

MOTOR TEMPERATURE

Temperature rise in a motor describes the temperature of the motor winding compared to the temperature of the surrounding air. The surrounding temperature is called the ambient temperature. The amount of temperature rise over ambient is important because the insulation used in the motor is rated to withstand a specific level of heat before its insulating properties degrade. To help prevent this from happening, motors have thermal protectors. They will disconnect the power from the motor if it reaches the maximum temperature. Another term used to describe motor temperature is total temperature which is the actual temperature of the motor winding. It is the sum of the ambient temperature plus the motor's temperature rise.

FACT Continuous duty motors should not operate at temperatures exceeding 100 degrees C (212 degrees F). The life of the bearings and lubrication system will be adversely affected.

FACT Overheating is a sign of an overloaded or underloaded motor. Even if the motor is properly sized, it may still overheat if proper cooling air is not blowing over the motor.

FACT Insulation systems are rated according to the temperature the coil windings can withstand. The two most common types of systems are Class A which can withstand a temperature of 105 degrees C (221 degrees F), and Class B which can withstand a temperature of 130 degrees C (266 degrees F). Due to their ability to withstand higher temperatures, motors with Class B insulation systems can be used to replace Class A rated motors.

FACT Heat is the primary enemy of motors. Excessive heat is the sign of a misapplication. It shortens insulation life, dries out the bearing lubrication system, and causes the overload protector to trip.

FACT Total motor operating temperature consists of motor temperature rise plus ambient (surrounding air) temperature. Watts (power) into a motor comes out as work and heat. A motor driving 200 watts which is 70% efficient will do 140 watts of work ($200 \times .70 = 140$) and 60 watts ($200 - 140 = 60$) will become heat. This heat results in motor temperature rise.

FACT After two hours of operation, maximum temperature rise should be reached. Ambient temperature in a house is usually 70 degrees to 80 degrees F. When an air conditioning unit is operating, the ambient temperature in the condenser unit can range from 75 degrees to 120 degrees F.



FACT It is important to understand a replacement motor's temperature limitations. The proper conversion from a degree reading in degrees F to degrees C and vice versa is important. To make this task simple, we have provided the following conversion table.

The numbers in bold refer to the temperature to be converted. For example, to convert 77 degrees F to C, find 77 in the middle bold column. To the left of 77 will read 25 which is the degrees C conversion. To convert 77 degrees C to degrees F, read the number on the right which is 170.6, the degrees F conversion.

