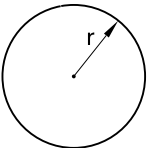
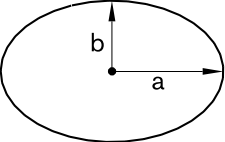
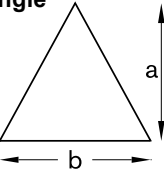
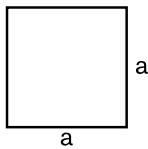
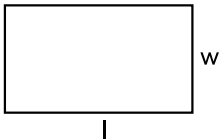
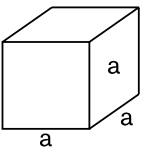
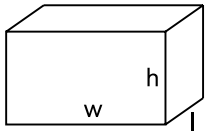
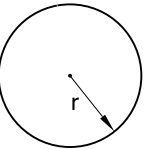
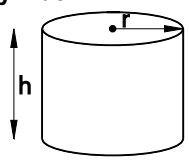
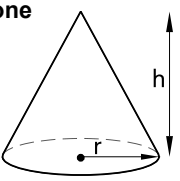


GENERAL ENGINEERING INFORMATION

General Power Transmission Formulas

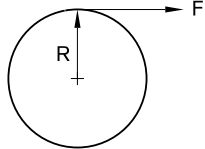
The following information helps to solve technical problems frequently encountered in the selection of power transmission components.

AREAS OF PLANE FIGURES	
FIGURE	AREA
Circle 	πr^2 circumference = $2\pi r$
Ellipse 	πab
Triangle 	$\frac{1}{2}ab$
Square 	a^2
Rectangle 	lw

VOLUMES AND SURFACE AREAS OF SOLIDS		
SOLID	SURFACE AREA	VOLUME
Cube 	$6a^2$	a^3
Rectangular Prism 	$2hw + 2hl + 2lw$	$l \times w \times h$
Sphere 	$4\pi r^2$	$\frac{4\pi r^3}{3}$
Cylinder 	$2\pi rh + 2\pi r^2$	$\pi r^2 h$
Cone 	$\pi r \sqrt{r^2 + h^2}$ (+ πr^2 if you add the base)	$\frac{\pi r^2 h}{3}$

GENERAL ENGINEERING INFORMATION

General Power Transmission Formulas

WEIGHT	
FORMULA	VARIABLES
WEIGHT (W) = V x ρ (lbs)	V = Volume (cubic inches) ρ = Material density (lbs per cubic inches)
TORQUE	
TORQUE (T) = F x R (lb-in) <div style="text-align: center; margin-top: 10px;">  </div>	F = Force (lbs) R = Perpendicular distance from the center of rotation to the force (in)
HORSEPOWER (HP)	
• Rotating Objects $HP = \frac{T \times RPM}{63,025}$	T = Torque in inch-pounds (lb-in) RPM = Shaft speed revolutions per minute (rpm)
• Objects in Linear Motion $HP = \frac{F \times V}{33,000}$	F = Force in pounds (lbs) V = Velocity in feet per minute (fpm)
• Hydraulic $HP = \frac{GPM \times PSI}{1,714}$	GPM = Flow rate in gallons per minute (gal/min) PSI = Pressure in pounds per square inch (lb/in ²)

LINEAR TO ROTARY MOTION	
FORMULA	VARIABLES
$N = \frac{V}{0.262D}$	N = Speed of shaft rotation (rpm) V = Velocity of material (fpm) D = Diameter of pulley or sprocket (in)
ACCELERATION / DECELERATION OF TORQUE AND FORCE	
• Rotating Objects $T = \frac{WK^2 \Delta N}{308t}$	T = Torque required (lb-ft) WK ² = Total inertia of load to be accelerated (lb-ft ²) ΔN = Change in speed (rpm) t = Time to accelerate load
• Objects in Linear Motion $F = \frac{W \Delta V}{1,933t}$	F = Force required (lbs) W = Weight (lbs) ΔV = Change in velocity (fpm) t = Time to accelerate load

TEMPERATURE		
TO CONVERT FROM	TO	USE FORMULA
temperature Celsius, t _C	temperature Kelvin, t _K	t _K = t _C + 273.15
temperature Fahrenheit, t _F	temperature Kelvin, t _K	t _K = (t _F + 459.67) / 1.8
temperature Celsius, t _C	temperature Fahrenheit, t _F	t _F = 1.8 t _C + 32
temperature Fahrenheit, t _F	temperature Celsius, t _C	t _C = (t _F - 32) / 1.8
temperature Kelvin, t _K	temperature Celsius, t _C	t _C = t _K - 273.15
temperature Kelvin, t _K	temperature Fahrenheit, t _F	t _F = 1.8 t _K - 459.67
temperature Kelvin, t _K	temperature Rankine, t _R	t _R = 9/5 t _K
temperature Rankine, t _R	temperature Kelvin, t _K	t _K = 5/9 t _R

GENERAL ENGINEERING INFORMATION

Metric Conversion Factors

LENGTH

MULTIPLY:	BY	TO OBTAIN:
centimeters	0.0328084	feet
centimeters	0.3937008	inches
feet	0.3048*	meters
feet	30.48*	centimeters
feet	304.8*	millimeters
inches	0.0254*	meters
inches	2.54*	centimeters
inches	25.4*	millimeters
kilometers	0.6213712	miles (U.S.)
meters	39.37008	inches
meters	3.280840	feet
meters	1.093613	yards
meters	0.00062137	miles (U.S.)
miles (U.S.)	1609.344*	meters
miles (U.S.)	1.609344*	kilometers
millimeters	0.003280840	feet
millimeters	0.03937008	inches
yards	0.9144*	meters

* Where an asterisk is shown, the figure is exact.

