Dry-Type Transformers

• Industrial Control • Encapsulated 600 Volt Class • Ventilated 600 Volt Class
• High Voltage General Purpose • Pad-Mounted • Unit Substation and Medium Voltage Power
• Vacuum Pressure Impregnated (VPI) and VPI/Epoxy Shielded
• NEMA Premium® 30 • NEMA TP-1 • DOE 2010 Efficiency Compliant
• Specialty Transformers • ABS Certified Marine Duty Transformers
• Transformer Repair, Rebuild, Refurbish, Upgrade

FEDERAL PACIFIC™

Transformer Catalog Numbering System

CATALOG CODE EXAMPLE #1

Three Phase, **Encapsulated**, General Purpose, 480 Delta - 208Y/120, 2-5% FCBN Taps, 9 kVA, 115° C Rise, Electrostatic Shield

T E 4 D 9 F

- Three Phase — T
- Construction (Encapsulated) — E
- Primary/Secondary Voltage — 4
- Taps — D
- kVA — 9
- Temperature Rise — F

CATALOG CODE EXAMPLE #2

Three Phase, **Ventilated** NEMA 1, General Purpose, 480 Delta - 208Y/120, 2-2.5% FCAN, Electrostatic Shield and 4-2.5% FCBN Taps, 45 kVA, 150° C Rise

T 4 T 45 "Blank" "F" or "B" S E EP3

- Three Phase — T
- Construction (No Code for NEMA 1)
- Primary/Secondary Voltage — 4
- Taps — T
- kVA — 45
- Temperature Rise (No Code is used for 150°C Rise, "F" for 115°C Rise, "B" for 80°C Rise) — "Blank" "F" or "B"
- Shield, if included — S
- NEMA TP1 — E
- NEMA Premium 30® — EP3

Phase

Phase	Code
1 Phase	S
3 Phase	T

Construction

Construction	Code
NEMA 1 Ventilated General Purpose	No Code
Outdoor NEMA 3R	R
Encapsulated Buck-Boost	B
Encapsulated General Purpose	E
Tenv	N
Open Core and Coil	O
Special	X

Single Phase Voltage

1 Phase Primary/Secondary Voltage	Code	1 Phase Primary/Secondary Voltage	Code
120 x 240 - 12/24	12	240 x 480 - 24/48	24
120 x 240 - 16/32	16	240 x 480 - 120/240	2
120 x 240 - 120/240	120	277 - 120/240	271
120 x 208/240/277 - 120/240	129	480 - 120/240	481
208 - 120/240	201	600 - 120/240	61

Three Phase Voltage

3 Phase Primary/Secondary Voltage	Code	3 Phase Primary/Secondary Voltage	Code
208D - 208Y/120	202	480D - 208Y/120	4
208D - 208D	208	480D - 220Y/127	42
208D - 480Y/277	204	480D - 240D	482
240D - 208Y/120	242	480D - 240D/120LT	43
240D - 240D	240	480D - 480D	480
240D - 480Y/277	244	480D - 480Y/277	484
440D - 208Y/120	420	600DE - 208Y/120	6
440D - 220Y/127	422	600D - 240D	62
440D - 240D/120LT	424	Special	9

Taps

Taps	Code	Taps	Code
No Taps	N	4 - 2.5% FCBN	G
2 - 2.5% FCBN	A	4 - 2.5% (2 FCAN, 2 FCBN)	H
2 - 4% (1 FCAN, 1 FCBN)	B	4 - 3% (2 FCAN, 2 FCBN)	J
2 - 5% FCBN	D	4 - 3.5% (2 FCAN, 2FCBN)	L
2 - 5% (1 FCAN, 1 FCBN)	E	6 - 2.5% (2 FCAN, 4 FCBN)	T
		Special	X

kVA

kVA	Code	kVA	Code	kVA	Code	kVA	Code
.050	.050	1.0	1	10	10	112.5	112
.075	.075	1.5	1.5	15	15	150	150
.100	.100	2.0	2	20	20	167	167
.150	.150	3.0	3	25	25	225	225
.250	.250	5.0	5	37.5	37	250	250
.500	.500	6.0	6	45	45	300	300
.750	.750	7.5	7.5	50	50	500	500
		9.0	9	100	100	750	750
						1000	999

Features

Other Features	Code
Copper Wound	C
Electrostatic Shield	S
K4	K4
K13	K13
K20	K20
50 HZ	V
Thermostats	T
NEMA TP1	E
Special Feature	X

Temperature

Temperature Rise	Code
150 Degree C	No Code
115 Degree C	F
80 Degree C	B

Transformer Quick Selector Guide

FEDERAL PACIFIC™

General Purpose Single Phase, 60 Hz

Type	Pri Sec KVA	120 x 240 120/240 No Taps	208 120/240 With Taps	240 x 480 120/240 No Taps	240 x 480 120/240 With Taps	277 120/240 With Taps	480 120/240 With Taps	600 120/240 With Taps (Electrostatically Shielded)
FB	.050			SE2N.050F				
	.075			SE2N.075F				
	.100			SE2N.100F				
	.150			SE2N.150F				
	.250			SE2N.250F				
	.500			SE2N.500F				
	.750			SE2N.750F				
	1	SE120N1F	SE201D1F	SE2N1F		SE271D1F	SE481D1F	SE61D1FS
	1.5	SE120N1.5F	SE201D1.5F	SE2N1.5F		SE271D1.5F	SE481D1.5F	SE61D1.5FS
	2	SE120N2F	SE201D2F	SE2N2F		SE271D2F	SE481D2F	SE61D2FS
	3	SE120N3F	SE201D3F	SE2N3FS	SE2T3F	SE271D3F	SE481D3F	SE61D3FS
	5	SE120N5F	SE201D5F	SE2N5FS	SE2T5F	SE271D5F	SE481D5F	SE61D5FS
	7.5	SE120N7.5F	SE201D7.5F	SE2N7.5F	SE2T7.5F	SE271D7.5F	SE481D7.5F	SE61D7.5FS
	10	SE120N10F	SE201D10F	SE2N10F	SE2T10F	SE271D10F	SE481D10F	SE61D10FS
	15	SE120N15F	SE201D15F	SE2N15F	SE2T15F	SE271D15F	SE481D15F	SE61G15FS
FH	15				S2T15E			S61T15SE
	25				S2T25E			S61T25SE
	37.5				S2T37E			S61T37SE
	50				S2T50E			S61T50SE
	75				S2T75E			S61T75SE
	100				S2T100E			S61T100SE
	167				S2T167E			S61T167SE

Buck Boost Single Phase, 60 Hz

Type	Pri Sec KVA	120 x 240 12/24	120/240 16/32	240 x 480 24/48
FB	.050	SB12N.050F	SB16N.050F	SB24N.050F
	.100	SB12N.100F	SB16N.100F	SB24N.100F
	.150	SB12N.150F	SB16N.150F	SB24N.150F
	.250	SB12N.250F	SB16N.250F	SB24N.250F
	.500	SB12N.500F	SB16N.500F	SB24N.500F
	.750	SB12N.750F	SB16N.750F	SB24N.750F
	1	SB12N1F	SB16N1F	SB24N1F
	1.5	SB12N1.5F	SB16N1.5F	SB24N1.5F
	2	SB12N2F	SB16N2F	SB24N2F
	3	SB12N3F	SB16N3F	SB24N3F
	5	SB12N5F	SB16N5F	SB24N5F

Type FB
- Encapsulated/Compound Filled
- 115° C Rise, 180° C Insulation System
- U.L.® Listed For Indoor & Outdoor Application

Type FH Energy Efficient
- Ventilated
- 150° C Rise, Optional 115° C & 80° C Rise
- 220° C Insulation System
- U. L.® Listed
- Floor Mounted
- NEMA TP-1 2002 Compliant
- NEMA Premium®

Catalog numbers shown in red indicate transformers normally in stock.

General Purpose Three Phase, 60 Hz

Type	Pri Sec KVA	208 - 208Y/120 Electrostatically Shielded	208 480Y/277	240 208Y/120 Electrostatically Shielded	440 220Y/127	480 208Y/120	480 - 208Y/120 Electrostatically Shielded
FB	3			TE242D3FS		TE4D3F	TE4D3FS
	6			TE242D6FS		TE4D6F	TE4D6FS
	9			TE242D9FS		TE4D9F	TE4D9FS
	15			TE242D15FS		TE4D15F	TE4D15FS
FH	15	T202H15SE	T204H15E	T242T15SE	T422X15E	T4T15E	T4T15SE
	30	T202H30SE	T204H30E	T242T30SE		T4T30E	T4T30SE
	45	T202H45SE	T204H45E	T242T45SE		T4T45E	T4T45SE
	75	T202H75SE	T204H75E	T242T75SE	T422X75E	T4T75E	T4T75SE
	112.5	T202H112SE	T204H112E	T242T112SE		T4T112E	T4T112SE
	150	T202H150SE	T204H150E	T242T150SE		T4T150E	T4T150SE
	225	T202J225SE	T204J225E	T242J225SE		T4T225E	T4T225SE
	300	T202L300SE	T204L300E	T242L300SE		T4T300E	T4T300SE
	500	T202E500SE	T204E500E	T242B500SE		T4T500E	T4T500SE
	750		T204E750E			T4T750E	T4T750SE
	1000					T4J1000E	T4J1000SE

115° C Optional Temperature Rise

Type	Pri Sec KVA	208 - 208Y/120 Electrostatically Shielded	208 480Y/277	240 208Y/120 Electrostatically Shielded	440 220Y/127	480 208Y/120	480 - 208Y/120 Electrostatically Shielded
FH	15	T202H15FSE	T204H15FE	T242T15FSE		T4T15FE	T4T15FSE
	30	T202H30FSE	T204H30FE	T242T30FSE		T4T30FE	T4T30FSE
	45	T202H45FSE	T204H45FE	T242T45FSE		T4T45FE	T4T45FSE
	75	T202H75FSE	T204H75FE	T242T75FSE		T4T75FE	T4T75FSE
	112.5	T202H112FSE	T204H112FE	T242T112FSE		T4T112FE	T4T112FSE
	150	T202J150FSE	T204J150FE	T242J150FSE		T4T150FE	T4T150FSE
	225	T202L225FSE	T204L225FE	T242L225FSE		T4T225FE	T4T225FSE
	300	T202B300FSE	T204B300FE	T242B300FSE		T4T300FE	T4T300FSE
	500		T204E500FE			T4T500FE	T4T500FSE

80° C Optional Temperature Rise

Type	Pri Sec KVA	208 - 208Y/120 Electrostatically Shielded	208 480Y/277	240 208Y/120 Electrostatically Shielded	440 220Y/127	480 208Y/120	480 - 208Y/120 Electrostatically Shielded
FH	15	T202H15BSE	T204H15BE	T242T15BSE		T4T15BE	T4T15BSE
	30	T202H30BSE	T204H30BE	T242T30BSE		T4T30BE	T4T30BSE
	45	T202H45BSE	T204H45BE	T242T45BSE		T4T45BE	T4T45BSE
	75	T202H75BSE	T204H75BE	T242T75BSE		T4T75BE	T4T75BSE
	112.5	T202J112BSE	T204J112BE	T242T112BSE		T4T112BE	T4T112BSE
	150	T202J150BSE	T204J150BE	T242J150BSE		T4T150BE	T4T150BSE
	225	T202B225BSE	T204B225BE	T242B225BSE		T4T225BE	T4T225BSE
	300	T202B300BSE	T204B300BE	T242B300BSE		T4T300BE	T4T300BSE
	500		T204E500BE			T4T500BE	T4T500BSE

	480 - 208Y/120 Electrostatically Shielded Copper	480 240/120 LT	480 - 240/120 LT Electrostatically Shielded	480 480Y/277	600 208Y/120 Electrostatically Shielded
		TE482D3F (No LT)	TE482D3FS (No LT)		
		TE482D6F (No LT)	TE482D6FS (No LT)		
		TE482D9F (No LT)	TE482D9FS (No LT)		
		TE482D15F (No LT)	TE482D15FS (No LT)		
	T4T15CSE	T43T15E	T43T15SE	T484T15E	T6T15SE
	T4T30CSE	T43T30E	T43T30SE	T484T30E	T6T30SE
	T4T45CSE	T43T45E	T43T45SE	T484T45E	T6T45SE
	T4T75CSE	T43T75E	T43T75SE	T484T75E	T6T75SE
	T4T112CSE	T43T112E	T43T112SE	T484T112E	T6T112SE
	T4T150CSE	T43T150E	T43T150SE	T484T150E	T6T150SE
	T4T225CSE	T43T225E	T43T225SE	T484T225E	T6T225SE
	T4T300CSE	T43T300E	T43T300SE	T484T300E	T6T300SE
	T4T500CSE	T43T500E	T43T500SE	T484T500E	T6T500SE
	T4T750CSE	T43T750E	T43T750SE	T484T750E	
	T4J1000CSE				
	T4T15FCSE	T43T15FE	T43T15FSE	T484T15FE	T6T15FSE
	T4T30FCSE	T43T30FE	T43T30FSE	T484T30FE	T6T30FSE
	T4T45FCSE	T43T45FE	T43T45FSE	T484T45FE	T6T45FSE
	T4T75FCSE	T43T75FE	T43T75FSE	T484T75FE	T6T75FSE
	T4T112FCSE	T43T112FE	T43T112FSE	T484T112FE	T6T112FSE
	T4T150FCSE	T43T150FE	T43T150FSE	T484T150FE	T6T150FSE
	T4T225FCSE	T43T225FE	T43T225FSE	T484T225FE	T6T225FSE
	T4T300FCSE	T43T300FE	T43T300FSE	T484T300FE	T6T300FSE
	T4T500FCSE	T43T500FE	T43T500FSE	T484T500FE	
	T4T15BCSE	T43T15BE	T43T15BSE	T484T15BE	T6T15BSE
	T4T30BCSE	T43T30BE	T43T30BSE	T484T30BE	T6T30BSE
	T4T45BCSE	T43T45BE	T43T45BSE	T484T45BE	T6T45BSE
	T4T75BCSE	T43T75BE	T43T75BSE	T484T75BE	T6T75BSE
	T4T112BCSE	T43T112BE	T43T112BSE	T484T112BE	T6T112BSE
	T4T150BCSE	T43T150BE	T43T150BSE	T484T150BE	T6T150BSE
	T4T225BCSE	T43T225BE	T43T225BSE	T484T225BE	T6T225BSE
	T4T300BCSE	T43T300BE	T43T300BSE	T484T300BE	T6T300BSE
	T4T500BCSE	T43T500BE	T43T500BSE	T484T500BE	

K-Factor Rated — 480-208Y/120, Three Phase, 60Hz

Type	KVA	Electrostatically Shielded Aluminum			Electrostatically Shielded Copper		
		K4	K13	K20	K4	K13	K20
FH	15	T4T15SK4E	T4T15SK13E	T4T15SK20E	T4T15CSK4E	T4T15CSK13E	T4T15CSK20E
	30	T4T30SK4E	T4T30SK13E	T4T30SK20E	T4T30CSK4E	T4T30CSK13E	T4T30CSK20E
	45	T4T45SK4E	T4T45SK13E	T4T45SK20E	T4T45CSK4E	T4T45CSK13E	T4T45CSK20E
	75	T4T75SK4E	T4T75SK13E	T4T75SK20E	T4T75CSK4E	T4T75CSK13E	T4T75CSK20E
	112.5	T4T112SK4E	T4T112SK13E	T4T112SK20E	T4T112CSK4E	T4T112CSK13E	T4T112CSK20E
	150	T4T150SK4E	T4T150SK13E	T4T150SK20E	T4T150CSK4E	T4T150CSK13E	T4T150CSK20E
	225	T4T225SK4E	T4T225SK13E	T4T225SK20E	T4T225CSK4E	T4T225CSK13E	T4T225CSK20E
	300	T4T300SK4E	T4T300SK13E	T4T300SK20E	T4T300CSK4E	T4T300CSK13E	T4T300CSK20E
	500	T4T500SK4E	T4T500SK13E	T4T500SK20E	T4T500CSK4E	T4T500CSK13E	T4T500CSK20E

115° C Optional Temperature Rise

Type	KVA	Aluminum K4	Aluminum K13	Aluminum K20	Copper K4	Copper K13	Copper K20
FH	15	T4T15FSK4E	T4T15FSK13E	T4T15FSK20E	T4T15FCSK4E	T4T15FCSK13E	T4T15FCSK20E
	30	T4T30FSK4E	T4T30FSK13E	T4T30FSK20E	T4T30FCSK4E	T4T30FCSK13E	T4T30FCSK20E
	45	T4T45FSK4E	T4T45FSK13E	T4T45FSK20E	T4T45FCSK4E	T4T45FCSK13E	T4T45FCSK20E
	75	T4T75FSK4E	T4T75FSK13E	T4T75FSK20E	T4T75FCSK4E	T4T75FCSK13E	T4T75FCSK20E
	112.5	T4T112FSK4E	T4T112FSK13E	T4T112FSK20E	T4T112FCSK4E	T4T112FCSK13E	T4T112FCSK20E
	150	T4T150FSK4E	T4T150FSK13E	T4T150FSK20E	T4T150FCSK4E	T4T150FCSK13E	T4T150FCSK20E
	225	T4T225FSK4E	T4T225FSK13E	T4T225FSK20E	T4T225FCSK4E	T4T225FCSK13E	T4T225FCSK20E
	300	T4T300FSK4E	T4T300FSK13E	T4T300FSK20E	T4T300FCSK4E	T4T300FCSK13E	T4T300FCSK20E
	500	T4T500FSK4E	T4T500FSK13E	T4T500FSK20E	T4T500FCSK4E	T4T500FCSK13E	T4T500FCSK20E

80° C Optional Temperature Rise

Type	KVA	Aluminum K4	Aluminum K13	Aluminum K20	Copper K4	Copper K13	Copper K20
FH	15	T4T15BSK4E	T4T15BSK13E	T4T15BSK20E	T4T15BCSK4E	T4T15BCSK13E	T4T15BCSK20E
	30	T4T30BSK4E	T4T30BSK13E	T4T30BSK20E	T4T30BCSK4E	T4T30BCSK13E	T4T30BCSK20E
	45	T4T45BSK4E	T4T45BSK13E	T4T45BSK20E	T4T45BCSK4E	T4T45BCSK13E	T4T45BCSK20E
	75	T4T75BSK4E	T4T75BSK13E	T4T75BSK20E	T4T75BCSK4E	T4T75BCSK13E	T4T75BCSK20E
	112.5	T4T112BSK4E	T4T112BSK13E	T4T112BSK20E	T4T112BCSK4E	T4T112BCSK13E	T4T112BCSK20E
	150	T4T150BSK4E	T4T150BSK13E	T4T150BSK20E	T4T150BCSK4E	T4T150BCSK13E	T4T150BCSK20E
	225	T4T225BSK4E	T4T225BSK13E	T4T225BSK20E	T4T225BCSK4E	T4T225BCSK13E	T4T225BCSK20E
	300	T4T300BSK4E	T4T300BSK13E	T4T300BSK20E	T4T300BCSK4E	T4T300BCSK13E	T4T300BCSK20E
	500	T4T500BSK4E	T4T500BSK13E	T4T500BSK20E	T4T500BCSK4E	T4T500BCSK13E	T4T500BCSK20E

Other K-Factor voltage combinations are also available from stock.

