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KE2 FanControl

General Product Information

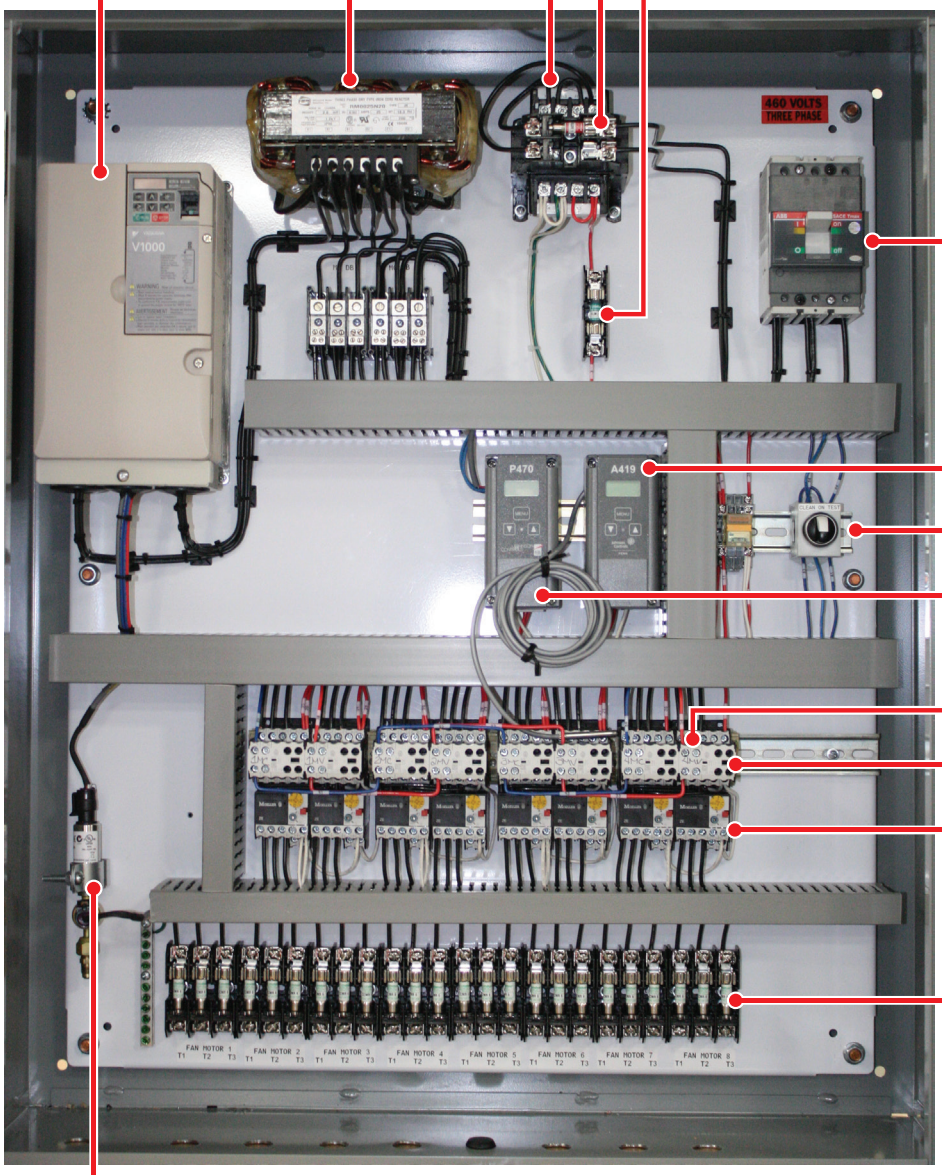
KE2 Therm Solutions,
Advanced Energy Saving Technology
for Commercial Refrigeration and AC Systems

KE2 FanControl
General Product Information

Introduction

The KE2 Fan Control provides a simple packaged solution to optimize energy efficiency of air cooled condensers. This package incorporates Variable Frequency Drive (VFD) technology to match fan speed with the varying load and ambient conditions.

Typically, condensers are sized for conditions that are experienced less than 5% of the time. The KE2 Fan Control package contains proprietary algorithms that match system conditions with equipment operation, providing the highest levels of efficiency, improving system operation and saving money.



