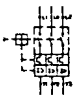
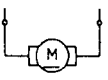
Hardness/Tensile Strength Relationship for Steel

HB = Brinell Hardness Test HRB = Rockwell Hardness Test (Ball Type)
HRC = Rockwell Hardness Test (Cone Type) HV = Vickers Hardness Test HS = Shore Scleroscope Test

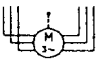
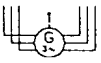
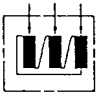
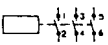
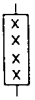
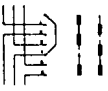
Hardness Numbers					Tensile Strength	
HB	HRB	HRC	HV	HS	PSI	Kgf/mm2
204			219		105,000	69
	95	15				
208			223		107,100	70
		16		34		
211			226		108,600	71
	96					
214		17	229		110,200	72
				35		
216	97		231		111,200	73
		18				
219			235		112,700	74
223	98	19	238	36	114,800	75
226		20	242		116,300	76
299	99		244		117,900	77
				37		
232		21	248		119,400	78
235	100		251		121,000	79
239		22	254	38	123,000	80
241	101		257		124,100	81
		23				
245			261	39	126,100	82
248	102	24	264		127,700	83
250			266		128,700	84
				40		
253	103	25	269		130,200	85
257			273		132,300	86
				41		
260	104	26	276		133,900	87
263			279		135,400	88
266		27	282	42	136,900	89
269	105		285		138,500	90
272		28	289		140,000	91
43						
275			292		141,600	92
106						
278		29	295		143,100	93
282			298	44	145,200	94
285	107	30	302		146,700	95
288			305	45	148,300	96
292			308		150,300	97
31						
295	108		312		151,900	98
297			314	46	152,900	99
300		32	317		154,500	100
304			321	47	156,500	101
307	109		325		158,100	102
309		33	327		159,100	103
313			330	48	161,100	104
317		34	334		163,200	105
319			336		164,200	106
	110			49		
323			340		166,300	107
325			342		167,300	108
		35				
329			346	50	169,400	109
331			348		170,400	110
333			350		171,400	111
337	111	36	354		173,500	112
				51		
339			357		174,500	113
341			359		175,600	114
345		37	363	52	177,600	115
347			365		178,700	116
350			368		180,200	117
352			370		181,200	118
	112			53		
356		38	374		183,300	119
359			377		184,800	120

International Schematics

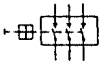
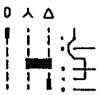
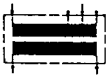
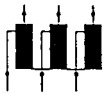
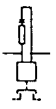
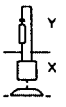
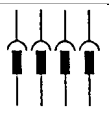
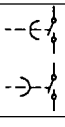
(Electric/Electronic Systems)

