rear)	406	Cover plate of DE grease valve (front)
26	Nameplate	54	NDE seal	456	Cover plate of NDE grease valve (rear)
27	Fan cover screw	55	Fixed part of NDE grease valve (rear)		
30	Drive end bearing	56	Moving part of NDE grease valve (rear)		

Note: The above illustration of parts does not necessarily show details, forms and volumes accurately.

H5 - Identification, exploded views and parts list

H5.5 - FRAME SIZE: 225 M to 280



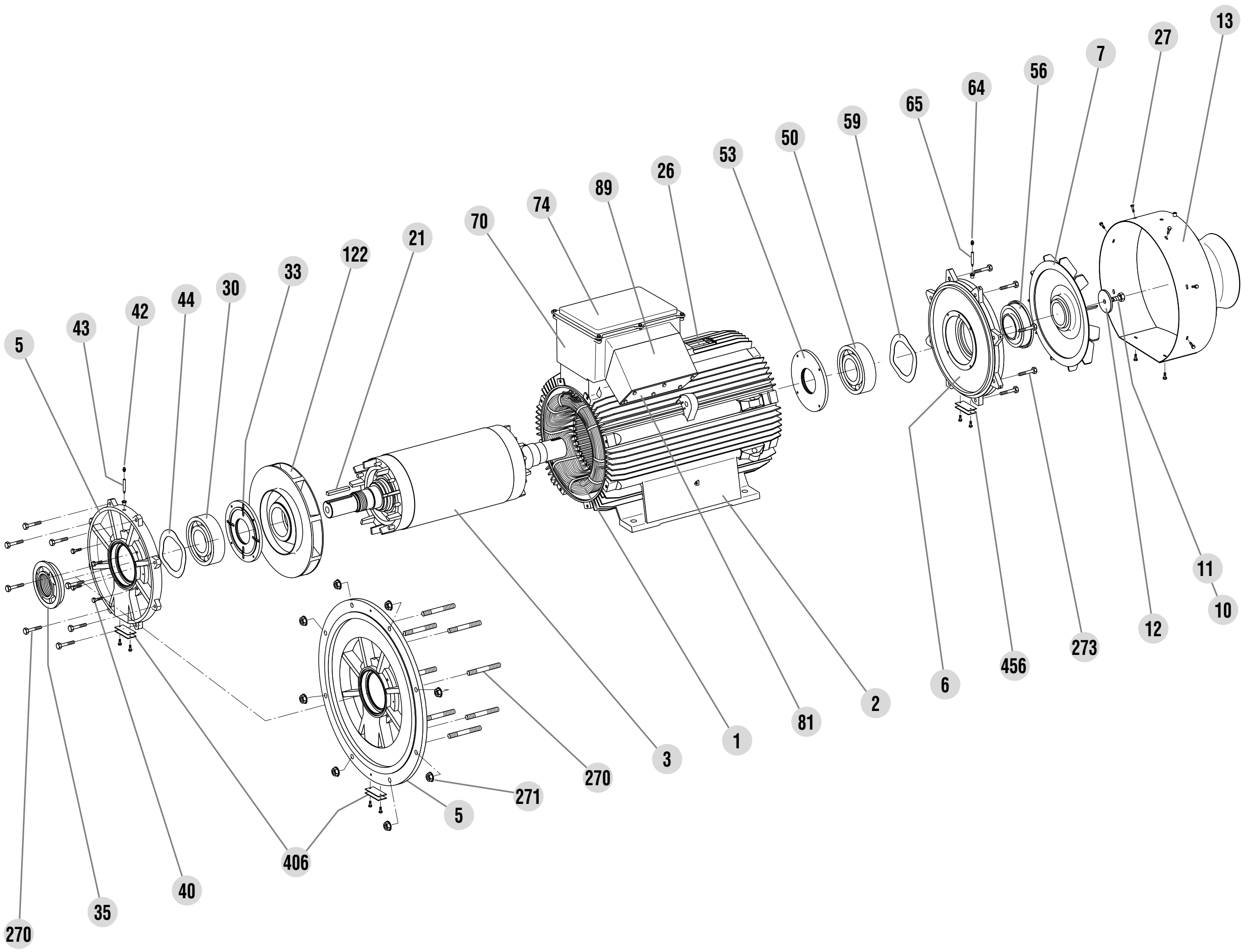
Frame size: 225 M to 280					
No.	**Description**	**No.**	**Description**	**No.**	**Description**
1	Wound stator	26	Nameplate	69	Terminal box base seal
2	Housing	27	Fan cover screw	70	Stator terminal box
3	Rotor	30	Drive end bearing	74	Stator terminal box lid
5	Drive end shield (DE)	33	DE internal cover (front)	75	Terminal box cover fixing screw
6	Non-drive end shield (NDE)	38	DE bearing circlip (front)	77	Terminal box cover seal
7	Fan	40	Cover fixing screw	81	Cable gland support plate
10	Turbine or fan screw (280 - 4p)	42	DE grease nipple (front)	270	DE shield fixing screw
11	Brake washer (not shown) (280 - 4p)	50	NDE bearing (rear)	271	DE shield fixing nut
12	Lock washer (280 - 4p)	53	NDE internal cover (rear)	273	NDE shield fixing screw
13	Fan cover	59	NDE preloading (wavy) washer	406	Cover plate of DE grease valve (front) - (plug)
21	Shaft extension key	64	NDE grease nipple (rear)	456	Cover plate of NDE grease valve (rear) - (plug)

