Arçelik Electrical Motors Plant performs manufacturing operations at its factory in Çerkezköy, Tekirdağ. Electrical Motors Plant manufactures industrial motors and White goods motors in a closed area of 39.000 m2, Electrical Motors Plant manufactures economic three-phase and single-phase asynchronous motors having new technology, high performance and modern appearance.

With a team of engineers, expert on electrical motors, the plant provides the users with necessary technical consultancy services, and offers a product range including three-phase asynchronous motors in 2000 different versions and single-phase asynchronous motors in 400 different versions.

With the purpose of launching products beyond customer expectations, new Technologies are closely followed and adapted in the plant. To convey product design into the production lines more quickly computer assisted production technology and concurrent engineering methods are being used.

Electrical Motors Plant, exporting more than half of its production and whose products are preferred abroad, expand its customer portfolio via constant and competitive quality policies. Continuous follow-up customer demands and complaints is considered main instrument for product development and customer satisfaction. Thanks to the advantage of long term relationships with customers - producers and dealers, the plant increases competitive power for both itself and the customers.

INTERNATIONAL STANDARDS

Electric motors are manufactured according to the international standards listed below:

IEC 60034-1	Rating and performance
IEC 60034-2-1	Methods for determining losses and efficiency
IEC 60034-5	Classification of degrees of protection
IEC 60034-6	Methods of cooling
IEC 60034-7	Symbols of construction and mounting arrangements
IEC 60034-8	Terminal markings and direction of rotation
IEC 60034-9	Noise limits
IEC 60034-11	Built-in thermal protection
IEC 60034-14	Vibration limits
IEC 60034-18-1	Functional evaluation of insulation system
IEC 60034-30	Efficiency classes (IE-code)
IEC 60038	Standard voltages
IEC 60072	Dimensions and output series for rotating electrical machines
EN 50347	Dimensions and output for electrical machines

EN 55014-1 EN 61000-3-2 EN 61000-3-3	Electromagnetic compatibility

Turkey	Germany	Great Britain
TSE EN 60034-1	DIN VDE 0530 DIN EN 60034	BS EN 60034

Three phases and single-phase motor series complying with UL 1004 and CSA. C 22.2 Nr 100.95 for UL and c-UL respectively, are also available for our standard product range.

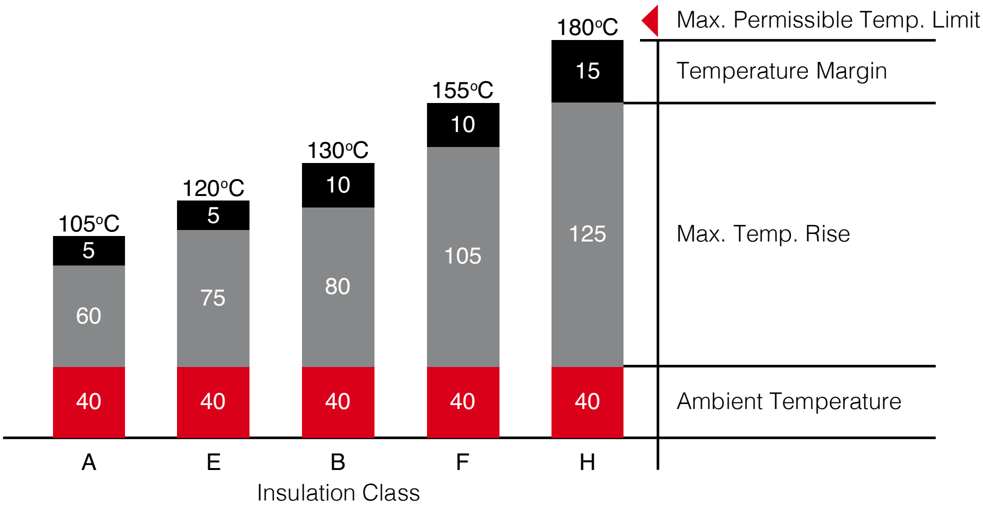
Our products do not contain prohibited materials according to 2011/65/EU RoHS (Recast) Declaration dated 08/06/2011 and 2003/11/EC Directive dated 15/08/2010.

INSULATION CLASSIFICATION

Our standard motors have insulation class F while the temperature rise is for Class B ensuring longer service life.

Upon the customer's request, H class insulation motors are manufactured.

Under specified measuring conditions in accordance with IEC 60034-1 standard, insulation class F for an electric motor means that at ambient temperature of 40°C the temperature rise of its windings may be max. 105°C with the additional temperature margin of 10°C.



DEGREE OF PROTECTION

According to IEC 60034-5 standard, electric motors are provided with IP code which determines the degree of protection ensured by the housing against access to dangerous parts, introducing foreign matter and/or water.

Our motors comply with IP55 protection class as standard.

Please ask for other protection classes.