NR NO NO NO	SYMBOL SYMBOL SYMBOLE SIMBOLO		ENGLISH	ITALIAN	GERMAN	SPANISH	FRENCH
1		F	FUSE	FUSIBILE	SCHMELZSICHERUNG	FUSIBLE	FUSIBLE
2		L	INDUCTANCE (COIL)	INDUTTANZA (BOBINA)	INDUKTIVITAT (SPULE)	INDUCTIVIDAD (BOBINA)	INDUCTANCE (BOBINE)
3		L	INDUCTANCE WITH IRON CORE	INDUTTANZA CON NUCLEO IN FERRO	INDUKTIVITAT MIT EISENKERN	INDUCTIVIDAD CON NUCLEAO DE HIERRO	INDUCTANCE A NOYAU DE FER
4		F	BIMETAL TRIGGER	RELÈ TERMICO TRIFASE	BIMETALLAUSLOSER	DISPARADOR DE BIMETAL	DECLENCHEUR BIMETALLIQUE
5		F	AUTOMATIC CIRCUIT-BREAKER	INTERRUTTORE AUTOMATICO MAGNETOTERMICO UNIPOLARE	SICHERUNGS-AUTOMAT	FUSIBLE AUTOMATICO	COUPE-CIRCUIT AUTOMATIQUE
6		O	MOTOR PROTECTING SWITCH WITH BIMETAL AND INSTANTANEOUS TRIGGER	INTERRUTTORE AUTOMATICO MAGNETOTERMICO TRIPOLARE (SALVAMOTRE)	MOTORSCHUTZ-SCHALTER MIT BIMETALL- UND SCHNELLAUSLOSER	DISYUNTOR PROTECTOR DEL MOTOR CON DISPARADOR DE BIMETALY DE ACCION INSTANTANEA	DISJONCTEUR DE PROTECTION DE MOTEUR INCL. DECLENCHEUR BIMETTALIQUE E A ACTION INSTANTANEE
7		M	DC-MOTOR	MOTORE IN CORRENTE CONTINUA	GLEICHSTROM-MOTOR	MOTOR DE CORRIENTE CONTINUA	MOTEUR A COURANT CONTINU
8		M	THREE-PHASE CURRENT MOTOR	MOTORE ASINCRONO TRIFASE	DREHSTROMMOTOR	MOTOR DE CORRIENTE TRIFASICA	MOTEUR TRIPHASE
9		G	3-POLE GENERATOR	GENERATORE TRIFASE	GENERATOR 3-POLIG	GENERADOR DE 3 POLOS	GENERATEUR A 3 POLES
10		M	SINGLE-PHASE MOTOR	MOTORE MONOFASE	EINPHASENMOTOR	MOTOR MONOFASICO	MOTEUR MONOPHASE

International Schematics
(Electric/Electronic Systems)

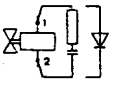
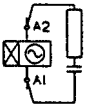
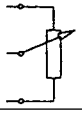
NR NO NO NO	SYMBOL SYMBÔL SYMBOLE SIMBOLO		ENGLISH	ITALIAN	GERMAN	SPANISH	FRENCH
11		M	THREE-PHASE MOTOR (STAR-DELTA)	MOTORE TRIFASE (STELLA TRIANGOLO)	DREIPHASENMOTOR (STERN-DREIECK)	MOTOR TRIFASICO (ESTRELLA-TRIANGULO)	MOTEUR TRIPHASE (ETOILE-TRIANGLE)
12		M	THREE-PHASE GENERATOR (STAR DELTA)	GENERATORE TRIFASE (STELLA TRIANGOLO)	DREIPHASEN-GENERATOR (STERN-DREIECK)	GENERADOR TRIFASICO (ESTRELLA-TRIANGULO)	GENERATEUR TRIPHASE (ETOILE-TRIANGLE)
13		T	THREE-PHASE TRANSFORMER	TRASFORMATORE TRIFASE	DREHSTROMTRANS-FORMATOR	TRANSFORMADOR DE CORRIENTE TRIFASICA	TRANSFORMATEUR TRIPHASE
14		K	POWER CONTACTOR	CONTATTORE DI POTENZA	LEISTUNGSSCHOTZ	CONTACTOR DE POTENCIA	CONTACTEUR DE PUISSANCE
15		X	PRIMARY CURRENT TERMINAL BLOCK	MORSETTIERA (PRINCIPALE)	HAUPTSTROM REIHENKLEMME	CORRIENTE PRINCIPAL BORNE EN SERIE	COURANT PRINCIPAL BARRETTE A BORNES
16		X	CONTROL CURRENT TERMINAL BLOCK	MORSETTO (DI SEGNALE)	STEUERSTROM REIHENKLEMME	CORRIENTE DE MANDO BORNE EN SERIE	COURANT DE COMMANDE BARRETTE A BORNES
17		X	CONTROL CURRENT TERMINAL BLOCK (FOR OPERATING PANEL)	MORSETTO (DI SEGNALE) PER PANNELLO OPERATORE	STEUERSTROM REIHENKLEMME (FUR BEDIENFELD)	CORRIENTE DE MANDO BORNE EN SERIE (PARA PANEL DE MANDO)	COURANTE DE COMMANDE BARRETTE A BORNES (POUR PANNEAU DE COMMANDE)
18		X	CONTROL CURRENT TERMINAL BLOCK (CORRESPONDING)	MORSETTO (CORRISPONDENTE)	STEUERSTROM REIHENKLEMME (KORRESPON-DIEREND)	CORRIENTE DE MANDO BORNE ENSERIE (CORRESPON-DIENDO)	COURANT DE COMMANDE BARRETTE A BORNES (CORRESPON-DANTE)
19		X	CONTROL CURRENT TERMINAL	MORSETTO TERMINALE	STEUERSTROM STUTZPUNKIKLEMME	CORRIENTE DE MANDO BORNE DE SOPORTE	COURANT DE COMMANDE BORNE DE POINT DE REPRISE
20		O (S)	REVERSING SWITCH	INTERRUTTORE D'INVERSIONE	WENDESCHALTER	INTERRUPTOR INVERSOR	COMBINATEUR D'INVERSION