Motor Drive Isolation Transformers Three-Phase, 60 Hz, Type FH

KVA	230Δ - 230Y	230Δ - 460Y	460Δ - 230Y	460Δ - 460Y	230Δ - 575Y	460Δ - 575Y	575Δ - 230Y	575Δ - 460Y	575Δ - 575Y
7.5	FH7.5AEMD	FH7.5AFMD	FH7.5CEMD	FH7.5CFMD	FH7.5AHMD	FH7.5CHMD	FH7.5DEMD	FH7.5DFMD	FH7.5DHMD
11	FH11AEMD	FH11AFMD	FH11CEMD	FH11CFMD	FH11AHMD	FH11CHMD	FH11DEMD	FH11DFMD	FH11DHMD
15	FH15AEMD	FH15AFMD	FH15CEMD	FH15CFMD	FH15AHMD	FH15CHMD	FH15DEMD	FH15DFMD	FH15DHMD
20	FH20AEMD	FH20AFMD	FH20CEMD	FH20CFMD	FH20AHMD	FH20CHMD	FH20DEMD	FH20DFMD	FH20DHMD
27	FH27AEMD	FH27AFMD	FH27CEMD	FH27CFMD	FH27AHMD	FH27CHMD	FH27DEMD	FH27DFMD	FH27DHMD
34	FH34AEMD	FH34AFMD	FH34CEMD	FH34CFMD	FH34AHMD	FH34CHMD	FH34DEMD	FH34DFMD	FH34DHMD
40	FH40AEMD	FH40AFMD	FH40CEMD	FH40CFMD	FH40AHMD	FH40CHMD	FH40DEMD	FH40DFMD	FH40DHMD
51	FH51AEMD	FH51AFMD	FH51CEMD	FH51CFMD	FH51AHMD	FH51CHMD	FH51DEMD	FH51DFMD	FH51DHMD
63	FH63AEMD	FH63AFMD	FH63CEMD	FH63CFMD	FH63AHMD	FH63CHMD	FH63DEMD	FH63DFMD	FH63DHMD
75	FH75AEMD	FH75AFMD	FH75CEMD	FH75CFMD	FH75AHMD	FH75CHMD	FH75DEMD	FH75DFMD	FH75DHMD
93	FH93AEMD	FH93AFMD	FH93CEMD	FH93CFMD	FH93AHMD	FH93CHMD	FH93DEMD	FH93DFMD	FH93DHMD
118	FH118AEMD	FH118AFMD	FH118CEMD	FH118CFMD	FH118AHMD	FH118CHMD	FH118DEMD	FH118DFMD	FH118DHMD
145	FH145AEMD	FH145AFMD	FH145CEMD	FH145CFMD	FH145AHMD	FH145CHMD	FH145DEMD	FH145DFMD	FH145DHMD
175	FH175AEMD	FH175AFMD	FH175CEMD	FH175CFMD	FH175AHMD	FH175CHMD	FH175DEMD	FH175DFMD	FH175DHMD
220	FH220AEMD	FH220AFMD	FH220CEMD	FH220CFMD	FH220AHMD	FH220CHMD	FH220DEMD	FH220DFMD	FH220DHMD
275	FH275AEMD	FH275AFMD	FH275CEMD	FH275CFMD	FH275AHMD	FH275CHMD	FH275DEMD	FH275DFMD	FH275DHMD
330	FH330AEMD	FH330AFMD	FH330CEMD	FH330CFMD	FH330AHMD	FH330CHMD	FH330DEMD	FH330DFMD	FH330DHMD
440	FH440AEMD	FH440AFMD	FH440CEMD	FH440CFMD	FH440AHMD	FH440CHMD	FH440DEMD	FH440DFMD	FH440DHMD
550	FH550AEMD	FH550AFMD	FH550CEMD	FH550CFMD	FH550AHMD	FH550CHMD	FH550DEMD	FH550DFMD	FH550DHMD
660	FH660AEMD	FH660AFMD	FH660CEMD	FH660CFMD	FH660AHMD	FH660CHMD	FH660DEMD	FH660DFMD	FH660DHMD
750	FH750AEMD	FH750AFMD	FH750CEMD	FH750CFMD	FH750AHMD	FH750CHMD	FH750DEMD	FH750DFMD	FH750DHMD

Catalog numbers shown in red indicate transformers normally in stock

600 Volt Class Transformers

FEDERAL PACIFIC™

LISTED

NEMA Premium

ISO 9001:2008 REGISTERED

Table of Contents - 600 Volt Class Transformers

Full Load Current Ratings

KVA Rating	Full Load Current (Amperes)			
	120 V	240 V	480 V	600 V
.050	0.42	0.21	0.1	0.08
.075	0.63	0.31	0.16	0.13
.100	0.83	0.42	0.21	0.17
.150	1.25	0.63	0.31	0.25
.250	2.08	1.04	0.52	0.42
.500	4.17	2.08	1.04	0.83
.750	6.25	3.13	1.56	1.25
1	8.33	4.17	2.08	1.67
1.5	12.5	6.25	3.13	2.5
2	16.7	8.33	4.17	3.33
3	25	12.5	6.25	5
5	41.7	20.8	10.4	8.33
7.5	62.5	31.3	15.6	12.5
10	83.3	41.7	20.8	16.7
15	125	62.5	31.2	25
25	208	104	52	41.7
37.5	312	156	78.1	62.5
50	417	208	104	83.3
75	625	312	156	125
100	833	417	208	167
167	1392	696	348	278
333	2775	1387	694	555

$$\text{Single-Phase KVA} = \frac{\text{Volts x Load Amperes}}{1000}$$

KVA Rating	Full Load Current (Amperes)			
	208 V	240 V	480 V	600 V
3	8.33	7.22	3.61	2.89
6	16.6	14.4	7.22	5.77
9	25	21.6	10.8	8.66
15	41.6	36.1	18	14.4
25	69.4	60.1	30.1	24.1
30	83.3	72.2	36.1	28.9
37.5	104	90.2	45.1	36.1
45	125	108	54.1	43.3
50	139	120	60.1	48.1
60	166	144	72.2	57.7
75	208	180	90.2	72.2
100	278	241	120	96.2
112.5	312	271	135	108
150	416	361	180	144
225	625	541	271	217
300	833	722	361	289
400	1110	962	481	385
500	1388	1203	601	481
750	2082	1804	902	722
1000	2776	2406	1203	962

$$\text{Three-Phase KVA} = \frac{\text{Volts x Load Amperes x 1.73}}{1000}$$

General Information

What is a Transformer?

A transformer is an electrical apparatus designed to convert alternating voltage from one voltage level to another. Transformers are completely static devices without continuously moving mechanical parts, which, by electromagnetic induction, transform electrical energy from one or more circuits to one or more other circuits at the same frequency.

In most cases, transformers change the voltage from an incoming source to its outgoing load. Transformers can be used to increase (step up) or decrease (step down) voltages. Sometimes transformers do not change voltages; that is, they are not used for step up or step down purposes. These transformers are only used for isolation.

Electric power is always distributed over a wide area by means of alternating current. Direct current is not used for several reasons, the most important being that it cannot be changed from one voltage level to another without expensive conversion equipment. Alternating current however can be simply changed to any convenient voltage by the use of transformers.

Description

Federal Pacific dry-type transformers rated 600 volts and below are available in a wide variety of types and ratings to provide reliable and versatile electrical distribution for lighting and power loads in industrial and commercial applications.

Ratings in the 600V class are available from .050 through 333 KVA in single-phase configurations and from 3 through 1500 KVA in three-phase. All standard primary and secondary voltage ratings are provided to match load requirements to the distribution system.

The air cooled dry-type construction requires no special vaults for installation. The units may be located in almost any indoor location convenient to the load being served. Most transformers are also available for outdoor installations. Maintenance requires only periodic inspection of cable connections and removal of any dust accumulation.

Industry Standards

Federal Pacific dry-type transformers are UL® Listed and are designed, tested, and manufactured in accordance with applicable industry standards:

- UL-5085, UL 1561, UL 1562
- CUL
- IEEE C57.12.01
- IEEE C57.12.91
- NEMA ST-20
- EPACT 2005
- Meets DOE Efficiency Levels as required by 10 CFR 431 and NEMA TP1[(1)]

Tested Performance

Ratio Test is performed on rated voltage connection and tap connections to assure proper turns ratio on all connections.

Polarity Test and phase relation tests are made to ensure proper polarity and marking because of their importance in paralleling or banking two or more transformers.

No-load (excitation) Loss Test determines the losses of a transformer which is excited at rated voltage and frequency, but which is not supplying a load. Transformer excitation loss consists mainly of the iron loss in the transformer core.

Load Loss Test determines the amount of losses in the transformer when carrying full rated load. These losses consist primarily of I^2R losses in the primary and secondary winding and ensure that specifications of the transformer design are met.

Excitation Current Test determines the current necessary to maintain transformer excitation.

Resistance Test is performed on the transformer windings and is used to determine I^2R loss.

Impedance Test is made to insure that transformer design standards are attained.

Dielectric Test (applied and induced potential) checks the insulation and workmanship to demonstrate that the transformer has been designed and manufactured to meet the insulation tests required by the standards.

Applied Potential Tests are made by impressing between windings and between each winding and ground, a low frequency voltage.

Induced Potential Tests call for over-exciting the transformer by applying between the terminals on one winding a voltage of twice the normal voltage developed in the winding for a period of 7200 cycles.

Primary Taps

All Federal Pacific three-phase transformers and most single-phase models are provided with taps in the primary winding to compensate for input voltage variations. The taps will provide a range of voltage adjustment above and/or below the nominal voltage rating of the transformer. The available quantity, location, and percentage of the tap connections are shown in the transformer listings. All transformers are furnished with a nameplate showing the terminal and tap arrangements.

[(1)]For certain energy efficiency regulated products

Selection and Application Considerations

Selection Steps

- Determine the system supply voltage available (primary voltage).
- Determine the required load voltage rating (secondary voltage).
- Determine the KVA rating of the load. (If the load rating is given only in amperes, the proper KVA size of the transformer can be selected from the charts on page 12.) The KVA capacity of the transformer must equal or be greater than the load rating.
- Select a transformer model from the listings on the following pages.

Connections

Many single-phase transformers are provided with a series multiple winding construction and a dual voltage primary or secondary identification (i.e. 240 x 480 to 120/240). These transformers will have two windings on the primary or secondary that can be connected either in series for the higher voltage or in parallel for the lower voltage. Transformers with voltage ratings containing an "x" can only be connected for one or the other of the two voltages. On those units with voltage ratings separated by a "slant", the windings can be connected to provide either or both voltages (three wire operation).

Three-phase transformers are provided with a delta primary for three wire input and either a wye secondary for four wire output or a delta secondary for three wire output. Transformers with 240 volt delta secondaries may have a 120 volt single-phase lighting tap as a standard feature. Maximum single-phase 120 volt load should not exceed 10% of the three-phase KVA rating. The load should also be balanced at 5% maximum between terminals X1 to X4 and 5% between terminals X2 to X4. The three-phase KVA must also be reduced by 30% of the nameplate rating. For example, a 45 KVA transformer can have a 4.5 KVA maximum single-phase, 120 volt load. Of that 4.5 KVA, 2.25 KVA must be loaded between X1 - X4 and 2.25 KVA must be loaded between X2 - X4. The three-phase KVA rating must be reduced to 31.5 KVA.

Preferred 3-Phase Connections

(Applies to 600 volt and medium volt ratings)

For two winding transformers:
The preferred winding connections are: Delta-Wye, Delta-Delta and Wye-Delta. For all of the above connections a three-legged core construction will be employed.

For a Wye-Wye connection Federal Pacific recommends that a four-legged or five-legged core be employed.

For auto-transformers:
Federal Pacific recommends using a Wye-Wye connection to minimize cost. Precautions to avoidunbalanced phase loading conditions should be undertaken.

Sound Levels

A humming sound is an inherent characteristic of transformers due to the vibration caused by alternating flux in the magnetic core. Sound levels will vary according to transformer size. Attention to installation methods can help reduce any objectionable noise. When possible, locate the transformer in an area where the ambient sound will be equal to or greater than the transformer sound level. Avoid locating units in corners. Make connections with flexible conduits and couplings to prevent transmitting vibration to other equipment. Larger units should be installed on flexible mountings to isolate the transformer from the building structure.

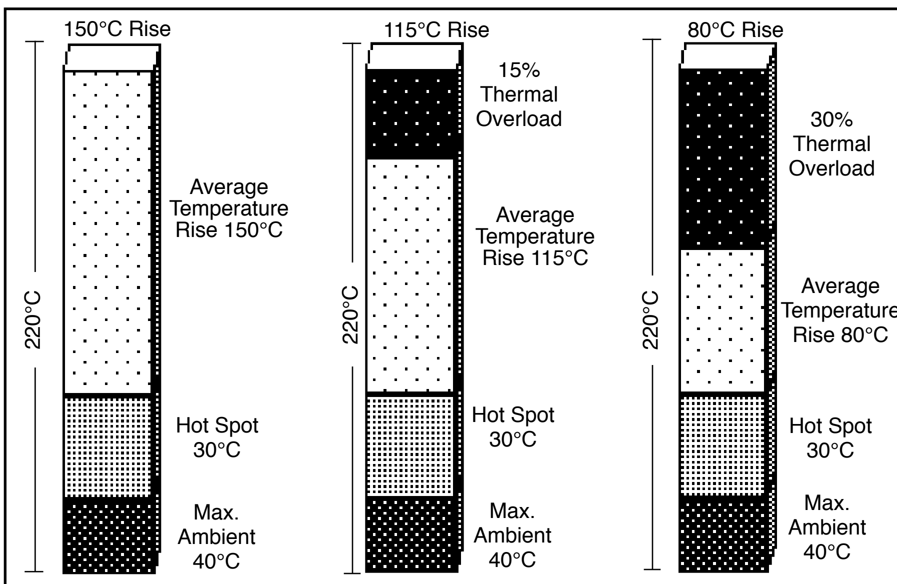
Federal Pacific transformers are designed, built, and comply with NEMA maximum sound level requirements as measured in accordance with NEMA ST 20-2014.

Temperature

Insulation system limiting temperatures for FH Style dry-type transformers are classified by industry standards based on a 40°C ambient, 25°C ambient for FB Styles.

Average Sound Level, Decibels				
	Self Cooled Ventilated			Self Cooled Sealed
	A	B	C	D
Equivalent Winding kVA Range	K Factor = 1 K Factor = 4 K Factor = 9	K Factor = 13 K Factor = 20	Forced Air When Fans Running	
3.00 and below	40	40	67	45
3.01 to 9.00	40	40	67	45
9.01 to 15.00	45	45	67	50
15.01 to 30.00	45	45	67	50
30.01 to 50.00	45	48	67	50
50.01 to 75.00	50	53	67	55
75.01 to 112.50	50	53	67	55
112.51 to 150.00	50	53	67	55
150.01 to 225.00	55	58	67	57
225.01 to 300.00	55	58	67	57
300.01 to 500.00	60	63	67	59
500.01 to 700.00	62	65	67	61
700.01 to 1000.00	64	67	67	63
Greater than 1000	Consult Factory			

Note 1: Consult factory for non-linear requirements exceeding a K-factor rating of 20.
Note 2: When the fans are not running columns A & B apply
Note 3: Sound levels are measured using the A-weighted scale (dB (A))



Definition of Average Temperature Rise

Selection and Application Considerations

Altitude

Standard self-cooled dry-type transformers are designed for operation with normal temperature rise at altitudes up to 3300 ft. above sea level. The transformer rated KVA should be reduced by 0.3% for each 330 ft. the transformer is installed above 3300 ft.

Polarity

Transformer polarity is an indication of the direction of current flow through the high voltage terminals with respect to the direction of current flow through the low voltage terminals at any given instant in the alternating cycle.

Primary and secondary terminals are said to have the same (or additive) polarity when, at a given instant, the current enters the primary terminal in question and leaves the secondary terminal in question in the same direction as though the two terminals formed a continuous circuit.

Single-phase transformers rated 600 volts and below normally have additive polarity.

The polarity of a three-phase transformer is fixed by the internal connections between phases. It is usually designated by means of a vector diagram showing the angular displacement of the windings and a sketch showing the markings of the terminals.

Angular Displacement

The angular displacement of a three-phase transformer is the time angle expressed in degrees between the line-to-neutral voltage of a specified high voltage terminal and the line-to-neutral voltage of a specified low voltage terminal.

The angular displacement between the high voltage and low voltage terminal voltages of three-phase transformers with delta-delta connections is zero degrees.

The angular displacement for three-phase transformers with delta-wye connections is 30 degrees with the low voltage lagging the high voltage.

Parallel Operation

Transformers with the same KVA ratings can be connected in parallel if required conditions are met. Single-phase transformers must have the same voltage rating, tap settings and frequency rating. Plus, the impedance values of the transformers must be within 7.5% of each other. When paralleling three-phase transformers, the same conditions would apply and, in addition, the angular displacement of the transformers must be the same.

Transformer Banking

Three single-phase transformers can be properly connected to supply a three-phase load. The single-phase units can be used in a three-phase bank with delta connected primary and wye or delta connected secondary. The equivalent three-phase capacity would be three times the nameplate rating of each single-phase transformer. For example, three 15 KVA single-phase transformers will, when properly banked, accommodate a 45 KVA three-phase load.

Balanced Loading

Single-phase loads connected to the secondary of a transformer must be distributed so as not to overload any one winding of the transformer.

Single-phase transformers generally have two winding secondaries that can be connected for 120/240 volt three wire operation. When so arranged, care must be taken when connecting 120 volt loads to assure that the total connected load on each secondary winding does not exceed one-half the nameplate KVA rating.

When connecting single-phase loads on a three-phase transformer, each phase must be considered as a single-phase transformer. The single-phase loading on each phase of a three-phase transformer must not exceed one-third of the nameplate KVA rating. For example, a 45 KVA three-phase transformer with a 208Y/120 Volt secondary should not have any 120 volt single-phase loads distributed such that more than 15 KVA of single-phase load is applied to any one phase.