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Fan Operation

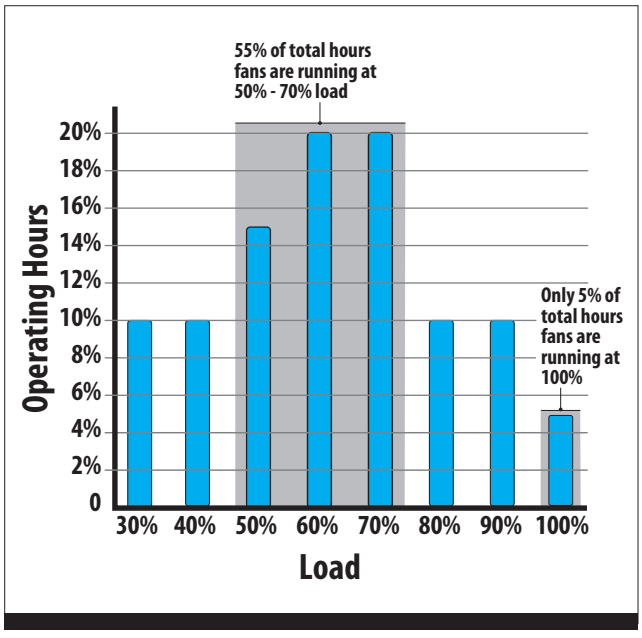
To cool a product, or to provide comfort, all refrigeration and air conditioning systems absorb heat from the conditioned space. The system must then reject the heat absorbed. Often, this is done with a fan, or fans, located on a outdoor condensing coil.

Smaller systems, like residential air conditioners or low capacity rooftop refrigeration units, have the compressor, condenser and fan built into a small packaged "condensing unit". However, as the need for cooling capacity increases, the fans and condenser coils are often separated from the compressors, and the package installed as an air cooled condenser.

These condensers have from 2 to 16 fans, and each fan will typically be sized from 1 to 1.5 hp. Traditionally, the fans run at a constant speed and can only be shut off when ambient temperature and system head pressure fall. In addition, the number and size of the fans is based on ambient design conditions that may only occur a few days a year. **Figure 1** shows that most of the time (55%) the units will run between 50% and 70% loaded.

Since constant speed fans can only run at full speed or be shut off, they use more energy than necessary under reduced load conditions. In **Figure 2**, relating Cubic Feet per Minute (CFM) of air delivered, if 7,500 CFM is required, two fans will be running at full speed (providing 13,500 CFM). The change to system pressures, because of this added heat rejection, will soon cause the fan to cycle off, and shortly cycle back on. This cycling creates instability in the system but, more importantly, wastes energy.

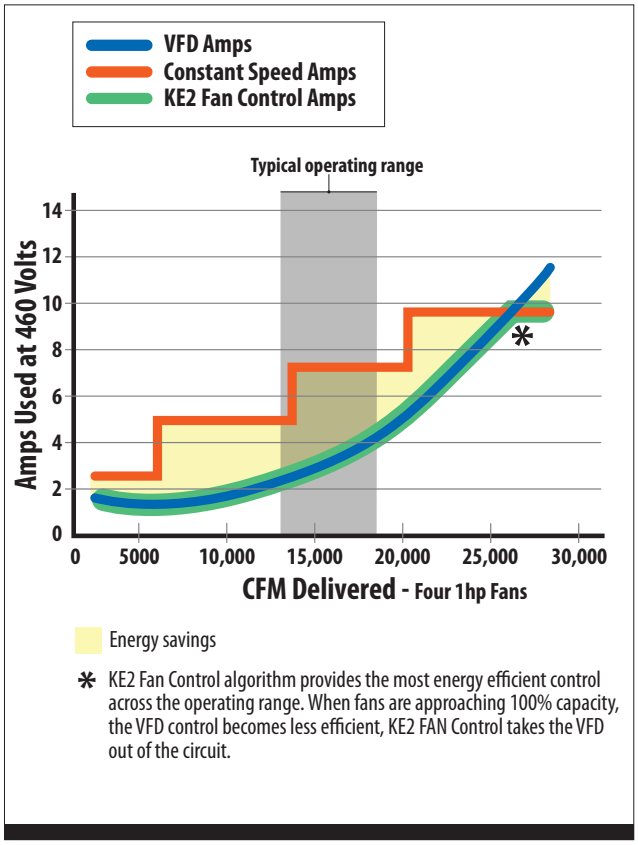
Figure 1 - Fan Loading During Total Run Time



