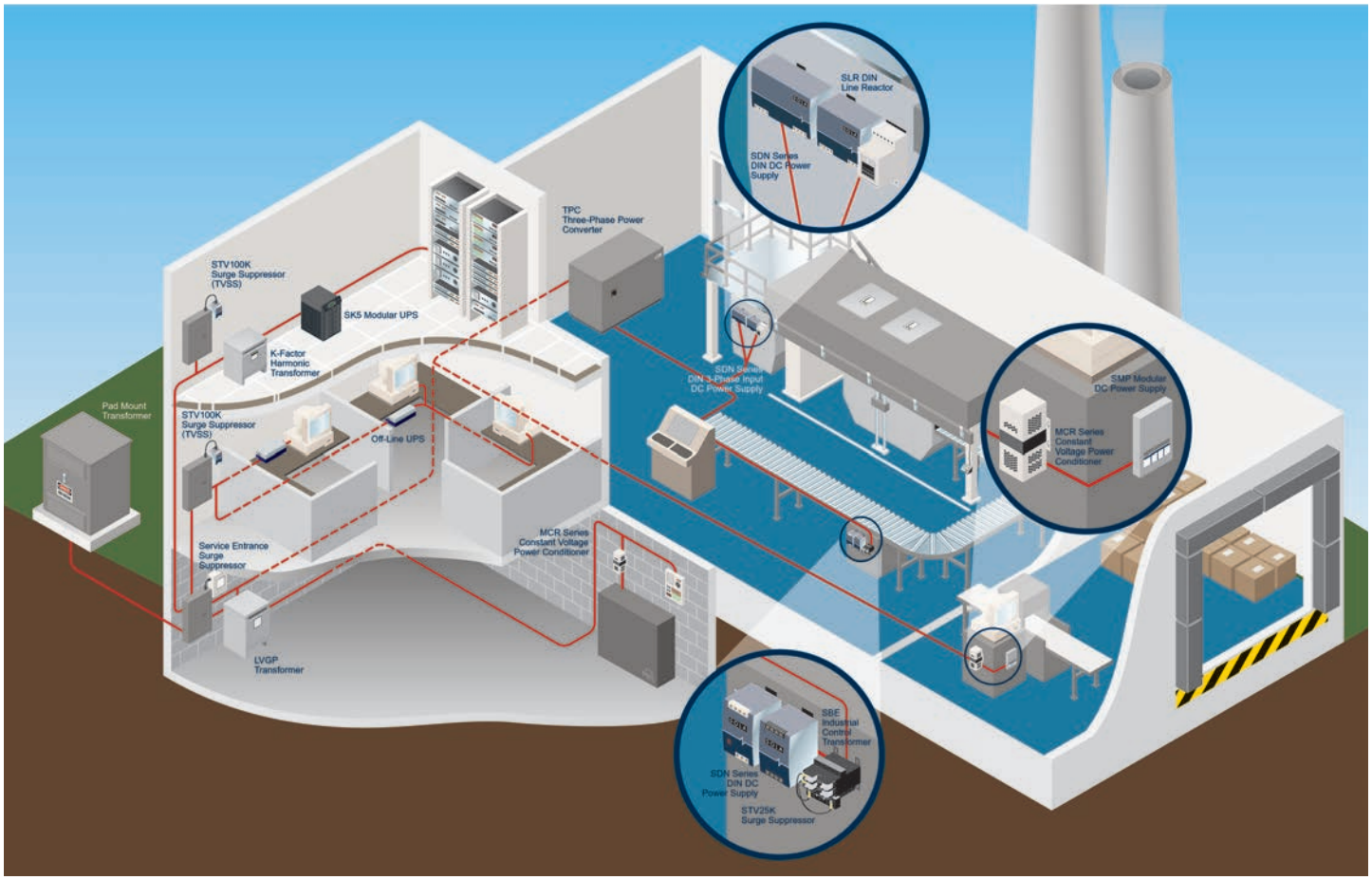
UNDERSTANDING THE DOE 2016 IMPACT:
ENERGY EFFICIENT TRANSFORMERS PRODUCT GUIDE

SOLAHD

EMERSON

POWER CONVERSION AND PROTECTION

SolaHD is at work for you on the facility floor, service entrance, branch panel, power distribution points and point of use applications. Our products power the most demanding applications and can be used in conjunction or alone to ensure controlled, reliable power to any part of the factory floor or machinery.



	Industrial Power Conversion and Protection				
	Power Conditioning	**Surge Suppression**	**Transformers**	**Power Supplies**	**UPS**
Service Entrance		X	X		
Branch Panels		X	X		
Networks	X	X		X	X
Large Machinery	X	X	X	X	X
Process Rooms	X	X			X
PLC's & Industrial PC's	X	X	X	X	X
Ethernet & Communications		X		X	X
DeviceNet		X		X	X
Motion Control		X		X	
Drives	X	X	X		
Analog I/O		X		X	

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ENERGY EFFICIENCY LEGISLATION FOR DISTRIBUTION TRANSFORMERS

The Impact on Transformers

As the world's largest energy consumer, the United States uses 3.7 trillion kilo-watt-hours per year of power. Even with the recent surge in energy prices and a greater awareness of the need to protect the environment, this number will continue to increase until consumers and businesses see the benefits of choosing more energy efficient product designs.

Congress, understanding that people can be financially enticed to change behaviors and business practices, created new legislation. According to the legislation, pertaining to low voltage dry-type distribution transformers, the responsibility has been placed on the transformer manufacturers to comply or face civil penalties. This will ensure that all new and replacement transformers will meet the new efficiency requirements by removing the option of using a lower efficiency unit.

Distribution Transformers manufactured after January 1, 2016 shall meet specific energy efficiency requirements. The requirements are based on a specification developed by the National Electrical Manufacturers Association (NEMA) with assistance from transformer manufacturers and the U.S. Department of Energy (DOE). DOE's CFR (Code of Federal Regulations) title 10 part 431 was published in the Federal Register Vol. 78, No. 75, also referred to as DOE 2016.

The term Distribution Transformer is clearly defined in the Federal Rule and specific exclusions are provided for some types of transformers. The exclusions only apply to designs where compliance would not be economically justifiable or would be technically difficult to accomplish. If in practice some of these exclusions are abused, the law will be modified to prevent such abuse. DOE 2016 defines the term "distribution transformers" as any transformer which:

- Has an input voltage of 34.5 kV or less
- Has an output voltage of 600 V or less
- Is rated for operation at a frequency of 60 Hz
- Has a capacity of 10 kVA to 2500 kVA for liquid-immersed units and 15 kVA to 2500 kVA for dry-type units

The following special purpose transformers are excluded from the definition of "distribution transformers" and are, therefore, not required to meet the energy efficiency standards at this time:

- Autotransformers
- Drive (isolation) transformers
- Grounding transformers
- Machine-tool (control) transformers
- Non-ventilated transformers
- Rectifier transformers
- Regulating transformers
- Sealed transformers
- Special-impedance transformers
- Testing transformers
- Transformer with tap range of 20 percent or more
- Uninterruptible power supply transformers
- Welding transformers

Product lines affected by the new requirements include; Low Voltage General Purpose (LVGP) transformers (ventilated units only), K-factor, and Low Temperature rise units. Non-compliant designs in these product categories became obsolete effective 12/31/15. Any units produced on or before that date can still be shipped and used by customers. All standard units in SolaHD's product line which are non-compliant with the new Federal Rule will be replaced with a new compliant design.

A majority of the units affected are included in this brochure. Custom units affected by the rule will be replaced on a case-by-case basis using the Custom Transformer Quote Request process. While the compliant transformers will add to the cost of construction and maintenance projects, the end user will save this cost over the life of the transformer.

It was a goal of the U.S. Department of Energy (DOE) to improve the energy efficiency of distribution transformers. They have the legal authority to define efficiency levels and enforce compliance. In addition, environmentally conscious consumers and individuals also recognize that buying a higher energy efficiency transformer will have both a financial and environmental impact in the coming years.

The DOE has worked over the last few years to established new and more stringent energy efficiency levels for distribution transformers. The law went into effect January 1, 2016 making these new levels mandatory. This new law primarily affects three-phase efficiency levels. Single phase levels will remain the same. Please refer to the table on page 5 for the efficiency levels which apply to the low-voltage dry-type transformers that SolaHD manufactures; these are distribution transformers that include low temperature rise, K-Factor and general purpose. There are additional distribution transformers affected. Those are defined in the DOE's CFR (Code of Federal Regulations) title 10, part 431 (also known as DOE 10 CFR p431). It was published in the Federal Register Vol. 78, No. 75.

How SolaHD is Supporting this Legislation and Our Customers.
It is important to note that the mandated energy efficiency levels were hovering around 98-99%, depending on the type of transformer and ratings. This means that any further efficiency improvements become more challenging to achieve. Typically they will require more and/or better core and conductor materials. In most cases, this will directly impact the cost of the transformer. However, there is an economic benefit to offset the higher initial transformer costs overtime. SolaHD has made every effort to optimize our DOE 2016 designs to minimize cost impacts, but expect prices to be higher throughout the transformer industry.

The end result of the new legislation is a lower environmental impact and a cost savings derived from decreased energy use for our customers. SolaHD supports this change, and the environmental benefits our society will receive as a result. SolaHD has a long tradition as a high quality, U.S. manufacturer of low voltage general purpose distribution transformers. We are proud to offer transformers that meet the most stringent energy efficiency requirements today, and are in a position that supports the new DOE 2016 higher efficiency designs for our valued partners and customers.

HIGHER ENERGY EFFICIENCIES

The Impact on Hevi-Duty Transformers

Benefiting from Higher Energy Efficiencies

Increasing the energy efficiency of a transformer allows the unit to operate at the same level of power with less energy being wasted in the process. This has a large impact on the consumption and distribution of energy because the reduction in energy usage improves the nation's energy independence, reduces environmental impacts, lessens infrastructure investment, and protects and strengthens the economy.

Decreasing usage through reduced waste by just .03% over the next 20 years cuts the need for new power generation by 60 to 66 million kw. That drop would eliminate the need for construction of 11 new 400-megawatt power plants by 2038. Electrical power generation accounts for 35% of all U.S. emissions of carbon dioxide, 75% of sulfur dioxide and 38% of nitrogen oxides. With higher-efficiency transformers, the country will see reduced emissions of CO2, NOx and Hg of 678.8 Mt, 187.7 kt, and 6.48 t over the next 30 years. Curbing energy imports also bolsters the U.S. economy by reducing the current $65 billion trade deficit and mitigating fuel prices through decreased demand.

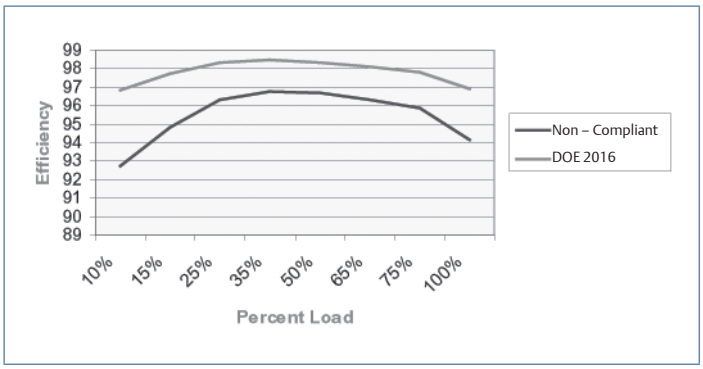
As your full-range provider of power conversion and power quality related products, SolaHD has been engineering and producing energy efficient transformers to meet the market demands.