H

Note: The above illustration of parts does not necessarily show details, forms and volumes accurately.

H5 - Identification, exploded views and parts list

H5.6 - FRAME SIZE: 315 to 355 LD



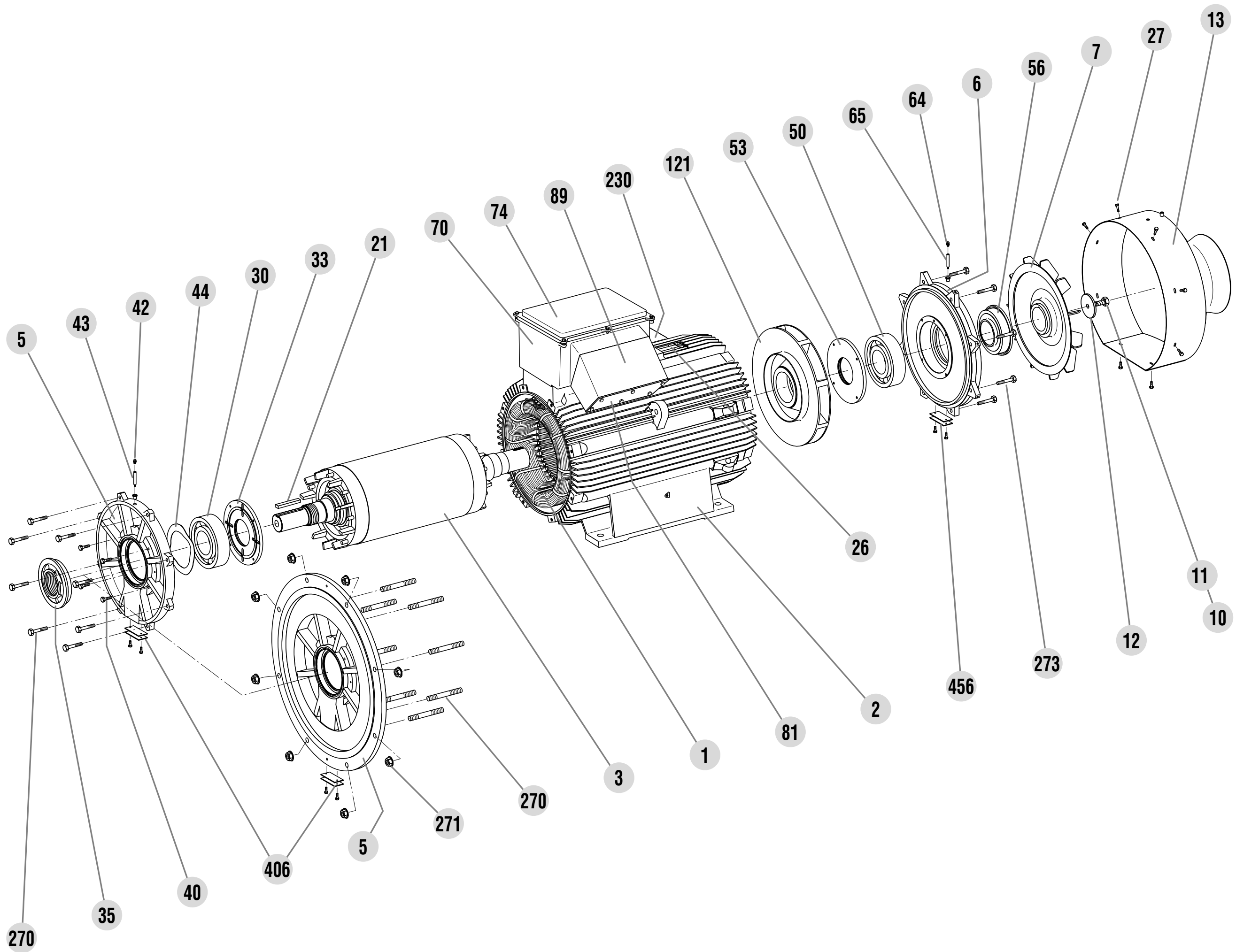
Frame size: 315 to 355 LD

No.	Description	No.	Description	No.	Description
1	Wound stator	27	Fan cover screw	64	NDE grease nipple (rear)
2	Housing	30	Drive end bearing	65	Extension for NDE grease nipple
3	Rotor	33	DE internal cover (front)	70	Stator terminal box
5	Drive end shield (DE)	35	Moving part of DE grease valve (front)	74	Stator terminal box lid
6	Non-drive end shield (NDE)	40	Cover fixing screw	81	Cable gland support plate
7	Fan	42	DE grease nipple (front)	89	Connection - Terminal box nozzle (optional)
10	Turbine or fan screw	43	Extension for DE grease nipple	122	Stirrer (only from 315 M to 355 LD)
11	Brake washer (not shown)	44	DE preloading (wavy) washer (from 315 M)	270	DE shield fixing screw
12	Lock washer	50	NDE bearing (rear)	271	DE shield fixing nut
13	Fan cover	53	NDE internal cover (rear)	273	NDE shield fixing screw
21	Shaft extension key	56	Moving part of NDE grease valve (rear)	406	Cover plate of DE grease valve (front)
26	Nameplate	59	NDE preloading (wavy) washer (315 ST)	456	Cover plate of NDE grease valve (rear)

Note: The above illustration of parts does not necessarily show details, forms and volumes accurately.

H5 - Identification, exploded views and parts list

H5.7 - FRAME SIZE: 355 LK to 450



Frame size: 355 LK to 450					
No.	**Description**	**No.**	**Description**	**No.**	**Description**
1	Wound stator	27	Fan cover screw	65	Extension for NDE grease nipple
2	Housing	30	Drive end bearing	70	Stator terminal box