The Fan Affinity Laws prove that the power needed to run a fan varies as the cube(X^3) of the speed of the fan. **This means that to double the speed of a fan requires 8 times more power!**

Frequency drives are inherently "soft starters" for motors. Typical inrush current for across-the-line starting is five times running current, or even higher. The KE2Fan control has algorithms that reduce inrush current to only about three times running current while also extending rise time of the current. This reduces electrical stress on the fan motor and assures best possible performance and motor life, while reducing peak demands on the incoming electrical supply. For a given air flow requirement, the VFD can run all the fans at a lower, and much more economical speed.

Figure 2 - Energy Usage Comparison



Stabilizing discharge pressure, which also increases efficiency, is another benefit provided by the KE2 Fan Control. And, a more stable operating pressure at the condenser translates to a more stable liquid temperature at the expansion device. Stable expansion valve operation means more consistent superheat at the compressor. This reduces compressor cycling, energy use, and wear and tear on this expensive component. Again, providing better system performance and efficiency. At a point where all fans must run at full speed to meet CFM needs, the VFD will be slightly less efficient. Since the system operates at this maximum condition only 5% of the time, VFD inefficiencies will be small. However, proprietary KE2 Therm Fan Control algorithms predict this point, and take the VFD out of the circuit, maximizing energy savings.

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An example of the efficiency realized with variable fan control is also shown in **Figure 3**. Here, we see a four fan system with 40,000 CFM capacity and a demand for 35,000 CFM. The KE2 Fan Control system provides the precise CFM required and reduces the amp usage considerably over the staged control system.

The Controller Package

KE2 Fan Control package provides a complete engineered, wired and ULc listed, solution to retrofitting VFD control to raise the efficiency of standard air cooled condensers, up to 16 fans.

All KE2 Fan Control packages have the VFD, contactors, motor overload safeties, transformers, fuses and circuit breakers needed to assure operation and safety when properly used. All components are sized for the number, voltage and current requirements of the fans on the condenser and are fully mounted in a NEMA3R metal enclosure. Installation only requires fastening the unit to the condenser and making the incoming power and fan connections to the labeled terminal blocks, and installing the pressure sensing line. A typical installation will have the KE2 Fan Control package with enclosure mounted independently to the condenser.

The KE2 Fan Control provides for bypass to direct line voltage whenever full capacity of the condenser is required, or if conditions leading to a fault or alarm condition in the drive. Most of the faults and alarms are reset automatically, while still being logged in drive memory for future reference.

Split Condenser Versions

Figure 1 illustrates the fact that much of the time condensers are oversized for the system load. This is even more true when the ambient temperature is low. If the entire surface area of the condenser is used at ambient temperatures below about 50°F, head pressure may continue to fall even with the condensing fans at low speed, or even off. The KE2 Fan Control actually runs the fans in reverse at a low speed to create a "heat blanket" over the condenser, but this has limits on lower ambients as well.

Typically, refrigerant side control, or liquid flooded condensers, take over once fan speed has been minimized. Systems using liquid flooding must contain more refrigerant to flood the condenser during low ambients, and have receivers large enough to store the extra refrigerant charge when not needed.

Environmental concerns, and some legislation, call for minimizing the amount of refrigerant in most systems.

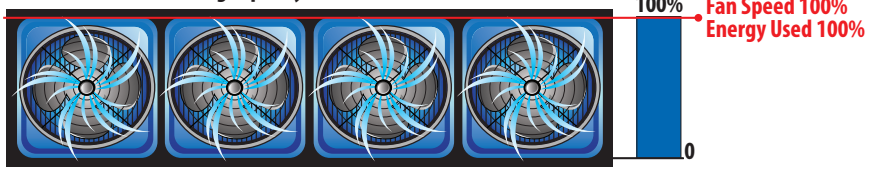
Figure 3 - Staged Control vs. Variable Control