Transformer Protection (Reference N.E.C. Article 450)

Transformers - 600 Volts or Less
Primary Protection Only

If secondary protection is not provided, a transformer must be protected by an individual overcurrent device on the primary side. The primary overcurrent device must be rated: No more than 125% of the rated primary current or the next higher standard device rating (for primary currents of 9 amperes or more); no more than 167% of the rated primary current (for 2 amperes to 9 amperes); and no more than 300 % of the rated primary current (for ratings less than 2 amperes). An individual transformer primary protective device is not necessary where the primary circuit overcurrent protective device provides the required protection.

Primary & Secondary Protection

If the transformer secondary is protected by an overcurrent protective device rated no more than 125% of the transformer rated secondary current (or the next higher standard rating device), an individual primary protective device is not required provided the primary feeder circuit overcurrent device is rated no more than 250% of the transformer rated primary current.

Selection and Application Considerations

For Reverse Feed (Back feed), or Step-Up Operation Only

Step-down transformers may be reverse fed for step-up operation to increase voltage. This means that the incoming power is connected to the low voltage (X's) and the load is connected to the high voltage (H's). If the low voltage is wye, the X0 terminal must **NOT** be connected in any way. Likewise, if the low voltage is a delta with a 120 volt lighting tap (high-leg), the X4 terminal must **NOT** be connected in any way.

CAUTION: Much higher than normal inrush currents may occur with reverse feed operation and may cause nuisance fuse blowing or breaker tripping. For this reason, fuses and breakers with time-delay characteristics must be used.

If a breaker is used for incoming over-current protection, it must be a thermal-magnetic type breaker, not a magnetic-only type breaker.

Type FB Transformers

Non-Ventilated • Indoor / Outdoor
Single-Phase: .050 to 15 KVA
Three-Phase: 3 to 15 KVA

Construction

The Type FB dry-type transformer is a totally enclosed, compound filled transformer. The core and coil assembly is embedded in a polyester resin compound, which provides a solid insulation. The embedding compound has an extremely high heat transfer rate, which permits a design of minimum size and weight. The compound-filled assembly is completely encased in a sturdy steel housing and cannot be damaged by dust, moisture, or adverse atmospheric conditions.

- Intentionally designed for a low enclosure temperature rise, **no** UL-506 special markings are needed to indicate clearance between the enclosure and adjacent surfaces.
- Type FB transformers are made in a temperature class based on a 25°C ambient, 115°C rise, 180°C insulation system.
- Sound level problems are negligible with Type FB transformers because the core and coils are rigidly encased in the polyester resin which is mechanically strong and acts as sound deadening material. Average sound levels are consistently below NEMA standards.
- A large wiring compartment with knockouts permits fast wiring connections. Compartment temperatures can attain temperatures reaching 90°C; therefore 90°C cable should be used.
- These units are supplied with flexible cable leads marked with easy identification, and are supplied with wall-mounting brackets to reduce installation time.

Application

Federal Pacific UL & CUL Listed Type FB dry-type transformers can be used in industrial, commercial, institutional, and residential installations for economical, efficient distribution of power.

Typical loads served include tanning beds, motors, lighting, heating, ranges, air conditioners, exhaust fans, control circuits, appliances, and portable tools. Other applications are found in pumping stations, mining and shipboard distribution systems.

Type FB units are ideal for dusty industrial areas and are suitable for **Indoor / Outdoor** applications.

Single-Phase .050 to 3 KVA | Single-Phase 5 KVA to 15 KVA | Three-Phase 3 KVA to 15 KVA

Type FH Transformers

Ventilated
Single-Phase: 15 to 333 KVA
Three-Phase: 7.5 to 1500 KVA

Construction
The Type FH line of ventilated dry-type transformers incorporates wire and/or strip wound coils in a barrel wound configuration. Horizontal and vertical spacers are strategically positioned in the windings to brace the winding layers and allow maximum ventilation. The electrical grade core steel is arranged in a construction designed to accommodate the coils.

Vibration Dampening System
The core and coil assembly is anchored to the enclosure through a vibration dampening system to reduce noise levels. Units through 600 KVA are provided with neoprene isolating pads while larger units are furnished with three layer rubber and cork pads. A flexible grounding conductor is installed between the core and coil assembly and the transformer enclosure.

Rugged Enclosure
Enclosures are rigidly braced and covers are fastened with slotted hex head screws for ease of removal. A rugged steel base supported by mounting feet opened outward provides safe handling with a fork lift and easy attachment to mounting pad.

Wiring Compartments
Front accessible wiring compartments are approved for 90°C cable. Terminals are sized to carry the full current capacity of the transformers.

UL Listed 220 °C Insulation System
To attain UL listing, it was necessary to complete an accelerated aging test as specified by Underwriters Laboratories, Inc.

This insulation system was subjected to a series of exposures to heat, vibration, moisture, and dielectric tests. As a proven system this insulation system has received from Underwriters Laboratories, Inc. a recognized 220°C continuous rating. This total temperature of 220°C is derived from the average conductor temperature rise of 150°C, hotspot temperature gradient of 30°C, and an ambient temperature of 30°C.

The major components that allow for this 220°C rating are Nomex®† paper, resin-glass laminates, silicon rubber, and polyester varnish.

This combination of materials and the care taken in construction and workmanship, not only give Federal Pacific Type FH Transformers a long operating life, but helps insure their quiet operation.

Versatile Performance
The design features of the Federal Pacific Type FH family of UL Listed transformers assures versatile, economical, and reliable distribution of power. All transformers are fully tested to insure trouble-free installation and operation. The unique combination of ratings makes the FH family suitable for a wide variety of applications.

† *Dupont T.M.*

Typical Ventilated Dry-Type Transformer Construction

Optional Temperature Rise Transformers

Energy Saving Optional Temperature Rises

Transformers are specifically designed for optimum performance on systems with a continuous high loading factor. The units feature either 80°C or 115°C temperature rise utilizing a 220°C insulation system which provides extended life and inherent overload capability (15% for 115°C and 30% for 80°C.) The transformers provide lower losses and minimize operating costs. The amount of savings will depend on loading factors and local energy costs. (See page 27 for single-phase model listings and 32-37 for three-phase model listings.)

Electrostatically Shielded Transformers

Electrostatically shielded transformers are designed to protect primary systems from unwanted high-frequency signals generated by loads connected to the transformers secondary.

While all transformers with separate primary and secondary windings isolate the load circuits, transients and electrical noise can be transmitted through the interwinding capacitance of the transformer.

These disturbances may have a detrimental effect on sensitive electronic equipment and can cause improper operation. Electrostatic shielding brings these unwanted signals to ground thus preventing the electrical disturbances from being transmitted to the load circuits.

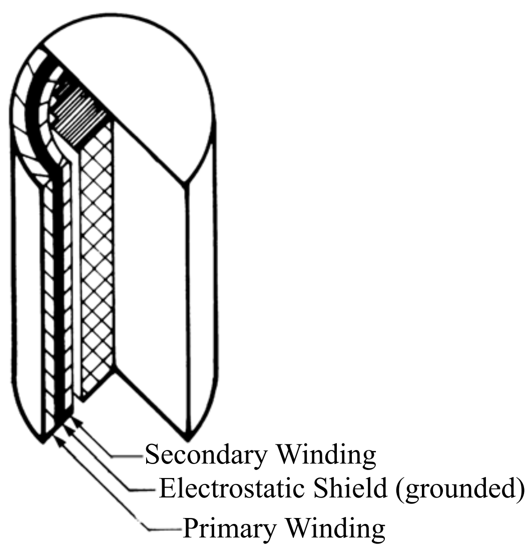
Federal Pacific UL Listed electrostatically shielded transformers provide all the quality features of the transformer plus an electrostatic shield consisting of a single turn, full height, copper or aluminum strip placed between the primary and secondary windings with a lead run to the transformer ground.

Applications

Electronic products ranging from solid state control relays to complex medical equipment are susceptible to malfunction due to transient disturbances in the power supply.

Typical applications would include:

- Hospital Operating Rooms
- X-Ray Equipment
- Computer Installations
- Data Processing
- Instrumentation
- Programmable Controllers



Cutaway Sketch, Shielded Transformer Winding

Energy Efficient Transformers

15 kVA through 1000 kVA

Federal Pacific's Energy Efficient Transformers are designed to meet the guidelines offered by the National Electrical Manufacturers Association (NEMA) Standard TP-1-2002 and EPACT 2005.

The NEMA guidelines require low voltage (600 V or less) isolation-type distribution transformers 15 kVA and above to have efficiency ratings as set forth in the NEMA Standard "Guide for Determining Energy Efficiency for Distribution Transformers".

This guideline considers the Total Ownership Cost (TOC) method where loading is defined as being 35% of nameplate at a temperature of 75° C.

The Key Product Criteria as defined in Table 1 (below) for Industrial Transformers (Single and Three-Phase) relates the required efficiency level by kVA.

Federal Pacific "Energy Efficient Transformers" are in compliance with 10 CFR 431. Test procedures are performed in accordance with Apendix A to Subpart K of 10 CFR Part 431.

Standards and Certifications

All Federal Pacific dry-type transformers are built and tested to applicable Industry Standards of ANSI, NEMA and IEEE.

TABLE 1*

NEMA Class 1 Efficiency Levels for Dry-Type Distribution Transformers

Single Phase		Three Phase	
kVA	Efficiency Level (%)	kVA	Efficiency Level (%)
15	97.7	15	97.0
25	98.0	30	97.5
37	98.2	45	97.7
50	98.3	75	98.0
75	98.5	112.5	98.2
100	98.6	150	98.3
157	98.7	225	98.5
250	98.8	300	98.6
333	98.9	500	98.7
		750	98.8
		1000	98.9

*Efficiencies shown at 35% load and 75°C as defined by NEMA® Standard TP-1-2002

Type FB Buck-Boost Transformers

Application

The Type FB Insulating and Buck-Boost Transformer has four separate windings, two windings in the primary and two windings in the secondary. The unit is designed for use as an isolating transformer or as an auto-transformer. As an autotransformer the unit can be connected to Buck (decrease) or Boost (increase) a supply voltage. When connected in either the Buck or Boost mode, the unit is no longer an isolating transformer but is an autotransformer.

Autotransformers are more economical and physically smaller than equivalent two-winding transformers designed to carry the same load. They will perform the same function as two-winding transformers with the exception of isolating two circuits. Since autotransformers may transmit line disturbances directly, they may be prohibited in some areas by local building codes. Before applying them, care should be taken to assure that they are acceptable according to local code.

Note: Three autotransformers are not used in closed delta connections as they introduce into the circuit a phase shift.

As isolating transformers, these units can accommodate a high voltage of 120x240 volts (SB12N and SB16N series) or 240x480 volts (SB24N series.) For the units with two 12 volt secondaries, the low voltage output can be 12 volts, 24 volts, or 3-wire 24/12 volts. For the units with two 16 volt secondaries, the output voltages can be 16 volts, 32 volts, or 3-wire 32/16 volts. For the units with two 24 volt secondaries, the output voltages can be 24 volts, 48 volts, or 3 wire 48/24 volts.

Operation

Electrical and electronic equipment is designed to operate on a standard supply voltage. When the supply voltage is constantly too high or too low, (usually greater than ± 5%), the equipment may fail to operate at maximum efficiency. A Buck-Boost transformer is a simple and economical means of correcting this off-standard voltage up to ± 20%. A Buck-Boost transformer will NOT, however, stabilize a fluctuating voltage.

Buck-Boost transformers are suitable for use in a three-phase autotransformer bank in either direction to supply 3-wire loads. They are also suitable for use in a three-phase autotransformer bank which provides a neutral return for unbalanced current. They are not suitable for use in a three-phase autotransformer bank to supply a 4-wire load when the source is only a 3-wire circuit, having no neutral.

Selection

To select the proper transformer for Buck-Boost applications, determine:

1. Input Line Voltage- the voltage that you want to buck (decrease) or boost (increase). This can be found by measuring the supply line voltage with a voltmeter.

2. Output Load Voltage- the voltage at which your equipment is designed to operate. This is listed on the nameplate of the load equipment.

3. Load KVA or Load Amps- you do not need to know both - one or the other is sufficient for selection purposes. This information usually can be found on the nameplate of the equipment that you want to operate.

4. Number of Phases- single- or three-phase line and load should match because a transformer is not capable of converting single-phase to three-phase. It is, however, a common application to make a single-phase transformer connection from a three-phase supply by use of one leg of the three-phase supply circuit. Care must always be taken not to overload the leg of the three-phase supply. This is particularly true in a Buck-Boost application because the supply must provide the load KVA, not just the nameplate rating of the Buck-Boost transformer.

5. Frequency- the supply line frequency must be the same as the frequency of the equipment to be operated - either 50 or 60 hertz.

Six Step Selection

1. Choose the selection table with the correct number of phases. Tables I, III and V for single-phase applications and Tables II, IV and VI for three-phase applications. Tables I and II are for 120x240-12/24 volt units, tables III and IV are for 120x240-16/32 volt units and tables V and VI are for 240x480-24/48 volt units.

2. Line/Load voltage combinations are listed across the top of the selection table. Use the boosting or bucking columns where appropriate.

3. Follow the selected column down until you find either the load KVA or load amps of your application. If you do not find the exact value, go on to the next highest rating.

4. Follow across the table to the far left-hand side to find the catalog number of the transformer you need.

5. Follow the column of your line/load voltage to the bottom to find the connection diagram for this application. NOTE: Connection diagrams show low voltage and high voltage connection terminals. Either can be input or output depending on buck or boost application.

6. In the case of three-phase loads, two (open Delta) or three (Wye) single-phase transformers are required as indicated in the "quantity required" line at the bottom of Table II, IV or VI. Select depending on whether a Wye connected bank of three transformers with a neutral is required or whether an open Delta connected bank of two transformers for a Delta connected load will be suitable.

For line/load voltages not listed on table, use the pair listed on the table that is slightly above your application for reference. Then apply the first formula at the bottom of the page to determine "New" output voltage. The new KVA rating can be found using the second formula.

For more extensive Buck-Boost combinations and connections go to our Buck-Boost Program Selector at:

***www.federalpacific.com/bbcalc.xls*.**

Buck-Boost Technical Data

Type FB: 115° C Rise • 180° C Insulation System • Non-Ventilated • Indoor/Outdoor

Type	KVA	Catalog Number	Taps	Approximate Enclosure Dimension - Inches			Approx. Total Lbs.	Weather Shield	Wiring Diagram †	Wall Mount Bracket
				H	W	D				
120 x 240 - 12/24 Volts, 60 Hz, No Taps										
FB	0.050	SB12N.050F	No Taps	8.25	3.25	4.25	8	N/R	10A	N/A
	0.100	SB12N.100F	No Taps	8.25	3.25	4.25	10	N/R	10A	N/A
	0.150	SB12N.150F	No Taps	9.25	4	5	14	N/R	10A	N/A
	0.250	SB12N.250F	No Taps	9.25	4	5	15	N/R	10A	N/A
	0.500	SB12N.500F	No Taps	11.25	5.25	6.5	21	N/R	10A	N/A
	0.750	SB12N.750F	No Taps	11.25	5.25	6.5	25	N/R	10A	N/A
	1	SB12N1F	No Taps	11.25	5.25	6.5	28	N/R	10A	N/A
	1.5	SB12N1.5F	No Taps	13.25	6.25	7.75	45	N/R	10A	N/A
	2	SB12N2F	No Taps	13.25	6.25	7.75	50	N/R	10A	N/A
	3	SB12N3F	No Taps	13.25	6.25	7.75	60	N/R	10A	N/A
	5	SB12N5F	No Taps	15	10.187	10.625	110	N/R	10A	N/A
120 x 240 - 16/32 Volts, 60 Hz, No Taps										
FB	0.050	SB16N.050F	No Taps	8.25	3.25	4.25	8	N/R	10A	N/A
	0.100	SB16N.100F	No Taps	8.25	3.25	4.25	10	N/R	10A	N/A
	0.150	SB16N.150F	No Taps	9.25	4	5	14	N/R	10A	N/A
	0.250	SB16N.250F	No Taps	9.25	4	5	15	N/R	10A	N/A
	0.500	SB16N.500F	No Taps	11.25	5.25	6.5	21	N/R	10A	N/A
	0.750	SB16N.750F	No Taps	11.25	5.25	6.5	25	N/R	10A	N/A
	1	SB16N1F	No Taps	11.25	5.25	6.5	28	N/R	10A	N/A
	1.5	SB16N1.5F	No Taps	13.25	6.25	7.75	45	N/R	10A	N/A
	2	SB16N2F	No Taps	13.25	6.25	7.75	50	N/R	10A	N/A
	3	SB16N3F	No Taps	13.25	6.25	7.75	60	N/R	10A	N/A
	5	SB16N5F	No Taps	15	10.187	10.625	110	N/R	10A	N/A
240 x 480 - 24/48 Volts, 60 Hz, No Taps										
FB	0.050	SB24N.050F	No Taps	8.25	3.25	4.25	8	N/R	10A	N/A
	0.100	SB24N.100F	No Taps	8.25	3.25	4.25	10	N/R	10A	N/A
	0.150	SB24N.150F	No Taps	9.25	4	5	14	N/R	10A	N/A
	0.250	SB24N.250F	No Taps	9.25	4	5	15	N/R	10A	N/A
	0.500	SB24N.500F	No Taps	11.25	5.25	6.5	21	N/R	10A	N/A
	0.750	SB24N.750F	No Taps	11.25	5.25	6.5	25	N/R	10A	N/A
	1	SB24N1F	No Taps	11.25	5.25	6.5	28	N/R	10A	N/A
	1.5	SB24N1.5F	No Taps	13.25	6.25	7.75	45	N/R	10A	N/A
	2	SB24N2F	No Taps	13.25	6.25	7.75	50	N/R	10A	N/A
	3	SB24N3F	No Taps	13.25	6.25	7.75	60	N/R	10A	N/A
	5	SB24N5F	No Taps	15	10.187	10.625	110	N/R	10A	N/A

† Connection diagram when used as an isolation transformer

N/R - Not Required

Buck-Boost Selector Program

For a more comprehensive selection use the following link:
www.federalpacific.com/bbcalc.xls

Buck-Boost Selection Tables

120 x 240 Volts Primary - 12/24 Volts Secondary • Buck - Boost Dry-Type Transformers