IP	5 The first characteristic numeral: Protection from introduction of solid foreign matter	5 The second characteristic numeral: Protection against penetration of water and its harmful effects	
0	Non-protected machine	Non-protected machine	0
1	Machine protected against solid objects greater than 50 mm	Machine protected against dripping water	1
2	Machine protected against solid objects greater than 12 mm	Machine protected against dripping water when tilted up to 15°	2
3	Machine protected against solid objects greater than 2.5 mm	Machine protected against spraying water	3
4	Machine protected against solid objects greater than 1 mm	Machine protected against splashing water	4
5	Dust-protected machine	Machine protected against water jets	5
6	Dust-tight machines	Machine protected against heavy seas	6

VIBRATION/BALANCING

All rotors are balanced dynamically with half key and this is indicated on the rating plate with letter H.

In accordance to IEC 60034-14, vibration level A is guaranteed for the standard motors. On customer demand, motors with reduced vibration level may also be produced.

Vibration in m/s2 for the frame sizes

Frame sizes	Vibration grade	
	A	B
63-132	1,6	0,7
160-280	2,2	1,1

ENVIRONMENTAL CONDITIONS

Motors are designed to operate at altitudes up to 1000 m and ambient temperature up to 40°C according to IEC 60034-1. Rated output will change at the % ratings given below for different altitudes and ambient temperatures.

ALTITUDE		up to 1000 m	1500 m	2000 m	2500 m	3000 m	3500 m	4000 m
Insulation class	B	100	97	94	90	86	82	77
	F	100	98	95	91	87	83	78

AMBIENT TEMPERATURE		30°	35°	40°	45°	50°	55°	60°
Insulation class	B	106	106	100	97	92	86	60
	F	105	102	100	97	93	87	82

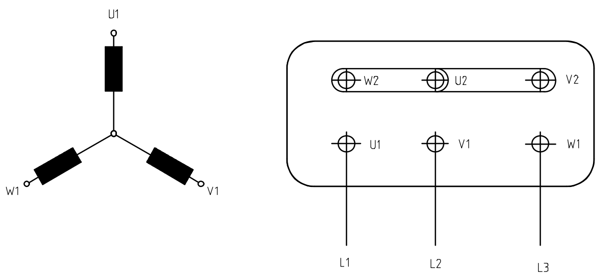
ELECTRICAL CONNECTIONS

Terminal plate has 6 connection terminals marked in accordance with IEC 60034-8.

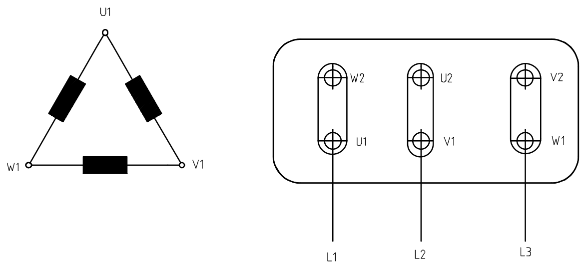
Frame size	63-80	90-100	112	132-160	180	200-225	250-280
Cable entry	M20	M25	M25	M32	M40	M50	M50/M63*
Number of Entries	1	1	2	2	2	2	2

*Optional

Standard three-phase motors can be connected with star or delta method.



Star connection is achieved by wiring W2, U2, V2 to each other; and U1, V1, W1 leads to voltage supply



Delta connection is achieved by wiring the end of a phase to the head of the other.

Star-Delta (Y/D) Start-Up

Most low voltage motors are delta wired to operate in 400V and star wired to operate at 690V. This flexibility can also be used to operate the motor under lower voltages. Apart from the fact that startup current in star-delta configuration drops to one third of direct starting, startup moment also decreases by around 25%. The motor is started in star connection and accelerated as much as possible, then it is transferred to delta connection. This method can only be used in asynchronous motors which are delta-connected to supply voltage.

VOLTAGE & FREQUENCY

Our motors are normally designed for 400V, 50Hz. Other voltages and 60 Hz frequency are optional. Our motors wound for 50Hz can be operated on 60Hz for the same output power. The ratios given below indicate changes in the given parameters.

		60 Hz Application Coefficients of 50 Hz Motor						
50 Hz Voltage	60 Hz Application	Rated Speed	Rated Power	Rated Torque	Rated Current	Starting Torque	Breakdown Torque	Starting Current
220 V	220 V	1,2	1	0,83	1	0,83	0,83	0,83
220 V	255 V	1,2	1,15	0,96	1	0,96	0,96	0,96
380 V	380 V	1,2	1	0,83	1	0,70	0,83	0,83
380 V	440 V	1,2	1,15	0,96	1	0,95	0,98	0,97

TOLERANCES

According to IEC 60034-1, catalogue values are permitted to deviate from the real values as follows:

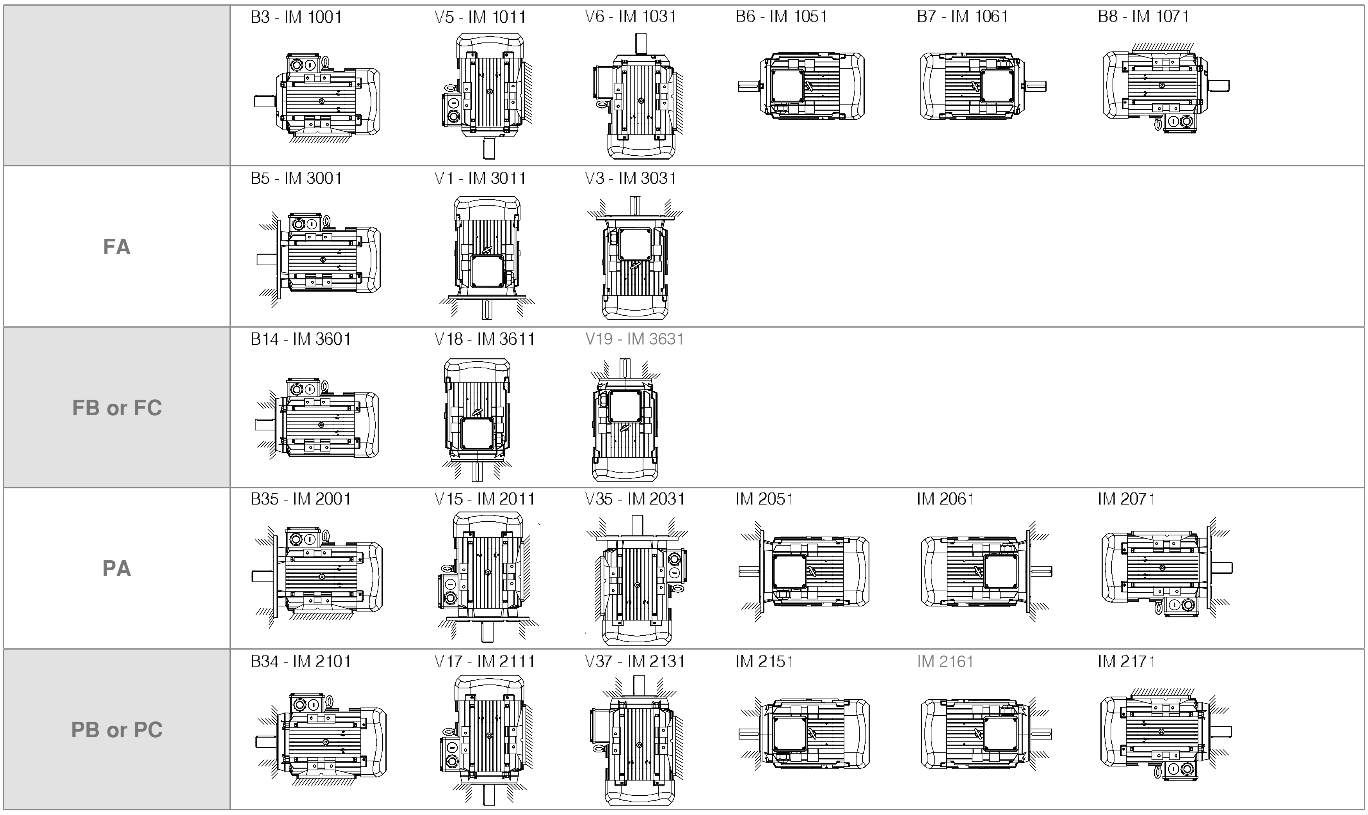
Speed (n)	$\Delta n = \pm 20\%(n_S - n_N)$, PN> 1kW $\Delta n = \pm 30\%(n_S - n_N)$, PN≤ 1kW
Efficiency % (n)	$\Delta n = -15\%(100 - n_N)$, PN<=150kW $\Delta n = -10\%(100 - n_N)$, PN>150kW
Power Factor (cos φ)	$\Delta \cos\varphi = -1/6\,(1-\cos\varphi)$
Locked Rotor Current (I_L/I_N)	$\Delta (I_L/I_N) = +20\%\,(I_L/I_N)$
Locked Rotor Torque (M_L/M_N)	min $(M_L/M_N) = -15\%(M_L/M_N)$ max $(M_L/M_N) = +25\%(M_L/M_N)$
Breakdown Torque (M_K/M_N)	$\Delta (M_K/M_N) = -10\%(M_K/M_N)$
Pull-up Torque (M_P/M_N)	$\Delta (M_P/M_N) = -15\%(M_P/M_N)$
Moment of Inertia (J) [kgm^2]	$\Delta J = \pm 10\%J$
Sound Pressure Level (LPA) [dB]	Δ LPA = +3 dB (A)

MATERIAL

<table>
<tr><th>Frame</th><th>Housing</th><th>Fan</th><th>Fan Cover</th><th>Endshields</th><th>B5 Flange</th><th>B14 Flange</th></tr>
<tr><td>63</td><td rowspan="11">Aluminium</td><td rowspan="13">Plastic</td><td rowspan="8">Steel</td><td rowspan="11">Aluminium</td><td rowspan="6">Aluminium</td><td rowspan="5">Aluminium</td></tr>
<tr><td>71</td></tr>
<tr><td>80</td></tr>
<tr><td>90</td></tr>
<tr><td>100</td></tr>
<tr><td>112</td><td rowspan="2">Cast Iron</td></tr>
<tr><td>132</td><td rowspan="7">Cast Iron</td></tr>
<tr><td>160</td><td rowspan="6"></td></tr>
<tr><td>180</td><td rowspan="3">Plastic*</td></tr>
<tr><td>200</td></tr>
<tr><td>225</td></tr>
<tr><td>250</td><td>AL / Cast Iron</td><td>Plastic/Steel</td><td rowspan="2">Cast Iron</td></tr>
<tr><td>280</td><td>Cast Iron</td><td>Steel</td></tr>
</table>

* Steel fan cover is optional.