Our experienced engineers provide the best performing, most cost-effective designs on the market. The SolaHD transformers are optimized to meet DOE 2016 limits for load losses calculated to 35% of the name plate rating, yet are the same compact size and footprint as its' conventional 150˚C rise units.

All units in this brochure meet or exceed the required DOE 2016 efficiency levels. On the surface the absolute change seems insignificant, however the reduction in lost energy is dramatic when you consider that almost all of the energy consumed goes through at least one distribution transformer.

The example pictured in Figure 1 shows the differences in efficiency for the old standard model compared to the compliant model. At 35% load, the absolute difference in efficiency is only 1.7%. However, that represents a 52% reduction in wasted energy. Taking that 52% reduction in wasted energy and multiplying it across all the energy consumed results in substantial savings.

Figure 1: 75 kVA Transformer Efficiency



DOE 2016 Energy Efficiency Levels

Note: Efficiency testing is done at 35% loading.

Single-Phase	
kVA	Eff %
15	97.7
25	98
37.5	98.2
50	98.3
75	98.5
100	98.6
167	98.7

Three-Phase	
kVA	Eff %
15	**97.89**
30	**98.23**
45	**98.4**
75	**98.6**
112.5	**98.74**
150	**98.83**
225	**98.94**
300	**99.02**
500	**99.14**

Some general effects of the legislation:
A transformer under normal operation is always on, thus making any energy efficiency improvements more significant over an extended period of time. This means that customers will be rewarded in two ways:

1. They are reducing greenhouse gas emissions and there is an economic payback through reduced energy costs overtime. Considering the life expectancy of a transformer and the fact that the transformer will be on 24 hours a day, 7 days a week for the next 25-30 years, even small energy efficiency improvements will pay dividends over the life of the transformer.
2. It will generate less heat. In many cases this translates into lower costs to cool the environment in which they are utilized equating into more savings not easily identified in calculations. (Note: Transformers on average are at 35% loading).

Some effects of the legislation on SolaHD:

- 600 Volt class 60 Hz, dry type general purpose, 3-phase 15-500 kVA
- Losses will be reduced approximately 30%, majority in the core
- Part numbers are
  - — General Distribution and Low Rise: ET Series will become E Series i.e. ET2H45S becomes E2H45S
  - — K-Factor: 3HXXT Series will become KXXE Series i.e. 3H4T2H15S becomes K4E2H15S
- Enclosure sizes are not changing
- Not affected: Single phase 600 Volt class will remain at EPACT 2005 (previously TP-1) levels and are now referred to as DOE 2016 levels.

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SolaHD FAMILY OF TRANSFORMERS

SolaHD offers a broad range of transformers to meet many applications. These dry-type transformers are offered encapsulated, ventilated or non-ventilated, 600 Volt Class, isolation type, single and three phase, through 500 kVA. Indoor and outdoor models are available.

Applications
Transformers are useful where the available voltage must be changed to accommodate the voltage required by the load. For many electrical circuits, the National Electrical Code (NEC) requires a separately derived neutral secondary connection provided by Delta-Wye connected transformers.

Typical applications include:
- Apartment Buildings
- Commercial Buildings
- High Rise Buildings
- Hospitals
- Industrial Plants
- Institutional Buildings
- Office Buildings
- Schools
- Shopping Centers

General purpose transformers can be located close to the load. No vaults are required for installation and no long, expensive feeder lines are needed. Common applications include inductive and resistive loads such as motors, lighting and heating.

SolaHD general purpose transformers are manufactured to meet applicable industry standards, are Listed in accordance with UL 506 and UL 1561 specifications and are classified as isolation transformers. The family of transformers includes:

General Purpose
These industry workhorses feature dry type construction and are classified as isolation transformers.

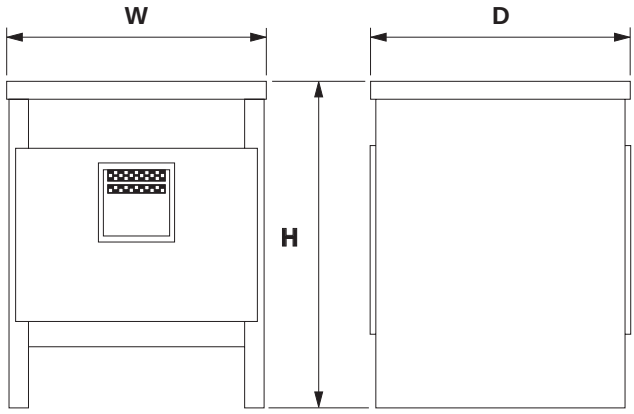
Low Temperature Rise
Lower thermal stress on transformer insulation increases useful life.

K-Factor
Designed to reduce the heating effects of harmonic currents created by solid state loads.

Copper Wound
SolaHD general purpose transformers have standard aluminum coil windings. As an option, copper windings are available.

UL LISTED

Design Style



Style 1 - Ventilated

SELECTION STEPS

To manually select a transformer:

Find the electrical load requirements.
This information is available from the equipment manufacturer and is typically listed on the nameplate of the equipment.
These are:

1. Load operating voltage.
2. Load frequency (expressed in Hz).
3. Determine load size - usually expressed in kVA, amperage or horsepower.
4. Is the load designed to operate on single phase or three phase power?

Know the supply voltage conditions:

1. Available source voltage.
2. Available source frequency (a transformer will not change frequency. The frequency of the supply voltage and the needed load voltage must be equal).
3. Number of phases on power source.

Determine the transformer kVA rating:

1. If the load is expressed in kVA, select the appropriate transformer from the following selection charts (make sure the selected transformer's kVA rating is equal to or greater than the required load kVA).

$$\text{kVA (1Ø)} = \frac{\text{Volts x Amps}}{1000}$$

2. If the load is expressed in amperage, use either the appropriate kVA formula listed below or the appropriate sizing chart on the next page.

$$\text{kVA (3Ø)} = \frac{\text{Volts x Amps x 1.732}}{1000}$$

3. If the load is expressed in wattage, either utilize the formula below to convert to kVA or refer to the equipment nameplate to obtain amperage requirement.

$$\text{kVA} = \frac{\text{Wattage}}{(1000 \text{ x Power Factor of the load})}$$

4. If the load is a motor and expressed in horsepower, refer to the motor horsepower charts on the next page.

Some sizes may require an optional weather shield (order separately) for outdoor use.

kVA Rating	120 V	208 V	240 V	277 V	480 V	600 V
	Amperes					
SINGLE PHASE: FULL LOAD CURRENT CHART						
0.05	0.42	0.24	0.21	0.18	0.1	0.08
0.075	0.63	0.36	0.31	0.27	0.16	0.13
0.1	0.83	0.48	0.42	0.36	0.21	0.17
0.15	1.3	0.72	0.63	0.54	0.31	0.25
0.25	2.1	1.2	1	0.9	0.52	0.42
0.5	4.2	2.4	2.1	1.8	1.4	0.83
0.75	6.3	3.6	3.1	2.7	1.6	1.3
1	8.3	4.8	4.2	3.6	2.1	1.7
1.5	12.5	7.2	6.3	5.4	3.1	2.5
2	16.7	9.6	8.3	7.2	4.2	3.3
3	25	14.4	12.5	10.8	6.3	5
5	41.7	24	20.8	18.1	10.4	8.3
7.5	62.5	36.1	31.3	27.1	15.6	12.5
10	83.3	48.1	41.7	36.1	20.8	16.7
15	125	72.1	62.5	54.2	31.3	25
25	208.3	120.2	104.2	90.3	52.1	41.7
37.5	312.5	180.3	156.3	135.4	78.1	62.5
50	416.7	240.4	208.3	180.5	104.2	83.3
75	625	361	313	271	156	125
100	833	481	417	361	208	167
167	1392	803	696	603	348	278
200	1667	962	833	722	417	333
250	2083	1202	1042	903	521	417

kVA Rating	120 V	208 V	240 V	277 V	480 V	600 V
	Amperes					
THREE PHASE: FULL LOAD CURRENT CHART						
3	—	8.3	7.2	—	3.6	2.9
6	—	16.7	14.4	—	7.2	5.8
9	—	25	21.7	—	10.8	8.7
15	—	41.6	36.1	—	18	14.4
30	—	83.3	72.2	—	36.1	28.9
45	—	125	108.3	—	54.1	43.3
75	—	208.2	180.4	—	90.2	72.2
112.5	—	312	271	—	135	108
150	—	416	361	—	180	144
225	—	625	541	—	271	217
300	—	833	722	—	361	289
500	—	1388	1203	—	601	481

SELECTION STEPS

Special Considerations:

Three things to keep in mind for AC, Motor Horsepower Amperage:

1. Motor horsepower charts are based on 1800 RPM squirrel cage induction motors. If using another type of motor, check running amperage against the chart and adjust as necessary.
2. Increase required transformer kVAby 20% if motors are started more than once per hour.
3. If your motor service factor is greater than 1, proportionally increase full load amperage. (i.e. – if service factor is 1.10, increase full load amperage by 10%).

Are there any special application considerations?

A. For ambient conditions over 40°C, derate the transformer nameplate kVA by 8% for each 10°C above 40°C.
B. For high altitude applications, derate the transformer nameplate kVA by 0.3% for every 330 feet over 3300 feet above sea level. This assures proper transformer convection cooling.
C. Some applications may require a transformer design that limits the BTU output of the unit at full load or a design to withstand and mitigate specific electrical anomalies.

Horse Power	115 V	208 V	230 V	460 V	575 V	Mini Tfmr. kVA	Std. NEMA kVA Size
SINGLE PHASE MOTOR CHART: AC, MOTOR HORSEPOWER AMPERAGE							
1/6	4.4	2.4	2.2	1.1	0.9	0.53	0.75
1/4	5.8	3.2	2.9	1.4	1.2	0.7	0.75
1/3	7.2	4	3.6	1.8	1.4	0.87	1
1/2	9.8	5.4	4.9	2.5	2	1.2	1.5
3/4	13.8	7.6	6.9	3.5	2.8	1.7	2
1	16	8.8	8	4	3.2	1.9	2
1-1/2	20	11	10	5	4	2.4	3
2	24	13.2	12	6	4.8	2.9	3
3	34	18.7	17	8.5	6.8	4.1	5
5	56	30.8	28	14	11.2	6.7	7.5
7.5	80	44	40	21	16	9.6	10
10	100	55	50	26	20	12	15

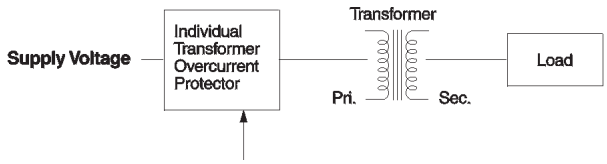
Horse Power	115 V	208 V	230 V	460 V	575 V	Mini Tfmr. kVA	Std. NEMA kVA Size
THREE PHASE MOTOR CHART: AC, MOTOR HORSEPOWER AMPERAGE							
1/2	—	2.2	2	1	0.8	0.9	3
3/4	—	3.1	2.8	1.4	1.1	1.2	3
1	—	4	3.6	1.8	1.4	1.5	3
1-1/2	—	5.7	5.2	2.6	2.1	2.1	3
2	—	7.5	6.8	3.4	2.7	2.7	3
3	—	10.7	9.6	4.8	3.9	3.8	6
5	—	16.7	15.2	7.6	6.1	6.3	9
7½	—	24	22	11	9	9.2	15
10	—	31	28	14	11	11.2	15
15	—	46	42	21	17	16.6	30
20	—	59	54	27	22	21.6	30
25	—	75	68	34	27	26.6	30
30	—	88	80	40	32	32.4	45
40	—	114	104	52	41	43.2	45
50	—	143	130	65	52	52	75
60	—	170	154	77	62	64	75
75	—	211	192	96	77	80	112.5
100	—	273	248	124	99	103	112.5
125	—	342	312	156	125	130	150
150	—	396	360	180	144	150	150
200	—	528	480	240	192	200	225

OVERCURRENT PROTECTION

Fusing and circuit breaker protection.