AREA

MULTIPLY:	BY	TO OBTAIN:
square centimeters	0.1550003	square inches
square centimeters	0.001076391	square feet
square feet	0.09290304*	square meters
square feet	929.0304	square centimeters
square feet	92,903.04*	square millimeters
square inches	645.16*	square millimeters
square inches	6.4516*	square centimeters
square inches	0.00064516*	square meters
square meters	1550.003	square inches
square meters	10.763910	square feet
square meters	1.195990	square yards
square millimeters	0.00001076391	square feet
square millimeters	0.001550003	square inches

* Where an asterisk is shown, the figure is exact.

VOLUME

MULTIPLY:	BY	TO OBTAIN:
cubic centimeters	0.06102376	cubic inches
cubic feet	0.02831685	cubic meters
cubic feet	28.31685	liters
gallons (U.K.)	0.004546092	cubic meters
gallons (U.K.)	4.546092	liters
gallons (U.S.)	0.003785412	cubic meters
gallons (U.S.)	3.785412	liters
cubic inches	16.38706	cubic millimeters
cubic inches	16.38706	cubic centimeters
cubic inches	0.000016387	cubic meters
liters	0.001*	cubic meters
liters	0.2199692	gallons(U.K.)
liters	0.2641720	gallons (U.S.)
liters	0.03531466	cubic feet
cubic meters	219.9692	gallons (U.K.)
cubic meters	264.172	gallons (U.S.)
cubic meters	35.31466	cubic feet
cubic meters	1000.*	liters
cubic meters	61,023.76	cubic inches
cubic millimeters	0.00006102	cubic inches

* Where an asterisk is shown, the figure is exact.

VELOCITY, ACCELERATION, AND FLOW

MULTIPLY:	BY	TO OBTAIN:
centimeters/second	1.968504	feet/minute
centimeters/second	0.03280840	feet/second
centimeters/minute	0.3937008	inches/minute
feet/hour	0.00008467	meters/second
feet/hour	0.00508*	meters/minute
feet/hour	0.3048	meters/hour
feet/minute	0.508*	centimeters/second
feet/minute	18.288*	meters/hour
feet/minute	0.3048*	meters/minute
feet/minute	0.00508*	meters/second
feet/second	30.48*	centimeters/second
feet/second	18.288*	meters/minute
feet/second	0.3048*	meters/second
feet/second squared	0.3048*	meters/second squared
cubic feet/minute	28.31685	cubic liters/minute
cubic feet/minute	0.000471947	cubic meters/second
gallons (U.S.)/min.	0.003785412	cubic meters/minute
gallons (U.S.)/min.	0.00006309000	cubic meters/second
gallons (U.S.)/min.	0.06309020	liters/second
gallons (U.S.)/min.	3.785412	liters/minute
gallons (U.K.)/min.	0.004546092	cubic meters/minute
gallons (U.K.)/min.	0.000075768	cubic meters/second
inches/minute	25.4*	millimeters/minute
inches/minute	2.54*	centimeters/ minute
inches/minute	0.0254*	meters/minute
inches/second squared	0.0254*	meters/second squared
kilometer/hour	0.6213712	miles/hour (U.S.)
liters/minute	0.03531466	cubic feet/minute
liters/minute	0.2641720	gallons (U.S.)/minute
liters/second	15.85032	gallons (U.S.)/minute
miles/hour	1.609344*	kilometers/hour
millimeters/minute	0.03937008	inches/minute
meters/second	11.811.02	feet/hour
meters/second	196.8504	feet/minute
meters/second	3.28084	feet/second
meter/second squared	3.280840	feet/second squared
meter/second squared	39.37008	inches/second squared
meters/minute	3.280840	feet/minute
meters/minute	0.05468067	feet/second
meters/minute	39.37008	inches/minute
meters/hour	3.280840	feet/hour
meters/hour	0.5468067	feet/minute
cubic meters/second	2118.880	cubic feet/minute
cubic meters/second	13,198.15	gallons (U.K.)/minute
cubic meters/second	15,850.32	gallons (U.S.)/minute
cubic meters/minute	219.9692	gallons (U.K.)/minute
cubic meters/minute	264.1720	gallons (U.S.)/minute

* Where an asterisk is shown, the figure is exact.

GENERAL ENGINEERING INFORMATION

Metric Conversion Factors (CONTINUED)

MASS AND DENSITY

MULTIPLY:	BY	TO OBTAIN:
grams	15.43236	grains
grams	0.001*	kilograms
grams/cubic centimeter	0.03612730	pounds/cubic inch
kilograms	1000*	grams
kilograms	35.27397	ounces
kilograms	32.15074	ounces (troy)
kilograms	2.204622	pounds
kilograms	0.06852178	slugs
kilograms	0.0009842	tons (long)
kilograms	0.0011023	tons (short)
kilograms	0.001*	tons (metric)
kilograms/cubic meter	0.06242797	pounds/cubic foot
kilograms/cubic meter	0.01002242	pounds/gallon (U.K.)
kilograms/cubic meter	0.008345406	pounds/gallon (U.S.)
ounces	28.34952	grams
ounces	0.02834952	kilograms
pounds	0.4535924	kilograms
pounds/cubic foot	16.01846	kilograms/cubic meter
pounds/cubic inch	27.67990	grams/cubic centimeter
pounds/gallon (U.S.)	119.8264	kilograms/cubic meter
pounds/gallon (U.K.)	99.77633	kilograms/cubic meter
slug	14.59390	kilograms
tons (long 2240 lbs)	1016.047	kilograms
tons (short 2000 lbs)	907.1847	kilograms
tons (metric)	1000.*	kilograms

* Where an asterisk is shown, the figure is exact.