Example: System cooling need - 35,000 CFM

Summary: Staged Control - 4 fans at 100%, supplying 40,000 CFM using 24 amps
KE2 Fan Control - 4 fans at 87.5%, supplying 35,000 CFM using 16 amps

Staged Control

Fans ON or OFF - matching capacity need is APPROXIMATE

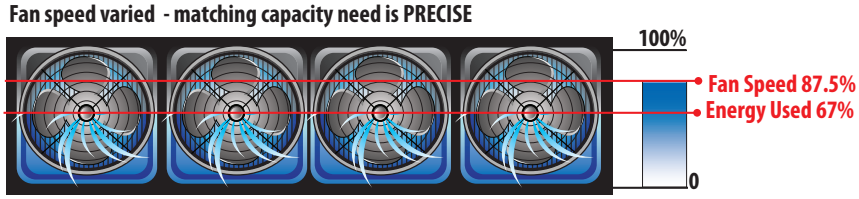


10,000 CFM 10,000 CFM 10,000 CFM 10,000 CFM

All fans ON at 100% speed

Variable Control with KE2 Fan Control

Fan speed varied - matching capacity need is PRECISE



8,750 CFM 8,750 CFM 8,750 CFM 8,750 CFM

All fans ON at 87.5% speed

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Split condensers address these issues. Simply, at low ambients, some part of the refrigerant circuit in the condenser is isolated and pumped out. At the same time, the fans cooling that part of the condenser are turned off. Isolation of the refrigerant is accomplished with solenoid or split condenser valves, and additional fan controls are required.

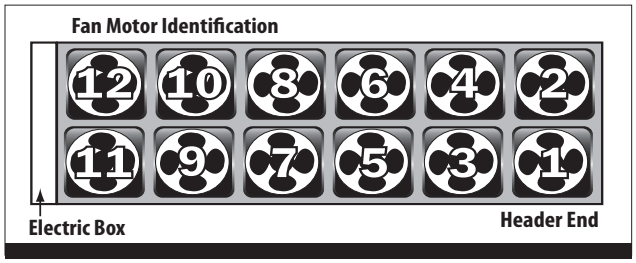
The KE2 Fan Control incorporates all these features in a split condenser version. An adjustable ambient temperature sensor and thermostat tell the fan control to energize the split condenser or solenoid valve and shut off the affected fans. The split temperature can be chosen by the user, but is defaulted to 30°F. When ambient reaches setpoint, the fan control will split the condenser, when above setpoint the condenser is returned to normal mode. **Figure 4** shows usual fan numbering conventions and odd numbered fans should be wired to the split condenser circuit. The split condenser valve is not included, consult the condenser manufacturer literature for details of piping and wiring.

KE2 Fan Control Installation and Quick Start guide N.2.1 has full details for installation and setting of the ambient control.

Fan Control Selection and Return on Investment

Figures 1, 2 and 3 illustrate the theory, background and hypothetical case for VFD based fan control. Since most condensers are oversized most of the time, and fan power varies as the cube

Figure 4 - Optional Split Condenser Wiring



of fan speed, there are real benefits to adopting variable speed fan control. The KE2 Fan Control provides these savings in fully wired, programmed and tested package. The completeness and ease of installation allow realization of energy savings, almost immediately, on both new and retrofit applications.

Built in safeties protect the fan motors, system and drive package without additional field installed parts.

Figure 5 is an illustration of the specific savings that the KE2 Fan may provide. The application example in **Figure 3** has been used with the Fan Return on Investment Calculator available at *www.KE2therm.com* under ROI-Fan Control. The calculator is fully interactive and application specifics are easy to input.

In **Figure 5**, the four fan unit previously described is entered into the calculator with pull down menus in the highlighted area. Average power cost can be selected by state or a specific entry can be made, if known.

Installed cost in this example is an estimate based on previous applications, but can be refined when actual costs are known.

The utility rebate section may be left blank, but since VFD based controllers are almost always eligible for utility rebates, this selection should be used.

In this specific example, the state chosen for installation is New Jersey. The major utility in New Jersey is PSE&G, and from their website, VFD applications qualify for prescriptive rebates of up to $155 per horsepower and interest free installation loans of up to 100% are also available. Custom rebates may be even higher. Rebates from other areas can be found at *www.dsireusa.org* in a database maintained by the University of North Carolina.