3	Rotor	33	DE internal cover (front)	74	Stator terminal box lid
5	Drive end shield (DE)	35	Moving part of DE grease valve (front)	81	Cable gland support plate
6	Non-drive end shield (NDE)	40	Cover fixing screw	89	Connection - Terminal box nozzle
7	Fan	42	DE grease nipple (front)	121	Air circulator
10	Turbine or fan screw	43	Extension for DE grease nipple	230	Auxiliary terminal box (355 LK to 450)
11	Brake washer (not shown)	44	DE preloading (wavy) washer	270	DE shield fixing screw
12	Lock washer	50	NDE bearing (rear)	271	DE shield fixing nut
13	Fan cover	53	NDE internal cover (rear)	273	NDE shield fixing screw
21	Shaft extension key	56	Moving part of NDE grease valve (rear)	406	Cover plate of DE grease valve (front)
26	Nameplate	64	NDE grease nipple (rear)	456	Cover plate of NDE grease valve (rear)

Note: The above illustration of parts does not necessarily show details, forms and volumes accurately.

Notes

Notes

I - APPLICATION AREA

Acceptance of our tenders or the placing of any order with us implies acceptance of the following conditions without exception or reservation. These conditions of sale shall prevail over all stipulations appearing on the customer's purchase order, his general conditions of purchase or any other document emanating from him and / or a third party.

A dispensation from these General Conditions of Sale applies to sales concerning foundry parts, which are subject to the European Foundries General Conditions of Sale, latest edition.

II - ORDERS

All orders, including those taken by our agents and representatives, by whatever mode of transmission, become valid only after we have accepted them in writing.