FORCE AND FORCE/LENGTH

MULTIPLY:	BY	TO OBTAIN:
kilograms-force	9.806650*	newtons
newtons	0.1019716	kilograms-force
newtons	0.2248089	pounds-force
newtons/meter	0.00571015	pounds/inch
newtons/meter	0.06852178	pounds/foot
pounds-force	4.448222	newtons
pounds/inch	175.1268	newtons/meter
pounds/foot	14.59390	newtons/meter

* Where an asterisk is shown, the figure is exact.

BENDING MOMENT OR TORQUE

MULTIPLY:	BY	TO OBTAIN:
kilograms-meters	9.806650*	newton-meters
ounce-inches	7.061552	newton-millimeters
ounce-inches	0.00706155	newton-meters
newton-meters	0.7375621	pound-feet
newton-meters	0.1019716	kilogram-meters
newton-meters	141.6119	ounce-inches
newton-millimeters	0.1416119	ounce-inches
pound-feet	1.355818	newton-meters

* Where an asterisk is shown, the figure is exact.

MOMENT OF INERTIA

MULTIPLY:	BY	TO OBTAIN:
kilogram-meters squared	23.73036	pound-feet squared
kilogram-meters squared	3417.171	pound-inches squared
pound-feet squared	0.04214011	kilogram-meters squared
pound-inches squared	0.00029264	kilogram-meters squared

MOMENTUM

MULTIPLY:	BY	TO OBTAIN:
kilogram-meters/second	7.233011	pound-feet/second
kilogram-meters/second	86.79614	pound-inches/second
pound-feet/second	0.1382550	kilogram-meters/second
pound-inches/second	0.01152125	kilogram-meters/second

PRESSURE AND STRESS

MULTIPLY:	BY	TO OBTAIN:
bars	14.50377	pounds/square inch
kilograms/square centimeter	14.22334	pounds/square inch
kilograms/square meter	9.806650*	newtons/square meter
kilograms/square meter	0.2048161	pounds/square foot
newtons/square centimeter	1.450377	pounds/square inch
newtons/square meter	0.00014504	pounds/square inch
newtons/square meter	0.1019716	kilograms/square meter
pounds/cubic foot	4.882429	kilograms/square meter
pounds/cubic inch	0.07030697	kilograms/square centimeter
pounds/cubic inch	0.6894757	newtons/square centimeter
pounds/cubic inch	6.894757	kilonewtons/square meter
pounds/cubic inch	6894.757	newtons/square meter
pounds/cubic inch	0.00689476	newtons/square millimeter

* Where an asterisk is shown, the figure is exact.

ENERGY AND WORK

MULTIPLY:	BY	TO OBTAIN:
Btu (mean)	1055.87	joule
calorie (mean)	4.19002	joule
foot-pound	1.355818	joule
joule	0.0009471	Btu (mean)
joule	0.2386623	calorie (mean)
joule	0.7375621	foot-pound
joule	0.999818	joule (International U.S.)
joule	0.999983	joule (U.S. legal, 1948)
joule (International U.S.)	1.000182	joule
joule (U.S. legal, 1948)	1.000017	joule
joule	0.00027778	watt-hour
watt-hour	3600.*	joule

* Where an asterisk is shown, the figure is exact.

POWER

MULTIPLY:	BY	TO OBTAIN:
Btu (International Table)/hour	0.2930711	watt
foot-pound/hour	0.000376616	watt
foot-pound/minute	0.02259697	watt
horsepower (550 ft-lb/s)	0.7456999	kilowatt
horsepower (550 ft-lb/s)	745.6999	watt
horsepower (electric)	746*	watt
horsepower (metric)	735.499	watt
horsepower (U.K.)	745.7	watt
kilowatt	1.341022	horsepower (550 ft-lb/s)
watt	2655.224	foot-pound/hour
watt	44.25372	foot-pound/minute
watt	0.001341022	horsepower (550 ft-lb/s)
watt	0.001340483	horsepower (electric)
watt	0.001359621	horsepower (metric)
watt	0.001341022	horsepower (U.K.)
watt	3.412141	Btu (International Table)/hour

* Where an asterisk is shown, the figure is exact.

VISCOSITY

MULTIPLY:	BY	TO OBTAIN:
centipoise	0.001*	pascal-second
centistoke	0.000001*	meters squared/second
meters squared/second	1,000,000	centistoke
meters squared/second	10,000.*	stoke
pascal-second	1000.*	centipoise
pascal-second	10.*	poise
poise	0.1*	pascal-second
stoke	0.0001	meters squared/second

* Where an asterisk is shown, the figure is exact.

GENERAL ENGINEERING INFORMATION

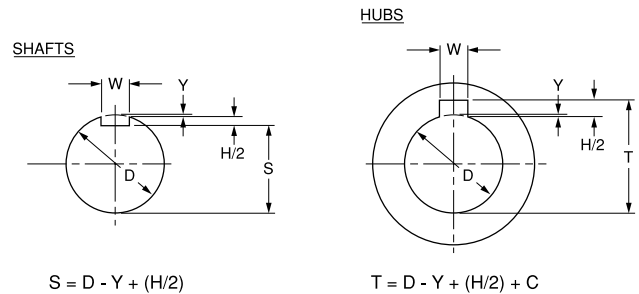
STANDARD KEY AND SETSCREW SIZES

KEYSEATS AND KEYS Drawings and formulas at right illustrate how the depth and width of standard keyseats in shafts and hubs are determined. Refer below to explanation of symbols.