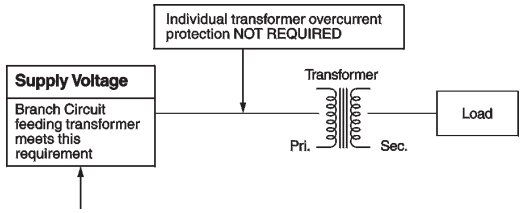
How to overcurrent protect 600 Volt class transformers and associated wiring per NEC 450.3 (B), NEC 240.3 and NEC 240.6 (A).

1. Primary protection only is required if the transformer is single-phase and the secondary has only two wires. Overcurrent protection rating and location are below.



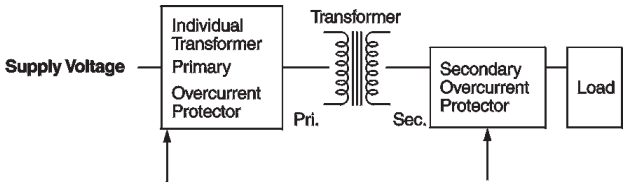
Primary Current	Overcurrent Protection Rating
2.2 Less than 2 amps	300% maximum
2 to 9 amps	167% maximum
9 amps or more	125% of rated primary current (or next highest standard rating)

2. If the branch circuit feeding the transformer has overcurrent protection to meet the individual protection requirements in Example 1, then individual transformer protection is not required.



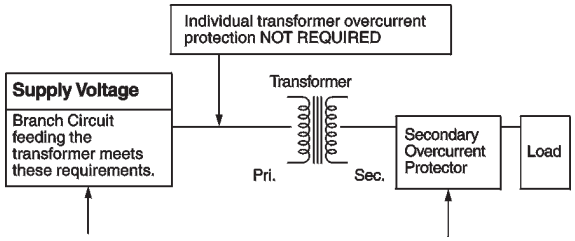
Primary Current	Overcurrent Protection Rating
2.2 Less than 2 amps	300% maximum
2 to 9 amps	167% maximum
9 amps or more	125% of rated primary current (or next highest standard rating)

3. Primary and secondary protection is required if the transformer has more than two wires on the secondary circuit.



Primary Current	Secondary Current	Overcurrent Protection Rating
250% primary current	Less than 9 amps	167% maximum
Not more than 250%	9 amps or more	125% (or next higher standard rating)

4. If the branch circuit feeding the transformer has overcurrent protection to meet the individual primary overcurrent protection requirements in Example 3, then individual primary protection is not required. Secondary OCP is required as shown below.



Primary Current	Secondary Current	Overcurrent Protection Rating
250% primary current	Less than 9 amps	167% maximum
Not more than 250%	9 amps or more	125% (or next higher standard rating)

PRIMARY FUSE RECOMMENDATIONS

Recommended fuse sizes per UL 508 and NEC 450.3 (B), NEC 430.72 and commercially available type fuses.

Primary Voltage													
Vin	120	200	208	220	230	240	277	440	460	480	550	575	600
VA													
50	1.25 (2)	.75 (1.25)	.6 (1.13)	.6 (1.13)	.6 (1)	.6 (1)	.5 (.8)	.3 (.5)	.3 (.5)	.3 (.5)	.25 (.4)	.25 (.4)	.25 (.4)
75	1.8 (3)	1.13 (1.8)	1 (1.8)	1 (1.6)	.8 (1.6)	.8 (1.5)	.8 (1.25)	.5 (.8)	.4 (.8)	.4 (.75)	.4 (.6)	.3 (.6)	.3 (.6)
100	2.5 (4)	1.5 (2.5)	1.4 (2.25)	1.25 (2.25)	1.25 (2)	1.25 (2)	1 (1.8)	.6 (1.13)	.6 (1)	.6 (1)	.5 (.8)	.5 (.8)	.5 (.8)
150	3.5 (6.25)	2.25 (3.5)	2 (3.5)	2 (3.2)	1.8 (3.2)	1.8 (3)	1.6 (2.5)	1 (1.6)	.8 (1.6)	.8 (1.5)	.8 (1.25)	.75 (1.25)	.75 (1.25)
200	5 (8)	3 (5)	2.8 (4.5)	2.5 (4.5)	2.5 (4)	2.5 (4)	2 (3.5)	1.25 (2.25)	1.25 (2)	1.25 (2)	1 (1.8)	1 (1.5)	1 (1.6)
250	3 (5)	3.5 (6.25)	3.5 (6)	3.2 (5.6)	3.2 (5)	3 (5)	2.5 (4.5)	1.6 (2.8)	1.6 (2.5)	1.5 (2.5)	1.25 (2.25)	1.25 (2)	1.25 (2)
300	4 (6.25)	4.5 (7.5)	4 (7)	4 (6.25)	3.5 (6.25)	3.5 (6.25)	3.2 (5)	2 (3.2)	1.8 (3.2)	1.8 (3)	1.6 (2.5)	1.5 (2.5)	1.5 (2.5)
350	4.5 (7)	5 (8)	5 (8)	4.5 (7.5)	4.5 (7.5)	4 (7)	3.5 (6.25)	2.25 (3.5)	2.25 (3.5)	2 (3.5)	1.8 (3)	1.8 (3)	1.75 (2.5)
500	6.25 (10)	4 (6.25)	4 (6)	3.5 (5.6)	3.5 (5)	3 (5)	5 (9)	3.2 (5.6)	3.2 (5)	3 (5)	2.5 (4.5)	2.5 (4)	2.5 (4)
750	10 (15)	6.25 (9)	6 (9)	5.6 (8)	5 (8)	5 (7.5)	8 (12)	5 (8)	4.5 (8)	4.5 (7.5)	4 (6.25)	3.5 (6.25)	3.5 (6.25)
1000	12 (20)	8 (12)	8 (12)	7.5 (10)	7 (10)	6.25 (10)	10 (17.5)	3.5 (5.6)	3.6 (5)	3 (5)	5 (9)	5 (8)	5 (8)
1500	17.5 (30)	12 (15)	12 (15)	10 (15)	10 (15)	10 (15)	15 (25)	5.6 (8)	5 (8)	5 (7.5)	4.5 (6.25)	4.5 (6.25)	4.5 (6.25)
2000	25 (40)	15 (25)	15 (20)	15 (20)	12 (20)	12 (20)	20 (35)	7.5 (10)	7 (10)	6.25 (10)	6 (9)	5.6 (8)	5 (8)
3000	35 (60)	20 (35)	20 (35)	17.5 (30)	17.5 (30)	20 (30)	35 (50)	10 (15)	10 (15)	10 (15)	9 (12)	8 (12)	8 (12)
5000	60 (100)	35 (60)	30 (60)	30 (50)	30 (50)	30 (50)	60 (90)	15 (25)	15 (25)	15 (25)	12 (20)	12 (20)	12 (20)
7500	80 (150)	50 (90)	45 (90)	45 (80)	45 (80)	40 (70)	90 (125)	25 (40)	25 (40)	20 (35)	20 (30)		
10K	110 (200)	70 (125)	60 (110)	60 (110)	60 (110)	60 (100)	110 (175)	30 (50)	30 (50)	30 (50)	25 (45)		
15K	175 (300)	100 (175)	90 (175)	90 (150)	90 (150)	80 (150)	175 (250)	45 (80)	45 (80)	40 (70)	35 (60)		
25K	300 (500)	175 (300)	150 (300)	150 (250)	150 (250)	150 (250)	90 (250)	60 (70)	70 (125)	70 (125)	60 (110)		
37K						200 (350)				100 (175)			80 (150)
50K						300 (500)				150 (250)			110 (200)
75K						400 (750)				200 (350)			175 (300)
100K						600 (1000)				300 (500)			225 (400)
167K						900 (1600)				450 (850)			350 (650)

Fuse = I times 300% next size smaller if primary current is less than 2 amp. No secondary fusing required.
*(Fuse) = (I*500%) next size smaller if used for a motor control circuit per NEC 430.72 (C) (4).*

Fuse = I times 167% next size smaller if primary current is less than 9 amp. No secondary fusing required.
(Fuse) = (I times 250%) next size smaller if primary current is less than 9 Amps. Secondary fusing is required see chart for size.

Fuse = I times 125% next size higher if primary current is 9 amp. or higher. No secondary fusing required.
(Fuse) = (I times 250%) next size smaller if primary current is 9 Amps. or higher. Secondary fusing is required see chart for size.

PRIMARY AND SECONDARY OVERCURRENTS

Primary Overcurrent Protection
A transformer has all the same component parts as a motor, and like a motor, exhibits an inrush when energized. This inrush current is dependent upon where in the sine wave the transformer was last turned off in relation to the point of the sinewave you are when you energize the transformer. Although transformer inrush could run up to 30 to 35 times full load current under no load, it typically is the same as a motor, about 6 to 8 times normal running current. For this reason it is important to use a dual element slow blow type fuse, the same type of fuse you would use with a motor. If using a circuit breaker, select a breaker with a time delay, again the same type you would use with a motor. If the time delay is not sufficient, you may experience "nuisance tripping" – a condition where the breaker trips when energizing the transformer but it functions properly after it is re-started.

Secondary Overcurrent Protection
Overcurrent devices are used between the output terminals of the transformer and the load for three reasons:

1. Protect the transformer from load electrical anomalies.
2. Since short circuit current is minimized, a smaller gauge wire may be used between the transformer and the load.
3. Per NEC, a larger primary fuse may be used to reduce nuisance tripping.

Secondary Fuse Recommendations

Secondary Voltage							
V_{OUT}	24	110	115	120	220	230	240
VA	Secondary Time Delay Dual Element Slow-Blow Fuse						
50	3.2	0.75	0.6	0.6	0.3	0.3	0.3
75	5	1.125	1	1	0.5	0.5	0.5
100	6.25	1.5	1.4	1.25	0.75	0.6	0.6
150	10	2.25	2	2	1.13	1	1
200	12	3	2.8	2.5	1.5	1.4	1.25
250	15	3.5	3.5	3.2	1.8	1.8	1.6
300	20	4.5	4	4	2.25	2	2
350	20	5	5	4.5	2.5	2.5	2.25
500	30	7.5	7	6.25	3.5	3.5	3.2
750	40	10	10	10	5.6	5	5
1000		12	12	12	7	7	6.25
1500		17.5	17.5	17.5	10	10	10
2000		25	25	25	12	12	12
3000		35	35	35	17.5	17.5	17.5
5000		60	60	60	30	30	30
7500		90	90	80	45	45	40
10K		125	110	110	60	60	60
15K		175	175	175	90	90	80
25K		300	300	300	150	150	150
37.5K				400			200
50K				600			300
75K				800			400
100K				1200			600
167K				1800			900

Fuse = I times 167% next size smaller if sec

Fuse = I times 125% next size smaller if secondary

GENERAL PURPOSE

Energy efficient dry-type transformers 600 Volt Class, isolation type, single and three phase, 15 kVA through 500 kVA. Indoor and outdoor models available.