AMPS = Load Amps
KVA = Load Circuit KVA

Single-Phase

TABLE I

Catalog Number		BOOSTING								BUCKING					
	Line-Voltage	96	100	105	109	189	208	218	220	125	132	229	245	250	252
	Load Voltage	115	120	116	120	208	229	240	242	114	120	208	223	227	240
SB12N.050F	KVA	0.24	0.25	0.48	0.50	0.43	0.48	0.50	0.50	0.52	0.55	0.48	0.51	0.52	1.05
	AMPS	2.08	2.08	4.17	4.17	2.08	2.08	2.08	2.08	4.58	4.58	2.29	2.29	2.29	4.38
SB12N.100F	KVA	0.48	0.50	0.96	1.00	0.87	0.95	1.00	1.01	1.04	1.10	0.95	1.02	1.04	2.10
	AMPS	4.17	4.17	8.33	8.33	4.17	4.17	4.17	4.17	9.17	9.17	4.58	4.58	4.58	8.75
SB12N.150F	KVA	0.72	0.75	1.44	1.50	1.30	1.43	1.50	1.51	1.56	1.65	1.43	1.53	1.56	3.15
	AMPS	6.25	6.25	12.50	12.50	6.25	6.25	6.25	6.25	13.75	13.75	6.87	6.87	6.87	13.13
SB12N.250F	KVA	1.20	1.25	2.41	2.50	2.17	2.38	2.50	2.52	2.60	2.75	2.39	2.55	2.60	5.25
	AMPS	10.42	10.42	20.83	20.83	10.42	10.42	10.42	10.42	22.92	22.92	11.46	11.46	11.46	21.88
SB12N.500F	KVA	2.40	2.50	4.81	5.00	4.33	4.77	5.00	5.04	5.21	5.50	4.77	5.10	5.21	10.50
	AMPS	20.83	20.83	41.67	41.67	20.83	20.83	20.83	20.83	45.83	45.83	22.92	22.92	22.92	43.75
SB12N.750F	KVA	3.60	3.75	7.22	7.49	6.5	7.15	7.49	7.56	7.81	8.25	7.16	7.66	7.81	15.75
	AMPS	31.25	31.25	62.50	62.50	31.25	31.25	31.25	31.25	68.75	68.75	34.37	34.37	34.37	65.63
SB12N1F	KVA	4.80	5.00	9.63	9.99	8.66	9.53	9.99	10.08	10.42	11.00	9.54	10.21	10.42	21.00
	AMPS	41.67	41.67	83.33	83.33	41.67	41.67	41.67	41.67	91.67	91.67	45.83	45.83	45.83	87.50
SB12N1.5F	KVA	7.20	7.5	14.44	14.99	12.99	14.30	14.99	15.13	15.62	16.50	14.31	15.31	15.62	31.50
	AMPS	62.50	62.50	125.00	125.00	62.50	62.50	62.50	62.50	137.50	137.50	68.75	68.75	68.75	131.25
SB12N2F	KVA	9.60	10.00	19.25	19.98	17.32	19.07	19.98	20.17	20.83	22.00	19.08	20.42	20.83	42.00
	AMPS	83.33	83.33	166.67	166.67	83.33	83.33	83.33	83.33	183.33	183.33	91.67	91.67	91.67	175.00
SB12N3F	KVA	14.40	15.00	28.88	29.98	25.99	28.60	29.98	30.25	31.25	33.00	28.62	30.62	31.25	63.00
	AMPS	125.00	125.00	250.00	250.00	125.00	125.00	125.00	125.00	275.00	275.00	137.50	137.50	137.50	262.50
SB12N5F	KVA	24.00	25.00	48.13	49.96	43.31	47.67	49.96	50.42	52.08	55.00	47.71	51.04	52.08	105.00
	AMPS	208.33	208.33	416.67	416.67	208.33	208.33	208.33	208.33	458.33	458.33	229.17	229.17	229.17	437.50
	*DIAGRAM	B	B	A	A	D	D	D	D	A	A	D	D	D	C

Three-Phase

TABLE II

Catalog Number		BOOSTING									BUCKING				
	Line Voltage	189Y/109	195Y/113	200Y/115	208Y/120	416Y/240	416Y/240	189	208	220	218	229	250	255	264
	Load Voltage	208Y/120	234Y/135	240Y/139	229Y/132	458Y/264	437Y/252	208	229	242	208	208	227	232	240
SB12N.050F	KVA	1.50	0.84	0.87	1.65	1.65	3.15	0.75	0.83	0.87	1.57	0.83	0.90	0.92	0.95
	AMPS	4.17	2.08	2.08	4.17	2.08	4.17	2.08	2.08	2.08	4.38	2.29	2.29	2.29	2.29
SB12N.100F	KVA	3.00	1.69	1.73	3.30	3.30	6.30	1.50	1.65	1.75	3.15	1.65	1.80	1.84	1.91
	AMPS	8.33	4.17	4.17	8.33	4.17	8.33	4.17	4.17	4.17	8.75	4.58	4.58	4.58	4.58
SB12N.150F	KVA	4.5	2.53	2.60	4.95	4.95	9.46	2.25	2.48	2.62	4.72	2.48	2.71	2.76	2.86
	AMPS	12.50	6.25	6.25	12.50	6.25	12.50	6.25	6.25	6.25	13.13	6.87	6.87	6.88	6.88
SB12N.250F	KVA	7.50	4.22	4.33	8.26	8.26	15.76	3.75	4.13	4.37	7.87	4.13	4.51	4.60	4.76
	AMPS	20.83	10.42	10.42	20.83	10.42	20.83	10.42	10.42	10.42	21.88	11.46	11.46	11.46	11.46
SB12N.500F	KVA	15.00	8.44	8.66	16.51	16.51	31.52	7.50	8.26	8.73	15.73	8.26	9.02	9.20	9.53
	AMPS	41.67	20.83	20.83	41.67	20.83	41.67	20.83	20.83	20.83	43.75	22.92	22.92	22.92	22.92
SB12N.750F	KVA	22.51	12.67	12.99	24.77	24.77	47.28	11.25	12.38	13.10	23.60	12.39	13.53	13.80	14.29
	1AMPS	62.50	31.25	31.25	62.50	31.25	62.50	31.25	31.25	31.25	65.63	34.37	34.37	34.37	34.38
SB12N1F	KVA	30.01	16.89	17.32	33.02	33.02	63.05	15.00	16.51	17.46	31.47	16.53	18.04	18.40	19.05
	AMPS	83.33	41.67	41.67	83.33	41.67	83.33	41.67	41.67	41.67	87.50	45.83	45.83	45.83	45.83
SB12N1.5F	KVA	45.01	25.66	25.98	49.54	49.54	94.57	22.51	24.77	26.20	47.20	24.79	27.06	27.60	28.58
	AMPS	125.00	62.50	62.50	125.00	62.50	125.00	62.50	62.50	62.50	131.25	68.75	68.75	68.75	68.75
SB12N2F	KVA	60.02	33.77	34.64	66.05	66.05	126.09	30.01	33.02	34.93	62.93	33.05	36.08	36.81	38.11
	AMPS	166.67	83.33	83.33	166.67	83.33	166.67	83.33	83.33	83.33	175.00	91.67	91.67	91.67	91.67
SB12N3F	KVA	90.02	50.66	51.96	99.07	99.07	189.14	45.01	49.54	52.39	94.40	49.58	54.13	55.21	57.16
	AMPS	250.00	125.00	125.00	250.00	125.00	250.00	125.00	125.00	125.00	262.50	137.50	137.50	137.50	137.50
SB12N5F	KVA	150.04	84.44	86.60	165.12	165.12	315.23	75.02	82.56	87.32	157.33	82.63	90.21	92.02	95.26
	AMPS	416.67	208.33	208.33	416.67	208.33	416.67	208.33	208.33	208.33	437.50	229.17	229.17	229.17	229.17
	No. of Transformers	3	3	3	3	3	3	2	2	2	2	2	2	2	2
	*DIAGRAM	F	E	E	F	J	K	G	G	G	H	G	G	G	G

* See Pages 59 - 63

Output voltage for lower input voltage can be found by: $\frac{\text{Rated Output Voltage}}{\text{Rated Input Voltage}}$ x Input Actual Voltage = Output New Voltage.

Output KVA available at reduced input voltage can be found by: $\frac{\text{Actual Input Voltage}}{\text{Rated Input Voltage}}$ x Output KVA = New KVA Rating.

Buck-Boost Selection Tables

120 x 240 Volts Primary - 16/32 Volts Secondary • Buck - Boost Dry-Type Transformers

AMPS = Load Amps
KVA = LoadCircuit KVA

Single-Phase

TABLE III

Catalog Number		BOOSTING								BUCKING					
	Line Voltage	95	100	105	208	215	215	220	225	135	240	240	245	250	255
	Load Voltage	120	113	119	236	244	229	235	240	120	212	225	230	234	239
SB16N.050F	KVA	0.19	0.35	0.37	0.37	0.38	0.72	0.73	0.75	0.42	0.38	0.75	0.77	0.78	0.80
	AMPS	1.56	3.13	3.13	1.56	1.56	3.12	3.13	3.12	3.54	1.77	3.33	3.33	3.33	3.33
SB16N.100F	KVA	0.38	0.71	0.74	0.74	0.76	1.43	1.47	1.50	0.84	0.75	1.50	1.53	1.56	1.59
	AMPS	3.13	6.25	6.25	3.13	3.13	6.25	6.25	6.25	7.08	3.54	6.67	6.67	6.67	6.67
SB16N.150F	KVA	0.56	1.06	1.12	1.11	1.14	2.15	2.20	2.25	1.27	1.13	2.25	2.30	2.34	2.39
	AMPS	4.69	9.38	9.38	4.69	4.69	9.37	9.37	9.37	10.63	5.31	10.00	10.00	10.00	10.00
SB16N.250F	KVA	0.94	1.77	1.86	1.84	1.90	3.58	3.67	3.75	2.11	1.88	3.75	3.83	3.91	3.98
	AMPS	7.81	15.63	15.63	7.81	7.81	15.62	15.62	15.62	17.71	8.85	16.67	16.67	16.67	16.67
SB16N.500F	KVA	1.88	3.54	3.72	3.68	3.81	7.17	7.33	7.50	4.22	3.75	7.50	7.66	7.81	7.97
	AMPS	15.63	31.25	31.25	15.63	15.63	31.25	31.25	31.25	35.42	17.71	33.33	33.33	33.33	33.33
SB16N.750F	KVA	2.82	5.31	5.58	5.53	5.71	10.75	11.00	11.25	6.33	5.63	11.25	11.48	11.72	11.95
	AMPS	23.44	46.88	46.88	23.44	23.44	46.87	46.87	46.87	53.13	26.56	50.00	50.00	50.00	50.00
SB16N1F	KVA	3.76	7.08	7.44	7.37	7.61	14.33	14.67	15.00	8.44	7.50	15.00	15.31	15.62	15.94
	AMPS	31.25	62.50	62.50	31.25	31.25	62.50	62.50	62.50	70.83	35.42	66.67	66.67	66.67	66.67
SB16N1.5F	KVA	5.64	10.63	11.16	11.05	11.42	21.50	22.00	22.50	12.66	11.25	22.50	22.97	23.44	23.91
	AMPS	46.88	93.75	93.75	46.88	46.88	93.75	93.75	93.75	106.25	53.13	100.00	100.00	100.00	100.00
SB16N2F	KVA	7.52	14.71	14.88	14.73	15.23	28.67	29.33	30.00	16.88	15.00	30.00	30.62	31.25	31.87
	AMPS	62.50	125.00	125.00	62.50	62.50	125.00	125.00	125.00	141.67	70.83	133.33	133.33	133.33	133.33
SB16N3F	KVA	11.28	21.25	22.31	22.10	22.84	43.00	44.00	45.00	25.31	22.50	45.00	45.94	46.87	47.81
	AMPS	93.75	187.50	187.50	93.75	93.75	187.50	187.50	187.50	212.50	106.25	200.00	200.00	200.00	200.00
SB16N5F	KVA	18.80	35.42	37.19	36.83	38.07	71.67	73.33	75.00	42.19	37.50	75.00	76.56	78.12	79.69
	AMPS	156.25	312.50	312.50	156.25	156.25	312.50	312.50	312.50	354.17	177.08	333.33	333.33	333.33	333.33
	*DIAGRAM	B	A	A	D	D	C	C	C	A	D	C	C	C	C

Three-Phase

TABLE IV

Catalog Number		BOOSTING					BUCKING					
	Line Voltage	183Y/106	208Y/120	195	208	225	240	245	250	256	265	272
	Load Voltage	208Y/120	236Y/136	208	236	240	208	230	234	240	234	240
SB16N.050F	KVA	1.12	1.28	1.13	0.64	1.30	0.56	1.33	1.35	1.39	0.72	0.74
	AMPS	3.13	3.13	3.12	1.56	3.12	1.56	3.33	3.33	3.33	1.77	1.77
SB16N.100F	KVA	2.25	2.55	2.25	1.28	2.60	1.13	2.65	2.71	2.77	1.43	1.47
	AMPS	6.25	6.25	6.25	3.13	6.25	3.13	6.67	6.67	6.67	3.54	3.54
SB16N.150F	KVA	3.37	3.83	3.38	1.91	3.90	1.69	3.98	4.06	4.16	2.15	2.21
	AMPS	9.38	9.38	9.37	4.69	9.37	4.69	10.00	10.00	10.00	5.31	5.31
SB16N.250F	KVA	5.61	6.38	5.63	3.19	6.50	2.81	6.63	6.77	6.93	3.59	3.68
	AMPS	15.63	15.62	15.62	7.81	15.62	7.81	16.67	16.67	16.67	8.85	8.85
SB16N.500F	KVA	11.23	12.76	11.26	6.38	12.99	5.63	13.26	13.53	13.86	7.17	7.36
	AMPS	31.25	31.25	31.25	15.63	31.25	15.63	33.33	33.33	33.33	17.71	17.71
SB16N.750F	KVA	16.84	19.14	16.89	9.58	19.49	8.44	19.89	20.30	20.78	10.76	11.04
	1AMPS	46.88	46.88	46.87	23.44	46.87	23.44	50.00	50.00	50.00	26.56	26.56
SB16N1F	KVA	22.45	25.52	22.52	12.76	25.98	11.26	26.52	27.06	27.71	14.34	14.72
	AMPS	62.50	62.50	62.50	31.25	62.50	31.25	66.67	66.67	66.67	35.42	35.42
SB16N1.5F	KVA	33.68	38.28	33.77	19.14	38.97	16.89	39.78	40.59	41.57	21.52	22.08
	AMPS	93.75	93.75	93.75	46.88	93.75	46.88	100.00	100.00	100.00	53.13	53.13
SB16N2F	KVA	44.90	51.04	45.03	25.52	51.96	22.52	53.04	54.13	55.43	28.69	29.44
	AMPS	125.00	125.00	125.00	62.50	125.00	62.50	133.33	133.33	133.33	70.83	70.83
SB16N3F	KVA	67.36	76.56	67.55	38.28	77.94	33.77	79.57	81.19	83.14	43.03	44.17
	AMPS	187.50	187.50	187.50	93.75	187.50	93.75	200.00	200.00	200.00	106.25	106.25
SB16N5F	KVA	112.26	127.59	112.58	63.80	129.90	56.29	132.61	135.32	138.56	71.72	73.61
	AMPS	312.50	312.50	312.50	156.25	312.50	156.25	333.33	333.33	333.33	177.08	177.08
	No. of Transformers	3	3	2	2	2	2	2	2	2	2	2
	*DIAGRAM	F	F	H	G	H	L	H	H	H	G	G

* See Pages 59 - 63

Output voltage for lower input voltage can be found by: $\frac{\text{Rated Output Voltage}}{\text{Rated Input Voltage}}$ x Input Actual Voltage = Output New Voltage.

Output KVA available at reduced input voltage can be found by: $\frac{\text{Actual Input Voltage}}{\text{Rated Input Voltage}}$ x Output KVA = New KVA Rating.

Buck-Boost Selection Tables

240 x 480 Volts Primary - 24/48 Volts Secondary • Buck - Boost Dry-Type Transformers

AMPS = Load Amps
KVA = Load Circuit KVA

Single-Phase

TABLE V

Catalog Number		BOOSTING									BUCKING				
	Line-Voltage	230	380	416	425	430	435	440	450	460	132	277	480	480	504
	Load Voltage	276	418	458	468	473	457	462	495	483	126	231	436	457	480
SB24N.050F	KVA	0.29	0.44	0.48	0.49	0.49	0.95	0.96	0.52	1.01	0.28	0.29	0.50	1.00	1.05
	AMPS	1.04	1.04	1.04	1.04	1.04	2.08	2.08	1.04	2.08	2.19	1.25	1.15	2.19	2.19
SB24N.100F	KVA	0.58	0.87	0.95	0.97	0.99	1.90	1.93	1.03	2.01	0.55	0.58	1.00	2.00	2.10
	AMPS	2.08	2.08	2.08	2.08	2.08	4.17	4.17	2.08	4.17	4.38	2.50	2.29	4.38	4.38
SB24N.150F	KVA	0.86	1.31	1.43	1.46	1.48	2.85	2.89	1.55	3.02	0.83	0.87	1.50	3.00	3.15
	AMPS	3.13	3.13	3.13	3.13	3.13	6.25	6.25	3.13	6.25	6.56	3.75	3.44	6.56	6.56
SB24N.250F	KVA	1.44	2.18	2.38	2.43	2.46	4.76	4.81	2.58	5.03	1.38	1.44	2.50	5.00	5.25
	AMPS	5.21	5.21	5.21	5.21	5.21	10.42	10.42	5.21	10.42	10.94	6.25	5.73	10.94	10.94
SB24N.500F	KVA	2.88	4.35	4.77	4.87	4.93	9.52	9.63	5.16	10.06	2.75	2.89	5.00	10.00	10.50
	AMPS	10.42	10.42	10.42	10.42	10.42	20.83	20.83	10.42	20.83	21.88	12.50	11.46	21.88	21.88
SB24N.750F	KVA	4.31	6.53	7.15	7.30	7.39	14.27	14.44	7.73	15.09	4.13	4.33	7.50	15.00	15.75
	AMPS	15.63	15.63	15.62	15.63	15.63	31.25	31.25	15.63	31.25	32.81	18.75	17.19	32.81	32.81
SB24N1F	KVA	5.75	8.71	9.53	9.74	9.85	19.03	19.25	10.31	20.13	5.50	5.77	10.00	20.00	21.00
	AMPS	20.83	20.83	20.83	20.83	20.83	41.67	41.67	20.83	41.67	43.75	25.00	22.92	43.75	43.75
SB24N1.5F	KVA	8.63	13.06	14.30	14.61	14.78	28.55	28.88	15.47	30.19	8.25	8.66	15.00	30.00	31.50
	AMPS	31.25	31.25	31.25	31.25	31.25	62.50	62.50	31.25	62.50	65.63	37.50	34.37	65.63	65.63
SB24N2F	KVA	11.50	17.42	19.07	19.48	19.71	38.06	38.50	20.63	40.25	11.00	11.54	20.00	40.00	42.00
	AMPS	41.67	41.67	41.67	41.67	41.67	83.33	83.33	41.67	83.33	87.50	50.00	45.83	87.50	87.50
SB24N3F	KVA	17.25	26.13	28.60	29.22	29.56	57.09	57.75	30.94	60.38	16.50	17.31	30.00	60.00	63.00
	AMPS	62.50	62.50	62.50	62.50	62.50	125.00	125.00	62.50	125.00	131.25	75.00	68.75	131.25	131.25
SB24N5F	KVA	28.75	43.54	47.67	48.70	49.27	95.16	96.25	51.56	100.63	27.50	28.85	50.00	100.00	105.00
	AMPS	104.17	104.17	104.17	104.17	104.17	208.33	208.33	104.17	208.33	218.75	125.00	114.58	218.75	218.75
	*DIAGRAM	B	D	D	D	D	C	C	D	C	C	B	D	C	C