We reserve the right to modify the characteristics of our goods without prior warning. However, the customer reserves the possibility to specify technical specifications in the order. Unless such requirements have been notified in writing, the customer will not be able to refuse delivery of new modified goods.

Our company will not accept responsibility for an incorrect choice of goods if this incorrect choice results from incomplete and / or erroneous conditions of use, or conditions that have not been conveyed to the vendor by the customer.

Unless otherwise specified, our tenders and estimates are only valid for thirty days from the date of issue.

When the goods have to satisfy standards, particular regulations and / or be inspected by standards or control organisations, the price request must be accompanied by full specifications with which we must comply with. This is mentioned in the estimate. All test and inspection fees are the customer's responsibility.

III - PRICE

Our prices and price lists are shown exclusive of tax and may be revised without prior notice.

Our prices are either firm for the duration specified on the estimate, or subject to revision according to a formula accompanying the tender which, depending on the regulations, covers a change in the cost of raw materials, products, various services and salaries, an index of which is published in the B.O.C.C.R.F. ("Bulletin Officiel de la Concurrence, de la Consommation et de la Répression des Fraudes").

For any order of goods not found in our catalogue, requiring special manufacture, the invoice will include a minimum fixed sum of 600 FRF (six hundred French Francs) exclusive of tax, to cover start - up costs. Any tax due will be charged to the customer.

All related costs, such as customs clearance and special inspections, will be added on.

Customers should remember that the French Franc (or other currency) is being replaced by the Single European Currency (EURO) according to a European Community ruling. In accordance with the general principles of monetary law, references to the French Franc will then as of right be considered to refer to the Euro. This substitution will be enforced on the date and in accordance with the conditions defined by the European Community ruling.

IV - DELIVERY

Our export sales are governed by the INCOTERMS published by the International Chamber of Commerce ("I.C.C. INCOTERMS"), latest edition.

Goods are despatched in accordance with the conditions indicated on our order acknowledgement, sent out in response to any order for goods and / or services.

Unless otherwise specified, our prices refer to goods put at customer's disposal in our factories, and include standard packaging.

Unless otherwise specified, goods are always transported at the consignee's risk. Without exception, it is up to the purchaser to raise with the transporter, in the legal form and time limits, any claim concerning the condition or the number of packages received and also to send us at the same time a copy of this declaration. Failure to respect this procedure will relieve us of all responsibility.

In the case of CIF (Cost, Insurance & Freight) or CIP (Carriage & Insurance Paid to) sales, etc…, in the event of damage, our responsibility will only be engaged if any reservations and required declarations have been notified in the required time period, and will not in any case exceed the indemnity sum received from our insurers.

If the arrangements for despatch are modified, we reserve the right to invoice any additional costs arising from such changes.

Packages cannot be returned.

Should the delivery of goods be delayed for a reason not attributable to the vendor, goods will be stored on the vendor's premises, at the own risk of the customer, at a charge for storage of 1% (one per cent) of the total order sum per week, beginning, without a grace period, on the day after the scheduled date of delivery indicated in the contract. After thirty days from this date, the vendor has the right to dispose of these goods as he wishes and arrange a new delivery date for the said goods with the customer. In all instances, all down payments received remain the property of the vendor as indemnity, without prejudice to other claims for damages that the vendor may wish to bring.

V - DELIVERY DATES

Delivery times are stated for information only, and do not include the month of August.

Delivery dates are counted from the issue date of the order acknowledgement from the vendor and are subject to compliance with the provisions indicated on the order acknowledgement, notably receipt of the down payment for the order, notification of the issuance of an irrevocable letter of credit conforming to all vendor requirements (especially as regards the amount, currency, validity, licence, etc.) and acceptance of the terms of payment with any guarantees which may be required, etc…

In no case does late delivery automatically entitle the customer to damages and / or penalties.

Unless otherwise specified, we reserve the right to make partial deliveries.

Delivery dates are automatically suspended without formal notice, and the vendor shall have no responsibility in cases of Force Majeure, or events beyond the control of the vendor or his suppliers such as delays, saturation, or unavailability of the planned transport methods, energy, raw materials etc., serious accidents such as fires, explosions, strikes, lock out, or emergency measures taken by the Authorities occurring after the conclusion of the order and preventing its normal execution.