MOUNTING ARRANGEMENTS



BEARING

63-225 frame motors are equipped with deep grove ball bearings with ZZ shields.
250 and 280 frame size motors have external lubrication.

Bearing & Seal Type

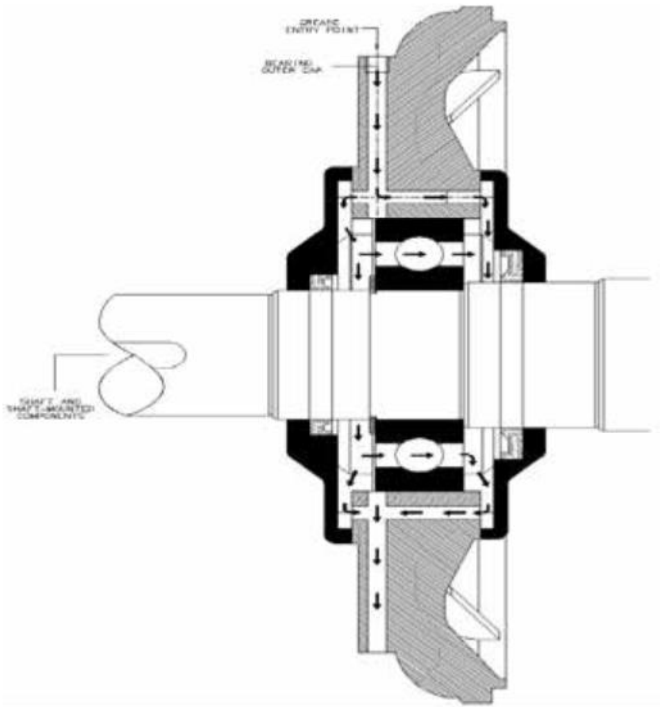
Frame	Bearing		Seal	
	Drive side	Non-drive side	Drive side	Non-drive side
63	6201-2Z	6201-2Z	12*22*7	12*22*7
71	6202-2Z	6202-2Z	15*24*5	15*24*5
80	6204-2Z	6204-2Z	20*30*7	20*30*7
90	6305-2Z	6305-2Z	25*40*7	25*40*7
100	6306-2Z	6305-2Z	30*47*7	25*40*7
112	6306-2Z	6306-2Z	30*47*7	30*47*7
132	6208-2Z	6208-2Z	40*62*10	40*62*10
160	6309-2Z	6209-2Z	45*72*10	45*72*10
180	6310-2Z	6310-2Z	50*80*10	50*80*10
200	6312-2Z	6312-2Z	60*90*10	60*90*10
225	6313-2Z	6313-2Z	65*100*13	65*100*13
250	6315	6313-2Z	75*112*12	65*100*13
250 (Cast Iron)	6316	6316	80*100*10	80*100*10
280 (Cast Iron)	6316	6316	80*100*10	80*100*10

LUBRICATION

Closed type (2Z) roller bearings are being used. These types of roller bearings do not require maintenance since they are lubricated with the type of lubricant specified by the manufacturer. Roller bearings should be replaced after 20,000 hours of operation (approx. 2-5 years of use) due to the specified operation temperature, vibration level and shaft loads.

The grease type and quantity are written on the nameplate for motors have externally lubricated roller bearings. There are bearing lubrication channel and grease nipple for motors have externally lubricated bearings.

After lubrication, grease nipple cover must be closed. Grease must be avoided from dirt and dust during lubrication. Quantity of grease indicated on the nameplatel should be considered and different grease must not be used. The mix of different grease must be avoided.



PAINTING

Our standard range of motors are painted with a grey protective paint according to RAL 7031 (grey). Other paint options are also available on request.

FEET

For 63-180 frame size motors, feet can be mounted on three sides, allowing terminal box assembly on the desired side. For 63-250 frame size aluminium motors, the feet are detachable and this feature provides flexibility for different mounting types.

TERMINAL BOX

Motors frame size 63-280 have terminal boxes on top situated at drive end which can be rotated 90°C, so that conduits can be at each side. For the other frame sizes, it is position on top and situated at the drive end.

DRAIN/CONDENSATION HOLES

In the basic design, motors are supplied without holes. In case of customer request, motors can be supplied with drain holes. Since these motors are provided with a special plug in the hole, the degree of protection remains IP 55.