International Schematics
(Electric/Electronic Systems)

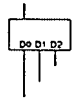
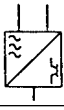
NR NO NO NO	SYMBOL SYMBOL SYMBOLE SIMBOLO		ENGLISH	ITALIAN	GERMAN	SPANISH	FRENCH
21		O	DISCONNECTOR	SEZIONATORE TRIFASE	TRENNSCHALTER	SECCIONADOR	INTERRUPTEUR SEPARATEUR
22		O	STAR-DELTA SWITCH WITH POSITION "O"	COMMUTATORE STELLA-TRIANGOLO CON POSIZIONE DI ZERO	STERN-DREIECK-SCHALTER MIT O-STELLUNG	INTERRUPTOR DE ESTRELLA-TRIANGULO CON POSICION "O"	COMMUTATEUR ETIOLE-TRIANGLE AVEC POSITION ZERO
23			CONTROL TRANSFORMER	TRASFORMATORE DI COMANDO	STEUERTRANS-FORMATOR	TRANSFORMADOR DE MANDO	TRANSFOR-MATEUR DE COMMANDE
24		T	THREE-PHASE CURRENT AUTOTRANS-FORMER Y-CONNECTION	AUTOTRASFOR-MATORE TRIFASE A STELLA	DREHSTROMSPAR-TRANSFORMATOR Y-SCHALTUNG	AUTOTRANS-FORMADOR DE CORRIENTE TRIFASICA CONEXION EN Y	AUTOTRANS-FORMANTEUR TRIPHASE MONTAGE EN Y
25		Y	MAGNETIC CLUTCH WITH RC ELEMENT	FRIZIONE ELETTRO-MAGNETICA CON ELEMENTO RC	MAGNETKUPPLUNG MIT RC-GLIED	ACOPLAMIENTO MAGNETICO CON MODULO RC	PRISE MAGNETIQUE INCL. MODULE RC
26			MAGNETIC BRAKE WITH RC ELEMENT	FRENO ELETTRO-MAGNETICO CON ELEMENTO RC	MAGNETBREMSE MIT RC-GLIED	FRENO MAGNETICO CON MODULO RC	FREIN MAGNETIQUE INCL. MODULE RC
27			PLUGS AND SOCKETS 4-FOLD	CONNETTORE QUADRIPOLARE	STECKVERBINDUNG 4-FACH	UNION ENCHUFABLE CUADRIPLO	CONNECTEUR QUADRUPLE
28		S (K)	NORMALLY CLOSED CONTACT	CONTATTO NORMALMENTE CHIUSO (NC)	OFFNER	CONTACTO DE REPOSO	CONTACT DE REPOS
29		S (K)	NORMALLY OPEN CONTACT	CONTATTO NORMALMENTE APERTO (NA)	SCHLIESSER	CONTACTO DE TRABAJO	CONTACT DE TRAVAIL
30		S (K)	DELAYED CONTACT (ADJUSTABLE)	CONTATTO TEMPORIZZATO (REGOLABILE)	KONTAKTVER-ZOGERUNG (EINSTELLBAR)	RETARDO DE CONTACTO (ADJUSTABLE)	TEMPORISATION DE CONTACT (REGLABLE)