Accessories and Optional Design Styles

- Electrostatic shield for quality power
- Wall mounting brackets (500 lbs maximum) (Item WB1C)
- Weather Shields (UL Listed/NEMA Type 3R)
- Stainless Steel Enclosures
- Totally enclosed non-ventilated designs (TENV) (Non UL) *
- Open core and coil designs (UL Recognized)
- Copper Wound designs
- Low temperature designs

Features

- Energy Efficient Compliant to DOE 2016
- UL Listed/NEMA Type 3R ventilated outdoor enclosures when used with optional weather shields (order separately)
- UL Class 220°C insulation system, 150°C temperature rise under full load
- Terminal board connections and spacious wiring compartment
- Panel enclosure design reduces labor time. Wiring diagram on inside front cover
- High efficiency for low cost operation
- Single and three phase availability
- Fast delivery
- 10 year limited warranty

Certifications and Compliances

- UL LISTED: E25872
  - UL 1561

Primary Voltage Selection Tables: Single Phase

kVA	Catalog Number	Type 3R Weather Shield ①	Height in (mm)	Width in (mm)	Depth in (mm)	Approx. Ship Weight lbs (kg)	Design Style ②	Elec Conn ②	Primary Amps	Secondary Amps
Group 1: 240 x 480 Volt Primary, 120/240 Secondary, 60 Hz										
15	ES5H15S	WS-15	28 (711)	16 (406)	16 (406)	210 (95)	1	1	62.5/31.3	125/62.5
25	ES5H25S	WS-15	28 (711)	16 (406)	16 (406)	245 (111)	1	1	104/52.1	208/104
37.5	ES5H37S	WS-17	31 (787)	18 (457)	18 (457)	340 (154)	1	1	156/78	313/156
50	ES5H50S	WS-17	31 (787)	18 (457)	18 (457)	415 (188)	1	1	208/104	416/208
75	ES5H75S	WS-09	44 (1118)	23 (584)	21 (533)	610 (277)	1	1	313/156	625/313
100	ES5H100S	WS-09	44 (1118)	23 (584)	21 (533)	705 (320)	1	1	417/208	833/417
167	ES5H167S	WS-16	46 (1168)	26 (660)	24 (610)	980 (445)	1	1	695/348	1392/695

kVA	Catalog Number	Type 3R Weather Shield ①	Height in (mm)	Width in (mm)	Depth in (mm)	Approx. Ship Weight lbs (kg)	Design Style ②	Elec Conn ②	Primary Amps @ 277 V	Secondary Amps
Group 2 – 120/208/240/277 Volt Primary, 120/240 Secondary, 60 Hz										
15	ES12H15S	WS-15	28 (711)	16 (406)	16 (406)	215 (98)	1	2	54.2	125/62.5
25	ES12H25S	WS-15	28 (711)	16 (406)	16 (406)	250 (113)	1	2	90.3	208/104

Notes:
① Weather shields (set of two) must be ordered separately.
② Design Styles and Electrical Connections can be found at the end of the Ventilated Distribution Transformers section.

** Not all optional designs are UL listed. Contact Technical Services.*

GENERAL PURPOSE

Energy efficient dry-type transformers 600 Volt Class, isolation type, single and three phase, 15 kVA through 500 kVA. Indoor and outdoor models available.

Selection Tables: Three Phase

kVA	Catalog Number	Type 3R Weather Shield ①	Height in (mm)	Width in (mm)	Depth in (mm)	Approx. Ship Weight lbs (kg)	Design Style ②	Elec Conn ②	Primary Amps	Secondary Amps
Group A: 480 Volt Δ Primary, 208/120 Secondary, 60 Hz										
15	E2H15 ③ E2H15S	WS-02	23 (584)	18 (457)	14 (356)	221 (100)	1	5	18.1	41.7
30	E2H30 ③ E2H30S	WS-14	28 (711)	23 (584)	16 (406)	310 (141)	1	5	36.1	83.4
45	E2H45 ③ E2H45S	WS-14	28 (711)	23 (584)	16 (406)	387 (176)	1	5	54.2	125
75	E2H75 ③ E2H75S	WS-30	34 (864)	28 (711)	22 (559)	678 (308)	1	5	90.3	208
112.5	E2H112S	WS-30	34 (864)	28 (711)	22 (559)	794 (360)	1	5	135	313
150	E2H150S	WS-10	44 (1118)	33 (838)	21 (533)	1005 (456)	1	5	181	417
225	E2H225S	WS-11	46 (1168)	36 (914)	24 (610)	1368 (621)	1	5	271	625
300	E2H300S	WS-11	46 (1168)	36 (914)	24 (6010)	1479 (671)	1	5	361	834
500	E2H500S	WS-12	65 (1651)	45 (1143)	35 (889)	2457 (1114)	1	5	602	1390
Group B: 480 Volt Δ Primary, 240 Volt Δ, Secondary with reduced capacity center tap ④, 60 Hz										
15	E5H15 ③ E5H15S	WS-02	23 (584)	18 (457)	14 (356)	221 (100)	1	6	18.1	36.1
30	E5H30 ③ E5H30S	WS-14	28 (711)	23 (584)	16 (406)	322 (146)	1	6	36.1	72.3
45	E5H45 ③ E5H45S	WS-14	28 (711)	23 (584)	16 (406)	387 (176)	1	6	54.2	108
75	E5H75 ③ E5H75S	WS-30	34 (864)	28 (711)	22 (559)	678 (308)	1	6	90.3	181
112.5	E5H112S	WS-30	34 (864)	28 (711)	22 (559)	792 (359)	1	6	135	271
150	E5H150S	WS-10	44 (1118)	33 (838)	21 (533)	1009 (458)	1	6	181	361
225	E5H225S	WS-11	46 (1168)	36 (914)	24 (610)	1367 (620)	1	6	271	542
300	E5H300S	WS-11	46 (1168)	36 (914)	24 (610)	1478 (670)	1	6	361	723
500	E5H500S	WS-12	65 (1651)	45 (1143)	35 (889)	2457 (1114)	1	6	602	1204

Notes:
① Weather shields (set of two) must be ordered separately.
② Design Styles and Electrical Connections can be found at the end of the Ventilated Distribution Transformers section.
③ Unshielded model.
④ Refer to Capacity of Center Tap in Center Tap Delta Transformers at the beginning of this section.

GENERAL PURPOSE

Energy efficient dry-type transformers 600 Volt Class, isolation type, single and three phase, 15 kVA through 500 kVA. Indoor and outdoor models available.

Selection Tables: Three Phase

kVA	Catalog Number	Type 3R Weather Shield ①	Height in (mm)	Width in (mm)	Depth in (mm)	Approx. Ship Weight lbs (kg)	Design Style ②	Elec Conn ②	Primary Amps	Secondary Amps
Group C: 480 Volt Δ Primary, 480Y/277 Secondary, 60 Hz										
15	E81H15S	WS-02	23 (584)	18 (457)	14 (356)	220 (100)	1	8	18.1	18.1
30	E81H30S	WS-14	28 (711)	23 (584)	16 (406)	322 (146)	1	8	36.1	36.1
45	E81H45S	WS-14	28 (711)	23 (584)	16 (406)	387 (176)	1	8	54.2	54.2
75	E81H75S	WS-30	34 (864)	28 (711)	22 (559)	679 (308)	1	8	90.3	90.3
112.5	E81H112S	WS-30	34 (864)	28 (711)	22 (559)	791 (359)	1	8	135	135
150	E81H150S	WS-10	44 (1118)	33 (838)	21 (533)	1001 (454)	1	8	181	181
225	E81H225S	WS-11	46 (1168)	36 (914)	24 (610)	1377 (625)	1	8	271	271
300	E81H300S	WS-11	46 (1168)	36 (914)	24 (6010)	1497 (679)	1	8	361	361
500	E81H500S	WS-12	65 (1651)	45 (1143)	35 (889)	2456 (1114)	1	8	602	602
Group D: 208 Volt Δ Primary, 480Y/277 Secondary, 60 Hz										
15	E84H15S	WS-02	23 (584)	18 (457)	14 (356)	220 (100)	1	10	41.7	18.1
30	E84H30S	WS-14	28 (711)	23 (584)	16 (406)	320 (145)	1	10	83.4	36.1
45	E84H45S	WS-14	28 (711)	23 (584)	16 (406)	390 (177)	1	10	125	54.2
75	E84H75S	WS-30	34 (864)	28 (711)	22 (559)	680 (308)	1	10	208	90.3
112.5	E84H112S	WS-30	34 (864)	28 (711)	22 (559)	799 (362)	1	10	313	135
150	E84H150S	WS-10	44 (1118)	33 (838)	21 (533)	1000 (454)	1	10	417	181
Group E: 208 Volt Δ Primary, 208Y/120 Secondary, 60 Hz										
15	E3H15S	WS-02	23 (584)	18 (457)	14 (356)	222 (101)	1	9	41.7	41.7
30	E3H30S	WS-14	28 (711)	23 (584)	16 (406)	320 (145)	1	9	83.4	83.4
45	E3H45S	WS-14	28 (711)	23 (584)	16 (406)	390 (177)	1	9	125	125
75	E3H75S	WS-30	34 (864)	28 (711)	22 (559)	679 (308)	1	9	208	208
112.5	E3H112S	WS-30	34 (864)	28 (711)	22 (559)	801 (363)	1	9	313	313
150	E3H150S	WS-10	44 (1118)	33 (838)	21 (533)	1004 (455)	1	9	416	416
Group F: 240 Volt Δ Primary, 208Y/120 Secondary, 60 Hz										
15	E6H15S	WS-02	23 (584)	18 (457)	14 (356)	220 (100)	1	11	36.1	41.7
30	E6H30S	WS-14	28 (711)	23 (584)	16 (406)	311 (141)	1	11	72.3	83.4
45	E6H45S	WS-14	28 (711)	23 (584)	16 (406)	392 (178)	1	11	108	125
75	E6H75S	WS-30	34 (864)	28 (711)	22 (559)	678 (308)	1	11	181	208
112.5	E6H112S	WS-30	34 (864)	28 (711)	22 (559)	799 (362)	1	11	271	313
150	E6H150S	WS-10	44 (1118)	33 (838)	21 (533)	1005 (456)	1	11	361	417

Notes:
① Weather shields (set of two) must be ordered separately.
② Design Styles and Electrical Connections can be found at the end of the Ventilated Distribution Transformers section.

GENERAL PURPOSE

Energy efficient dry-type transformers 600 Volt Class, isolation type, single and three phase, 15 kVA through 500 kVA. Indoor and outdoor models available.