MOTOR IDENTIFICATION SYMBOLS

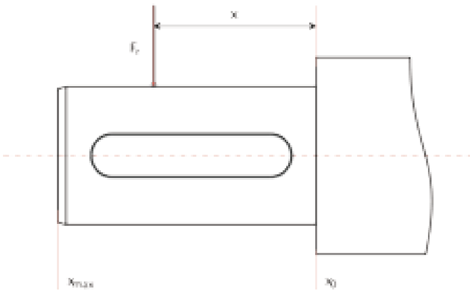
Q3EFA225M4C43 (Sample motor number)		
Q3E	Motor Type	
Q4E	IE4 efficieency class motors	
Q3E	IE3 efficiency class motors	
Q2E	IE2 efficiency class motors	
Q1E	IE1 efficiency class motors	
Q1D	IE1 efficiency class inverter entegrated motors	
Q2D	IE2 efficiency class inverter entegrated motors	
Q3D	IE3 efficiency class inverter entegrated motors	
QS	Dahlander type motors	
QB	Brake motors	
QM	Single phase motors with run capacitor	
QC	Single phase motors with start and run capacitors	
P	Housing Type	
---	Aluminium	
P	Cast Iron	
FA	Construction Type	
---	with feet	B3,B6,B7,B8,V5,V6/V19
FA	with A flange	B5,V1,V3
FB	with B flange	B14,V18,V19
FC	with C flange	B14,V18,V19
FS	with special flange	-
PA	with feet and A flange	B3/B5,V1/V5,V3/V6
PB	with feet and B flange	B3/B14,V5/V18,V6/V19
PC	with feet and C flange	B3/B14,V5/V18,V6/V19
PS	with feet and special flange	-
X	without feet,flange and/or end-shield	B9,V8,V9

225	Frame Size	
	Shaft height (mm)	
M	Motor Leght	
	S	Short
	M	Medium
	L	Long
4	Number of Poles	
	2.4.6.8 Poles	
C	Core Length (Does not affect outside dimensions)	
	A	Short
	B	Medium
	C	Long
	D,E	Extra Long
43	Special Motor Number	
	01 - ... - 99	

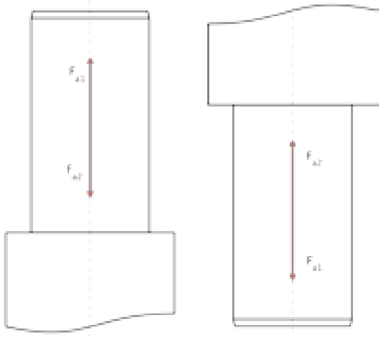
PERMISSIBLE LOADING ON THE SHAFT END

Frame Size	Number of Poles	F_r (x=0) (kN)	F_r (x=max) (kN)	F_{a1} (kN)	F_{a2} (kN)
63	2	0,25	0,22	0,18	0,18
	4	0,29	0,25	0,21	0,21
	6	0,31	0,27	0,23	0,23
71	2	0,30	0,26	0,21	0,21
	4	0,35	0,29	0,25	0,25
	6	0,37	0,31	0,27	0,27
	8	0,38	0,32	0,28	0,28
80	2	0,54	0,45	0,38	0,38
	4	0,62	0,51	0,44	0,44
	6	0,66	0,54	0,48	0,48
	8	0,67	0,55	0,49	0,49
90	2	0,91	0,74	0,70	0,36
	4	0,99	0,80	0,77	0,40
	6	1,04	0,84	0,82	0,43
	8	1,03	0,83	0,80	0,43
100	2	1,21	0,96	0,91	0,36
	4	1,31	1,04	1,01	0,40
	6	1,38	1,09	1,07	0,43
	8	1,38	1,09	1,07	0,43
112	2	1,23	1,00	0,91	0,54
	4	1,33	1,09	1,01	0,60
	6	1,40	1,14	1,07	0,64
	8	1,40	1,14	1,07	0,61
132	2	1,22	0,98	0,86	0,86
	4	1,31	1,04	0,92	0,92
	6	1,34	1,08	0,95	0,95
	8	1,42	1,14	1,03	1,03
160	2	2,22	1,72	1,59	1,59
	4	2,34	1,82	1,71	1,71
	6	2,34	1,82	1,71	1,71
	8	2,48	1,92	1,83	1,83
180	2	2,68	2,12	1,94	1,94
	4	2,82	2,23	2,07	2,07
	6	2,93	2,31	2,17	2,17
	8	2,92	2,31	2,16	2,16
200	2	3,80	3,04	2,79	2,79
	4	3,95	3,16	2,93	2,93
	6	4,07	3,26	3,05	3,05
	8	3,95	3,16	2,93	2,93
225	2	4,45	3,65	3,25	3,25
	4	4,59	3,60	3,39	3,39
	6	4,73	3,71	3,52	3,52
	8	4,53	3,55	3,32	3,32
250	2	4,97	3,93	3,61	2,94
	4	5,78	4,57	4,26	3,15
280	2	4,97	3,93	3,61	2,94
	4	5,78	4,57	4,26	3,15

Horizontal operation



Vertical operation



Calculations are based on 20,000h (L10aah) bearing life time and the actual values will differ if radial and axial loads act at the same time. Mechanical strength of the end-shields should also be considered for critical applications.