International Schematics

(Electric/Electronic Systems)

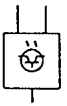
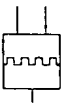
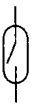
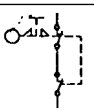
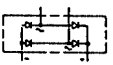
NR NO NO NO	SYMBOL SYMBÖL SYMBOLE SIMBOLO		ENGLISH	ITALIAN	GERMAN	SPANISH	FRENCH
31		F	BIMETAL RELAY (AUXILIARY CONTACT)	CONTATTO AUSILIARIO DI RELE TERMICO	BIMETALLRELAIS (HILFSKONTAKT)	RELE DE BIMETAL (CONTACT AUXILIAIRE)	RELAIS THERMIQUE (CONTACT AUXILIAIRE)
32		A	CHANGEOVER CONTACT	COMMUTATORE	UMSCHALTER	CONMUTADOR	INVERSEUR
33		A	NORMALLY CLOSED CONTACT, LAGGING	CONTATTO NORMALMENTE CHIUSO RITARDATO	OFFNER, NACHEILENO	CONTACTO DE REPOSO, RETARDADO	CONTACT DE REPOS EN RETARD
34		A	NORMALLY OPEN CONTACT, LEADING	CONTATTO NORMALMENTE APERTO ANTICIPATO	SCHLIESSER, VOREILENO	CONTACTO DE TRABAJO ADELANTADO	CONTACT DE TRAVAIL EN AVANCE
35		Y	SOLENOID VALVE WITH RC ELEMENT OR SUPPRESSOR DIODE	ELETTROVALVOLA CON MODULO RC O DIODO SOPPRESSORE DI INSERZIONE	MAGNETVENTIL MIT RC-GLIED ODER LOSCHDIODE	VALVULA MAGNETICA CON MODULO RC O DIODO SUPRESOR	ELECTROVANNE INCL. MODULE RC OU DIODE D'EXTINCTION
36		K	ON-DELAY RELAY, ELECTRO-MECHANICAL WITH RC ELEMENT	RELÈ ELETTRO-MECCANICO RITARDATO CON MODULO RC	ZEITRELAIS ELECTROMECHANISCH ANZUGVERZOGERT MIT RC-GLIED	RELE TEMPORIZADOR ELECTRO-MECANICO, DE CIERRE RETARDADO CON MODULO RC	RELAIS DE TEMPORISATION ELECTRO-MECHANIQUE A ACTIONNEMENT RETARDE INCL. MODUL RC
37		R	POTENTIOMETER	POTENZIOMETRO	POTENTIOMETER	POTENCIO-METRO	POTENTIOMETRE
38		P	COUNTING MECHANISM	CONTATORE (SIMBOLO GENERALE)	ZAEHLWERK	MECANISIMO CONTADOR	COMPTEUR
39		H	HORN	TROMBA	HUPE	BOCINA	AVERTISSEUR
40		H	LAMP	LAMPADA	LAMPE	LAMPARA	LAMPE

International Schematics
(Electric/Electronic Systems)