Selection Tables: Three Phase

kVA	Catalog Number	Type 3R Weather Shield ①	Height in (mm)	Width in (mm)	Depth in (mm)	Approx. Ship Weight lbs (kg)	Design Style ②	Elec Conn ②	Primary Amps	Secondary Amps
Group G: 240 Volt Δ Primary, 480Y/277 Secondary, 60 Hz										
15	E85H15S	WS-02	23 (584)	18 (457)	14 (356)	221 (100)	1	12	36.1	18.1
30	E85H30S	WS-14	28 (711)	23 (584)	16 (406)	322 (146)	1	12	72.3	36.1
45	E85H45S	WS-14	28 (711)	23 (584)	16 (406)	392 (178)	1	12	108	54.2
75	E85H75S	WS-30	34 (864)	28 (711)	22 (559)	682 (309)	1	12	181	90.3
112.5	E85H112S	WS-30	34 (864)	28 (711)	22 (559)	798 (362)	1	12	271	135
150	E85H150S	WS-10	44 (1118)	33 (838)	21 (533)	1001 (454)	1	12	361	181
Group J: 480 Volt Δ Primary, 380Y/220 Secondary, 60 Hz										
15	E79H15S	WS-02	23 (584)	18 (457)	14 (356)	220 (100)	1	7	18.1	22.8
30	E79H30S	WS-14	28 (711)	23 (584)	16 (406)	320 (145)	1	7	36.1	45.6
45	E79H45S	WS-14	28 (711)	23 (584)	16 (406)	387 (176)	1	7	54.2	68.4
75	E79H75S	WS-30	34 (864)	28 (711)	22 (559)	678 (308)	1	7	90.3	114
112.5	E79H112S	WS-30	34 (864)	28 (711)	22 (559)	797 (362)	1	7	135.3	170.9
150	E79H150S	WS-10	44 (1118)	33 (838)	21 (533)	1011 (459)	1	7	180.4	227.9
Group K: 480 Volt Δ Primary, 208Y/120 Secondary, 60 Hz, Copper-Wound										
15	E2H15SCU	WS-02	23 (584)	18 (457)	14 (356)	255 (116)	1	5	18.1	41.7
30	E2H30SCU	WS-14	28 (711)	23 (584)	16 (406)	349 (158)	1	5	36.1	83.4
45	E2H45SCU	WS-14	28 (711)	23 (584)	16 (406)	455 (206)	1	5	54.2	125
75	E2H75SCU	WS-30	34 (864)	28 (711)	22 (559)	781 (354)	1	5	90.3	208
112.5	E2H112SCU	WS-30	34 (864)	28 (711)	22 (559)	923 (419)	1	5	135	313
150	E2H150SCU	WS-10	44 (1118)	33 (838)	21 (533)	1154 (523)	1	5	181	417
225	E2H225SCU	WS-11	46 (1168)	36 (914)	24 (610)	1539 (698)	1	5	271	625
300	E2H300SCU	WS-11	46 (1168)	36 (914)	24 (610)	1662 (754)	1	5	361	834
500	E2H500SCU	WS-12	65 (1651)	45 (1143)	35 (889)	2457 (1114)	1	5	602	1390

Notes:
① Weather shields (set of two) must be ordered separately.
② Design Styles and Electrical Connections can be found at the end of the Ventilated Distribution Transformers section.

LOW TEMPERATURE RISE

SolaHD low temperature rise transformers feature a 220°C insulation system and temperature rise of only 80°C or 115°C under full nameplate load. Reduction in temperature rise increases reliability.

The 35°C thermal reserve on 115°C rise units and 70°C reserve on 80°C rise units definitely mean higher reliability. The extra benefit is being able to operate either of these transformers as a 150°C rise unit and have a short term overload capacity of 15-30% without compromising normal life expectancy (See Figure 1 below).

Low temperature rise transformers are designed for any critical application requiring extra overload capability and cooler operating temperatures. All are available with either a 115°C or 80°C thermal rise and a Class 220°C insulation system.

Features

- Energy Efficient Compliant to DOE 2016
- Extra thermal reserve

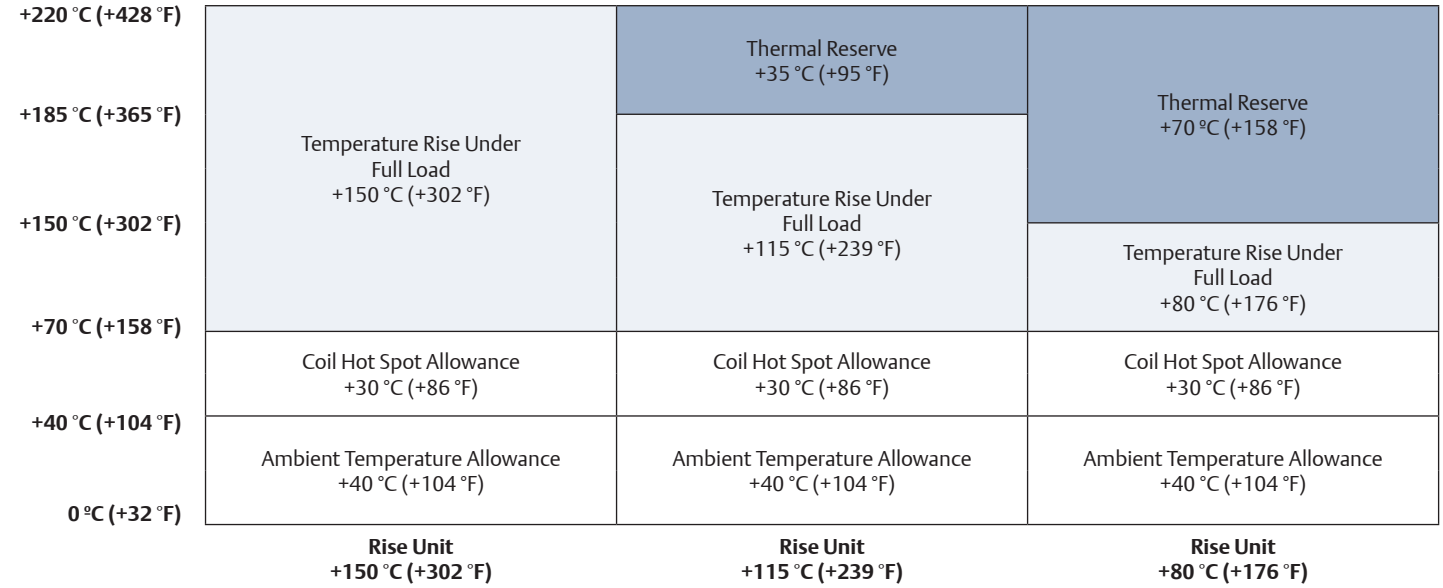
Accessories and Optional Design Styles

- Energy Efficient Compliant to DOE 2016
- Wall mounting brackets (500 lbs maximum) (Item WB1C)
- Weather Shields (UL Listed/NEMA Type 3R)
- Stainless Steel Enclosures
- Totally enclosed non-ventilated designs (TENV) (Non UL) *
- Open core and coil designs (UL Recognized)
- Copper Wound designs

Certifications and Compliances

- UL LISTED: E25872
  - UL 1561

Figure 1



LOW TEMPERATURE RISE

SolaHD low temperature rise transformers feature a 220°C insulation system and temperature rise of only 80°C or 115°C under full nameplate load. Reduction in temperature rise increases reliability.

Selection Tables: Low Temperature Rise, Single Phase, 80°C Rise

kVA	Catalog Number 80°C Rise	Type 3R Weather Shield ①	Height in (mm)	Width in (mm)	Depth in (mm)	Approx. Ship Weight lbs (kg)	Design Style ②	Elec Conn ②	Primary Amps	Secondary Amps
Group 1: 240 x 480 Volt Primary, 120/240 Secondary, 60 Hz, 80°C Rise										
15	ES5HB15S	WS-15	28 (711)	16 (406)	16 (406)	265 (120)	1	1	62.5/31.3	125/62.5
25	ES5HB25S	WS-17	31 (787)	18 (457)	18 (457)	340 (154)	1	1	104/52.1	208/104
37.5	ES5HB37S	WS-17	31 (787)	18 (457)	18 (457)	425 (193)	1	1	156/78	313/156
50	ES5HB50S	WS-09	44 (1118)	23 (584)	21 (533)	655 (297)	1	1	208/104	416/208
75	ES5HB75S	WS-09	44 (1118)	23 (584)	21 (533)	750 (340)	1	1	313/156	625/313
100	ES5HB100S	WS-16	46 (1168)	26 (660)	24 (610)	980 (445)	1	1	417/208	833/417

Selection Tables: Low Temperature Rise, Three Phase, 80°C Rise

kVA	Catalog Number 80°C Rise	Type 3R Weather Shield ①	Height in (mm)	Width in (mm)	Depth in (mm)	Approx. Ship Weight lbs (kg)	Design Style ②	Elec Conn ②	Primary Amps	Secondary Amps
Group A: 480 Δ Primary, 208Y/120 Secondary, 60 Hz, 80°C Rise										
15	E2HB15S	WS-14	28 (711)	23 (584)	16 (406)	310 (141)	1	5	18.1	41.7
30	E2HB30S	WS-14	28 (711)	23 (584)	16 (406)	387 (176)	1	5	36.1	83.4
45	E2HB45S	WS-30	34 (864)	28 (711)	22 (559)	678 (308)	1	5	54.2	125
75	E2HB75S	WS-30	34 (864)	28 (711)	22 (559)	794 (360)	1	5	90.3	208
112.5	E2HB112S	WS-10	44 (1118)	33 (838)	21 (533)	1005 (456)	1	5	135	313
150	E2HB150S	WS-11	46 (1168)	36 (914)	24 (610)	1368 (621)	1	5	181	417
225	E2HB225S	WS-11	46 (1168)	36 (914)	24 (610)	1479 (671)	1	5	271	625
300	E2HB300S	WS-12	65 (1651)	45 (1143)	35 (889)	2457 (1114)	1	5	361	834
Group B: 480 Δ Primary, 240 Δ Secondary with 120V Reduced Capacity Center Tap ③, 80°C Rise										
15	E5HB15S	WS-14	28 (711)	23 (584)	16 (406)	322 (146)	1	6	18.1	36.1
30	E5HB30S	WS-14	28 (711)	23 (584)	16 (406)	387 (176)	1	6	36.1	72.3
45	E5HB45S	WS-30	34 (864)	28 (711)	22 (559)	678 (308)	1	6	54.2	108
75	E5HB75S	WS-30	34 (864)	28 (711)	22 (559)	792 (359)	1	6	90.3	181
112.5	E5HB112S	WS-10	44 (1118)	33 (838)	21 (533)	1009 (458)	1	6	135	271
150	E5HB150S	WS-11	46 (1168)	36 (914)	24 (610)	1367 (620)	1	6	181	361
225	E5HB225S	WS-11	46 (1168)	36 (914)	24 (610)	1478 (670)	1	6	271	542
300	E5HB300S	WS-12	65 (1651)	45 (1143)	35 (889)	2457 (1114)	1	6	361	723

Notes:
① Weather shields (set of two) must be ordered separately.
② Design Styles and Electrical Connections can be found at the end of the Ventilated Distribution Transformers section.
③ Refer to Capacity of Center Tap in Center Tap Delta Transformers at the beginning of this section.

LOW TEMPERATURE RISE

SolaHD low temperature rise transformers feature a 220°C insulation system and temperature rise of only 80°C or 115°C under full nameplate load. Reduction in temperature rise increases reliability.