C°	F°	C°	F°	C°	F°	C°	F°				
-45.6	-50	-58	1.67	35	95.0	23.9	75	167.0	79.4	175	347
-40.0	-40	-40	2.22	36	96.8	24.4	76	168.8	82.2	180	356
-34.4	-30	-22	2.78	37	98.6	25.0	77	170.6	85.0	185	365
-28.9	-20	-4	3.33	38	100.4	25.6	78	172.4	87.8	190	374
-23.3	-10	14	3.89	39	102.2	26.1	79	174.2	90.6	195	383
-17.8	0	32	4.44	40	104.0	26.7	80	176.0	93.3	200	392
-17.2	1	33.8	5.00	41	105.8	27.2	81	177.8	96.1	205	401
-16.7	2	35.8	5.56	42	107.6	27.8	82	179.6	98.9	210	410
-16.1	3	37.4	6.11	43	109.4	28.3	83	181.4	100.0	212	413
-15.6	4	39.2	6.67	44	111.2	28.9	84	183.2	101.7	215	419
-15.0	5	41.0	7.22	45	113.0	29.4	85	185.0	104.4	220	428
-14.4	6	42.8	7.78	46	114.8	30.0	86	186.8	107.2	225	437
-13.9	7	44.6	8.33	47	116.6	30.6	87	188.6	110.0	230	446
-13.3	8	46.4	8.89	48	118.4	31.1	88	190.4	112.8	235	455
-12.8	9	48.2	9.44	49	120.2	31.7	89	192.2	115.6	240	464
-12.2	10	50.0	10.0	50	122.0	32.2	90	194.0	118.3	245	473
-11.7	11	51.8	10.6	51	123.8	32.8	91	195.8	121.1	250	482
-11.1	12	53.6	11.1	52	125.6	33.3	92	197.6	123.9	255	491
-10.6	13	55.4	11.7	53	127.4	33.9	93	199.4	126.7	260	500
-10.0	14	57.2	12.2	54	129.2	34.4	94	201.2	129.4	265	509
-9.44	15	59.0	12.8	55	131.0	35.0	95	203.0	132.2	270	518
-8.99	16	60.8	13.3	56	132.8	35.6	96	204.8	135.0	275	527
-8.33	17	62.6	13.9	57	134.6	36.1	97	206.6	137.8	280	536
-7.78	18	64.4	14.4	58	136.4	36.7	98	208.4	140.6	285	545
-7.22	19	66.2	15.0	59	138.2	37.2	99	210.2	143.3	290	554
-6.67	20	68.0	15.6	60	140.0	37.8	100	212.0	146.1	295	563
-6.11	21	69.8	16.1	61	141.8	40.6	105	221.0	148.9	300	572
-5.56	22	71.6	16.7	62	143.6	43.3	110	230	151.7	305	581
-5.00	23	73.4	17.2	63	145.4	46.1	115	239	154.4	310	590
-4.44	24	75.2	17.8	64	147.2	48.9	120	248	157.2	315	599
-3.89	25	77.0	18.3	65	149.0	51.7	125	257	160.0	320	608
-3.33	26	78.8	18.9	66	150.8	54.5	130	266	162.8	325	617
-2.78	27	80.6	19.4	67	152.6	57.2	135	275	165.6	330	626
-2.22	28	82.4	20.0	68	154.4	60.0	140	284	168.3	335	635
-1.67	29	84.4	20.6	69	156.2	62.8	145	293	171.1	340	644
-1.11	30	86.0	21.1	70	158.0	65.6	150	302	173.9	345	653
-0.56	31	87.8	21.7	71	159.8	68.3	155	311	176.7	350	662
0	32	89.6	22.2	72	161.6	71.1	160	320	179.4	355	671
0.56	33	91.4	22.8	73	163.4	73.9	165	329	182.2	360	680
1.11	34	93.2	23.2	74	165.2	76.7	170	338	185.0	365	689

MOTOR TEMPERATURE (continued)

FACT A replacement motor can be assumed to be operating successfully and with an acceptable operating temperature if it is not overloaded or underloaded and has about the same amount of ventilation holes as the original motor.

FACT The overload protector opens the electrical circuit to a motor before the winding reaches a temperature that would damage the winding insulation. The overload protector should never be removed or shorted out (jumped).

FACT Heat and moisture are the two most important factors limiting motor life. Moisture can be the result of either rain or the condensing of warm moisture inside the motor when it cools down in the evenings. Water can collect in a motor without drain holes at the lowest point and, if the coils are touched by this water, a ground or short circuit can occur.

FACT An underpowered replacement is more likely to cause problems than overpowering.

FACT Be careful when touching a motor as it may be at its normal operating temperature. The motor housing surface could be hot enough to cause injury.

FACT Ambient temperature around the motor should not exceed 40 degrees C (104 degrees F).

FACT The ventilation style of a motor is determined by three parts. Namely, the two end shields and the motor shell. The condenser fan blade will provide a certain amount of cooling air flow over the motor. If the OEM designs a condenser for an open ventilated fan motor and the contractor replaces it down the road with a TENV design, there is a chance that the blade will not provide enough air flow to cool the motor since a TENV motor can require a higher amount of air flow to cool. The result can cause nuisance tripping of the motor overload. It is best to match enclosures when suggesting or installing a replacement.

FACT When replacing condenser fan motors, the replacement motor should have the same nameplate horsepower as the OEM motor. Condensers are designed with a specific fan motor horsepower requirement needed to circulate the air through the coils. When a replacement motor is used that has a higher HP rating, two things result. The required amount of cooling air needed over the motor increases since the heat generated is higher. This is something that the fan blade may not be able to provide since it will be running at the same speed of 1075 RPM, for example. The second concern is that the higher HP motor will be running underloaded which causes increased heat in a PSC motor. The result with either of these two conditions can cause nuisance tripping of the overload protector which trips when a specific temperature is sensed in the motor windings.