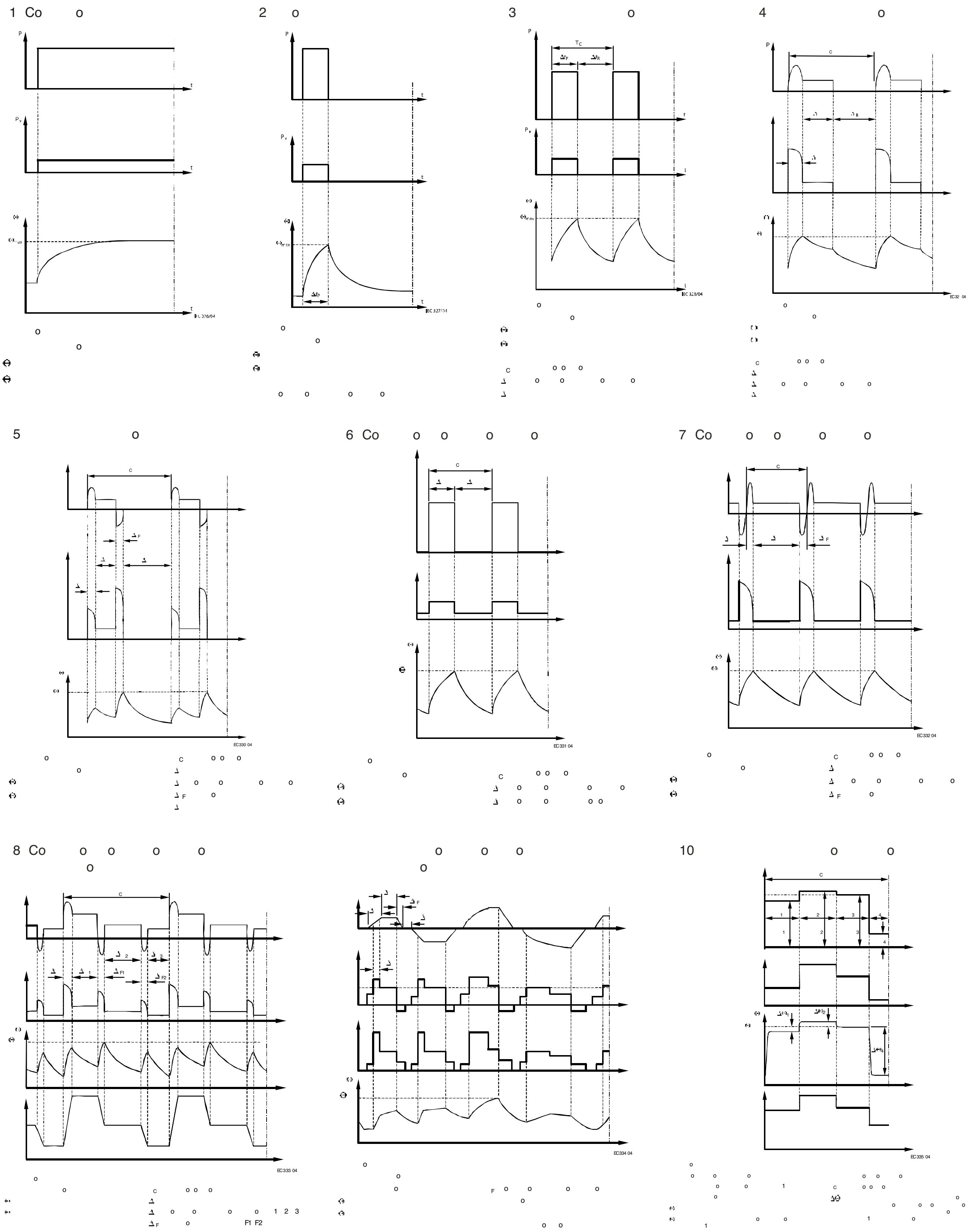
Value of force Fr acting on any point of the shaft end (between points X=max and X=0) may be calculated according to the following formula:

$$F_r = F_{x0} - \frac{x}{E} \times (F_{x0} - F_{xmax}) \text{ [kN]}$$

Where; F_{x0} - value of Fr force acting on the beginning of the shaft end
F_{xmax} - value of Fr force acting on the shaft end
E - length of the shaft end

DUTY TYPE

Duty types according to the IEC 60034-1 are given below:



The duty type of our standard motors is S1. On customer demand, the other duty type-motors can be produced.

RUNNING INDUCTION MOTORS WITH INVERTERS

Squirrel cage induction motors, for ease of production and their low costs;also by having a simple and rugged construction, are the most preferred type of motor in the industry because they require little maintenance. In particular, studies on the energy efficiency in recent years, technological developments on power electronics and also in parallel cost reduction in circuits, asynchronous motor with inverter usage is increasing every day. The aim of this technical information note is to describe how the settings can be done in applications where the motors are used together with inverters. In this context, considering common industrial inverter brands and types, inverter parameter settings for each type was described.
Two different modes of operation for the inverter parameter settings are taken into account.

1. V/f control mode
2. Vector control mode

Parameter settings are given in technical information note is valid for the specified models of their respective companies. The corresponding manuals must be investigated for setting the parameters of different models and manufacturers.

V/f CONTROL MODE

In this operating mode, V/f ratio is kept constant, in order to adjust air gap flux Q to a desired level. In this operating mode there is no need for any motor speed feedback. Therefore, encoder, tachometer etc. is not needed. This motor label information must be presented correctly on the operating mode of the inverter.

Things that must be take into account while Open Loop Working;

1. The nature of the inverter, the lower and upper semiconductor switches at the same time for the introduction of “dead time of transition” is available. Therefore, particularly at low frequencies (up to approximately 30 Hz) sinusoidal phase currents in the motor divergence occurs. This deterioration in the current vibration motor as will be encountered.