Similarly, delivery dates are automatically suspended without formal notice in all cases of failure to perform or late payment by the customer.

VI - TESTS

All goods manufactured by the vendor are tested before leaving the factory in accordance with vendor's ISO 9001 certifications.

Customers may attend these tests : they simply have to convey the wish to do so in writing when the order is placed.

Specific tests and acceptance tests requested by the customer, whether conducted on the customer's premises, in our factories, on-site, or by inspection organisations, must be noted on the order and are to be paid for by the customer.

Goods specially developed for a customer will have to be approved by the latter before any delivery of mass - produced goods, notified by signing and returning to us the Product Approval Schedule reference Q1. T. 034.

In the event of the customer's insistence on delivery without having signed this form beforehand, the goods will then still be considered as prototypes and the customer will assume sole responsibility for using it or supplying it to his own customers.

VII -TERMS OF PAYMENT

All our sales are considered as carried out and payable at the registered office of the vendor, without exception, whatever the method of payment, the place of conclusion of the sale and delivery.

When the customer is based in France, our invoices are payable on receipt in cash, by banker's draft, or by L.C.R. ("Lettre de Change - Relevé"), within thirty days from the end of the month following the invoice date, net and without discount.

When the customer is based outside France, our invoices are payable in cash against delivery of the dispatching documents or by irrevocable documentary credit confirmed by a first class French bank with all bank charges payable by the customer.

Payments must be made in the currency of the invoice.

In accordance with French Law N° 92.1442 dated December 31,1992, non-payment of an invoice by its due date will give rise, after formal notice, to a penalty equal to one and a half times (1.5) the official rate of interest, and to late payment interest at the bank base rate plus five per cent. If the invoice carries V.A.T. (Value Added Tax), this is calculated on the amount, inclusive of tax, of the remaining sum due and comes into force from the due date.

Should steps have to be taken to recover the said amount, a surcharge of 15% (fifteen per cent) of the sum demanded will be payable.

Moreover, as a consequence of non - payment of an invoice or any term of payment, whatever the method of payment envisaged, the customer shall pay immediately for the whole of the outstanding amount owed to the vendor (including his subsidiaries, sister or parent companies, whether in France or overseas) for all deliveries or services, whatever their initial due date.

Notwithstanding any particular terms of payment arranged between the parties concerned, the vendor reserves the right to demand :

– payment in cash, before the goods leave the factory, for all orders in the process of manufacture, in the event of a problem with payment, or if the customer's financial situation justifies it,
– a down payment for the order.

Unless we are at fault, all down payments are non - returnable, without prejudice to our right to claim damages.

Any payment made in advance of the fixed payment date will lead to a discount of 0.2 % (zero point two per cent) per month of the amount concerned.

VIII - COMPENSATION CLAUSE

Unless prohibited by law, the vendor and the customer expressly agree between one another to compensate their respective debts arising from their commercial relationship, even if the conditions defined by law for legal compensation are not all satisfied.

In applying this clause, by vendor we mean any company in the LEROY SOMER group.

IX - TRANSFER OF RISKS - TRANSFERT OF TITLE

Transfer of risks occurs upon the handing over of the goods, according to the delivery conditions agreed at the time of ordering.

THE TRANSFER OF TITLE OF THE GOODS SOLD TO THE CUSTOMER OCCURS UPON PAYMENT OF THE WHOLE PRINCIPAL SUM AND INTEREST.

The provision of a document creating an obligation to pay (bank draft or similar) does not constitute payment.

So long as the price has not been paid in full, the customer is obliged to inform the vendor, within twenty - four hours, of the seizure, requisition or confiscation of goods to the benefit of a third party, and to take all safety measures to acquaint others with and respect our right of title in the event of intervention by creditors.

Failure to pay the amount due, whether total or partial, on the due date, for whatever reason and on whatever grounds, authorises the vendor to demand as of right and without formal notice, the return of the goods, wherever they may be, at the customer's expense and risk.

Return of the goods does not imply to cancellation of the sale .However, we reserve the option to apply the cancellation clause contained in these General Conditions of Sale.

X - CONFIDENTIALITY

The vendor and the customer undertake to maintain confidentiality of information of a technical, commercial or other nature, obtained during negotiations and / or the execution of any order.