The **Results** area of the calculator shows savings in kW, percentage and dollars. More importantly is the payback period, in this case 1.46 years, a compelling reason to install a KE2 Fan Control.

Figure 5 - KE2 Fan Control Fan Selection and ROI Calculator

Fan Selection Program	
Number of Fans	4
Is this a split condenser?	No
Hp of Fan Motors	1.5 hp
Fans Unloaded at a Time	1
Installed Cost Estimate	$7,000
Utility Rebates	$900
Published Commercial Price - Energy by State Default $0.152	New Jersey $0.152
Motor Voltage	230 Volts
Individual Motor FLA DO NOT use the default for sizing - default 6.6	6.0
(hrs)	24 hours
(days)	365 days
*Default value is based on a nominal value for a given horsepower motor and should not be used to size KE2 Fan Control. Default should only be used for estimated savings calculation if known value is unavailable.	**Recommended**
KE2 Fan Part Number(s)	**20228**
	Results
Non-VFD KW-hr used/yr	**48577 KW-hr**
VFD KW-hr used/yr	**21022 KW-hr**
% Savings	**56.72%**
$ Saved Annually	**$4,180**
Estimated Payback	**1.46 Years**

Table 2a
Voltage 208-230/60/3
nominal HP, order by motor amp

Table 2a- KE2 Fan Control Models
Voltage 208-230/60/3
nominal HP, order by moor amps