Selection Tables: Low Temperature Rise, Single Phase, 115°C Rise

kVA	Catalog Number 115°C Rise	Type 3R Weather Shield ①	Height in (mm)	Width in (mm)	Depth in (mm)	Approx. Ship Weight lbs (kg)	Design Style ②	Elec Conn ②	Primary Amps	Secondary Amps
Group 1: 240 x 480 Volt Primary, 120/240 Secondary, 60 Hz, 115°C Rise										
15	ES5HF15S	WS-15	28 (711)	16 (406)	16 (406)	210 (95)	1	1	62.5/31.3	125/62.5
25	ES5HF25S	WS-15	28 (711)	16 (406)	16 (406)	245 (111)	1	1	104/52.1	208/104
37.5	ES5HF37S	WS-17	31 (787)	18 (457)	18 (457)	340 (154)	1	1	156/78	313/156
50	ES5HF50S	WS-17	31(787)	18(457)	18 (457)	425 (193)	1	1	208/104	416/208
75	ES5HF75S	WS-09	44 (1118)	23 (584)	21 (533)	610 (277)	1	1	313/156	625/313
100	ES5HF100S	WS-09	44 (1118)	23 (584)	21 (533)	750 (340)	1	1	417/208	833/417

Selection Tables: Low Temperature Rise, Three Phase, 115°C Rise

kVA	Catalog Number 115°C Rise	Type 3R Weather Shield ①	Height in (mm)	Width in (mm)	Depth in (mm)	Approx. Ship Weight lbs (kg)	Design Style ②	Elec Conn ②	Primary Amps	Secondary Amps
Group A: 480 Δ Primary, 208Y/120 Secondary, 60 Hz, 115°C Rise										
15	E2HF15S	WS-02	23 (584)	18 (457)	14 (356)	222 (101)	1	5	18.1	41.7
30	E2HF30S	WS-14	28 (711)	23 (584)	16 (406)	307 (139)	1	5	36.1	83.4
45	E2HF45S	WS-14	28 (711)	23 (584)	16 (406)	378 (171)	1	5	54.2	125
75	E2HF75S	WS-30	34 (864)	28 (711)	22 (559)	672 (305)	1	5	90.3	208
112.5	E2HF112S	WS-30	34 (864)	28 (711)	22 (559)	794 (360)	1	5	135	313
150	E2HF150S	WS-10	44 (1118)	33 (838)	21 (533)	1002 (454)	1	5	181	417
225	E2HF225S	WS-11	46 (1168)	36 (914)	24 (610)	1393 (632)	1	5	271	625
300	E2HF300S	WS-11	46 (1168)	36 (914)	24 (610)	1519 (689)	1	5	361	834
Group B: 480 Volt Δ Primary, 240 Volt Δ, Secondary with reduced capacity center tap, 60 Hz, 80°C Rise										
15	E5HF15S	WS-02	23 (584)	18 (457)	14 (356)	224 (102)	1	6	18.1	36.1
30	E5HF30S	WS-14	28 (711)	23 (584)	16 (406)	307 (139)	1	6	36.1	72.3
45	E5HF45S	WS-14	28 (711)	23 (584)	16 (406)	378 (171)	1	6	54.2	108
75	E5HF75S	WS-30	34 (864)	28 (711)	22 (559)	668 (303)	1	6	90.3	181
112.5	E5HF112S	WS-30	34 (864)	28 (711)	22 (559)	794 (360)	1	6	135	271
150	E5HF150S	WS-10	44 (1118)	33 (838)	21 (533)	1002 (454)	1	6	181	361
225	E5HF225S	WS-11	46 (1168)	36 (914)	24 (610)	1393 (632)	1	6	271	542
300	E5HF300S	WS-11	46 (1168)	36 (914)	24 (610)	1519 (689)	1	6	361	723

Notes:
① Weather shields (set of two) must be ordered separately.
② Design Styles and Electrical Connections can be found at the end of the Ventilated Distribution Transformers section.

K-FACTOR

K-Factor transformers are designed to reduce the heating effects of harmonic currents created by loads like those shown in Chart A. The K-Factor rating is an index of the transformer's ability to withstand harmonic content while operating within the temperature limits of its insulating system. SolaHD K-Factor transformers have UL ratings of K-4, K-13, and K-20.

The SolaHD K-Factor design is a specialized transformer that offers these benefits:

- Conductors capable of carrying the harmonic currents of non-linear loads without exceeding the temperature rating of the insulation system.
- A transformer design that takes into account the increase in naturally occurring "stray" losses caused by non-linear loads. These losses cause standard transformers to dramatically overheat and substantially shorten design life.
- A core and coil design that manages the DC flux caused by triplen harmonics. As these harmonics increase, they cause additional current to circulate in the delta winding. This produces a DC flux in the core which leads to core saturation, voltage instability and overheating.

Features

- Energy Efficient Compliant to DOE 2016
- Conductors to carry harmonics of a K-rated load without exceeding insulation temperature ratings
- UL 1561 Listed up to K-20 rated protection
- Rated temperature rise of 150°C, 220°C insulation
- Shielded for quality power
- Basic design takes "stray losses" into account and functions within safe operating temperatures
- Core and coil design engineered to manage the zero sequence flux caused by triplen harmonics
- Provides 100% rated current without overheating the windings or saturating the core

Accessories and Optional Design Styles

- Wall mounting brackets (500 lbs maximum) (Item WB1C)
- Weather Shields (UL Listed/NEMA Type 3R)
- Totally enclosed non-ventilated designs (TENV) (Non UL) *
- Low temperature rise units available
- Open core and coil designs (UL Recognized)
- Copper Wound designs
- Alternate voltages

Certifications and Compliances

- UL LISTED: E25872
  - UL 1561

Chart A: Typical Load K-Factors

Load	K-Factor
Electric discharge lighting	K-4
UPS with optional input filter	K-4
Welders	K-4
Induction heating equipment	K-4
PLCs and solid state controls	K-4
Telecommunications equipment (e.g.. PBX)	K-13
UPS without input filtering	K-13
Multiwire receptacle circuits in general care areas of health care facilities and classrooms of schools, etc.	K-13
Multi-wire receptacle circuits supplying inspection or testing equipment on an assembly or production line	K-13
Mainframe computer loads	K-20
Solid state motor drives (variable speed drives)	K-20

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** Not all optional designs are UL Listed. Contact Technical Services.*

K-FACTOR

K-Factor transformers are designed to reduce the heating effects of harmonic currents created by loads like those shown in Chart A. The K-Factor rating is an index of the transformer's ability to withstand harmonic content while operating within the temperature limits of its insulating system. SolaHD K-Factor transformers have UL ratings of K-4, K-13, and K-20.

Selection Tables: Three Phase

kVA	Catalog Number	Type 3R Weather Shield ①	Height in (mm)	Width in (mm)	Depth in (mm)	Approx. Ship Weight lbs (kg)	Design Style ②	Elec Conn ②	Primary Amps	Secondary Amps
Group A: K-4 Rated 480 Δ Primary, 208Y/120 Secondary, 60 Hz										
15	K4E2H15S	WS-02	23 (584)	18 (457)	14 (356)	221 (100)	1	5	18.1	41.7
30	K4E2H30S	WS-14	28 (711)	23 (584)	16 (406)	310 (141)	1	5	36.1	83.4
45	K4E2H45S	WS-14	28 (711)	23 (584)	16 (406)	387 (176)	1	5	54.2	125
75	K4E2H75S	WS-30	34 (864)	28 (711)	22 (559)	678 (308)	1	5	90.3	208
112.5	K4E2H112S	WS-30	34 (864)	28 (711)	22 (559)	794 (360)	1	5	135	313
150	K4E2H150S	WS-10	44 (1118)	33 (838)	21 (533)	1005 (456)	1	5	181	417
225	K4E2H225S	WS-11	46 (1168)	36 (914)	24 (610)	1368 (621)	1	5	271	625
300	K4E2H300S	WS-11	46 (1168)	36 (914)	24 (610)	1479 (671)	1	5	361	834
500	K4E2H500S	WS-12	65 (1651)	45 (1143)	35 (889)	2457 (1114)	1	5	602	1390
Group B: K-13 Rated 480 Δ Primary, 208Y/120 Secondary, 60 Hz										
15	K13E2H15S	WS-14	28 (711)	23 (584)	16 (406)	310 (141)	1	5	18.1	41.7
30	K13E2H30S	WS-14	28 (711)	23 (584)	16 (406)	387 (176)	1	5	36.1	83.4
45	K13E2H45S	WS-30	34 (864)	28 (711)	22 (559)	678 (308)	1	5	54.2	125
75	K13E2H75S	WS-30	34 (864)	28 (711)	22 (559)	794 (360)	1	5	90.3	208
112.5	K13E2H112S	WS-10	44 (1118)	33 (838)	21 (533)	1005 (456)	1	5	135	313
150	K13E2H150S	WS-11	46 (1168)	36 (914)	24 (610)	1368 (621)	1	5	181	417
225	K13E2H225S	WS-11	46 (1168)	36 (914)	24 (610)	1479 (671)	1	5	271	625
300	K13E2H300S	WS-12	65 (1651)	45 (1143)	35 (889)	2457 (1114)	1	5	361	834
Group C: K-20 Rated 480 Δ Primary, 208Y/120 Secondary, 60 Hz										
15	K20E2H15S	WS-14	28 (711)	23 (584)	16 (406)	310 (141)	1	5	18.1	41.7
30	K20E2H30S	WS-14	28 (711)	23 (584)	16 (406)	387 (176)	1	5	36.1	83.4
45	K20E2H45S	WS-30	34 (864)	28 (711)	22 (559)	678 (308)	1	5	54.2	125
75	K20E2H75S	WS-30	34 (864)	28 (711)	22 (559)	794 (360)	1	5	90.3	208
112.5	K20E2H112S	WS-10	44 (1118)	33 (838)	21 (533)	1005 (456)	1	5	135	313
150	K20E2H150S	WS-11	46 (1168)	36 (914)	24 (610)	1368 (621)	1	5	181	417
225	K20E2H225S	WS-11	46 (1168)	36 (914)	24 (610)	1479 (671)	1	5	271	625
300	K20E2H300S	WS-12	65 (1651)	45 (1143)	35 (889)	2457 (1114)	1	5	361	834

Notes:
① Weather shields (set of two) must be ordered separately.
② Design Styles and Electrical Connections can be found at the end of the Ventilated Distribution Transformers section.