Three-Phase

TABLE VI

Catalog Number		BOOSTING								BUCKING							
	Line Voltage	399Y/230	380	430	440	460	460	480	480	440	440	460	460	480	480	500	500
	Load Voltage	480Y/277	418	473	462	506	483	528	504	400	419	438	418	457	436	455	476
SB24N.050F	KVA	0.86	0.75	0.85	1.67	0.91	1.74	0.95	1.82	0.79	1.59	1.66	0.83	1.73	0.87	0.90	1.80
	AMPS	1.04	1.04	1.04	2.08	1.04	2.08	1.04	2.08	1.15	2.19	2.19	1.15	2.19	1.15	1.15	2.19
SB24N.100F	KVA	1.73	1.51	1.71	3.33	1.83	3.49	1.91	3.64	1.59	3.18	3.32	1.66	3.46	1.73	1.80	3.61
	AMPS	2.08	2.08	2.08	4.17	2.08	4.17	2.08	4.17	2.29	4.38	4.38	2.29	4.38	2.29	2.29	4.38
SB24N.150F	KVA	2.59	2.26	2.56	5.00	2.74	5.23	2.86	5.46	2.38	4.76	4.98	2.49	5.20	2.60	2.71	5.41
	AMPS	3.13	3.13	3.13	6.25	3.13	6.25	3.13	6.25	3.44	6.56	6.56	3.44	6.56	3.44	3.44	6.56
SB24N.250F	KVA	4.32	3.77	4.27	8.34	4.56	8.71	4.76	9.09	3.97	7.94	8.30	4.15	8.66	4.33	4.51	9.02
	AMPS	5.21	5.21	5.21	10.42	5.21	10.42	5.21	10.42	5.73	10.94	10.94	5.73	10.94	5.73	5.73	10.94
SB24N.500F	KVA	8.64	7.54	8.53	16.67	9.13	17.43	9.53	18.19	7.94	15.88	16.60	8.30	17.32	8.66	9.02	18.04
	AMPS	10.42	10.42	10.42	20.83	10.42	20.83	10.42	20.83	11.46	21.88	21.88	11.46	21.88	11.46	11.46	21.88
SB24N.750F	KVA	12.96	11.31	12.80	25.01	13.69	26.14	14.29	27.28	11.91	23.82	24.90	12.45	25.98	12.99	13.53	27.06
	1AMPS	15.62	15.63	15.63	31.25	15.63	31.25	15.63	31.25	17.19	32.81	32.81	17.19	32.81	17.19	17.19	32.81
SB24N1F	KVA	17.28	15.08	17.07	33.34	18.26	34.86	19.05	36.37	15.88	31.75	33.20	16.60	34.64	17.32	18.04	36.08
	AMPS	20.83	20.83	20.83	41.67	20.83	41.67	20.83	41.67	22.92	43.75	43.75	22.92	43.75	22.92	22.92	43.75
SB24N1.5F	KVA	25.92	22.62	25.60	50.01	27.39	52.29	28.58	54.56	23.82	47.63	49.80	24.90	51.96	25.98	27.06	54.13
	AMPS	31.25	31.25	31.25	62.50	31.25	62.50	31.25	62.50	34.38	65.63	65.63	34.38	65.63	34.37	34.37	65.63
SB24N2F	KVA	34.55	30.17	34.14	66.68	36.52	69.72	38.11	72.75	31.75	63.51	66.40	33.20	69.28	34.64	36.08	72.17
	AMPS	41.67	41.67	41.67	83.33	41.67	83.33	41.67	83.33	45.83	87.50	87.50	45.83	87.50	45.83	45.83	87.50
SB24N3F	KVA	51.83	45.25	51.20	100.03	54.78	104.57	57.16	109.12	47.63	95.26	99.59	49.80	103.92	51.96	54.13	108.25
	AMPS	62.50	62.50	62.50	125.00	62.50	125.00	62.50	125.00	68.75	131.25	131.25	68.75	131.25	68.75	68.75	131.25
SB24N5F	KVA	86.39	75.42	85.34	166.71	91.29	174.29	95.26	181.87	79.39	158.77	165.99	82.99	173.21	86.60	90.21	180.42
	AMPS	104.17	104.17	104.17	208.33	104.17	208.33	104.17	208.33	114.58	218.75	218.75	114.58	218.75	114.58	114.58	218.75
	No. of Transformers	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	*DIAGRAM	E	G	G	H	G	H	G	H	G	H	H	G	H	G	G	H

* See Pages 59 - 63

Output voltage for lower input voltage can be found by: $\frac{\text{Rated Output Voltage}}{\text{Rated Input Voltage}}$ x Input Actual Voltage = Output New Voltage.

Output KVA available at reduced input voltage can be found by: $\frac{\text{Actual Input Voltage}}{\text{Rated Input Voltage}}$ x Output KVA = New KVA Rating.

Single-Phase General Purpose Technical Data

Type FB: 115°C Rise • 180°C Insulation System • Non-Ventilated • Indoor/Outdoor
Type FH: 150°C Rise • 220°C Insulation System • Indoor Ventilated • Floor Mounted

Type	KVA	Catalog Number	Taps	Approximate Enclosure Dimensions - Inches			Approx. Wt. in Lbs.	Weather Shield[1]	Wiring Diagram	Wall Mount Bracket
				H	W	D				
120 x 240 - 120/240 Volts, 60 Hz, No Taps										
FB	1	SE120N1F	No Taps	11.25	5.25	6.5	28	N/R	5	N/A
	1.5	SE120N1.5F	No Taps	13.25	6.25	7.75	45	N/R	5	N/A
	2	SE120N2F	No Taps	13.25	6.25	7.75	50	N/R	5	N/A
	3	SE120N3F	No Taps	13.25	6.25	7.75	60	N/R	5	N/A
	5	SE120N5F	No Taps	15	10.187	10.625	110	N/R	5	N/A
	7.5	SE120N7.5F	No Taps	15	10.187	10.625	150	N/R	5	N/A
	10	SE120N10F	No Taps	17	13.187	13.125	175	N/R	5	N/A
	15	SE120N15F	No Taps	17	13.187	13.125	270	N/R	5	N/A
208 - 120/240 Volts, 60 Hz										
FB	1	SE201D1F	-2 x 5%	11.25	5.25	6.5	28	N/R	6	N/A
	1.5	SE201D1.5F	-2 x 5%	13.25	6.25	7.75	45	N/R	6	N/A
	2	SE201D2F	-2 x 5%	13.25	6.25	7.75	50	N/R	6	N/A
	3	SE201D3F	-2 x 5%	13.25	6.25	7.75	60	N/R	6	N/A
	5	SE201D5F	-2 x 5%	15	10.187	10.625	110	N/R	6	N/A
	7.5	SE201D7.5F	-2 x 5%	15	10.187	10.625	150	N/R	6	N/A
	10	SE201D10F	-2 x 5%	17	13.187	13.125	175	N/R	6	N/A
	15	SE201D15F	-2 x 5%	17	13.187	13.125	270	N/R	6	N/A
240 X 480 - 120/240 Volts, 60 Hz										
FB	0.050	SE2N.050F	No Taps	8.25	3.25	4.25	8	N/R	1	N/A
	0.075	SE2N.075.F	No Taps	8.25	3.25	4.25	9	N/R	1	N/A
	0.100	SE2N.100F	No Taps	8.25	3.25	4.25	10	N/R	1	N/A
	0.150	SE2N.150F	No Taps	9.25	4	5	14	N/R	1	N/A
	0.250	SE2N.250F	No Taps	9.25	4	5	15	N/R	1	N/A
	0.500	SE2N.500F	No Taps	11.25	5.25	6.5	21	N/R	1	N/A
	0.750	SE2N.750F	No Taps	11.25	5.25	6.5	25	N/R	1	N/A
	1	SE2N1F	No Taps	11.25	5.25	6.5	28	N/R	1	N/A
	1.5	SE2N1.5F	No Taps	13.25	6.25	7.75	45	N/R	1	N/A
	2	SE2N2F	No Taps	13.25	6.25	7.75	50	N/R	1	N/A
	3	SE2N3FS	No Taps	13.25	6.25	7.75	60	N/R	10	N/A
	3	SE2T3F	+2, -4 x 2.5%	13.25	6.25	7.75	60	N/R	8	N/A
	5	SE2N5FS	No Taps	15	10.187	10.625	110	N/R	10	N/A
	5	SE2T5F	+2, -4 x 2.5%	15	10.187	10.625	110	N/R	8	N/A
	7.5	SE2N7.5F	No Taps	15	10.187	10.625	150	N/R	1	N/A
	7.5	SE2T7.5F	+2, -4 x 2.5%	15	10.187	10.625	150	N/R	8	N/A
	10	SE2N10F	No Taps	17	13.187	13.125	175	N/R	1	N/A
	10	SE2T10F	+2, -4 x 2.5%	17	13.187	13.125	175	N/R	8	N/A
	15	SE2N15F	No Taps	17	13.187	13.125	270	N/R	1	N/A
	15	SE2T15F	+2, -4 x 2.5%	17	13.187	13.125	270	N/R	8	N/A
FH	15	S2T15E[2]	+2, -4 x 2.5%	33	16.625	18.375	170	WS-3	9	WMB-3
	25	S2T25E[2]	+2, -4 x 2.5%	33	16.625	18.375	195	WS-3	9	WMB-3
	37.5	S2T37E[2]	+2, -4 x 2.5%	37	22.375	19.875	270	WS-4	9	WMB-3
	50	S2T50E[2]	+2, -4 x 2.5%	37	22.375	19.875	300	WS-4	9	WMB-3
	75	S2T75E[2]	+2, -4 x 2.5%	45.5	24.75	20	450	WS-5	9	WMB-4
	100	S2T100E[2]	+2, -4 x 2.5%	52	25.375	23	610	WS-7	9	WMB-4
	167	S2T167E[2]	+2, -4 x 2.5%	60	33.375	26	1070	WS-9	9	NONE

[1]All transformer catalog numbers shown are in a NEMA 2 enclosure, which covers all the requirements of NEMA 1 by offering a degree of protection against the ingress of falling dirt and dripping liquid. The addition of a weather shield kit converts the indoor NEMA 2 transformer to an outdoor NEMA 3R.

[2] Can be furnished with CSA EEV label in compliance with CSA C802.2-06.

N/R - Not Required

Single-Phase General Purpose Technical Data

Type FB: 115°C Rise • 180°C Insulation System • Non-Ventilated • Indoor/Outdoor
Type FH: 150°C Rise • 220°C Insulation System • Indoor Ventilated • Floor Mounted

Type	KVA	Catalog Number	Taps	Approximate Enclosure Dimensions - Inches			Approx. Wt. in Lbs.	Weather Shield[1]	Wiring Diagram	Wall Mount Bracket
				H	W	D				
277 - 120/240 Volts, 60 Hz										
FB	1	SE271D1F	-2 x 5%	11.25	5.25	6.5	28	N/R	7	N/A
	1.5	SE271D1.5F	-2 x 5%	13.25	6.25	7.75	45	N/R	7	N/A
	2	SE271D2F	-2 x 5%	13.25	6.25	7.75	50	N/R	7	N/A
	3	SE271D3F	-2 x 5%	13.25	6.25	7.75	60	N/R	7	N/A
	5	SE271D5F	-2 x 5%	15	10.187	10.625	110	N/R	7	N/A
	7.5	SE271D7.5F	-2 x 5%	15	10.187	10.625	150	N/R	7	N/A
	10	SE271D10F	-2 x 5%	17	13.187	13.125	175	N/R	7	N/A
	15	SE271D15F	-2 x 5%	17	13.187	13.125	270	N/R	7	N/A
480- 120 x 240 Volts, 60 Hz										
FB	1	SE481D1F	-2 x 5%	11.25	5.25	6.5	28	N/R	2	N/A
	1.5	SE481D1.5F	-2 x 5%	13.25	6.25	7.75	45	N/R	2	N/A
	2	SE481D2F	-2 x 5%	13.25	6.25	7.75	50	N/R	2	N/A
	3	SE481D3F	-2 x 5%	13.25	6.25	7.75	60	N/R	2	N/A
	5	SE481D5F	-2 x 5%	15	10.187	10.625	110	N/R	2	N/A
	7.5	SE481D7.5F	-2 x 5%	15	10.187	10.625	150	N/R	2	N/A
	10	SE481D10F	-2 x 5%	17	13.187	13.125	175	N/R	2	N/A
	15	SE481D15F	-2 x 5%	17	13.187	13.125	270	N/R	2	N/A
600 - 120/240 Volts, 60 Hz, Electrostatically Shielded										
FB	1	SE61D1FS	-2 x 5%	11.25	5.25	6.5	28	N/R	3	N/A
	1.5	SE61D1.5FS	-2 x 5%	13.25	6.25	7.75	45	N/R	3	N/A
	2	SE61D2FS	-2 x 5%	13.25	6.25	7.75	50	N/R	3	N/A
	3	SE61D3FS	-2 x 5%	13.25	6.25	7.75	60	N/R	3	N/A
	5	SE61D5FS	-2 x 5%	15	10.187	10.625	110	N/R	3	N/A
FB	7.5	SE61D7.5FS	-2 x 5%	15	10.187	10.625	150	N/R	3	N/A
	10	SE61D10FS	-2 x 5%	17	13.187	13.125	175	N/R	3	N/A
	15	SE61G15FS	-4 x 2.5%	17	13.187	13.125	270	N/R	4	N/A
FH	15	S61T15SE[2]	+2, -4 x 2.5%	33	16.625	18.375	170	WS-3	11	WMB-3
	25	S61T25SE[2]	+2, -4 x 2.5%	33	16.625	18.375	195	WS-3	11	WMB-3
	37.5	S61T37SE[2]	+2, -4 x 2.5%	37	22.375	19.875	300	WS-4	11	WMB-3
	50	S61T50SE[2]	+2, -4 x 2.5%	37	22.375	19.875	300	WS-4	11	WMB-3
	75	S61T75SE[2]	+2, -4 x 2.5%	45.5	24.75	20	450	WS-5	11	WMB-4
	100	S61T100SE[2]	+2, -4 x 2.5%	52	25.375	23	610	WS-7	11	WMB-4
	167	S61T167SE[2]	+2, -4 x 2.5%	60	33.375	26	1070	WS-9	11	NONE
600 - 120/240 Volts, 60 Hz, Electrostatically Shielded Copper										
FH	15	S61T15CSE[2]	+2, -4 x 2.5%	33	16.625	18.375	210	WS-3	11	WMB-3
	25	S61T25CSE[2]	+2, -4 x 2.5%	33	16.625	18.375	260	WS-3	11	WMB-3
	37.5	S61T37CSE[2]	+2, -4 x 2.5%	37	22.375	19.875	400	WS-4	11	WMB-3
	50	S61T50CSE[2]	+2, -4 x 2.5%	37	22.375	19.875	330	WS-4	11	WMB-3

[1]All transformer catalog numbers shown are in a NEMA 2 enclosure, which covers all the requirements of NEMA 1 by offering a degree of protection against the ingress of falling dirt and dripping liquid. The addition of a weather shield kit converts the indoor NEMA 2 transformer to an outdoor NEMA 3R.

[2] Can be furnished with CSA EEV label in compliance with CSA C802.2-06.

N/R - Not Required

Single-Phase Optional Temperature Rise Technical Data

Type FH: 115°C and 80°C Rise • 180°C Insulation System
Indoor Ventilated • Floor Mounted

Type	KVA	Catalog Number	Taps	Approximate Enclosure Dimensions - Inches			Approx. Wt. in Lbs.	Weather Shield[1]	Wiring Diagram	Wall Mount Bracket
				H	W	D				
115° C Rise, 240 x 480 - 120/240 Volts, 60 Hz										
FH	15	S2T15FE	+2, -4 x 2.5%	33	16.625	18.375	170	WS-3	9	WMB-3
	25	S2T25FE	+2, -4 x 2.5%	37	22.375	19.875	270	WS-4	9	WMB-3
	37.5	S2T37FE	+2, -4 x 2.5%	37	22.375	19.875	270	WS-4	9	WMB-3
	50	S2T50FE	+2, -4 x 2.5%	45.5	24.75	20	450	WS-5	9	WMB-4
	75	S2T75FE	+2, -4 x 2.5%	52	25.375	23	610	WS-7	9	WMB-4
	100	S2T100FE	+2, -4 x 2.5%	52	25.375	23	820	WS-7	9	WMB-4
	167	S2T167FE	+2, -4 x 2.5%	60	33.375	26	1090	WS-9	9	NONE
80° C Rise, 240 x 480 - 120/240 Volts, 60 Hz										
FH	15	S2T15BE	+2, -4 x 2.5%	33	16.625	18.375	195	WS-3	9	WMB-3
	25	S2T25BE	+2, -4 x 2.5%	37	22.375	19.875	270	WS-4	9	WMB-3
	37.5	S2T37BE	+2, -4 x 2.5%	37	22.375	19.875	300	WS-4	9	WMB-3
	50	S2T50BE	+2, -4 x 2.5%	45.5	24.75	20	450	WS-5	9	WMB-4
	75	S2T75BE	+2, -4 x 2.5%	52	25.375	23	610	WS-7	9	WMB-4
	100	S2T100BE	+2, -4 x 2.5%	60	33.375	26	1070	WS-9	9	NONE

[1]All transformer catalog numbers shown are in a NEMA 2 enclosure, which covers all the requirements of NEMA 1 by offering a degree of protection against the ingress of falling dirt and dripping liquid. The addition of a weather shield kit converts the indoor NEMA 2 transformer to an outdoor NEMA 3R.