* consists of 2 interlocked contactors and 2 overloads

	Part #	Description	Voltage	Number of Fans	Overload Range Amp		VFD Amp	Split Condenser	Contactor Module*
4 Fan	20161	4 FAN KE2 Fan Control - 230V, 2.4-4.0 Overload Range, 19.6 Amp VFD	230	4	2.4	4.0	19.6	NO	20413
	20323	4 FAN KE2 Fan Control - 230V, 4.0-6.0 Overload Range, 19.6 Amp VFD	230	4	4.0	6.0	19.6	NO	20413
	20228	4 FAN KE2 Fan Control - 230V, 4.0-6.0 Overload Range, 30 Amp VFD	230	4	4.0	6.0	30.0	NO	20413
	20230	4 FAN KE2 Fan Control - 230V, 6.0-9.0 Overload Range, 30 Amp VFD	230	4	6.0	9.0	30.0	NO	20413
6 Fan	20324	6 FAN KE2 Fan Control - 230V, 2.4-4.0 Overload Range, 19.6 Amp VFD	230	6	2.4	4.0	19.6	NO	20413
	20162	6 FAN KE2 Fan Control - 230V, 2.4-4.0 Overload Range, 30 Amp VFD	230	6	2.4	4.0	30.0	NO	20413
	20325	6 FAN KE2 Fan Control - 230V, 4.0-6.0 Overload Range, 30 Amp VFD	230	6	4.0	6.0	30.0	NO	20413
	20231	6 FAN KE2 Fan Control - 230V, 4.0-6.0 Overload Range, 40 Amp VFD	230	6	4.0	6.0	40.0	NO	20413
	20232	6 FAN KE2 Fan Control - 230V, 6.0-9.0 Overload Range, 40 Amp VFD	230	6	6.0	9.0	40.0	NO	20413
8 Fan	20326	8 FAN KE2 Fan Control - 230V, 2.4-4.0 Overload Range, 30 Amp VFD	230	8	2.4	4.0	30.0	NO	20413
	20163	8 FAN KE2 Fan Control - 230V, 2.4-4.0 Overload Range, 40 Amp VFD	230	8	2.4	4.0	40.0	NO	20413
	20327	8 FAN KE2 Fan Control - 230V, 4.0-6.0 Overload Range, 40 Amp VFD	230	8	4.0	6.0	40.0	NO	20413
	20233	8 FAN KE2 Fan Control - 230V, 4.0-6.0 Overload Range, 56 Amp VFD	230	8	4.0	6.0	56.0	NO	20413
	20234	8 FAN KE2 Fan Control - 230V, 6.0-9.0 Overload Range, 56 Amp VFD	230	8	6.0	9.0	56.0	NO	20413
10 Fan	20328	10 FAN KE2 Fan Control - 230V, 2.4-4.0 Overload Range, 30 Amp VFD	230	10	2.4	4.0	30.0	NO	20413
	20164	10 FAN KE2 Fan Control - 230V, 2.4-4.0 Overload Range, 40 Amp VFD	230	10	2.4	4.0	40.0	NO	20413
	20329	10 FAN KE2 Fan Control - 230V, 4.0-6.0 Overload Range, 56 Amp VFD	230	10	4.0	6.0	56.0	NO	20413
	20235	10 FAN KE2 Fan Control - 230V, 4.0-6.0 Overload Range, 69 Amp VFD	230	10	4.0	6.0	69.0	NO	20413
	20236	10 FAN KE2 Fan Control - 230V, 6.0-9.0 Overload Range, 69 Amp VFD	230	10	6.0	9.0	69.0	NO	20413
8 Fan-SC	20330	8 FAN KE2 Fan Control - 230V, 2.4-4.0 Overload Range, 30 Amp VFD, Split Condenser	230	8	2.4	4.0	30.0	YES	20413
	20305	8 FAN KE2 Fan Control - 230V, 2.4-4.0 Overload Range, 40 Amp VFD, Split Condenser	230	8	2.4	4.0	40.0	YES	20413
	20331	8 FAN KE2 Fan Control - 230V, 4.0-6.0 Overload Range, 40 Amp VFD, Split Condenser	230	8	4.0	6.0	40.0	YES	20413
	20306	8 FAN KE2 Fan Control - 230V, 4.0-6.0 Overload Range, 56 Amp VFD, Split Condenser	230	8	4.0	6.0	56.0	YES	20413
	20307	8 FAN KE2 Fan Control - 230V, 6.0-9.0 Overload Range, 56 Amp VFD, Split Condenser	230	8	6.0	9.0	56.0	YES	20413
10 Fan-SC	20332	10 FAN KE2 Fan Control - 230V, 2.4-4.0 Overload Range, 30 Amp VFD, Split Condenser	230	10	2.4	4.0	30.0	YES	20413
	20308	10 FAN KE2 Fan Control - 230V, 2.4-4.0 Overload Range, 40 Amp VFD, Split Condenser	230	10	2.4	4.0	40.0	YES	20413
	20333	10 FAN KE2 Fan Control - 230V, 4.0-6.0 Overload Range, 56 Amp VFD, Split Condenser	230	10	4.0	6.0	56.0	YES	20413
	20309	10 FAN KE2 Fan Control - 230V, 4.0-6.0 Overload Range, 69 Amp VFD, Split Condenser	230	10	4.0	6.0	69.0	YES	20413
	20310	10 FAN KE2 Fan Control - 230V, 6.0-9.0 Overload Range, 69 Amp VFD, Split Condenser	230	10	6.0	9.0	69.0	YES	20413

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Table 2b
Voltages 460-480/60/3

Table 2b- KE2 Fan Control Models
Voltage 460-480/ 60 / 3
nominal HP, order by motor amps