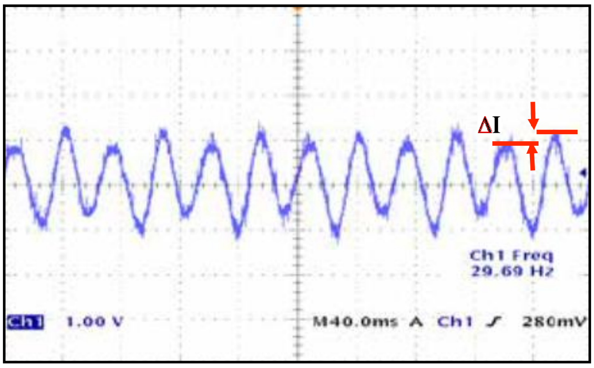


Figure 1. Phase current waveform with a distorted sinus form

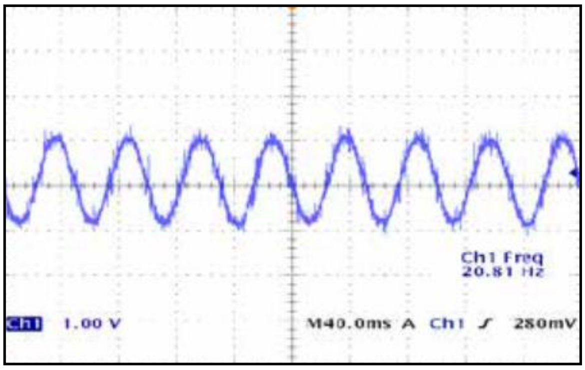


Figure 2. Phase current waveform with a sinus form

This is intended to avoid some of the problems inverter companies have taken a series of measures.

2. Another drawback, set extra IR compensation is rising at low speeds due to the extreme value of the motor phase currents. As a result, the motor entering saturation, with overheating and operating with low efficiency will arise.

In order to eliminate those drawbacks in open loop operating, switching to “vector control” mode is recommended.

VECTOR CONTROL

As well as eliminating the disadvantages mentioned above, Vector control is an algorithm that runs the motor at its most efficient point by determining the optimum operating point. However, vector control mode is not included in all inverter models. It must be learnt from its catalogue or learning from the producer whether the inverter has this mode or not.
Defining parameters required for vector module can be made by two different methods. The first method, the literature “rotating auto-tuning” in the past, the inverter motor running unloaded his calculation parameters. However, this method is not always applicable, because the engine is connected to the load system can not allow this. Another method “non rotating tune” In the past, the algorithm that detects the engine rotation parameters.
Vector control algorithm is the most sensitive point, is to be able to accurately determine the set of motor parameters and the inverter. For this purpose, we recommend that the motor parameters, the engine manufacturer is to provide the firm. If the engine parameters from engine manufacturers as possible, the value has been calculated on the inverter must be paid to compliance with autotune mode. This algorithm is the most efficient point of the motor parameters in order to ensure a healthy work and determination should be introduced to the inverter.

1.2.1. Induction Motor Equivalent Circuit

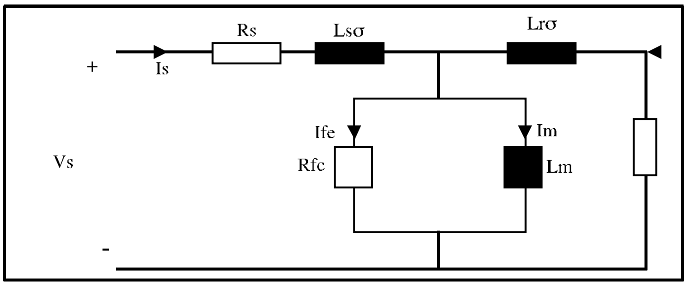


Figure 3. induction motor equivalent circuit diagram

Rs : Stator phase resistance for a phase [ohm]
Lss : Stator leakage inductance for a phase [mh]
Lm : Magnetizing inductance [mh]
L¢rs : Stator phase for a reduced rotor leakage inductance [mh]
R’r : Stator phase for a reduced rotor resistance [ohm]
Tr : Motor time constant [ms] = $L'r\sigma + Lm$
Is : Stator phase current [A]
Iso : Idle stator phase current [A]
Im : Magnetizing current [A]
(Usually if the flow can be neglected IM = iso)

$$\text{s: Slip frequency [Hz]} = \frac{\text{Synchronous speed - Rated speed}}{\text{Synchronous speed}} \times \text{Nominal frequency}$$

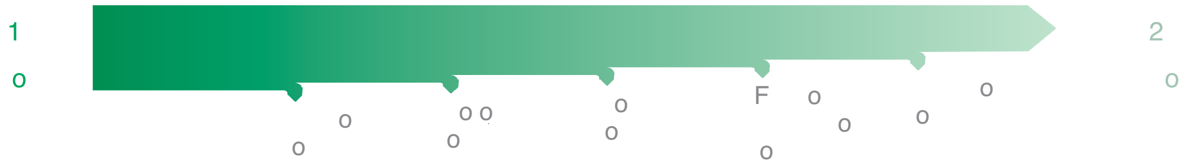
Please contact with us for our motors’ Equivalent Circuit Parameters.