Three-Phase General Purpose Technical Data

Type FB: 115°C Rise • 180°C Insulation System • Non-Ventilated • Indoor/Outdoor
Type FH: 150°C Rise • 220°C Insulation System • Indoor Ventilated • Floor Mounted

Type	KVA	Catalog Number	Taps	Approximate Enclosure Dimensions - Inches			Approx. Wt. in Lbs.	Weather Shield[1]	Wiring Diagram	Wall Mount Bracket
				H	W	D				
208 - 208Y/120 Volts, 60 Hz, Electrostatically Shielded										
	15	T202H15SE	+2, -2 x 2.5%	29	17.125	19.375	185	WS-2	19	WMB-3
	30	T202H30SE	+2, -2 x 2.5%	34	22.375	19.875	370	WS-4	19	WMB-3
	45	T202H45SE	+2, -2 x 2.5%	34	22.375	19.875	400	WS-4	19	WMB-3
	75	T202H75SE	+2, -2 x 2.5%	37	26	19.875	585	WS-18A	19	WMB-4
FH	112.5	T202H112SE	+2, -2 x 2.5%	43	28.5	23.5	760	WS-18	19	WMB-4
	150	T202H150SE	+2, -2 x 2.5%	46	32	28	915	WS-10B	19A	NONE
	225	T202J225SE	+2, -2 x 3%	51	42.125	26	1385	WS-12	19B	NONE
	300	T202L300SE	+2, -2 x 3.5%	63	46.5	30.875	1630	WS-14	19C	NONE
	500	T202E500SE	+1, -1 x 5%	72.75	53.375	36.875	2620	WS-16	19E	NONE
208 - 480Y/277 Volts, 60 Hz										
	15	T204H15E	+2, -2 x 2.5%	29	17.125	19.375	185	WS-2	23	WMB-3
	30	T204H30E	+2, -2 x 2.5%	34	22.375	19.875	370	WS-4	23	WMB-3
	45	T204H45E	+2, -2 x 2.5%	34	22.375	19.875	400	WS-4	23	WMB-3
FH	75	T204H75E	+2, -2 x 2.5%	37	26	19.875	585	WS-18A	23	WMB-4
	112.5	T204H112E	+2, -2 x 2.5%	43	28.5	23.5	760	WS-18	23	WMB-4
	150	T204H150E	+2, -2 x 2.5%	46	32	28	915	WS-10B	23A	NONE
	225	T204J225E	+2, -2 x 3%	51	36	30	1190	WS-12A	23B	NONE
240 - 208Y/120 Volts, 60 Hz, Electrostatically Shielded										
	3	TE242D3FS	-2 x 5%	12.062	12.125	8.375	95	N/R	12	N/A
FB	6	TE242D6FS	-2 x 5%	14.562	20.125	10.625	225	N/R	12	N/A
	9	TE242D9FS	-2 x 5%	14.562	20.125	10.625	270	N/R	12	N/A
	15	TE242D15FS	-2 x 5%	16.062	21.125	15.125	435	N/R	12	N/A
	15	T242T15SE[2]	+2, -4 x 2.5%	29	17.125	19.375	185	WS-2	26	WMB-3
	30	T242T30SE[2]	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	26	WMB-3
	45	T242T45SE	+2, -4 x 2.5%	34	22.375	19.875	400	WS-4	26	WMB-3
	75	T242T75SE[2]	+2, -4 x 2.5%	37	26	19.875	575	WS-18A	26	WMB-4
FH	112.5	T242T112SE	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	26	WMB-4
	150	T242T150SE	+2, -4 x 2.5%	46	32	28	915	WS-10B	26A	NONE
	225	T242J225SE	+2, -2 x 3%	51	36	30.5	1190	WS-12A	26B	NONE
	300	T242L300SE	+2, -2 x 3.5%	63	46.5	30.875	1630	WS-14	26C	NONE
	500	T242B500SE	+1, -1 x 4%	72.75	53.375	36.875	2620	WS-16	26D	NONE

[1]All transformer catalog numbers shown are in a NEMA 2 enclosure, which covers all the requirements of NEMA 1 by offering a degree of protection against the ingress of falling dirt and dripping liquid. The addition of a weather shield kit converts the indoor NEMA 2 transformer to an outdoor NEMA 3R.

[2] Can be furnished with CSA EEV label in compliance with CSA C802.2-06.

N/R - Not Required

Three-Phase General Purpose Technical Data

Type FB: 115°C Rise • 180°C Insulation System • Non-Ventilated • Indoor/Outdoor
Type FH: 150°C Rise • 220°C Insulation System • Indoor Ventilated • Floor Mounted

Type	KVA	Catalog Number	Taps	Approximate Enclosure Dimensions - Inches			Approx. Wt. in Lbs.	Weather Shield[1]	Wiring Diagram	Wall Mount Bracket
				H	W	D				
480 - 208Y/120 Volts, 60 Hz										
FB	3	TE4D3F	-2 x 5%	12.062	12.125	8.375	95	N/R	13	N/A
	6	TE4D6F	-2 x 5%	14.562	20.125	10.625	225	N/R	13	N/A
	9	TE4D9F	-2 x 5%	14.562	20.125	10.625	270	N/R	13	N/A
	15	TE4D15F	-2 x 5%	16.062	21.125	15.125	435	N/R	13	N/A
FH	15	T4T15E[2]	+2, -4 x 2.5%	29	17.125	19.375	185	WS-2	22	WMB-3
	30	T4T30E[2]	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	22	WMB-3
	45	T4T45E[2]	+2, -4 x 2.5%	34	22.375	19.875	400	WS-4	22	WMB-3
	75	T4T75E[2]	+2, -4 x 2.5%	37	26	19.875	575	WS-18A	22	WMB-4
	112.5	T4T112E[2]	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	22	WMB-4
	150	T4T150E[2]	+2, -4 x 2.5%	46	32	28	915	WS-10B	22A	NONE
	225	T4T225E[2]	+2, -4 x 2.5%	51	36	30.5	1190	WS-12A	22A	NONE
480 - 208Y/120 Volts, 60 Hz, Electrostatically Shielded										
FB	3	TE4D3FS	-2 x 5%	12.062	12.125	8.375	95	N/R	15	N/A
	6	TE4D6FS	-2 x 5%	14.562	20.125	10.625	225	N/R	15	N/A
	9	TE4D9FS	-2 x 5%	14.562	20.125	10.625	270	N/R	15	N/A
	15	TE4D15FS	-2 x 5%	16.062	21.125	15.125	435	N/R	15	N/A
FH	15	T4T15SE[2]	+2, -4 x 2.5%	29	17.125	19.375	185	WS-2	18	WMB-3
	30	T4T30SE[2]	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	18	WMB-3
	45	T4T45SE[2]	+2, -4 x 2.5%	34	22.375	19.875	400	WS-4	18	WMB-3
	75	T4T75SE[2]	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	18	WMB-4
	112.5	T4T112SE[2]	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	18	WMB-4
	150	T4T150SE[2]	+2, -4 x 2.5%	46	32	28	915	WS-10B	18A	NONE
	225	T4T225SE[2]	+2, -4 x 2.5%	51	36	30.5	1190	WS-12A	18A	NONE
	300	T4T300SE[2]	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	18A	NONE
	500	T4T500SE[2]	+2, -4 x 2.5%	72.75	53.375	36.875	2620	WS-16	18A	NONE
	750	T4T750SE	+2, -4 x 2.5%	76.75	53.375	44.375	3280	NONE	18A	NONE
	1000	T4J1000SE	+2, -2 x 3%	80	61	44.375	4450	NONE	18B	NONE
480 - 208Y/120 Volts, 60 Hz, Electrostatically Shielded, Copper										
FH	15	T4T15CSE[2]	+2, -4 x 2.5%	29	17.125	19.375	230	WS-2	22	WMB-3
	30	T4T30CSE[2]	+2, -4 x 2.5%	34	22.375	19.875	410	WS-4	22	WMB-3
	45	T4T45CSE[2]	+2, -4 x 2.5%	34	22.375	19.875	460	WS-4	22	WMB-3
	75	T4T75CSE[2]	+2, -4 x 2.5%	37	26	19.875	645	WS-18A	22	WMB-4
	112.5	T4T112CSE[2]	+2, -4 x 2.5%	43	28.5	23.5	855	WS-18	22	WMB-4
	150	T4T150CSE[2]	+2, -4 x 2.5%	46	32	28	1080	WS-10B	22A	NONE
	225	T4T225CSE[2]	+2, -4 x 2.5%	51	42.125	26	1440	WS-12	22A	NONE
	300	T4T300CSE[2]	+2, -4 x 2.5%	63	46.5	30.875	1930	WS-14	22A	NONE
	500	T4T500CSE[2]	+2, -4 x 2.5%	72.75	53.375	36.875	3000	WS-16	22A	NONE
	750	T4T750CSE	+2, -4 x 2.5%	76.75	53.375	44.375	3800	NONE	18A	NONE
	1000	T4J1000CSE	+2, -2 x 3%	80	61	44.375	4895	NONE	18B	NONE

[1]All transformer catalog numbers shown are in a NEMA 2 enclosure, which covers all the requirements of NEMA 1 by offering a degree of protection against the ingress of falling dirt and dripping liquid. The addition of a weather shield kit converts the indoor NEMA 2 transformer to an outdoor NEMA 3R.

[2] Can be furnished with CSA EEV label in compliance with CSA C802.2-06.

N/R - Not Required

Three-Phase General Purpose Technical Data

Type FB: 115°C Rise • 180°C Insulation System • Non-Ventilated • Indoor/Outdoor

Type FH: 150°C Rise • 220°C Insulation System • Indoor Ventilated • Floor Mounted

Type	KVA	Catalog Number	Taps	Approximate Enclosure Dimensions - Inches			Approx. Wt. in Lbs.	Weather Shield[1]	Wiring Diagram	Wall Mount Bracket
				H	W	D				
480 - 240 Volts, 60 Hz										
FB	3	TE482D3F	-2 x 5%	12.062	12.125	8.375	95	N/R	14	N/A
	6	TE482D6F	-2 x 5%	14.562	20.125	10.625	225	N/R	14	N/A
	9	TE482D9F	-2 x 5%	14.562	20.125	10.625	270	N/R	14	N/A
	15	TE482D15F	-2 x 5%	16.062	21.125	15.125	435	N/R	14	N/A
480 - 240 Volts, Electrostatically Shielded										
FB	3	TE482D3FS	-2 x 5%	12.062	12.125	8.375	95	N/R	16	N/A
	6	TE482D6FS	-2 x 5%	14.562	20.125	10.625	225	N/R	16	N/A
	9	TE482D9FS	-2 x 5%	14.562	20.125	10.625	270	N/R	16	N/A
	15	TE482D15FS	-2 x 5%	16.062	21.125	15.125	435	N/R	16	N/A
480 - 240/120 Volts - LT (Lighting Tap), 60 Hz										
FH	15	T43T15E[2]	+2, -4 x 2.5%	29	17.125	19.375	185	WS-2	21	WMB-3
	30	T43T30E[2]	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	21	WMB-3
	45	T43T45E[2]	+2, -4 x 2.5%	34	22.375	19.875	400	WS-4	21	WMB-3
	75	T43T75E[2]	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	21	WMB-4
	112.5	T43T112E[2]	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	21	WMB-4
	150	T43T150E[2]	+2, -4 x 2.5%	46	32	28	915	WS-10B	21A	NONE
	225	T43T225E[2]	+2, -4 x 2.5%	51	36	30.5	1190	WS-12A	21A	NONE
480 - 240/120 Volts - LT (Lighting Tap), 60 Hz, Electrostatically Shielded										
FH	15	T43T15SE	+2, -4 x 2.5%	29	17.125	19.375	185	WS-2	17	WMB-3
	30	T43T30SE	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	17	WMB-3
	45	T43T45SE[2]	+2, -4 x 2.5%	34	22.375	19.875	400	WS-4	17	WMB-3
	75	T43T75SE[2]	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	17	WMB-4
	112.5	T43T112SE	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	17	WMB-4
	150	T43T150SE[2]	+2, -4 x 2.5%	46	32	28	915	WS-10B	17A	NONE
	225	T43T225SE	+2, -4 x 2.5%	51	36	30.5	1190	WS-12A	17A	NONE
	300	T43T300SE	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	17A	NONE
	500	T43T500SE	+2, -4 x 2.5%	72.75	53.375	36.875	2620	WS-16	17A	NONE
	750	T43T750SE	+2, -4 x 2.5%	76.75	53.375	44.375	3280	NONE	17A	NONE

[1]All transformer catalog numbers shown are in a NEMA 2 enclosure, which covers all the requirements of NEMA 1 by offering a degree of protection against the ingress of falling dirt and dripping liquid. The addition of a weather shield kit converts the indoor NEMA 2 transformer to an outdoor NEMA 3R.

[2] Can be furnished with CSA EEV label in compliance with CSA C802.2-06.

N/R - Not Required

Three-Phase General Purpose Technical Data

Type FH: 150°C Rise • 220°C Insulation System • Indoor Ventilated • Floor Mounted

Type	KVA	Catalog Number	Taps	Approximate Enclosure Dimensions - Inches H	W	D	Approx. Wt. in Lbs.	Weather Shield[1]	Wiring Diagram	Wall Mount Bracket
480 - 480Y/277 Volts, 60 Hz										
FH	15	T484T15E	+2, -4 x 2.5%	29	17.125	19.375	185	WS-2	20	WMB-3
	30	T484T30E[2]	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	20	WMB-3
	45	T484T45E[2]	+2, -4 x 2.5%	34	22.375	19.875	400	WS-4	20	WMB-3
	75	T484T75E[2]	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	20	WMB-4
	112.5	T484T112E	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	20	WMB-4
	150	T484T150E	+2, -4 x 2.5%	46	32	28	915	WS-10B	20A	NONE
	225	T484T225E	+2, -4 x 2.5%	51	36	30.5	1190	WS-12A	20A	NONE
600 - 208Y/120 Volts, 60 Hz, Electrostatically Shielded										
FH	15	T6T15SE[2]	+2, -4 x 2.5%	29	17.125	19.375	185	WS-2	24	WMB-3
	30	T6T30SE[2]	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	24	WMB-3
	45	T6T45SE[2]	+2, -4 x 2.5%	34	22.375	19.875	400	WS-4	24	WMB-3
	75	T6T75SE[2]	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	24	WMB-4
	112.5	T6T112SE[2]	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	24	WMB-4
	150	T6T150SE[2]	+2, -4 x 2.5%	46	32	28	915	WS-10B	24A	NONE
	225	T6T225SE	+2, -4 x 2.5%	51	36	30.5	1190	WS-12A	24A	NONE
	300	T6T300SE	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	24A	NONE
	500	T6T500SE	+2, -4 x 2.5%	72.75	53.375	36.875	2620	WS-16	24A	NONE
600 - 208Y/120 Volts, 60 Hz, Electrostatically Shielded Copper										
FH	15	T6T15CSE[2]	+2, -4 x 2.5%	29	17.125	19.375	230	WS-2	24	WMB-3
	30	T6T30CSE[2]	+2, -4 x 2.5%	34	22.375	19.875	410	WS-4	24	WMB-3
	45	T6T45CSE[2]	+2, -4 x 2.5%	34	22.375	19.875	460	WS-4	24	WMB-3
	50	T6T50CSE[2]	+2, -4 x 2.5%	37	26	19.875	665	WS-18A	24	WMB-4
	75	T6T75CSE[2]	+2, -4 x 2.5%	37	26	19.875	645	WS-18A	24	WMB-4
	112.5	T6T112CSE[2]	+2, -4 x 2.5%	43	28.5	23.5	855	WS-18	24	WMB-4
	150	T6T150CSE	+2, -4 x 2.5%	46	32	28	1080	WS-10B	24A	NONE

[1]All transformer catalog numbers shown are in a NEMA 2 enclosure, which covers all the requirements of NEMA 1 by offering a degree of protection against the ingress of falling dirt and dripping liquid. The addition of a weather shield kit converts the indoor NEMA 2 transformer to an outdoor NEMA 3R.

[2] Can be furnished with CSA EEV label in compliance with CSA C802.2-06.

N/R - Not Required

Three-Phase Optional Temperature Rise Technical Data

Type FH: 115°C Rise • 220°C Insulation System • Indoor Ventilated • Floor Mounted

Type	KVA	Catalog Number	Taps	Approximate Enclosure Dimensions - Inches			Approx. Wt. in Lbs.	Weather Shield[1]	Wiring Diagram	Wall Mount Bracket
				H	W	D				
208 - 208Y/120 Volts, 60 Hz, Electrostatically Shielded										
FH	15	T202H15FSE	+2, -2 x 2.5%	29	17.125	19.375	185	WS-2	24	WMB-3
	30	T202H30FSE	+2, -2 x 2.5%	34	22.375	19.875	370	WS-4	19	WMB-3
	45	T202H45FSE	+2, -2 x 2.5%	37	26	19.875	585	WS-18A	19	WMB-4
	75	T202H75FSE	+2, -2 x 2.5%	43	28.5	23.5	760	WS-18	19	WMB-4
	112.5	T202H112FSE	+2, -2 x 2.5%	46	32	28	915	WS-10B	19A	NONE
	150	T202J150FSE	+2, -2 x 3%	51	36	30.5	1190	WS-12A	19B	NONE
	225	T202L225FSE	+2, -2 x 3.5%	51	42.125	26	1385	WS-12	19C	NONE
	300	T202B300FSE	+1, -1 x 4%	72.75	53.375	36.875	2070	WS-16	19D	NONE
208 - 480Y/277 Volts, 60 Hz										
FH	15	T204H15FE	+2, -2 x 2.5%	29	17.125	19.375	185	WS-2	23	WMB-3
	30	T204H30FE	+2, -2 x 2.5%	34	22.375	19.875	370	WS-4	23	WMB-3
	45	T204H45FE	+2, -2 x 2.5%	37	26	19.875	585	WS-18A	23	WMB-4
	75	T204H75FE	+2, -2 x 2.5%	43	28.5	23.5	760	WS-18	23	WMB-4
	112.5	T204H112FE	+2, -2 x 2.5%	46	32	28	915	WS-10B	23A	NONE
	150	T204J150FE	+2, -2 x 3%	51	42.125	26	1190	WS-12A	23B	NONE
	225	T204L225FE	+2, -2 x 3.5%	51	42.125	26	1385	WS-12	23C	NONE
	300	T204B300FE	+1, -1 x 4%	72.75	53.375	36.875	2070	WS-16	23D	NONE
	500	T204E500FE	+1, -1 x 5%	72.75	53.375	36.875	2800	WS-16	23E	NONE
240 - 208Y/120 Volts, 60 Hz, Electrostatically Shielded										
FH	15	T242T15FSE	+2, -4 x 2.5%	29	17.125	19.375	185	WS-2	26	WMB-3
	30	T242T30FSE	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	26	WMB-3
	45	T242T45FSE	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	26	WMB-4
	75	T242T75FSE	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	26	WMB-4
	112.5	T242T112FSE	+2, -4 x 2.5%	46	32	28	915	WS-10B	26A	NONE
	150	T242J150FSE	+2, -2 x 3%	51	36	30.5	1190	WS-12A	26B	NONE
	225	T242L225FSE	+2, -2 x 3.5%	51	42.125	26	1385	WS-12	26C	NONE
	300	T242B300FSE	+1, -1 x 4%	72.75	53.375	36.875	2070	WS-16	26D	NONE
480 - 208Y/120 Volts, 60 Hz, Aluminum										
FH	15	T4T15FE	+2, -4 x 2.5%	29	17.125	19.375	185	WS-2	22	WMB-3
	30	T4T30FE	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	22	WMB-3
	45	T4T45FE	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	22	WMB-4
	75	T4T75FE	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	22	WMB-4
	112.5	T4T112FE	+2, -4 x 2.5%	46	32	28	915	WS-10B	22A	NONE
	150	T4T150FE	+2, -4 x 2.5%	51	36	30.5	1190	WS-12A	22A	NONE
	225	T4T225FE	+2, -4 x 2.5%	51	42.125	26	1385	WS-12	22A	NONE
	300	T4T300FE	+2, -4 x 2.5%	72.75	53.375	36.875	2070	WS-16	22A	NONE
	500	T4T500FE	+2, -4 x 2.5%	72.75	53.375	36.875	2800	WS-16	22A	NONE

[1]All transformer catalog numbers shown are in a NEMA 2 enclosure, which covers all the requirements of NEMA 1 by offering a degree of protection against the ingress of falling dirt and dripping liquid. The addition of a weather shield kit converts the indoor NEMA 2 transformer to an outdoor NEMA 3R.