SYMBOLS:

- C = Allowance or clearance for key (normally 0.005" for parallel keys).
- D = Nominal shaft or bore diameter (in)
- H = Nominal key height (in)
- W = Nominal key width (in)
- Y = Chordal height (in)

$$Y = \frac{D - \sqrt{D^2 - W^2}}{2}$$



Shaft Diameters		Key W x H	Set Screw	Shaft Diameters		Key W x H	Set Screw	Shaft Diameters		Key W x H	Set Screw	Shaft Diameters		Key W x H
Over	Thru			Over	Thru			Over	Thru			Over	Thru	
7/16	9/16	1/8 x 1/8	#10	1 3/4	2 1/4	1/2 x 1/2	1/2	4 1/2	5 1/2	1 1/4 x 1 1/4	7/8	11	13	3 x 2
9/16	7/8	3/16 x 3/16	1/4	2 1/4	2 3/4	5/8 x 5/8	1/2	5 1/2	6 1/2	1 1/2 x 1 1/2	1	13	15	3 1/2 x 2 1/2
7/8	1 1/4	1/4 x 1/4	5/16	2 3/4	3 1/4	3/4 x 3/4	5/8	6 1/2	7 1/2	1 3/4 x 1 1/2	N-	15	18	4 x 3
1 1/4	1 3/8	5/16 x 5/16	3/8	3 1/4	3 3/4	7/8 x 7/8	3/4	7 1/2	9	2 x 1 1/2	N-	18	22	5 x 3 1/2
1 3/8	1 3/4	3/8 x 3/8	3/8	3 3/4	4 1/2	1 x 1	3/4	9	11	2 1/2 x 1 3/4	N-	22	26	6 x 4

DIAMETERS AND AREAS OF UNIFIED SCREW THREADS UNC & UNF

Size Designation	Nominal Major Diameter (in)	Coarse Series — UNC			Fine Series — UNF		
		Threads per inch (N)	Tensile Stress Area (in ²)	Area of Minor Dia. (in ²)	Threads per inch (N)	Tensile Stress Area (in ²)	Area of Minor Dia. (in ²)
0	0.0600				80	0.00180	0.00151
1	0.0730	64	0.00263	0.00218	72	0.00278	0.00237
2	0.0860	56	0.00370	0.00310	64	0.00394	0.00339
3	0.0990	48	0.00487	0.00406	56	0.00523	0.00451
4	0.1120	40	0.00604	0.00496	48	0.00661	0.00566
5	0.1250	40	0.00796	0.00672	44	0.00830	0.00716
6	0.1380	32	0.00909	0.00745	40	0.01015	0.00874
8	0.1640	32	0.0140	0.01196	36	0.01474	0.01285
10	0.1900	24	0.0175	0.01450	32	0.0200	0.0175
12	0.2160	24	0.0242	0.0206	28	0.0258	0.0226
1/4	0.2500	20	0.0318	0.0269	28	0.0364	0.0326
5/16	0.3125	18	0.0524	0.0454	24	0.0580	0.0524
3/8	0.3750	16	0.0775	0.0678	24	0.0878	0.0809
7/16	0.4375	14	0.1063	0.0933	20	0.1187	0.1090
1/2	0.5000	13	0.1419	0.1257	20	0.1599	0.1486
9/16	0.5625	12	0.182	0.162	18	0.203	0.189
5/8	0.6250	11	0.226	0.202	18	0.256	0.240
3/4	0.7500	10	0.334	0.302	16	0.373	0.351
7/8	0.8750	9	0.462	0.419	14	0.509	0.480
1	1.0000	8	0.606	0.551	12	0.663	0.625
1 1/4	1.2500	7	0.969	0.890	12	1.073	1.024
1 1/2	1.5000	6	1.405	1.294	12	1.581	1.521

BOLT TORQUES

TORQUE REQUIREMENTS FOR DRY BLACK FASTENERS		
SAE	GENERAL PURPOSE GRADE 2	HIGH STRENGTH GRADE 5
DIA.	TORQUE (ft. lbs.)	TORQUE (ft. lbs.)
1/4	6	9
5/16	12	18
3/8	21	33
7/16	34	53
1/2	52	80
9/16	75	116
5/8	104	160
3/4	184	285
7/8	178	460
1	265	690
1 1/8	380	850
1 1/4	530	1200
1 3/8	700	1570
1 1/2	930	2080

- The torques shown produce a clamp load of 80% of proof load. They assume clean, dry threads with a torque coefficient of 0.2.
- Plated threads need only 3/4 torque shown.
- Well lubricated threads need only 1/2 torque shown.

ALL PLANETGEAR SPEED REDUCERS USE GRADE 5 FASTENERS.

GENERAL ENGINEERING INFORMATION

Motor Operating Parameters and Formulas

NEMA STANDARDS Electric motors are required to meet certain industrial safety and manufacturing standards. The accepted authority in the U.S.A. is the National Electrical Manufacturers Association — an organization that sets voluntary standards for acceptable practice for the motor industry. For example, they specify standard frame sizes, ratings, torque, and horsepower classifications — as well as dimensions, performance, testing, etc.