ELECTRICAL CONNECTIONS

Single Phase

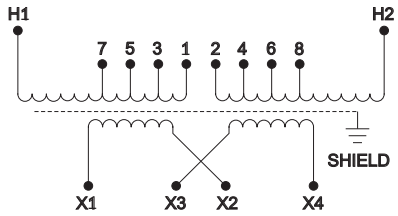
ES5 Series

1

240 x 480 Volt Primary

120/240 Volt Secondary

Taps: 2, 2-1/2% FCAN
4, 2-1/2% FCBN



Primary Voltage	Interconnect	Connect Lines to
504	1 to 2	H1 & H2
492	2 to 3	H1 & H2
480	3 to 4	H1 & H2
468	4 to 5	H1 & H2
456	5 to 6	H1 & H2
444	6 to 7	H1 & H2
432	7 to 8	H1 & H2
252	H1 to 2 H2 to 1	H1 & H2
240	H1 to 4 H2 to 3	H1 & H2
228	H1 to 6 H2 to 5	H1 & H2
216	H1 to 8 H2 to 7	H1 & H2
Secondary Voltage	**Interconnect**	**Connect Lines to**
240	X2 to X3	X1 & X4
120-0-120	X2 to X3 X2 to ⏚	X1-X2-X4
120	X1 to X3 X2 to X4	X1 & X4

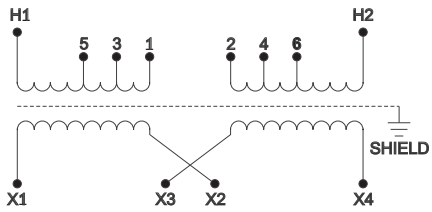
ES12 Series

2

120/208/240/277 Volt Primary

120/240 Volt Secondary

Taps: None



Primary Voltage	Interconnect	Connect Lines to
277	1 to 2	H1 & H2
240	3 to 4	H1 & H2
208	5 to 6	H1 & H2
120	H1 to 4 H2 to 3	H1 & H2
Secondary Voltage	**Interconnect**	**Connect Lines to**
240	X2 to X3	X1 & X4
120-0-120	X2 to X3 X2 to ⏚	X1-X2-X4
120	X1 to X3 X2 to X4	X1 & X4

SOLAHD

ELECTRICAL CONNECTIONS

Three Phase

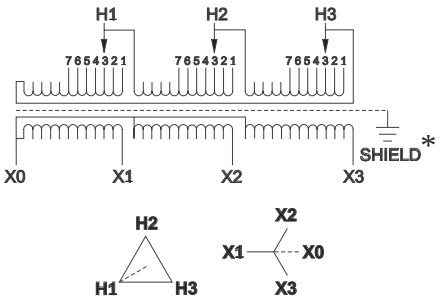
E2 and Kxx Series

5

480 Δ Volt Primary

208Y/120 Volt Secondary

Taps: 2, 2-1/2% FCAN
4, 2-1/2% FCBN



** Shield available in electrostatically shielded units only.*

Primary Voltage		Secondary Voltage	
@ Tap	Voltage	X1, X2, X3	X0- X1, X2, X3
1	504	208	120
2	492		
3	480		
4	468		
5	456		
6	444		
7	432		

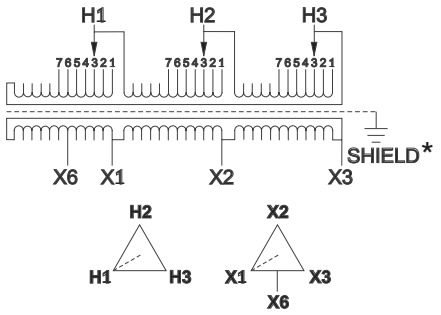
E5 Series

6

480 Δ Volt Primary

240 Δ W/120 CT Volt Secondary

Taps: 2, 2-1/2% FCAN
4, 2-1/2% FCBN



** Shield available in electrostatically shielded units only.*

Primary Voltage		Secondary Voltage	
@ Tap	Voltage	X1, X2, X3	X0- X1, X2, X3
1	504	240	120
2	492		
3	480		
4	468		
5	456		
6	444		
7	432		

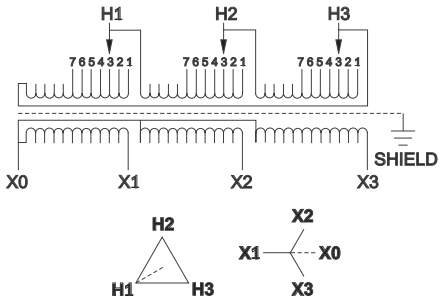
E79 Series

7

480 Δ Volt Primary

380/220 Volt Secondary

Taps: 2, 2-1/2% FCAN
4, 2-1/2% FCBN



Primary Voltage H1-H2-H3		Secondary Voltage	
@ Tap	Voltage	X1, X2, X3	X0- X1, X2, X3
1	504	380	220
2	492		
3	480		
4	468		
5	456		
6	444		
7	432		

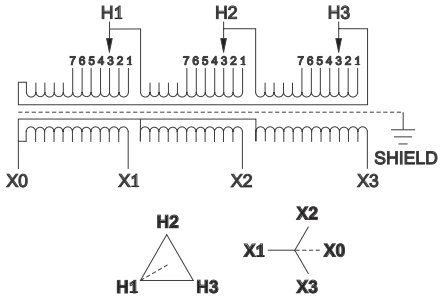
E81 Series

8

480 Δ Volt Primary

480Y/277 Volt Secondary

Taps: 2, 2-1/2% FCAN
4, 2-1/2% FCBN



Primary Voltage H1-H2-H3		Secondary Voltage	
@ Tap	Voltage	X1, X2, X3	X0- X1, X2, X3
1	504	480	277
2	492		
3	480		
4	468		
5	456		
6	444		
7	432		

ELECTRICAL CONNECTIONS

Three Phase

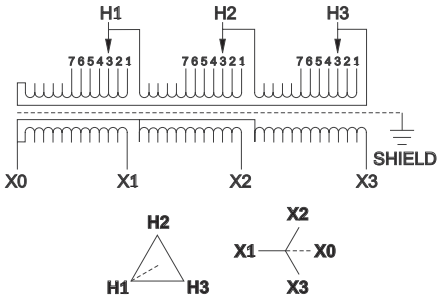
E3 Series

9

208 Δ Volt Primary

208Y/120 Volt Secondary

Taps: 2, 2-1/2% FCAN
4, 2-1/2% FCBN



Primary Voltage H1-H2-H3		Secondary Voltage	
@ Tap	Voltage	X1, X2, X3	X0- X1, X2, X3
1	218	208	120
2	213		
3	208		
4	203		
5	198		
6	192		
7	187		

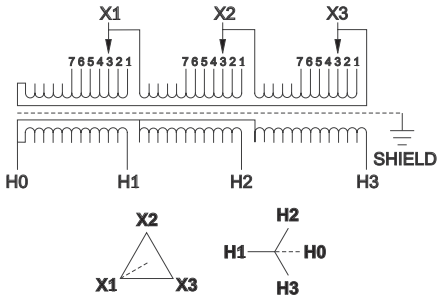
E84 Series

10

208 Δ Volt Primary

480Y/277 Volt Secondary

Taps: 2, 2-1/2% FCAN
4, 2-1/2% FCBN



Primary Voltage H1-H2-H3		Secondary Voltage	
@ Tap	Voltage	X1, X2, X3	X0- X1, X2, X3
1	218	480	277
2	213		
3	208		
4	203		
5	198		
6	192		
7	187		

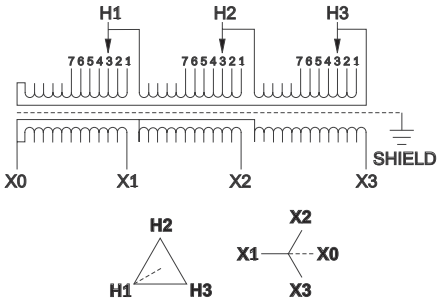
E6 Series

11

240 Δ Volt Primary

208Y/120 Volt Secondary

Taps: 2, 2-1/2% FCAN
4, 2-1/2% FCBN



Primary Voltage H1-H2-H3		Secondary Voltage	
@ Tap	Voltage	X1, X2, X3	X0- X1, X2, X3
1	252	208	120
2	246		
3	240		
4	234		
5	288		
6	222		
7	216		

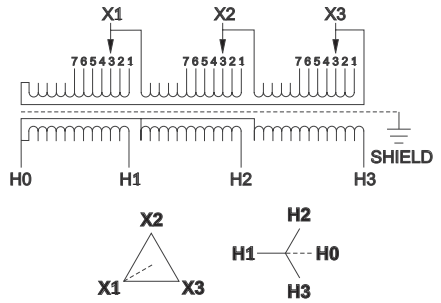
E85 Series

12

240 Δ Volt Primary

480Y/277 Volt Secondary

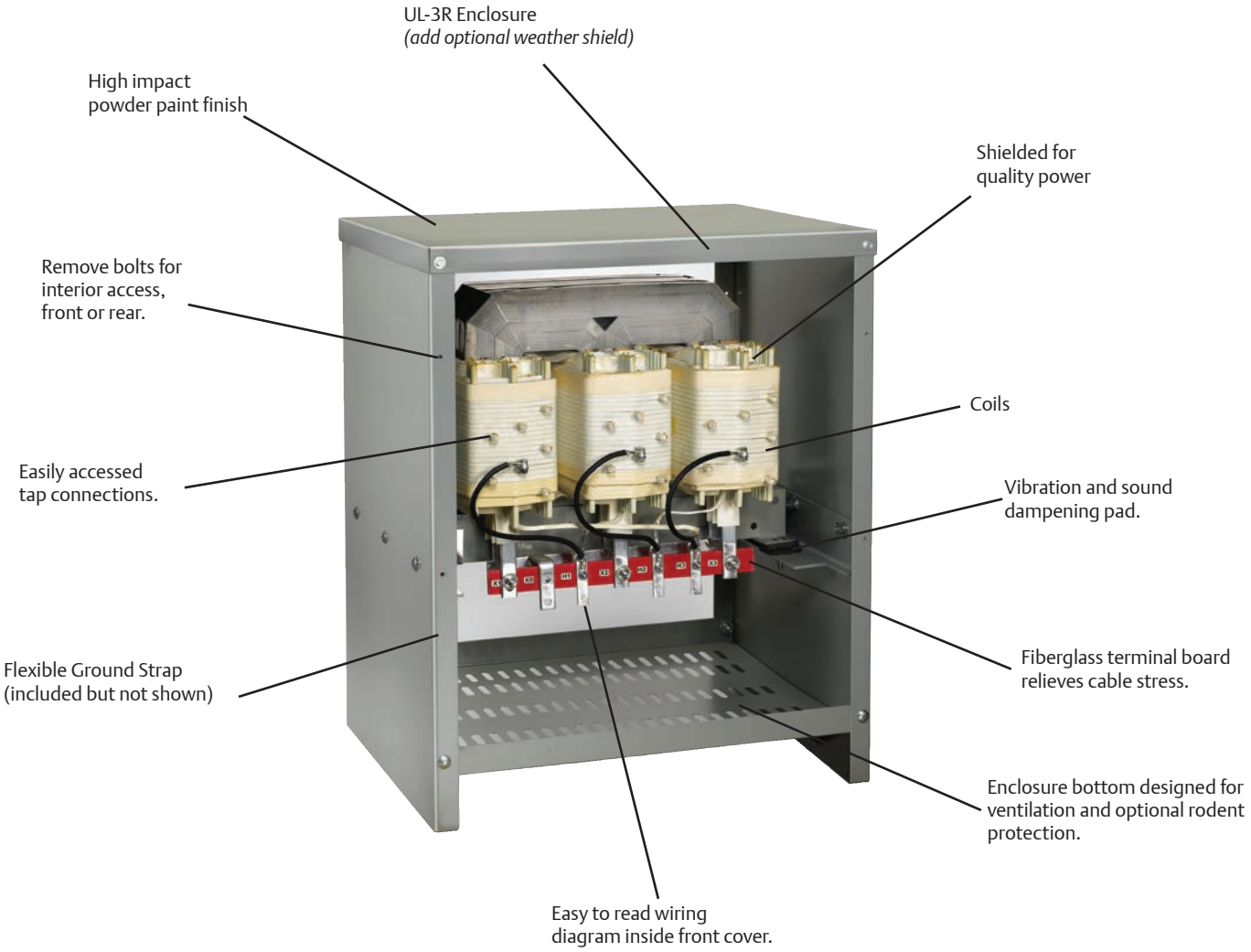
Taps: 2, 2-1/2% FCAN
4, 2-1/2% FCBN



Primary Voltage H1-H2-H3		Secondary Voltage	
@ Tap	Voltage	X1, X2, X3	X0- X1, X2, X3
1	252	480	277
2	246		
3	240		
4	234		
5	288		
6	222		
7	216		

SOLAHD

TRANSFORMER DESIGN



SPECIFICATION GUIDE

Low Voltage, General Purpose, Dry Type Transformers (600 Volt Class) - 15 kVA and larger

General

- Single and three phase distribution transformers (600 Volt and below)
- Provide and install, as referenced on the electrical plans, enclosed dry type transformers as manufactured by SolaHD or approved equal.