Three-Phase Optional Temperature Rise Technical Data

Type FH: 115°C Rise • 220°C Insulation System • Indoor Ventilated • Floor Mounted

Type	KVA	Catalog Number	Taps	Approximate Enclosure Dimensions - Inches			Approx. Wt. in Lbs.	Weather Shield[1]	Wiring Diagram	Wall Mount Bracket
				H	W	D				
480 - 208Y/120 Volts, 60 Hz, Electrostatically Shielded										
FH	15	T4T15FSE	+2, -4 x 2.5%	29	17.125	19.375	185	WS-2	18	WMB-3
	30	T4T30FSE	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	18	WMB-3
	45	T4T45FSE	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	18	WMB-4
	75	T4T75FSE	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	18	WMB-4
	112.5	T4T112FSE	+2, -4 x 2.5%	46	32	28	915	WS-10B	18A	NONE
	150	T4T150FSE	+2, -4 x 2.5%	51	36	30.5	1190	WS-12A	18A	NONE
	225	T4T225FSE	+2, -4 x 2.5%	51	42.125	26	1385	WS-12	18A	NONE
	300	T4T300FSE	+2, -4 x 2.5%	72.75	53.375	36.875	2070	WS-16	18A	NONE
	500	T4T500FSE	+2, -4 x 2.5%	72.75	53.375	36.875	2800	WS-16	18A	NONE
480 - 208Y/120 Volts, 60 Hz, Electrostatically Shielded Copper										
FH	15	T4T15FCSE	+2, -4 x 2.5%	29	17.125	19.375	230	WS-2	22	WMB-3
	30	T4T30FCSE	+2, -4 x 2.5%	34	22.375	19.875	410	WS-4	22	WMB-3
	45	T4T45FCSE	+2, -4 x 2.5%	37	26	19.875	645	WS-18A	22	WMB-4
	75	T4T75FCSE	+2, -4 x 2.5%	43	28.5	23.5	855	WS-18	22	WMB-4
	112.5	T4T112FCSE	+2, -4 x 2.5%	46	32	28	1080	WS-10B	22A	NONE
	150	T4T150FCSE	+2, -4 x 2.5%	51	42.125	26	1440	WS-12	22A	NONE
	225	T4T225FCSE	+2, -4 x 2.5%	51	42.125	26	1490	WS-12	22A	NONE
	300	T4T300FCSE	+2, -4 x 2.5%	72.75	53.375	36.875	2170	WS-16	22A	NONE
	500	T4T500FCSE	+2, -4 x 2.5%	72.75	53.375	36.875	2880	WS-16	22A	NONE
480 - 240/120 Volts, LT (Lighting Tap), 60 Hz										
FH	15	T43T15FE	+2, -4 x 2.5%	29	17.125	19.375	185	WS-2	21	WMB-3
	30	T43T30FE	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	21	WMB-3
	45	T43T45FE	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	21	WMB-4
	75	T43T75FE	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	21	WMB-4
	112	T43T112FE	+2, -4 x 2.5%	46	32	28	915	WS-10B	21A	NONE
	150	T43T150FE	+2, -4 x 2.5%	51	36	30.5	1190	WS-12A	21A	NONE
	225	T43T225FE	+2, -4 x 2.5%	51	42.125	26	1385	WS-12	21A	NONE
480 - 240/120 Volts, LT (Lighting Tap), 60 Hz, Electrostatically Shielded										
FH	15	T43T15FSE	+2, -4 x 2.5%	29	17.125	19.375	185	WS-2	18	WMB-3
	30	T43T30FSE	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	17	WMB-3
	45	T43T45FSE	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	17	WMB-4
	75	T43T75FSE	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	17	WMB-4
	112.5	T43T112FSE	+2, -4 x 2.5%	46	32	28	915	WS-10B	17A	NONE
	150	T43T150FSE	+2, -4 x 2.5%	51	36	30.5	1190	WS-12A	17A	NONE
	225	T43T225FSE	+2, -4 x 2.5%	51	42.125	26	1385	WS-12	21A	NONE
	300	T43T300FSE	+2, -4 x 2.5%	72.75	53.375	36.875	2070	WS-16	17A	NONE

[1]All transformer catalog numbers shown are in a NEMA 2 enclosure, which covers all the requirements of NEMA 1 by offering a degree of protection against the ingress of falling dirt and dripping liquid. The addition of a weather shield kit converts the indoor NEMA 2 transformer to an outdoor NEMA 3R.

Three-Phase Optional Temperature Rise Technical Data

Type FH: 115°C Rise • 220°C Insulation System • Indoor Ventilated • Floor Mounted

Type	KVA	Catalog Number	Taps	Approximate Enclosure Dimensions - Inches			Approx. Wt. in Lbs.	Weather Shield[1]	Wiring Diagram	Wall Mount Bracket
				H	W	D				
480 - 480Y/277 Volts, 60 Hz										
FH	15	T484T15FE	+2, -4 x 2.5%	29	17.125	19.375	185	WS-2	20	WMB-3
	30	T484T30FE	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	20	WMB-3
	45	T484T45FE	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	20	WMB-4
	75	T484T75FE	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	20	WMB-4
	112.5	T484T112FE	+2, -4 x 2.5%	46	32	28	915	WS-10B	20A	NONE
	150	T484T150FE	+2, -4 x 2.5%	51	36	30.5	1190	WS-12A	20A	NONE
	225	T484T225FE	+2, -4 x 2.5%	51	42.125	26	1385	WS-12	20A	NONE
600 - 208Y/120 Volts, 60 Hz, Electrostatically Shielded										
FH	15	T6T15FSE	+2, -4 x 2.5%	29	17.125	19.375	185	WS-2	24	WMB-3
	30	T6T30FSE	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	24	WMB-3
	45	T6T45FSE	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	24	WMB-4
	75	T6T75FSE	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	24	WMB-4
	112.5	T6T112FSE	+2, -4 x 2.5%	46	32	28	915	WS-10B	24A	NONE
	150	T6T150FSE	+2, -4 x 2.5%	51	36	30.5	1190	WS-12A	24A	NONE
	225	T6T225FSE	+2, -4 x 2.5%	51	42.125	26	1385	WS-12	24A	NONE
	300	T6T300FSE	+2, -4 x 2.5%	72.75	53.375	36.875	2070	WS-16	24A	NONE

[1]All transformer catalog numbers shown are in a NEMA 2 enclosure, which covers all the requirements of NEMA 1 by offering a degree of protection against the ingress of falling dirt and dripping liquid. The addition of a weather shield kit converts the indoor NEMA 2 transformer to an outdoor NEMA 3R.

Three-Phase Optional Temperature Rise Technical Data

Type FH: 80°C Rise • 220°C Insulation System • Indoor Ventilated • Floor Mounted

Type	KVA	Catalog Number	Taps	Approximate Enclosure Dimensions - Inches			Approx. Wt. in Lbs.	Weather Shield [1]	Wiring Diagram	Wall Mount Bracket
				H	W	D				
208 - 208Y/120 Volts, 60 Hz, Electrostatically Shielded										
FH	15	T202H15BSE	+2, -2 x 2.5%	34	22.375	19.875	370	WS-4	19	WMB-3
	30	T202H30BSE	+2, -2 x 2.5%	34	22.375	19.875	400	WS-4	19	WMB-3
	45	T202H45BSE	+2, -2 x 2.5%	37	26	19.875	585	WS-18A	19	WMB-4
	75	T202H75BSE	+2, -2 x 2.5%	43	28.5	23.5	760	WS-18	19	WMB-4
	112.5	T202J112BSE	+2, -2 x 3%	46	32	28	1180	WS-10B	19B	NONE
	150	T202J150BSE	+2, -2 x 3%	51	36	30.5	1190	WS-12A	19B	NONE
	225	T202B225BSE	+1, -1 x 4%	63	46.5	30.875	1630	WS-14	19D	NONE
	300	T202B300BSE	+1, -1 x 4%	72.75	53.375	36.875	2620	WS-16	19D	NONE
208 - 480Y/277 Volts, 60 Hz										
FH	15	T204H15BE	+2, -2 x 2.5%	34	22.375	19.875	370	WS-4	23	WMB-3
	30	T204H30BE	+2, -2 x 2.5%	34	22.375	19.875	400	WS-4	23	WMB-3
	45	T204H45BE	+2, -2 x 2.5%	37	26	19.875	585	WS-18A	23	WMB-4
	75	T204H75BE	+2, -2 x 2.5%	43	28.5	23.5	760	WS-18	23	WMB-4
	112.5	T204J112BE	+2, -2 x 3%	46	32	28	1180	WS-10B	23B	NONE
	150	T204J150BE	+2, -2 x 3%	51	36	30.5	1190	WS-12A	23B	NONE
	225	T204B225BE	+1, -1 x 5%	63	46.5	30.875	1630	WS-14	23D	NONE
240 - 208Y/120 Volts, 60 Hz, Electrostatically Shielded										
FH	15	T242T15BSE	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	26	WMB-3
	30	T242T30BSE	+2, -4 x 2.5%	34	22.375	19.875	400	WS-4	26	WMB-3
	45	T242T45BSE	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	26	WMB-4
	75	T242T75BSE	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	26	WMB-4
	112.5	T242T112BSE	+2, -4 x 2.5%	46	32	28	1180	WS-10B	26A	NONE
	150	T242J150BSE	+2, -2 x 3%	51	36	30.5	1190	WS-12A	26B	NONE
	225	T242B225BSE	+1, -1 x 4%	63	46.5	30.875	1630	WS-14	26D	NONE
	300	T242B300BSE	+1, -1 x 4%	72.75	53.375	36.875	2620	WS-16	26D	NONE
480 - 208Y/120 Volts, 60 Hz										
FH	15	T4T15BE	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	22	WMB-3
	30	T4T30BE	+2, -4 x 2.5%	34	22.375	19.875	400	WS-4	22	WMB-3
	45	T4T45BE	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	22	WMB-4
	75	T4T75BE	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	22	WMB-4
	112.5	T4T112BE	+2, -4 x 2.5%	46	32	28	1180	WS-10B	22A	NONE
	150	T4T150BE	+2, -4 x 2.5%	51	36	30.5	1190	WS-12A	22A	NONE
	225	T4T225BE	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	22A	NONE

[1] All transformer catalog numbers shown are in a NEMA 2 enclosure, which covers all the requirements of NEMA 1 by offering a degree of protection against the ingress of falling dirt and dripping liquid. The addition of a weather shield kit converts the indoor NEMA 2 transformer to an outdoor NEMA 3R.

Three-Phase Optional Temperature Rise Technical Data

Type FH: 80°C Rise • 220°C Insulation System • Indoor Ventilated • Floor Mounted

Type	KVA	Catalog Number	Taps	Approximate Enclosure Dimensions - Inches			Approx. Wt. in Lbs.	Weather Shield [1]	Wiring Diagram	Wall Mount Bracket
				H	W	D				
480 - 208Y/120 Volts, 60 Hz, Electrostatically Shielded										
FH	15	T4T15BSE	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	18	WMB-3
	30	T4T30BSE	+2, -4 x 2.5%	34	22.375	19.875	400	WS-4	18	WMB-3
	45	T4T45BSE	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	18	WMB-4
	75	T4T75BSE	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	18	WMB-4
	112.5	T4T112BSE	+2, -4 x 2.5%	46	32	28	1180	WS-10B	18A	NONE
	150	T4T150BSE	+2, -4 x 2.5%	51	36	30.5	1190	WS-12A	18A	NONE
	225	T4T225BSE	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	18A	NONE
	300	T4T300BSE	+2, -4 x 2.5%	72.75	53.375	36.875	2620	WS-16	18A	NONE
	500	T4T500BSE	+2, -4 x 2.5%	76.75	53.375	44.375	3280	NONE	18A	NONE
480 - 208Y/120 Volts, 60 Hz, Electrostatically Shielded Copper										
FH	15	T4T15BCSE	+2, -4 x 2.5%	34	22.375	19.875	410	WS-4	18	WMB-3
	30	T4T30BCSE	+2, -4 x 2.5%	34	22.375	19.875	460	WS-4	18	WMB-3
	45	T4T45BCSE	+2, -4 x 2.5%	37	26	19.875	645	WS-18A	18	WMB-4
	75	T54T75BCSE	+2, -4 x 2.5%	43	28.5	23.5	855	WS-18	18	WMB-4
	112.5	T4T112BCSE	+2, -4 x 2.5%	46	32	28	1080	WS-10B	18A	NONE
	150	T4T150BCSE	+2, -4 x 2.5%	51	42.125	26	1440	WS-12	18A	NONE
	225	T4T225BCSE	+2, -4 x 2.5%	63	46.5	30.875	1930	WS-14	18A	NONE
	300	T4T300BCSE	+2, -4 x 2.5%	72.75	53.375	36.875	3000	WS-16	18A	NONE
	500	T4J500BCSE	+2, -2 x 3%	CONSULT FACTORY						NONE
480 - 240/120 Volts, LT (Lighting Tap), 60 Hz										
FH	15	T43T15BE	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	21	WMB-3
	30	T43T30BE	+2, -4 x 2.5%	34	22.375	19.875	400	WS-4	21	WMB-3
	45	T43T45BE	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	21	WMB-4
	75	T43T75BE	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	21	WMB-4
	112.5	T43T112BE	+2, -4 x 2.5%	46	32	28	915	WS-10B	21A	NONE
	150	T43T150BE	+2, -4 x 2.5%	51	36	30.5	1190	WS-12A	21A	NONE
	225	T43T225BE	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	21A	NONE
480 - 240/120 Volts, LT (Lighting Tap), 60 Hz, Electrostatically Shielded										
FH	15	T43T15BSE	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	17	WMB-3
	30	T43T30BSE	+2, -4 x 2.5%	34	22.375	19.875	400	WS-4	17	WMB-3
	45	T43T45BSE	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	17	WMB-4
	75	T43T75BSE	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	17	WMB-4
	112.5	T43T112BSE	+2, -4 x 2.5%	46	32	28	1180	WS-10B	17A	NONE
	150	T43T150BSE	+2, -4 x 2.5%	51	36	30.5	1190	WS-12A	17A	NONE
	225	T43T225BSE	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	17A	NONE
	300	T43T300BSE	+2, -4 x 2.5%	72.75	53.375	36.875	2620	WS-16	17A	NONE

[1]All transformer catalog numbers shown are in a NEMA 2 enclosure, which covers all the requirements of NEMA 1 by offering a degree of protection against the ingress of falling dirt and dripping liquid. The addition of a weather shield kit converts the indoor NEMA 2 transformer to an outdoor NEMA 3R.

Three-Phase Optional Temperature Rise Technical Data

Type FH: 80°C Rise • 220°C Insulation System • Indoor Ventilated • Floor Mounted

Type	KVA	Catalog Number	Taps	Approximate Enclosure Dimensions - Inches			Approx. Wt. in Lbs.	Weather Shield [1]	Wiring Diagram	Wall Mount Bracket
				H	W	D				
480 - 480Y/277 Volts, 60 Hz										
FH	15	T484T15BE	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	20	WMB-3
	30	T484T30BE	+2, -4 x 2.5%	34	22.375	19.875	400	WS-4	20	WMB-3
	45	T484T45BE	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	20	WMB-4
	75	T484T75BE	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	20	WMB-4
	112.5	T484T112BE	+2, -4 x 2.5%	46	32	28	1180	WS-10B	20A	NONE
	150	T484T150BE	+2, -4 x 2.5%	51	36	30.5	1190	WS-12A	20A	NONE
	225	T484T225BE	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	20A	NONE
600 - 208Y/120 Volts, 60 Hz, Electrostatically Shielded										
FH	15	T6T15BSE	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	24	WMB-3
	30	T6T30BSE	+2, -4 x 2.5%	34	22.375	19.875	400	WS-4	24	WMB-3
	45	T6T45BSE	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	24	WMB-4
	75	T6T75BSE	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	24	WMB-4
	112.5	T6T112BSE	+2, -4 x 2.5%	46	32	28	1180	WS-10B	24A	NONE
	150	T6T150BSE	+2, -4 x 2.5%	51	36	30.5	1190	WS-12A	24A	NONE
	225	T6T225BSE	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	24A	NONE
	300	T6T300BSE	+2, -4 x 2.5%	72.75	53.375	36.875	2620	WS-16	24A	NONE

[1]All transformer catalog numbers shown are in a NEMA 2 enclosure, which covers all the requirements of NEMA 1 by offering a degree of protection against the ingress of falling dirt and dripping liquid. The addition of a weather shield kit converts the indoor NEMA 2 transformer to an outdoor NEMA 3R.

Three-Phase General Purpose Technical Data

Type FH: 150°C Rise • 220°C Insulation System • Indoor Ventilated • Floor Mounted

Type	KVA	Catalog Number	Taps[3]	Approximate Enclosure Dimensions - Inches			Approx. Wt. in Lbs.	Weather Shield [1]	Wiring Diagram	Wall Mount Bracket
				H	W	D				
480/440/420 - 220Y/127 Volts, 60 Hz										
FH	15	T422X15E	504, 492, 480, 468, 456, 440, 442, 420	29	17.125	19.375	210	WS-2	28	WMB-3
	30	T422X30E[2]	504, 492, 480, 468, 456, 440, 442, 420	34	22.375	19.875	370	WS-4	28	WMB-3
	45	T422X45E[2]	504, 492, 480, 468, 456, 440, 442, 420	34	22.375	19.875	400	WS-4	28	WMB-3
	75	T422X75E[2]	504, 492, 480, 468, 456, 440, 442, 420	37	26	19.875	575	WS-18A	28	WMB-4
	112	T422X112E	504, 492, 480, 468, 456, 440, 442, 420	43	28.5	23.5	760	WS-18	28	WMB-4
	150	T422X150E	504, 492, 480, 468, 456, 440, 442, 420	46	32	28	1180	WS-10B	29	NONE

[1]All transformer catalog numbers shown are in a NEMA 2 enclosure, which covers all the requirements of NEMA 1 by offering a degree of protection against the ingress of falling dirt and dripping liquid. The addition of a weather shield kit converts the indoor NEMA 2 transformer to an outdoor NEMA 3R.