NR NO NO NO	SYMBOL SYMBOL SYMBOLE SIMBOLO		ENGLISH	ITALIAN	GERMAN	SPANISH	FRENCH
41		H	GLOW LAMP	LAMPADA FLUORESCENTE	GLIMMLAMPE	LAMPARA DE EFLUVIOS	LAMPE AU NEON
42		K	ON-DELAY RELAY	RELE RITARDATO IN ECCITAZIONE	ZEITRELAIS ANZUGVERZOGERT	RELE TEMPORIZADOR DE CIERRE TETARDADO	RELAIS DE TEMPORISATION A ACTIONNEMENT RETARDE
43		K	OFF-DELAY RELAY	RELÈ RITARDATO IN DISECCITAZIONE	ZEITRELAIS , ABFALLVERZOGERT	RELE TEMPORIZADOR DE APERTURE RETARDADA	RELAIS DE TEMPORISATION A RETOMBEE RETARDE
44		K	ON-DELAY AND OFF-DELAY RELAY	RELÈ RITARDATO IN ECCITAZIONE E IN DISECCITAZIONE	ZEITRELAIS, ANZUG- UND ABFALLVERZOGERT	RELE TEMPORIZADOR DE CIERRE Y APERTURA RETARDADOS	RELAIS DE TEMPORISATION A ACTIONNEMENT ET RETOMBEE RETARDES
45		K	LATCHING RELAY	RELÈ CON AUTORITENUTA	SELBSTHALTE-RELAIS	RELE ENGANCHADOR	RELAIS AUTO-ENTRETIEN
46		K	DRIVE WITH AC MOTOR	AZIONAMENTO PER MOTORE AC	ANTRIEB MIT WECHSELSTROM-MOTOR	ACCIONAMIENT POR MOTOR DE CORRIENTE ALTERNA	EINTRAINEMENT PAR MOTEUR A COURANT ALTERNATIF
47		F	UNDER- AND OVERVOLTAGE RELAY	RELÈ DI MASSIMA E MINIMA TENSIONE	SPANNUNG-SWACHTER	RELE DE CONTROL DE TENSION	RELAIS DE PROTCTION VOLTMETRIQUE
48		H	FLUORESCENT LAMP	TUBO FLUORESCENTE	LEUCHTSTOFFROHRE	TUBO FLUORESCHENTE	TUBE FLUORESCENT
49		S	DECADE SWITH	COMMUTATORE DECADICO	DEKADENSCHALTER	INTERRUPTOR DECADICO	COMMUTATEUR DECADIQUE
50		S	LIGHT SWITCH	FOTOCELLULA	LICHTTASTER	PULSADOR DE FIBRO-OPTICA	COMMUTATEUR D'ECLAIRAGE
51		S	IND./CAP. PROXIMITY SWITCH	INTERUTTORE DI PROSSIMITA INDUTTIVO O CAPACITIVO	IND./KAP. NAHERUNGS-SCHALTER	INTERRUPTOR DE PROXIMIDAD IND./CAP.	COMMUTATEUR INDUCTIF/ CAPACITIF

International Schematics

(Electric/Electronic Systems)

NR NO NO NO	SYMBOL SYMBÔL SYMBOLE SIMBOLO		ENGLISH	ITALIAN	GERMAN	SPANISH	FRENCH
52		S	LIGHT-EMITTING DIODE (TRANSMITTER)	FOTODIODO (TRASMETTITORE)	LEUCHTDIODE (SENDER)	DIODO LUMINOSO (EMISOR)	DIODE LUMINESCENTE (EMETTEUR)
53		S	LIGHT BARRIER (RECEIVER)	BARRIERA FOTOELETTRICA (RICEVITORE)	LICHTSCHRANKE (EMPFANGER)	BARRERA DE LUZ (RECEPTOR)	BARRAGE PHOTOELETRIQUE (RECEPTEUR)
54		B	ENCODER	ENCODER	DREHGEBER	TRANSMISOR ROTATIVO	ENCODEUR
55		S	SWITCH MECH.	INTERRUTTORE MECCANICO	SCHALTER MECH.	INTERRUPTOR MEC.	COMMUTATEUR MEC.
56		S	SWITCH WITH AUTOMATIC DISCONNECTION MECH.	INTERRUTTORE CON SGANCIO AUTOMATICO MECCANICO	SCHALTER MIT ZWANGSTRENNER MECH.	INTERRUPTOR CON DESCONECTOR AUTOMATICO	COMMUTATEUR INCL. INTERRUPTEUR-SEPARATEUR COMMANDE MEC.
57		S	REED CONTACT	CONTATTO REED	REED-KONTAKT	CONTACTO TIPO REED	CONTACT REED
58		S	SWITCH WITHOUT LATCHING	PULSANTE NORMALMENTE APERTO	TASTER OHNE RASTUNG	PULSADOR SIN TRINOUETE	BOUTON-POUSSOIR CRANTAGE
59		S	SWITCH WITH LATCHING	PULSANTE PERMANENTE NORMALMENTE APERTO	TASTER MIT RASTUNG	PULSADOR CON TRINOUETE	BOUTON-POUSSOIR AVEC CRANTAGE
60		S	SWITCH MECHANICALLY CONNECTED	PULSANTE AD AZIONE MECCANICA	TASTER, MECH. VERBUNDEN	PULSADOR, UNIDO MECANICAMENTE	BOUTON-POUSSOIR A RACCOINDEMENT MEC.
61		S	CABLE-OPERATED SWITCH WITH LATCHING	CONTATTO COMANDATO A CAVO CON AUTORITENUTA	SEILZUGSCHALTER MIT RASTUNG	INTERRUPTOR DEL SISTEMA DE CABLE DE TRACCION CON TRINOUETE	COMMUTATEUR A CABLE AVEC CRANTAGE
62		U	RECTIFIER CIRCUIT	RADDRIZZATORE	GLEICHRICHTER-SCHALTUNG	CIRCUITO RECTIFICADOR	MONTAGE EN REDRESSEUR