Standards

- Transformers must be listed by Underwriters Laboratory, certified with Canadian Standards Association and designed, constructed and rated in accordance with NEMA ST 20 and applicable IEEE & OSHA specifications.

Construction — Cores

- All transformer cores shall be constructed of low loss, high quality, electrical grade laminate steel. By design, the flux density is to be kept well below the saturation level to reduce audible sound level and minimize core losses. The core volume shall allow operation at 10%above rated primary voltage at no load without exceeding the temperature rise of the unit.

Construction — Coils

- Coil conductors shall be either aluminum or copper and must be continuous. The entire core and coil assembly shall be impregnated with a thermal setting varnish and cured to reduce hot spots in the coils and seal out moisture. Coils with exposed magnet wire will not be acceptable. Transformers shall have common core construction.
- All transformers shall incorporate a faraday (electrostatic) shield between primary and secondary windings for the attenuation of voltage spikes, line noise and voltage transients.
- Transformers shall be provided with six 2.5% full capacity taps – two above and four below primary rated voltage.
- General purpose transformers are classified as isolation transformers.

Enclosures

- Transformer enclosures shall be constructed of heavygauge sheet steel and coated with a grey powder paint finish (ANSI 61). Ventilated transformer enclosures shall be UL/NEMA Type 1 rated and UL/NEMA Type 3R rated for outdoor use with the addition of a weather shield. This information must be listed on the transformer nameplate.
- Maximum transformer enclosure temperature will not exceed 65°C rise above a 40°C ambient under full load.
- Transformers must have vibration isolators located between the core and coil assembly and the transformer enclosure to reduce audible sound levels caused from magnetostriction of the transformer core. No externally located vibration dampening pads shall be used as they tend to increase audible noise. Ventilated transformers are to be floor mounted to aconcrete pad.
- The transformer enclosure must be grounded by the installer in accordance with the latest edition of the National Electric Code and any local codes or ordinances.

Performance

- Audible sound levels will not exceed limits established in NEMA ST20:

  10 to 50 kVA 45 db
  51 to 150 kVA 50 db
  151 to 300 kVA 55 db
  301 to 500 kVA 60 db

- Transformers, 15 kVA to 500 kVA, shall incorporate a UL recognized 220°C insulation system and exhibit a maximum 150°C temperature rise above a maximum ambient of 40°C under full load.

Warranty

- Transformers are warranted against material, performance and workmanship defects for a period of ten (10) years from date of manufacture with the provision for an additional two (2) years.

BROADEST RANGE OF TRANSFORMERS

SolaHD is pleased to offer the broadest range of transformers on the market including many custom designs. If you can't find what you are looking for, please fill out the information below and submit to our Technical Services Group at solahd.technicalservices@emerson.com. We are happy to provide a quote on a custom transformer if available.

Information is required prior to quotation being issued | Email this form to solahd.technicalservices@emerson.com or fax to (800) 538-6545.

Information in **bold** is REQUIRED prior to quotation being issued.	**Date:**
Customer Information	
Distributor: _____	**Representative:** _____
Contact: _____	**Contact:** _____
Account Number: _____	**Phone:** _____
Phone: _____	Fax: _____
Fax: _____	**Email:** _____
Email: _____	**Job/Project Name:** _____
City/State: _____	

1: Specifications

1A: Size

☐ 15	☐ 25	☐ 30	☐ 37.5	☐ 45	☐ 50	☐ 75	☐ 100	☐ 112.5	☐ 150	☐ 167	☐ 225	☐ 300	☐ 500
☐ kVA	☐ VA												

1B: Quantity

_____ Number of Units	☐ One Time Buy		☐ Annual Usage	_____ Frequency of Purchase

1C: Temperature Rise (Check One)

☐ 80°C	☐ 115°C	☐ 150°C	

1C: Check all that apply

☐ Three Phase	☐ Single Phase	☐ LVGP	☐ DOE 2016 (≥15kVA ventilated distribution transformers only)
☐ 50 Hz	☐ 60 Hz (Standard)	☐ K-Factor 13	
☐ Copper Windings	☐ Aluminum Windings (Standard)	☐ K-Factor 20	☐ SCR Drive Isolation
☐ No Electrostatic Shield	☐ Other: _____		

1D: Enclosure Type — Check all that apply

VENTILATED:	☐ Open Coil *(Top Terminated Standard (UL Recognized)*	☐ NEMA 1	☐ NEMA 1 (SS)	☐ NEMA 3R (WSXX)	☐ NEMA 3R (SS)
ENCLOSED (NON-UL):	☐ TENV	☐ TENV (SS)			
ENCAPSULATED:	☐ NEMA 3R	☐ NEMA 3R (SS)	☐ NEMA 4/12 (SS)	☐ NEMA 4X (SS)	
(SS) Stainless Steel Grade:	☐ Standard (304)	☐ Optional (316)			
Hazardous Location Class 1, Division 2:		☐ No	☐ Yes (UL Certified)		

1E: Other

Please specify _____

3: Industrial Control Transformers

☐ ICE	☐ HSZ Series	☐ Other: _____

4: Primary Voltage						**5: Secondary Voltage**					
☐ 120	☐ 208	☐ 240	☐ 480	☐ 600	☐ Other: _____	☐ 120	☐ 208	☐ 240	☐ 480	☐ 600	☐ Other: _____
Taps:	☐ Standard: _____			☐ Other: _____		If Three-Phase:		☐ Delta (Standard)		☐ Wye	
If Three-Phase:	☐ Delta (Standard)										

6: Agency Certification

☐ UL	☐ CSA or cULus	☐ CE	☐ Other: _____

7: Additional Information

Please quote a Catalog or Design Number :	☐ Similar to (must note changes above): _____		☐ Exactly Like: _____
Does this request pertain to a bid specification?:	☐ No	☐ Yes	

8: Competitive Data — Must be completed for special pricing considerations

End User/Contractor: _____	Competition: _____
Competitor's Part Number : _____	Competitor's Price : _____
Target End User's Price : _____	Distributor Margin: _____

GLOSSARY

AC (Alternating Current)
Current that reverses direction in response to voltage that is changing polarity.

Attenuation
Decrease in signal voltage or power.

CE Mark (Conformité Européenne)
A marking that shows the product meets the fundamental safety, health, environmental and consumer protection requirements of the European Community.

Common-Mode Noise
Noise that occurs between the current carrying conductors and ground.

CVT (Constant Voltage Transformer)
A power conditioner that provides a stable and regulated sinewave output voltage.

Continuous Duty
The service requirement that demands operation at a constant load for an indefinite period of time.

Control Transformer
Usually referred to as an Industrial Control transformer. Designed for good voltage regulation characteristics when low power factor and /or large inrush currents are drawn (5 to 15 times normal).

CSA
Canadian Standard Association.

DC (Direct Current)
Current that flows in only one direction.

Derating
The specified reduction in an operating parameter to improve reliability.

DOE 2016
Department of Energy (DOE). DOE's CFR (Code of Federal Regulations) title 10 part 431 was published in the Federal Register Vol. 78, No. 75, published April 18, 2013. Effectivity date for legislation on distribution transformers: 01/01/2016.

Dynamic Load Regulation
The ratio of change in output voltage to change in load current.

Eddy Currents
Additional currents caused by a magnetic field.

Efficiency
A measure of energy loss in a circuit.

EMC (Electromagnetic Compatibility)
A directive necessary to get the CE Mark, which shows the electrical device will not create high levels of EMI and will not fail due to normal levels of EMI.

Encapsulated
Method of sealing a device with epoxy to resist environmental effects.

EPACT 2005
Energy Policy Act of 2005.

Energy Star
Department of Energy program promoting energy efficient appliances and apparatus *(does not apply to distribution transformers)*.

Force Air Cooled
A means of accelerating heat dissipation to lower the temperature rise of an electrical device.

Frequency (Hertz)
Cycles per second.

Harmonics Distortion
The distortion of the AC waveform due to the addition of sine waves of different frequencies being added to the AC voltage.

Input Voltage Range
The high and low input voltage limits within which a device meets its specifications.

kVA Rating
A measurement of apparent power. 1 kVA = 1000 VA.

KW Rating (kilowatts)
A measurement of real power delivered to a load 1 KW = 1000 VA x Power Factor.

Line Regulation
The change in output voltage due to a variation in input voltage.

Load Regulation
The change in output voltage due to a variation in load.

Noise/Electrical Noise
Also called electromagnetic interference, or EMI. Unwanted electrical signals that produce undesirable effects and otherwise disrupt the control system circuits.

Output Current Limiting
An output protection feature which limits the output current to a predetermined value in order to prevent damage to the device under overload conditions.

Output Voltage
The nominal value of the voltage at the output terminals of a device.

PE (Protective Earthing)
The incoming earthing conductor provided by the utility.

Rated Output Current
The continuous load current that a device was designed to provide.

Short-Circuit Protection
A feature which protects the device from a short-circuit so that the device will not be damaged.

Thermal Protection
An internal safeguard circuit that shuts down the unit in the event of excess internal temperatures.

THD (Total Harmonic Distortion)
The ratio of the harmonic content to the fundamental frequency expressed as a percent of the fundamental.

Transformer
An electrical device that changes AC voltage from one level to another.

UL (Underwriters Laboratories)
Acronym for Underwriters Laboratories tested.

UL Recognized
Designation given to components that when used properly in an end product are deemed to be safe.

UL Listed
Designation given to products ready for end use.

VA (Voltamp)
A measure of power. 1000 VA = 1 kVA.

SolaHD is our premium line of power conversion and power quality products under Appleton Group, a business unit of Emerson Industrial Automation. SolaHD offers industrial grade products that help increase machine availability and ensure data reliability while bringing greater flexibility to the design of your machines and production line. SolaHD products improve efficiency, productivity and longevity in the most demanding industrial environments.

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This group is made up of the Appleton, Nutsteel and O-Z/Gedney brands, offering a broad range of electrical products including conduit and cable fittings, plugs and receptacles, enclosures and controls, conduit bodies and industrial and hazardous lighting. Whether the application is hazardous location, industrial or commercial, the electrical construction materials group has the products to meet your needs.

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The SolaHD brand offers the broadest power quality line, including uninterruptible power supplies, power conditioners, voltage regulators, shielded transformers, surge protection devices and power supplies.

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Appleton Grp LLC
9377 W. Higgins Road
Rosemont, IL 60018
1.800.377.4384
solahd.com

Asia/Pacific
+ 65.6891.7600

Australia
+ 61.3.9721.0348

Brazil – São Paulo/SP
+ 55.11.2122.5777

Brazil – Camaçari/BA
+ 55.71.3496.4427

Canada
+ 1.888.765.2226

China
+ 86.21.3418.3888

Europe
+ 33.3.2254.2759

Mexico/Latin America
+ 52.55.5809.5049

Middle East/Africa/India
+ 971.4.881.8100

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