* consists of 2 interlocked contactors and 2 overloads

	Part #	Description	Voltage	Number of Fans	Overload Range Amp		VFD Amp	Split Condenser	Contactor Module*
4 Fan	20189	4 FAN KE2 Fan Control - 480V, 1.0-1.6 Overload Range, 6.9 Amp VFD	480	4	1.0	1.6	6.9	NO	20414
	20237	4 FAN KE2 Fan Control - 480V, 1.6-2.4 Overload Range, 11.1 Amp VFD	480	4	1.6	2.4	11.1	NO	20414
	20334	4 FAN KE2 Fan Control - 480V, 2.4-4.0 Overload Range, 11.1 Amp VFD	480	4	2.4	4.0	11.1	NO	20414
	20238	4 FAN KE2 Fan Control - 480V, 2.4-4.0 Overload Range, 17.5 Amp VFD	480	4	2.4	4.0	17.5	NO	20414
6 Fan	20335	6 FAN KE2 Fan Control - 480V, 1.0-1.6 Overload Range, 6.9 Amp VFD	480	6	1.0	1.6	6.9	NO	20414
	20190	6 FAN KE2 Fan Control - 480V, 1.0-1.6 Overload Range, 11.1 Amp VFD	480	6	1.0	1.6	11.1	NO	20414
	20336	6 FAN KE2 Fan Control 480V, 1.6-2.4 Overload Range, 11.1 Amp VFD	480	6	1.6	2.4	11.1	NO	20414
	20239	6 FAN KE2 Fan Control - 480V, 1.6-2.4 Overload Range, 17.5 Amp VFD	480	6	1.6	2.4	17.5	NO	20414
	20337	6 FAN KE2 Fan Control - 480V, 2.4-4.0 Overload Range, 17.5 Amp VFD	480	6	2.4	4.0	17.5	NO	20414
	20240	6 FAN KE2 Fan Control - 480V, 2.4-4.0 Overload Range, 24 Amp VFD	480	6	2.4	4.0	24.0	NO	20414
8 Fan	20338	8 FAN KE2 Fan Control - 480V, 1.0-1.6 Overload Range, 11.1 Amp VFD	480	8	1.0	1.6	11.1	NO	20414
	20191	8 FAN KE2 Fan Control - 480V, 1.0-1.6 Overload Range, 17.5 Amp VFD	480	8	1.0	1.6	17.5	NO	20414
	20339	8 FAN KE2 Fan Control - 480V, 1.6-2.4 Overload Range, 17.5 Amp VFD	480	8	1.6	2.4	17.5	NO	20414
	20241	8 FAN KE2 Fan Control - 480V, 1.6-2.4 Overload Range, 24 Amp VFD	480	8	1.6	2.4	24.0	NO	20414
	20340	8 FAN KE2 Fan Control - 480V, 2.4-4.0 Overload Range, 24 Amp VFD	480	8	2.4	4.0	24.0	NO	20414
	20242	8 FAN KE2 Fan Control - 480V, 2.4-4.0 Overload Range, 31 Amp VFD	480	8	2.4	4.0	31.0	NO	20414
10 Fan	20192	10 FAN KE2 Fan Control - 480V, 1.0-1.6 Overload Range, 17.5 Amp VFD	480	10	1.0	1.6	17.5	NO	20414
	20341	10 FAN KE2 Fan Control - 480V, 1.6-2.4 Overload Range, 17.5 Amp VFD	480	10	1.6	2.4	17.5	NO	20414
	20243	10 FAN KE2 Fan Control- 480V, 1.6-2.4 Overload Range, 24 Amp VFD	480	10	1.6	2.4	24.0	NO	20414
	20244	10 FAN KE2 Fan Control- 480V, 2.4-4.0 Overload Range, 38 Amp VFD	480	10	2.4	4.0	38.0	NO	20414
8 Fan-SC	20342	8 FAN KE2 Fan Control - 480V, 1.0-1.6 Overload Range, 11.1 Amp VFD, Split Condenser	480	8	1.0	1.6	11.1	YES	20414
	20311	8 FAN KE2 Fan Control - 480V, 1.0-1.6 Overload Range, 17.5 Amp VFD, Split Condenser	480	8	1.0	1.6	17.5	YES	20414
	20343	8 FAN KE2 Fan Control - 480V, 1.6-2.4 Overload Range, 17.5 Amp VFD, Split Condenser	480	8	1.6	2.4	17.5	YES	20414
	20312	8 FAN KE2 Fan Control - 480V, 1.6-2.4 Overload Range, 24 Amp VFD, Split Condenser	480	8	1.6	2.4	24.0	YES	20414
	20345	8 FAN KE2 Fan Control - 480V, 2.4-4.0 Overload Range, 24 Amp VFD, Split Condenser	480	8	2.4	4.0	24.0	YES	20414
	20313	8 FAN KE2 Fan Control - 480V, 2.4-4.0 Overload Range, 31 Amp VFD, Split Condenser	480	8	2.4	4.0	31.0	YES	20414
10 Fan-SC	20314	10 FAN KE2 Fan Control - 480V, 1.0-1.6 Overload Range, 17.5 Amp VFD, Split Condenser	480	10	1.0	1.6	17.5	YES	20414
	20344	10 FAN KE2 Fan Control - 480V, 1.6-2.4 Overload Range, 17.5 Amp VFD, Split Condenser	480	10	1.6	2.4	17.5	YES	20414
	20315	10 FAN KE2 Fan Control - 480V, 1.6-2.4 Overload Range, 24 Amp VFD, Split Condenser	480	10	1.6	2.4	24.0	YES	20414
	20316	10 FAN KE2 Fan Control - 480V, 2.4-4.0 Overload Range, 38 Amp VFD, Split Condenser	480	10	2.4	4.0	38.0	YES	20414