Electrical Formulas

Amperes, Horsepower, Kilowatts and KVA

To find	Single phase	Three phase	Direct current
Kilowatts	$\frac{I \times E \times PF}{1000}$	$\frac{I \times E \times 1.73 \times PF}{1000}$	$\frac{I \times E}{1000}$
KVA	$\frac{I \times E}{1000}$	$\frac{I \times E \times 1.73}{1000}$	–
Horsepower	$\frac{I \times E \times \% \text{ Eff} \times PF}{746}$	$\frac{I \times E \times 1.73 \times \% \text{ Eff} \times PF}{746}$	$\frac{I \times E \times \% \text{ Eff}}{746}$
Amperes when Horsepower is known	$\frac{HP \times 746}{E \times \% \text{ Eff} \times PF}$	$\frac{HP \times 746}{1.73 \times E \times \% \text{ Eff} \times PF}$	$\frac{HP \times 746}{E \times \% \text{ Eff}}$
Amperes when Kilowatts is known	$\frac{kW \times 1000}{E \times PF}$	$\frac{kW \times 1000}{1.73 \times E \times PF}$	$\frac{kW \times 1000}{E}$
Amperes when KVA is known	$\frac{KVA \times 1000}{E}$	$\frac{KVA \times 1000}{1.73 \times E}$	
E=Volts	I = Amperes	% Eff = Per cent efficiency	PF = Power factor

Amperage = $\frac{\text{Wattage (W)}}{\text{Voltage (V)}}$	Amperage (AMP) x Resistance (Ω) = Voltage

Average efficiency and power factor values of motors:
When the actual efficiencies and power factors of the motors to be controlled are not known, the following approximations may be used.

Efficiencies:
- DC motors, 35 horsepower and less .....80% to 85%
- DC motors, above 35 horsepower .....85% to 90%
- Synchronous motors (at 100% Power factor) .....92% to 95%

"Apparent" efficiencies (= Efficiency x Power factor):
- Three phase induction motors, 25 horsepower and less 70%
- Three phase induction motors, above 25 horsepower 80%
- These figures may be decreased slightly for single phase induction motors.