MOTOR ELECTRICAL FORMULAS

TO FIND	Alternating Current		TO FIND	ALTERNATING OR DIRECT CURRENT
	Single-Phase	Three-Phase		
Amperes when Horsepower is known	$\frac{HP \times 746}{E \times \text{Eff} \times \text{pf}}$	$\frac{HP \times 746}{1.73 \times E \times \text{Eff} \times \text{pf}}$	Amperes when voltage and resistance are known:	E / R
Amperes when kilowatts are known	$\frac{KW \times 1,000}{E \times \text{pf}}$	$\frac{KW \times 1,000}{1.73 \times E \times \text{pf}}$	Voltage when resistance and current are known:	IR
Amperes when Kva are known	$\frac{Kva \times 1,000}{E}$	$\frac{Kva \times 1,000}{1.73 \times E}$	Resistance when voltage and current are known:	E / I
Kilowatts	$\frac{I \times E \times \text{pf}}{1,000}$	$\frac{1.73 \times I \times E \times \text{pf}}{1,000}$	I = Amperes E = Volts Eff = Efficiency pf = Power Factor KW = Kilowatts R = Ohms Kva = Kilovolt Amperes General Information (Approximation) All Voltages at 100% Load At 1,800 rpm, a motor develops a 36 lb-in per HP At 1,200 rpm, a motor develops a 54 lb-in per HP At 575 volts, a three-phase motor draws 1 amp per HP At 460 volts, a three-phase motor draws 1.25 amp per HP At 230 volts, a three-phase motor draws 2.5 amp per HP At 230 volts, a single-phase motor draws 5 amp per HP At 115 volts, a single-phase motor draws 10 amp per HP	
Kva	$\frac{I \times E}{1,000}$	$\frac{1.73 \times I \times E}{1,000}$		
Horsepower = (Output)	$\frac{I \times E \times \text{Eff} \times \text{pf}}{746}$	$\frac{1.73 \times I \times E \times \text{Eff} \times \text{pf}}{746}$		
For variable descriptions, see chart at right.				

MOTOR AMPS AT FULL LOAD

HP	Alternating Current		DC	HP	Alternating Current		DC	HP	Alternating Current		DC	HP	Alternating Current		DC
	Single Phase	Three Phase			Single Phase	Three Phase			Single Phase	Three Phase			Single Phase	Three Phase	
1/2	4.9	2.0	2.7	5	28	14.4	20	25	—	60	92	75	—	180	268
1	8.0	3.4	4.8	7 1/2	40	21.0	29	30	—	75	110	100	—	240	355
1 1/2	10.0	4.8	6.6	10	50	26.0	38	40	—	100	146	125	—	300	443
2	12.0	6.2	8.5	15	—	38.0	56	50	—	120	180	150	—	360	534
3	17.0	8.6	12.5	20	—	50.0	74	60	—	150	215	200	—	480	712
Values are for all speeds and frequencies at 230 volts. Amperage for other than 230 volts can be calculated as follows: $I = \frac{230 \times \text{Amps from Table}}{\text{New Voltage}}$								Example: For 40 HP, three-phase at 550 volts $I = \frac{230 \times 100}{550} = 42 \text{ amps}$ Power Factor estimated at 80% for most motors. Efficiency is usually 80-90%.							

OBSOLETE MOTOR SHAFT DIMENSIONS

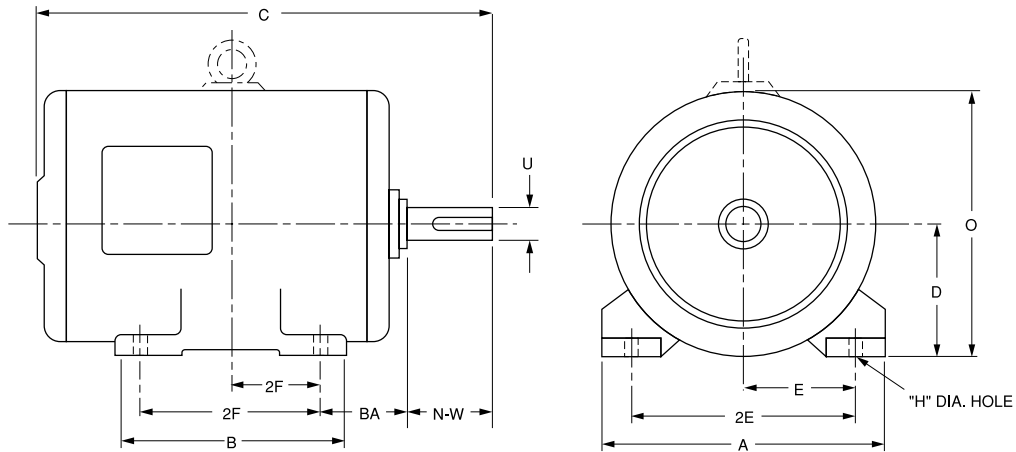
Motor ratings and dimensions shown in the table below are the obsolete or 1953 NEMA "U" frame standards. These were replaced by the 1963 re-rating program which established the present "T" frames. In effect, a larger motor shaft and hp rating is obtained compared to the corresponding "U" frame sizes.

U-FRAME NEMA ASSIGNMENTS AND DIMENSIONS

Horsepower Ratings		U-Frame No.	U	Shaft Keyseat		Key Length	N-W	Horsepower Ratings		U-Frame No.	U	Shaft Keyseat		Key Length	N-W
1800	1200			Width	Depth			1800	1200			Width	Depth		
1	3/4	182	7/8	3/16	3/32	1 3/8	2 1/4	40	25	364U	2 1/8	1/2	1/4	5	6 3/8
1 1/2 & 2	1 & 1 1/2	184	7/8	3/16	3/32	1 3/8	2 1/4	—	—	364US	1 7/8	1/2	1/4	2	3 3/4
3	2	213	1 1/8	1/4	1/8	2	3	50	30	365U	2 1/8	1/2	1/4	5	6 3/8
5	3	215	1 1/8	1/4	1/8	2	3	—	—	365US	1 7/8	1/2	1/4	2	3 3/4
7 1/2	5	254U	1 3/8	1/4	1/8	2 3/4	3 3/4	60	40	404U	2 3/8	5/8	1/4	5 1/2	7 1/8
10	7 1/2	256U	1 3/8	1/4	1/8	2 3/4	3 3/4	—	—	404US	2 1/8	1/2	1/4	2 3/4	4 1/4
15	10	284U	1 5/8	3/8	3/16	3 3/4	4 7/8	75	50	405U	2 3/8	5/8	1/4	5 1/2	7 1/8
20	—	286U	1 5/8	3/8	3/16	3 3/4	4 7/8	—	—	405US	2 1/8	1/2	1/4	2 3/4	4 1/4
25	15	324U	1 7/8	1/2	1/4	4 1/4	5 5/8	100	60	444U	2 7/8	3/4	3/8	7	8 5/8
—	—	324S	1 5/8	3/8	3/16	1 7/8	3 1/4	—	—	444US	2 1/8	1/2	1/4	2 3/4	4 1/4
30	20	326U	1 7/8	1/2	1/4	4 1/4	5 5/8	125	75	445U	2 7/8	3/4	3/8	7	8 5/8
—	—	326S	1 5/8	3/8	3/16	1 7/8	3 1/4	—	—	445US	2 1/8	1/2	1/4	2 1/4	4 1/4