EFFICIENCY

European Committee of Manufacturers of Electrical Machines and Power Electronics (CEMEP) and European Commission issued a declaration on June 28, 1999 that categorized the motors in efficiency classes.

This standard covers 2, 4 and 6 pole motors in 0.75kW and 375kW power range and 50-60Hz frequency and refers to IEC standard 60034-2-1 to define efficiency.

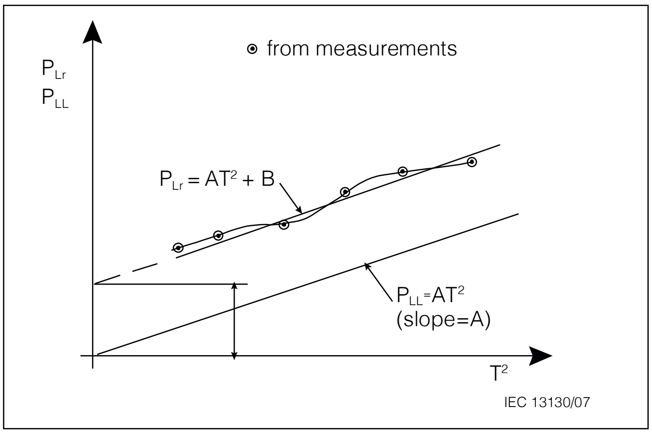
Efficiency is defined as the ratio of output power of the motor to the input power reflected in the cost and it is actually an indicator of losses.



According to IEC 60034-2-1, these losses are obtained with specific methods and efficiency is calculated after loss analysis. Before 2-1 standard issued in September 2007, 60034-2 standard was used for efficiency calculations. The main difference between

Additional losses	
IEC 60034-2	0.5% of input power
IEC 60034-2-1	Determined by measurement

New measurement standard 60034-2-1 offers different methods to determine additional losses. Arçelik determines additional losses by means of the method (8.2.2.5.1) whose accuracy is stated to be highest by the standard. In this method, additional losses are determined according to the results obtained from measurement values. There is not any assumption in question.

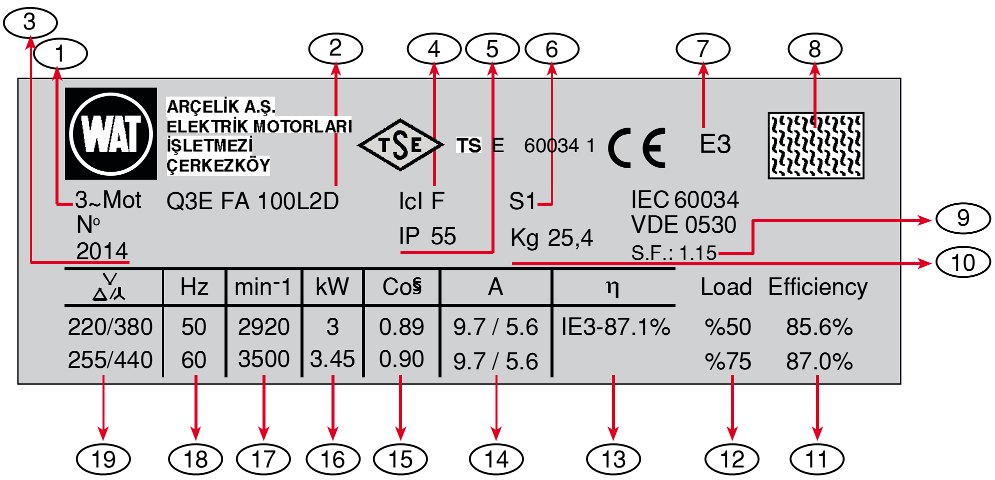


EU Regulation related to the subject has been issued in June 2009. This regulation focuses on some changes in 60034-30 standard and includes certain obligatory applications.

June 16, 2011	Minimum IE2 efficiency class obligatory
January 1, 2015	Minimum IE3 efficiency class (or IE2+inverter) obligatory (7.5-375kW)
January 1, 2017	Minimum IE3 efficiency class (or IE2+inverter) obligatory (0.75-375kW)

In parallel with transition to IE series, it has become obligatory to include certain technical information in technical documents and web sites of motors and products integrated with motors.

With this new amendment, motor labels will include 50Hz and 60Hz motor data as well as IE codes and efficiency value. Most prominent feature of new labels is that 2D barcoding will be placed on the labels. This application ensures the customers to track the motors. With barcoding, the motor users will be able to reach information such as manufacture date of motor, results of routine testing (current with neutral resistance, power etc.) and serial no. and etc.



1 Motor type: Three-phase asynchronous motor
2 Motor code
3 Year of Manufacture
4 Insulation class
5 IP Protection class
6 Service Type
7 Efficiency class (according to IEC 60034-30)
8 2D barcode
9 Service factor*
10 Motor weight
11 Efficiency value (according to IEC 60034-2-1)
12 Load value
13 Efficiency value (according to IEC 60034-2-1)
14 Nominal current
15 Power factor
16 Motor output power
17 Rated speed
18 Motor nominal frequency
19 Operation voltage

* For IE2 and above efficiency motors