Approximate Motor Full-Load Current Rating

Ampères

Three Phase Induction motors
60 cycles
Full load current

HP	RPM	230V	460V	575V
1/4	1800	.96	.48	.38
1/3	1800	1.16	.58	.47
1/2	1800	1.68	.84	.67
3/4	1800	2.33	1.17	.93
1	3600	2.75	1.38	1.10
	1800	3.05	1.53	1.22
1-1/2	3600	4.17	2.09	1.67
	1800	4.28	2.14	1.71
2	3600	5.56	2.78	2.22
	1800	5.76	2.88	2.30
3	3600	7.87	3.94	3.14
	1800	8.29	4.14	3.32
5	3600	12.7	6.34	5.08
	1800	13.2	6.60	5.28
7-1/2	3600	19.2	9.6	7.68
	1800	19.3	9.7	7.72
10	3600	24.5	12.3	9.8
	1800	25.2	12.6	10.1
15	3600	36.7	18.4	14.7
	1800	50.5	25.3	20.2
25	3600	59.2	29.6	23.6
	1800	62.7	31.3	25.0
30	1800	72.8	36.4	29.2
	1200	77.1	38.6	30.8
40	1800	98	49.0	39.2
	1200	99	49.5	39.6
50	1800	121	60.5	48.4
	1200	122	61.0	48.8
60	1800	143	71.5	57.2
	1200	148	74.0	59.2
75	1800	178	89.0	71.2
	1200	181	90.5	72.4
100	1800	233	116	93.2
	1200	239	120	95.6
125	1800	289	144	115
	1200	298	149	119
150	1800	346	173	138
	1200	350	175	140
200	1800	460	230	184
	1200	466	233	186
250	1800	572	286	229
	1200	580	290	232
300	1800	685	343	274
	1200	696	348	278

Single phase induction motors
60 cycles
Full load current

HP	RPM	115V	230V
1/8	3600	2.52	1.26
	1800	2.80	1.40
1/6	3600	2.88	1.44
	1800	3.20	1.60
1/4	3600	4.00	2.00
	1800	4.60	2.30
1/3	3600	4.70	2.35
	1800	5.20	2.60
1/2	3600	6.50	3.25
	1800	7.40	3.70
3/4	3600	9.05	4.52
	1800	10.20	5.10
1	3600	11.70	5.85
	1800	13.00	6.50
1-1/2	3600	17.80	8.90
	1800	18.40	9.20
2	3600	23.00	11.50
	1800	24.00	12.00
3	3600	32.30	16.15
	1800	34.00	17.00
5	3600	54.00	27.00
	1800	56.00	28.00
7-1/2	3600	79.20	39.60
	1800	80.00	40.00
10	3600	97.50	48.75
	1800	100.00	50.00

Variations of Ohm's Law

Volts

$$\text{Volts} = \sqrt{\text{Watts} \times \text{Ohms}}$$

$$\text{Volts} = \frac{\text{Watts}}{\text{Amperes}}$$

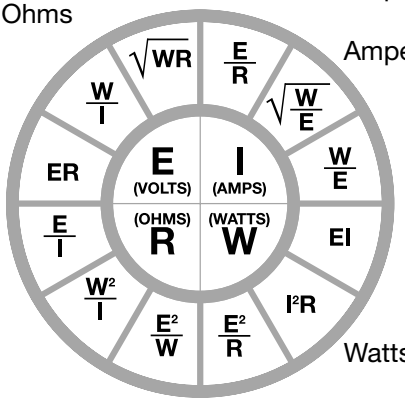
$$\text{Volts} = \text{Amperes} \times \text{Ohms}$$

Amperes

$$\text{Amperes} = \frac{\text{Volts}}{\text{Ohms}}$$

$$\text{Amperes} = \frac{\text{Watts}}{\text{Volts}}$$

$$\text{Amperes} = \sqrt{\frac{\text{Watts}}{\text{Ohms}}}$$



Ohms

$$\text{Ohms} = \frac{\text{Volts}}{\text{Amperes}}$$

$$\text{Ohms} = \frac{\text{Volts}}{\text{Watts}}$$

$$\text{Ohms} = \frac{\text{Volts}}{\text{Amperes}^2}$$

Watts

$$\text{Watts} = \frac{\text{Volts}^2}{\text{Ohms}}$$

$$\text{Watts} = \text{Amperes}^2 \times \text{Ohms}$$

$$\text{Watts} = \text{Volts} \times \text{Amperes}$$

Wattage varies directly as ratio of voltages squared

$$W_2 = W_1 \times \left(\frac{E^2}{E^1}\right)$$

$$\text{3 Phase Amperes} = \frac{\text{Total Watts}}{\text{Volts} \times 1.732}$$

Useful Physical Constants

ACCELERATION OF GRAVITY (STANDARD)
$G = 32.17$ ft./sec^2 = 980.6 cm./sec^2

VELOCITY OF SOUND IN DRY AIR @ 0°C AND 1 atm
33,136 cm./sec = 1,089 ft./sec

HEAT OF VAPORIZATION OF WATER @ 1.0 atm
540 cal./g = 970 Btu/lb.