GENERAL ENGINEERING INFORMATION

NEMA Electric T-Frame & TS-Frame Motor Dimensions



T-FRAME & TS-FRAME NEMA ASSIGNMENTS AND DIMENSIONS

Horsepower Ratings				T-Frame No.	U	Shaft Keyseat		Key Length	N-W *	A Max.	B Max.	C ‡	D	E	F	H	BA	O ‡	
TEFC	Open	Open & TEFC				Width	Depth												
1800	1800	1200	900																
1	1	3/4	1/2	143T	0.875	0.19	0.09	1.38	2.25	7.00	6.00	12.63	3.50	2.75	2.00	0.34	2.25	7.00	
1 1/2 & 2	1 1/2 & 2	1	3/4	145T	0.875	0.19	0.09	1.38	2.25	7.00	6.00	12.63	3.50	2.75	2.50	0.34	2.25	7.00	
3	3	1 1/2	1	182T	1.125	0.25	0.13	1.75	2.75	9.00	6.50	12.75	4.50	3.75	2.25	0.41	2.75	9.00	
5	5	2	1 1/2	184T	1.125	0.25	0.13	1.75	2.75	9.00	7.50	13.75	4.50	3.75	2.75	0.41	2.75	9.00	
7 1/2	7 1/2	3	2	213T	1.375	0.31	0.16	2.38	3.38	10.50	7.50	15.81	5.25	4.25	2.75	0.41	3.50	10.50	
10	10	5	3	215T	1.375	0.31	0.16	2.38	3.38	10.50	9.00	17.31	5.25	4.25	3.50	0.41	3.50	10.50	
15	15	7 1/2	5	254T	1.625	0.38	0.19	2.88	4.00	12.50	10.75	20.50	6.25	5.00	4.13	0.53	4.25	12.50	
20	20	10	7 1/2	256T	1.625	0.38	0.19	2.88	4.00	12.50	12.50	22.25	6.25	5.00	5.00	0.53	4.25	12.50	
25	25	15	10	284T	1.875	0.50	0.25	3.25	4.63	14.00	12.50	23.31	7.00	5.50	4.75	0.53	4.75	14.00	
25	25	15	10	284TS	1.625	0.38	0.19	1.88	3.25	14.00	12.50	22.00	7.00	5.50	4.75	0.53	4.75	14.00	
30	30	20	15	286T	1.875	0.50	0.25	3.25	4.63	14.00	14.00	24.88	7.00	5.50	5.50	0.53	4.75	14.00	
30	30	20	15	286TS	1.625	0.38	0.19	1.88	3.25	14.00	14.00	23.50	7.00	5.50	5.50	0.53	4.75	14.00	
40	40	25	20	324T	2.125	0.50	0.25	3.88	5.25	16.00	14.00	26.50	8.00	6.25	5.25	0.66	5.25	16.00	
40	40	25	20	324TS	1.875	0.50	0.25	2.00	3.75	16.00	14.00	24.63	8.00	6.25	5.25	0.66	5.25	16.00	
50	50	30	25	326T	2.125	0.50	0.25	3.88	5.25	16.00	15.50	27.75	8.00	6.25	6.00	0.66	5.25	16.00	
50	50	30	25	326TS	1.875	0.50	0.25	2.00	3.75	16.00	15.50	26.13	8.00	6.25	6.00	0.66	5.25	16.00	
60	60	40	30	364T	2.375	0.63	0.31	4.25	5.88	18.00	15.25	28.75	9.00	7.00	5.63	0.66	5.88	18.00	
60	60	40	30	364TS	1.875	0.50	0.25	2.00	3.75	18.00	15.25	26.56	9.00	7.00	5.63	0.66	5.88	18.00	
75	75	50	40	365T	2.375	0.63	0.31	4.25	5.88	18.00	16.25	29.75	9.00	7.00	6.13	0.66	5.88	18.00	
75	75	50	40	365TS	1.875	0.50	0.25	2.00	3.75	18.00	16.25	27.56	9.00	7.00	6.13	0.66	5.88	18.00	
—	100	60	50	404T	2.875	0.75	0.38	5.63	7.25	20.00	16.25	32.63	10.00	8.00	6.13	0.81	6.63	20.00	
—	100	60	50	404TS	2.125	0.50	0.25	2.75	4.25	20.00	16.25	29.63	10.00	8.00	6.13	0.81	6.63	20.00	
100	125	75	60	405T	2.875	0.75	0.38	5.63	7.25	20.00	17.75	34.13	10.00	8.00	6.88	0.81	6.63	20.00	
100	125	75	60	405TS	2.125	0.50	0.25	2.75	4.25	20.00	17.75	31.13	10.00	8.00	6.88	0.81	6.63	20.00	
125	150	100	75	444T	3.375	0.88	0.44	6.88	8.50	22.00	18.50	37.88	11.00	9.00	7.25	0.81	7.50	22.00	
125	150	100	75	444TS	2.375	0.63	0.31	3.00	4.75	22.00	18.50	34.13	11.00	9.00	7.25	0.81	7.50	22.00	
150	200	125	100	445T	3.375	0.88	0.44	6.88	8.50	22.00	20.50	39.88	11.00	9.00	8.25	0.81	7.50	22.00	
150	200	125	100	445TS	2.375	0.63	0.31	3.00	4.75	22.00	20.50	36.13	11.00	9.00	8.25	0.81	7.50	22.00	
—	—	—	—	447T	3.375	0.88	0.44	6.88	8.50	22.00	23.00	43.25	11.00	9.00	10.00	0.81	7.50	22.00	
—	—	—	—	447TS	2.375	0.63	0.31	3.00	4.75	22.00	23.00	39.50	11.00	9.00	10.00	0.81	7.50	22.00	
—	—	—	—	449T	3.375	0.88	0.44	6.88	8.50	22.00	28.00	48.25	11.00	9.00	12.50	0.81	7.50	22.00	
—	—	—	—	449TS	2.375	0.63	0.31	3.00	4.75	22.00	28.00	44.50	11.00	9.00	12.50	0.81	7.50	22.00	