KE2 Fan Control**
General Product Information

Table 2c
Voltages 575-600/60/3

Table 2c - KE2 Fan Control Models - Voltage 575-600/60/3
nominal HP, order by motor amps

* consists of 2 interlocked contactors and 2 overloads

	Part #	Description	Voltage	Number of Fans	Overload Range Amp		VFD Amp	Split Condenser	Contactor Module*
4 Fan	20193	4 FAN KE2 Fan Control - 575V, 1.0-1.6 Overload Range, 11 Amp VFD	575	4	4.0	6.4	11.0	NO	20415
	20245	4 FAN KE2 Fan Control - 575V, 1.6-2.4 Overload Range, 11 Amp VFD	575	4	6.4	9.6	11.0	NO	20415
	20246	4 FAN KE2 Fan Control - 575V, 2.4-4.0 Overload Range, 17.5 Amp VFD	575	4	9.6	16	17.5	NO	20415
6 Fan	20194	6 FAN KE2 Fan Control - 575V, 1.0-1.6 Overload Range, 11 Amp VFD	575	6	6.0	9.6	11.0	NO	20415
	20247	6 FAN KE2 Fan Control - 575V, 1.6-2.4 Overload Range, 17.5 Amp VFD	575	6	9.7	14.4	17.5	NO	20415
	20248	6 FAN KE2 Fan Control - 575V, 2.4-4.0 Overload Range, 22 Amp VFD	575	6	14.5	24.0	22.0	NO	20415
8 Fan	20195	8 FAN KE2 Fan Control - 575V, 1.0-1.6 Overload Range, 17.5 Amp VFD	575	8	8.0	12.8	17.5	NO	20415
	20249	8 FAN KE2 Fan Control - 575V, 1.6-2.4 Overload Range, 22 Amp VFD	575	8	12.9	19.2	22.0	NO	20415
	20250	8 FAN KE2 Fan Control - 575V, 2.4-4.0 Overload Range, 27 Amp VFD	575	8	19.3	32.0	27.0	NO	20415
10 Fan	20196	10 FAN KE2 Fan Control - 575V, 1.0-1.6 Overload Range, 17.5 Amp VFD	575	10	10.0	16.0	17.5	NO	20415
	20251	10 FAN KE2 Fan Control - 575V, 1.6-2.4 Overload Range, 27 Amp VFD	575	10	16.1	24.0	27.0	NO	20415
	20252	10 FAN KE2 Fan Control - 575V, 2.4-4.0 Overload Range, 41 Amp VFD	575	10	24.1	40.0	41.0	NO	20415
8 Fan-SC	20317	8 FAN KE2 Fan Control - 575V, 1.0-1.6 Overload Range, 17.5 Amp VFD, Split Condenser	575	8	8.0	12.8	17.5	YES	20415
	20318	8 FAN KE2 Fan Control - 575V, 1.6-2.4 Overload Range, 22 Amp VFD, Split Condenser	575	8	12.9	19.2	22.0	YES	20415
	20319	8 FAN KE2 Fan Control - 575V, 2.4-4.0 Overload Range, 27 Amp VFD, Split Condenser	575	8	19.3	32.0	27.0	YES	20415
10 Fan-SC	20320	10 FAN KE2 Fan Control - 575V, 1.0-1.6 Overload Range, 17.5 Amp VFD, Split Condenser	575	10	10.0	16.0	17.5	YES	20415
	20321	10 FAN KE2 Fan Control - 575V, 1.6-2.4 Overload Range, 27 Amp VFD, Split Condenser	575	10	16.1	24.0	27.0	YES	20415
	20322	10 FAN KE2 Fan Control - 575V, 2.4-4.0 Overload Range, 41 Amp VFD, Split Condenser	575	10	24.1	40.0	41.0	YES	20415

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