DENSITY OF DRY AIR @ 0°C AND 760 mm Hg
0.001293 g/cm^3

Useful Motor Formulas

Nominal Input Power
The nominal power of an electric motor is that given to the shaft at nominal voltage and frequency in continuous duty (S1[2]). The unit of power is kW or HP and they are related as follows:

1 HP = 0.736 kW (at 50Hz)
1 HP = 0.746 kW (at 60Hz)

Continuous Duty S1
Constant load running with life at least sufficient to reach the thermic equilibrium. Running with a continuous overload is not scheduled in the specifications. With correct voltage and frequency an overload capacity of 106% (min.) of the nominal torque for 2 minutes is permitted. If the overload is higher then the time must be reduced proportionally.

Voltage and Supply Frequency
CEI 2-3 and IEC 34-1 specifications allow a nominal voltage change of ±5% and a max. temperature rise of 10°C higher than the permissible values of the different insulation classes.

The motors wound at 50 Hz for a certain voltage, can be used without modifications at 60 Hz but the characteristics will change according to the table below.

Example:

	Tensione *Tension*	Potenza *Power*	Potenza *Power*	Corrente *Current*	Ca/Cn	Velocitá *Speed*
Dati a 50 Hz *Data at*	380 V	11 kW	15 HP	23 A	2	1450
Fattore di Conversione *Conversion ratio*	–	1.15	1.15	1.0	0.95	1.20
Dati a 60 Hz *Data at*	440 V	12.6 kW	17.3 HP	23 A	1.9	1740

Note: A motor wound for use at 60 Hz cannot be used at 50 Hz. The current increase can damage the motor and become a fire hazard.

Useful Motor Formulas (at 60 Hz)

Kgm = (Pound Feet) Lbf • ft x 0.1383

(Pound Feet) Lbf • ft = $\frac{\text{Kgm}}{0.1383}$

Kgm - (Pound Inches) Lbf • in = $\frac{\text{Kgm}}{0.011525}$

$HP_1 = \frac{M_1 \text{ (Kgm) x n}}{726.4 \times \eta}$

$HP_2 = \frac{M_2 \text{ (daNm) x } n_2}{712.6 \times \eta}$

$HP = \frac{kW}{0.746}$

kW = HP x 0.746

Speed In The Rotary Motion

$V = \pi \times d \times n$

V = speed m/min
d = diameter in m
n = RPM

Torque

$M = F \times r$

$M = \frac{955 \times P}{n}$

M = torque in daNm
r = lever arm
P = power in kW
n = RPM
F = force in daN

Power

Lifting

$P = \frac{m \times g \times V}{\eta \times 1000}$

P = power (kW)
Fr = frictional resistance (daN)
m = Mass (Kg.)
V = speed (m/sec)
η = efficiency
μ = friction coefficient
M = torque in daNm
n = RPM
g = 9.81

Translation

$P = Fr \times V$

$Fr = \mu \times m \times g$

Rotation

$P = \frac{M \times n}{955}$

Absorbed current Pr in kW

$In = \frac{Pr \bullet 1000}{\sqrt{3} \bullet V \bullet \cos\psi \bullet \eta}$ [A]

Absorbed current Pr in HP

$In = \frac{Pr \bullet 746}{\sqrt{3} \bullet V \bullet \cos\psi \bullet \eta}$ [A]

Nominal torque Pr in kW

$Cn = \frac{Pr \bullet 1000}{1.027 \bullet n}$ [kgm]

Nominal torque Pr in HP

$Cn = \frac{Pr \bullet 746}{1.027 \bullet n}$ [kgm]

Synchronous speed $n_1 = \frac{7200}{\text{nr. poles}}$