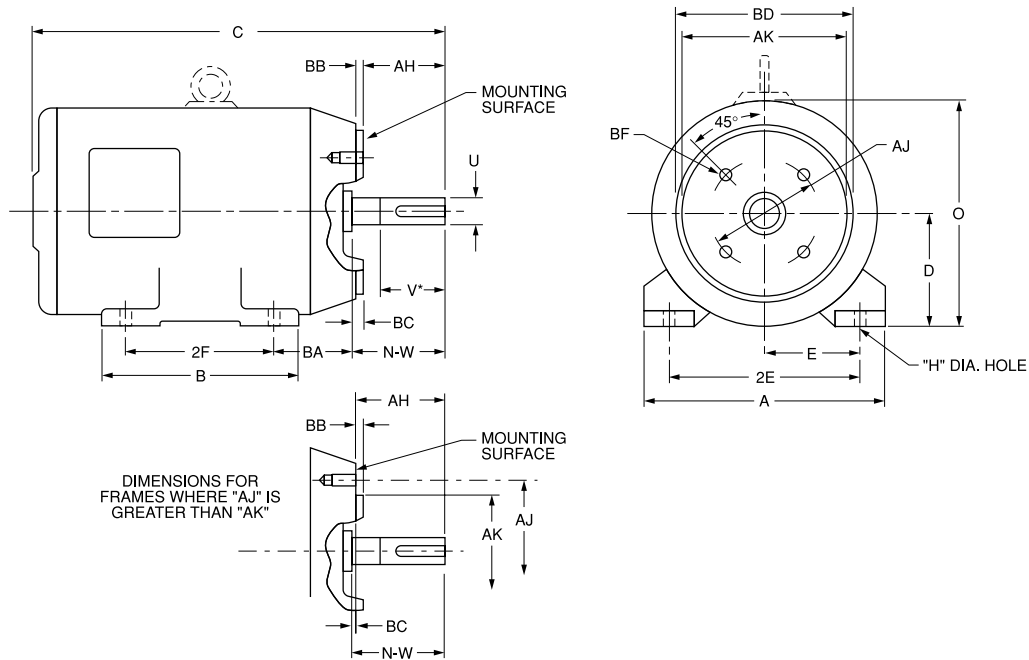
NOTE: Suffix "S" indicates short shaft for direct coupled service only. Motors of 25 hp and up listed as T-Frame may also be available in TS-Frames.

‡ These dimensions are not NEMA standard, but they are average and common to a number of manufactures for Open (Drip Proof) motors. TEFC motors will be up to 5 inches longer, and may be slightly taller (less than an inch difference).

* Usable length of shaft "V" is 1/4 inch shorter than "N-W".