XI - INDUSTRIAL AND INTELLECTUAL PROPERTY RIGHTS

The results, data, studies and information (whether patentable or not), or software developed by the vendor during execution of any order, and delivered to the customer, are the sole property of the vendor.

Apart from the instructions for use, servicing and maintenance, reports and documents of any type that we deliver to our customers remain our property and must be returned to us on request, even when design fees have been charged for them, and they shall not be communicated to third parties or used without the prior written agreement of the vendor.

XII - CANCELLATION CLAUSE

We reserve the right to cancel immediately, as of right and without formal notice, the sale of our goods in case of non-payment of any part of the price by the due date, or in case of any breach in the contractual obligations of the customer. In this case, the goods will have to be returned to us immediately, at the customer's own risk and expense, subject to a penalty of 10% (ten per cent) of its value per week of delay. All payments already received shall remain our property as indemnity, without prejudice to our rights to claim damages.

XIII -WARRANTY

The vendor warrants the goods against any defect, arising from a default in material or in workmanship, for twelve months starting from the date on which they are made available, according to the conditions defined below.

The warranty for goods with special applications, or goods used 24 hours a day, is automatically reduced by half.

On the other hand, parts or accessories of other origin, which bear their own brand name, are included in our warranty only to the extent of the warranty conditions granted by the suppliers of these parts.

The vendor's warranty will only apply insofar as the goods have been stored, used and maintained in accordance with the vendor's instructions and documentation. It cannot be invoked when the default results from :

– failure to monitor, maintain or store the goods correctly,

– normal wear and tear of goods,

– intervention on or modification to the goods without the vendor's prior authorisation in writing,

– abnormal use, or use not conforming to the intended purpose,

– defective installation at the customer's and / or the final user's premises,

– non-communication, by the customer, of the intended purpose or the conditions of use of the goods,

– failure to use original manufacturer's spare parts,

– Force Majeure or any event beyond the control of the vendor,

– etc …

In all cases, the warranty is limited to the replacement or the repair of parts or goods recognised as defective by our technical departments. If the repair is entrusted to a third party, it should only be carried out after acceptance by the vendor of the estimate for repair.

No goods should be returned without the vendor's prior authorisation in writing .

Goods to be repaired should be sent prepaid, to the address indicated by the vendor. If the goods have not been repaired under warranty, the cost of dispatching it back will be invoiced to the customer or to the end purchaser.

This warranty applies to our goods in accessible form and therefore does not cover the cost of dismantling and reinstallation of the said goods in the equipment in which they are integrated .

Repair, modification, or replacement of spare parts or goods during the warranty period will not extend the duration of the warranty.

The provisions of this article constitute the only obligation on the part of the vendor concerning the warranty for the goods supplied.

XIV -LIABILITY

The vendor will be liable for bodily injury caused by his goods or personnel.

The repair of property damages attributable to the vendor is expressly limited to a sum which may not exceed the amount of the goods found as defective.

It is expressly agreed that the vendor and the customer each waive any right to claim for indirect, consequential and / or punitive damages of any kind, such as loss of production, loss of profit, costs of withdrawal from the market or costs of recall, costs of dismantling and reinstallation of goods, loss of contracts, etc.

XV - SPARE PARTS AND ACCESSORIES

Spare parts and accessories are provided on request insofar as they are available. Related costs (carriage and any other costs) are always added to the invoice.

We reserve the right to demand a minimum quantity or invoice a minimum per order.

XVI - PARTIAL INVALIDITY

If any provision of these General Conditions of Sale is held to be unenforceable for any reason, it shall be adjusted rather than voided, if possible, in order to achieve the intent of the parties to the extent possible. In any event, all other provisions shall be deemed valid and enforceable to the full extent possible.

XVII -DISPUTES

THESE GENERAL CONDITIONS OF SALE ARE GOVERNED BY FRENCH LAW.

ANY DISPUTE RELATING TO OUR SALES, EVEN IN THE CASE OF MULTIPLE DEFENDANTS, SHALL BE, IN THE ABSENCE OF AMICABLE SETTLEMENT AND NOTWITHSTANDING ANY CLAUSE TO THE CONTRARY, SUBJECT TO THE JURISDICTION OF THE COURTS OF ANGOULEME (France).

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