GENERAL ENGINEERING INFORMATION

NEMA Electric TC-Frame Motor Dimensions



TC-FRAME NEMA ASSIGNMENTS AND DIMENSIONS†

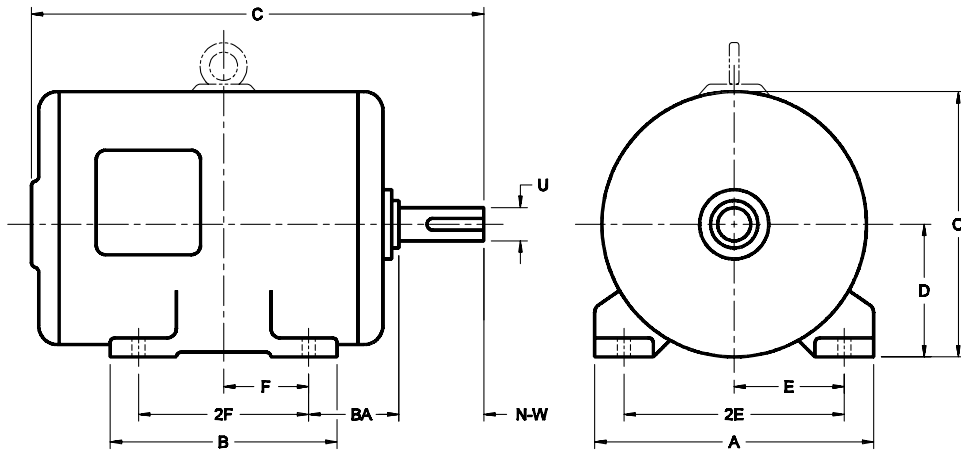
Frame No.	AJ	AK	BA	BB min.	BC	BD max.	BF (hole)			AH	U	Shaft Keyseat		
							Number of Holes	Tap Size	Bolt Penetration Allowance			Width	Depth	Key Length
56C	5.875	4.500	2.75	0.16	-0.19	6.50	4	3/8-16	N-	2.06	0.625	0.19	0.09	1.38
143TC and 145TC	5.875	4.500	2.75	0.16	0.12	6.50	4	3/8-16	0.56	2.12	0.875	0.19	0.09	1.38
182TC and 184TC	7.250	8.500	3.50	0.25	0.12	9.00	4	1/2-13	0.75	2.62	1.125	0.25	0.13	1.75
182TCH and 184TCH	5.875	4.500	3.50	0.16	0.12	6.50	4	3/8-16	0.56	2.62	1.125	0.25	0.13	1.75
213TC and 215TC	7.250	8.500	4.25	0.25	0.25	9.00	4	1/2-13	0.75	3.12	1.375	0.31	0.16	2.38
254TC and 256TC	7.250	8.500	4.75	0.25	0.25	10.00	4	1/2-13	0.75	3.75	1.625	0.38	0.19	2.88
284TC and 286TC	9.000	10.500	4.75	0.25	0.25	11.25	4	1/2-13	0.75	4.38	1.875	0.50	0.25	3.25
284TSC and 286TSC	9.000	10.500	4.75	0.25	0.25	11.25	4	1/2-13	0.75	3.00	1.625	0.38	0.19	1.88
324TC and 326TC	11.000	12.500	5.25	0.25	0.25	14.00	4	5/8-11	0.94	5.00	2.125	0.50	0.25	3.88
324TSC and 326TSC	11.000	12.500	5.25	0.25	0.25	14.00	4	5/8-11	0.94	3.50	1.875	0.50	0.25	2.00
364TC and 365TC	11.000	12.500	5.88	0.25	0.25	14.00	8	5/8-11	0.94	5.62	2.375	0.63	0.31	4.25
364TSC and 365TSC	11.000	12.500	5.88	0.25	0.25	14.00	8	5/8-11	0.94	3.50	1.875	0.50	0.25	2.00
404TC and 405TC	11.000	12.500	6.62	0.25	0.25	15.50	8	5/8-11	0.94	7.00	2.875	0.75	0.38	5.63
404TSC and 405TSC	11.000	12.500	6.62	0.25	0.25	15.50	8	5/8-11	0.94	4.00	2.125	0.50	0.25	2.75
444TC and 445TC	14.000	16.000	7.50	0.25	0.25	18.00	8	5/8-11	0.94	8.25	3.375	0.88	0.44	6.88
444TSC and 445TSC	14.000	16.000	7.50	0.25	0.25	18.00	8	5/8-11	0.94	4.50	2.375	0.63	0.31	3.00

* Usable length of shaft "V" is 1/4 inch shorter than "N-W".

† Refer to T-Frame chart (page 118) for dimensions not listed.

GENERAL ENGINEERING INFORMATION

IEC Electric Motor Dimensions



IEC STANDARDS Many countries have adopted IEC Standards, IEC stands for "The International Electrotechnical Commission". The object of the commission is to facilitate the coordination and unification of National Electrotechnical Standards.

IEC motors are in service worldwide. The standards have been incorporated into individual national standards. Outputs are in KW and dimensions are in millimeters. Table below shows the common IEC frame sizes of one motor manufacturer.

Mechanically, the major mounting dimensions of NEMA vs IEC are similar. Each standard has adopted units of dimensions predominant with the country used in.

IEC THREE-PHASE MOTORS WITH SQUIRREL CAGE ROTOR

KW Rating				IEC Frame No.*			N - W (mm)	E (mm)	F (mm)	BA (mm)
RPM				D (mm)	C	U (mm)				
3000	1500	1000	750							
0.75	—	.25, .37	—	80	—	19	40	63	50	50
1.5	1.1	0.75	—	90	S	24	50	70	50	56
2.2	1.5	1.1	—	90	L	24	50	70	62	56
3	2.2, 3	1.5	.75, 1.1	100	L	28	60	80	70	63
4	4	2.2	1.5	112	M	28	60	95	70	70
5.5, 7.5	5.5	3	2.2	132	S	38	80	108	70	89
—	7.5	4, 5.5	3	132	M	38	80	108	89	89
11, 15	11	7.5	4, 5.5	160	M	42	110	127	105	108
18.5	15	11	7.5	160	L	42	110	127	127	108
22	18.5	—	—	180	M	48	110	140	120	121
—	22	15	11	180	L	48	110	140	140	121
30, 37	30	18.5, 22	15	200	L	55	110	159	152	133
—	37	—	18.5	225	S	60	140	178	143	149
45	—	—	—	225	M	55	110	178	156	149
—	45	30	22	225	M	60	140	178	156	149
55	—	—	—	250	M	60	140	203	174	168
—	55	37	30	250	M	65	140	203	174	168
75	—	—	—	280	S	65	140	229	184	190
—	75	45	37	280	S	75	140	229	184	190
90	—	—	—	280	M	65	140	229	210	190
—	90	55	45	280	M	75	140	229	210	190
110	—	—	—	315	S	65	140	254	203	216
—	110	75	55	315	S	80	170	254	203	216
132	—	—	—	315	M	65	140	254	228	216
—	132	90	75	315	M	80	170	254	228	216

* IEC frame sizes are made up of shaft height, (mm), length (letter) and shaft diameter (mm), for example 90S-24. Three frame lengths may be offered, S = Short, M = Medium, L = Long.

KEY SIZES

Shaft Size Dia. U † (mm)	Shaft Length (N-W) † (mm)	Key Size (Square: W, H) (mm)
7	16	2
9	20	3
11	23	4
14	30	5
16	40	5
18	40	6
19	40	6
22	50	6
24	50	8
28	60	8
32	80	10
38	80	10
42	110	12
48	110	14
55	110	16
60	140	18
65	140	18
70	140	20
75	140	20
80	170	22
85	170	22
90	170	25
95	170	25
100	210	28
110	210	28

† From motor sketch.