[2] Can be furnished with CSA EEV label in compliance with CSA C802.2-06.

[3] Voltages shown closely represent the actual tap voltage on each rating, but may vary by 0.4% on the larger KVAs having fewer turns that do not allow these exact tap voltages.

NEMA Premium® 30 Energy Efficient Transformers

Federal Pacific 600 Volt Class NEMA Premium® 30 Energy Efficient Transformers are designed to exceed present minimum DOE TP-1 efficiency program standards by having at least 30% lower losses beyond the TP-1 rating at a 35% nameplate loading. See graph on page 39. NEMA Premium® 30 Transformers will allow the user to apply for LEED® certifications in commercial, industrial and institutional facilities. NEMA Premium® 30 Transformers are vey nearly equivalent to what is sometimes referred to in the industry as a CSL.3 efficiency transformer.

NEMA Premium ®30 Type FH: 150°C Rise • 220°C Insulation System • Indoor Ventilated • Floor Mounted

Type	KVA	Catalog Number	Taps	Approximate Enclosure Dimensions - Inches			Approx. Wt. in Lbs.	Weather Shield	Wiring Diagram	Wall Mount Bracket
				H	W	D				
480 - 208Y/120 Volts, 60 Hz, Electrostatically Shielded										
FH	15	T4T15SEP3	+2, -4 x 2.5%	29	17.125	19.375	215	WS-2	22	WMB-3
	30	T4T30SEP3	+2, -4 x 2.5%	34	22.375	19.875	430	WS-4	22	WMB-3
	45	T4T45SEP3	+2, -4 x 2.5%	34	22.375	19.875	460	WS-4	22	WMB-3
	75	T4T75SEP3	+2, -4 x 2.5%	37	26	19.875	665	WS-18A	22	WMB-4
	112.5	T4T112SEP3	+2, -4 x 2.5%	43	28.5	23.5	875	WS-18	22	WMB-4
	150	T4T150SEP3	+2, -4 x 2.5%	51	36	30.5	1520	WS-12A	18A	NONE
	225	T4T225SEP3	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	18A	NONE
	300	T4T300SEP3	+2, -4 x 2.5%	72.75	53.375	36.875	2620	WS-16	18A	NONE
	500	T4T500SEP3	+2, -4 x 2.5%	76.75	53.375	44.375	3280	NONE	18A	NONE
	750	T4T750SEP3	+2, -4 x 2.5%	80	61	44.375	4450	NONE	22B	NONE
	1000	T4J1000SEP3	+2, -2 x 3%	80	61	44.375	5340	NONE	22B	NONE
480 - 208Y/120 Volts, 60 Hz, Electrostatically Shielded, Copper										
FH	15	T4T15CSEP3	+2, -4 x 2.5%	29	17.125	19.375	260	WS-2	22	WMB-3
	30	T4T30CSEP3	+2, -4 x 2.5%	34	22.375	19.875	475	WS-4	22	WMB-3
	45	T4T45CSEP3	+2, -4 x 2.5%	34	22.375	19.875	530	WS-4	22	WMB-3
	75	T4T75CSEP3	+2, -4 x 2.5%	37	26	19.875	745	WS-18A	22	WMB-4
	112.5	T4T112CSEP3	+2, -4 x 2.5%	43	28.5	23.5	985	WS-18	22	WMB-4
	150	T4T150CSEP3	+2, -4 x 2.5%	46	32	28	1330	WS-10B	22A	NONE
	225	T4T225CSEP3	+2, -4 x 2.5%	51	42.125	26	1750	WS-12	22A	NONE
	300	T4T300CSEP3	+2, -4 x 2.5%	63	46.5	30.875	2220	WS-14	22A	NONE
	500	T4T500CSEP3	+2, -4 x 2.5%	72.75	53.375	36.875	3450	WS-16	22A	NONE
	750	T4T750CSEP3	+2, -4 x 2.5%	76.75	53.375	44.375	4370	NONE	18A	NONE
	1000	T4J1000CSEP3	+2, -2 x 3%	80	61	44.375	5630	NONE	18B	NONE
480 - 240/120 Volts, LT (Lighting Tap), 60 Hz, Electrostatically Shielded										
FH	15	T43T15SEP3	+2, -4 x 2.5%	29	17.125	19.375	215	WS-2	22	WMB-3
	30	T43T30SEP3	+2, -4 x 2.5%	34	22.375	19.875	430	WS-4	22	WMB-3
	45	T43T45SEP3	+2, -4 x 2.5%	34	22.375	19.875	460	WS-4	22	WMB-3
	75	T43T75SEP3	+2, -4 x 2.5%	37	26	19.875	665	WS-18A	22	WMB-4
	112.5	T43T112SEP3	+2, -4 x 2.5%	43	28.5	23.5	875	WS-18	22	WMB-4
	150	T43T150SEP3	+2, -4 x 2.5%	51	36	30.5	1520	WS-12A	18A	NONE
	225	T43T225SEP3	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	18A	NONE
	300	T43T300SEP3	+2, -4 x 2.5%	72.75	53.375	36.875	2620	WS-16	18A	NONE
	500	T43T500SEP3	+2, -4 x 2.5%	76.75	53.375	44.375	3280	NONE	18A	NONE
	750	T43T750SEP3	+2, -4 x 2.5%	80	61	44.375	4450	NONE	22B	NONE

Beginning January 1, 2016, higher efficiency levels will be mandated by the Department of Energy in accordance with 10 CFR 431 part 196. These efficiencies are shown in Table 1, contact factory for more information about 2016 efficient transfromers.

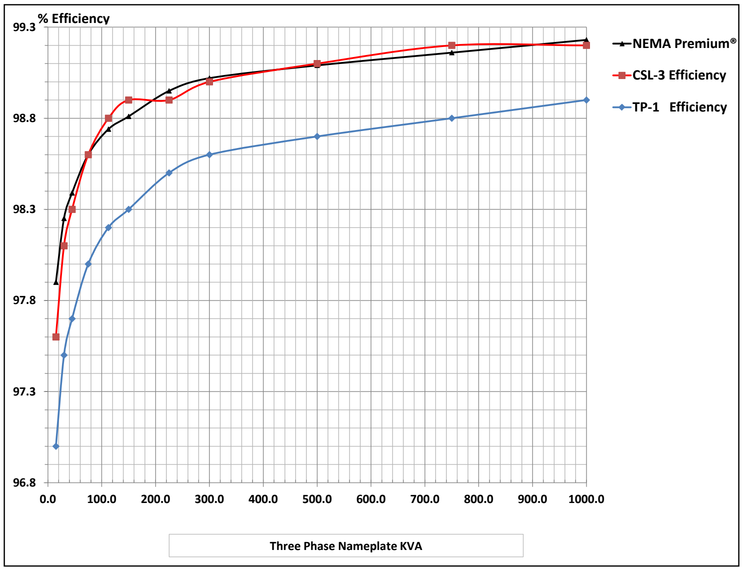
NEMA Premium® 30 Energy Efficient Transformers

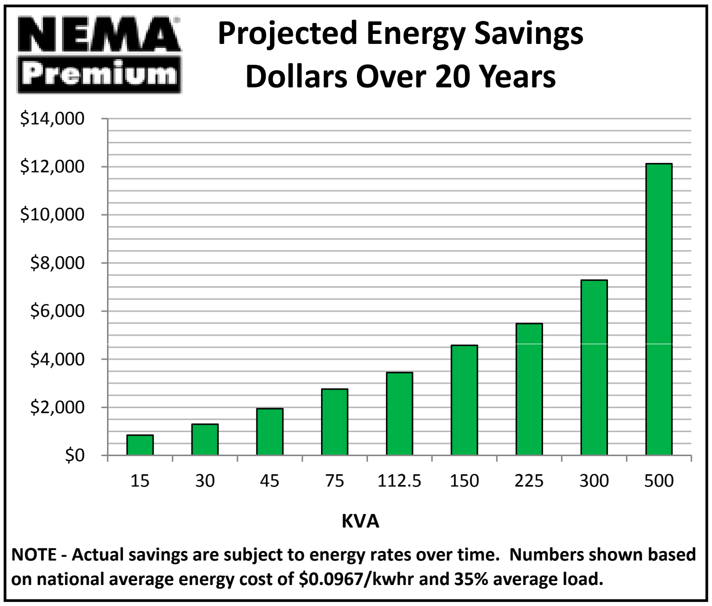
Table 1 - Low Voltage Dry-Type Transformer Efficiency Levels
***All efficiencies shown computed at 35% load and adjusted to 75°C**

KVA	Phase	TP1 Efficiency	NEMA Premium 30 Efficiency	CSL3 Efficiency	DOE 2016
15	3	97	97.90	97.6	97.89
30	3	97.5	98.25	98.1	98.23
45	3	97.7	98.39	98.3	98.40
75	3	98	98.60	98.6	98.60
112.5	3	98.2	98.74	98.8	98.74
150	3	98.3	98.81	98.9	98.83
225	3	98.5	98.95	98.9	98.94
300	3	98.6	99.02	99.0	99.02
500	3	98.7	99.09	99.1	99.14
750	3	98.8	99.16	99.2	99.23
1000	3	98.9	99.23	—	99.28
15	1	97.7	98.39	98.1	97.70
25	1	98	98.60	98.4	98.00
37.5	1	98.2	98.74	98.6	98.20
50	1	98.3	98.81	98.7	98.30
75	1	98.5	98.95	98.9	98.50
100	1	98.6	99.02	99.0	98.60
167	1	98.7	99.09	99.1	98.70
250	1	98.8	99.16	99.2	98.80
333	1	98.9	99.23	99.3	98.90

CSL3 efficiency levels according to C10 CFR Part 430 Energy Conservation Program for Commercial and Industrial Equipment: Energy Conservation Standards for Distribution Transformers; Proposed Rule (July 29, 2004)

NEMA Premium® 30 Energy Efficient Transformers





Type FH Motor Drive Isolation Transformers

Type FH motor drive isolation transformers are designed to meet the requirements of SCR controlled variable speed motor drives. They are specifically constructed to withstand the mechanical forces associated with SCR drive duty cycles and to isolate the line from most SCR generated voltage spikes and transient feedback. Similarly, the two-winding construction also aids in reducing some types of line transients that can cause misfiring of the SCR's.

The units are UL Listed and incorporate all the features of the FH transformer line. The transformers can also be supplied as core and coil units with UL component recognition.

Delta-wye designs are available for all commonly used primary and secondary voltages. All units include primary taps consisting of one 5% FCAN and one 5% FCBN.

7.5 KVA - 220 KVA

275 KVA - 750 KVA

Three-Phase Motor Drive Isolation Transformer Technical Data

Type FH: 150°C Rise • 220° C Insulation System • Indoor Ventilated • Floor Mounted

HV TAPS: 1 -5% FCAN, 1-5% FCBN										
Motor HP	KVA	Voltages - Primary-Delta, Secondary - Wye, 60 Hz				Approximate Dimensions - Inches			Wt. In Lbs.	Weather Shield
		230Δ - 230Y/133	230Δ - 460Y/266	460Δ - 230Y/133	460Δ- 460Y/266	H	W	D		
3 & 5	7.5	7.5AEMD	7.5AFMD	7.5CEMD	7.5CFMD	29	17.125	19.375	145	WS-2
7.5	11	11AEMD	11AFMD	11CEMD	11CFMD	29	17.125	19.375	160	WS-2
10	15	15AEMD	15AFMD	15CEMD	15CFMD	29	17.125	19.375	185	WS-2
15	20	20AEMD	20AFMD	20CEMD	20CFMD	34	22.375	19.875	285	WS-4
20	27	27AEMD	27AFMD	27CEMD	27CFMD	34	22.375	19.875	320	WS-4
25	34	34AEMD	34AFMD	34CEMD	34CFMD	34	22.375	19.875	320	WS-4
30	40	40AEMD	40AFMD	40CEMD	40CFMD	34	22.375	19.875	340	WS-4
40	51	51AEMD	51AFMD	51CEMD	51CFMD	34	22.375	19.875	380	WS-4
50	63	63AEMD	63AFMD	63CEMD	63CFMD	37	26	19.875	485	WS-18A
60	75	75AEMD	75AFMD	75CEMD	75CFMD	37	26	19.875	485	WS-18A
75	93	93AEMD	93AFMD	93CEMD	93CFMD	43	28.5	23.5	665	WS-18
100	118	118AEMD	118AFMD	118CEMD	118CFMD	43	28.5	23.5	675	WS-18
125	145	145AEMD	145AFMD	145CEMD	145CFMD	46	32	28	915	WS-10B
150	175	175AEMD	175AFMD	175CEMD	175CFMD	51	42.125	26	1270	WS-12
200	220	220AEMD	220AFMD	220CEMD	220CFMD	51	42.125	26	1320	WS-12
250	275	275AEMD	275AFMD	275CEMD	275CFMD	55.25	44.375	27.25	1450	NONE
300	330	330AEMD	330AFMD	330CEMD	330CFMD	60.5	50.375	34.25	1720	NONE
400	440	440AEMD	440AFMD	440CEMD	440CFMD	60.5	50.375	34.25	2085	NONE
500	550	550AEMD	550AFMD	550CEMD	550CFMD	72	53.375	44.375	2750	NONE
600	660	660AEMD	660AFMD	660CEMD	660CFMD	72	53.375	44.375	3100	NONE
700	750	750AEMD	750AFMD	750CEMD	750CFMD	76.75	53.375	44.375	3150	NONE

See wiring diagram #25.

Type FH: 150°C Rise • 220° C Insulation System • Indoor Ventilated • Floor Mounted

HV TAPS: 1 -5% FCAN, 1-5% FCBN											
Motor HP	KVA	Voltages - Primary-Delta, Secondary - Wye, 60 Hz					Approximate Dimensions - Inches			Wt. In Lbs.	Weather Shield
		230Δ - 575Y/332	460Δ - 575Y/332	575Δ - 230Y/133	575Δ -460Y/266	575Δ -575Y/332	H	W	D		
3 & 5	7.5	7.5AHMD	7.5CHMD	7.5DEMD	7.5DFMD	7.5DHMD	29	17.125	19.375	145	WS-2
7.5	11	11AHMD	11CHMD	11DEMD	11DFMD	11DHMD	29	17.125	19.375	160	WS-2
10	15	15AHMD	15CHMD	15DEMD	15DFMD	15DHMD	29	17.125	19.375	185	WS-2
15	20	20AHMD	20CHMD	20DEMD	20DFMD	20DHMD	34	22.375	19.875	285	WS-4
20	27	27AHMD	27CHMD	27DEMD	27DFMD	27DHMD	34	22.375	19.875	320	WS-4
25	34	34AHMD	34CHMD	34DEMD	34DFMD	34DHMD	34	22.375	19.875	320	WS-4
30	40	40AHMD	40CHMD	40DEMD	40DFMD	40DHMD	34	22.375	19.875	340	WS-4
40	51	51AHMD	51CHMD	51DEMD	51DFMD	51DHMD	34	22.375	19.875	380	WS-4
50	63	63AHMD	63CHMD	63DEMD	63DFMD	63DHMD	37	26	19.875	485	WS-18A
60	75	75AHMD	75CHMD	75DEMD	75DFMD	75DHMD	37	26	19.875	485	WS-18A
75	93	93AHMD	93CHMD	93DEMD	93DFMD	93DHMD	43	28.5	23.5	665	WS-18
100	118	118AHMD	118CHMD	118DEMD	118DFMD	118DHMD	43	28.5	23.5	675	WS-18
125	145	145AHMD	145CHMD	145DEMD	145DFMD	145DHMD	46	32	28	915	WS-10B
150	175	175AHMD	175CHMD	175DEMD	175DFMD	175DHMD	51	42.125	26	1270	WS-12
200	220	220AHMD	220CHMD	220DEMD	220DFMD	220DHMD	51	42.125	26	1320	WS-12
250	275	275AHMD	275CHMD	275DEMD	275DFMD	275DHMD	55.25	44.375	27.25	1450	NONE
300	330	330AHMD	330CHMD	330DEMD	330DFMD	330DHMD	60.5	50.375	34.25	1720	NONE
400	440	440AHMD	440CHMD	440DEMD	440DFMD	440DHMD	60.5	50.375	34.25	2085	NONE
500	550	550AHMD	550CHMD	550DEMD	550DFMD	550DHMD	72	53.375	44.375	2750	NONE
600	660	660AHMD	660CHMD	660DEMD	660DFMD	660DHMD	72	53.375	44.375	3100	NONE
700	750	750AHMD	750CHMD	750DEMD	750DFMD	750DHMD	76.75	53.375	44.375	3150	NONE

See wiring diagram #25.

Re-connectable Industrial Transformers

Dry-Type Transformers For 3-Phase, 60 Hz, 400 VAC Rated Equipment

Primary voltage: .... 208/240/480 Delta-10 kV BIL
Secondary voltage:...... 400Y/231-10 kV BIL
Primary Taps: .... +1/-1 @ 5%
Frequency:.................... 60 Hertz
Phase: .... Three Phase
Temperature Rise: .... 150° above an average ambient of 30°C
Conductor:.................... Aluminum Windings
Impedance:................... Factory Standard
Insulation System:........ 220°C insulation system

Transformer Characteristics
Drive Isolation
Indoor, NEMA 2, Category C (Accessible to authorized personnel only)
Freestanding unit suitable for cable connection
Bolted panel construction; not tamper resistant
Polyurethane powder coat paint system; ANSI-61 color (gray)
AA self-cooled only
UL® Listed
Rated at K4 K-Factor
Terminal lugs on primary and secondary
Normally closed 200°C thermostat in center coil

kVA	Catalog No.	kVA	Catalog No.
20 KVA	TX40T20-A	75 KVA	TX40T75-A
27 KVA	TX40T27-A	93 KVA	TX40T93-A
34 KVA	TX40T34-A	118 KVA	TX40T118-A
40 KVA	TX40T40-A	150 KVA	TX40T150-A
51 KVA	TX40T51-A	170 KVA	TX40T170-A
63 KVA	TX40T63-A	250 KVA	TX40T250-A

Energy efficient models complying with C802.2-06 are also available.

K-Factor Dry-Type Transformers - Type FHK

Application

With today's modern electronic, electrical components and circuitry constantly changing, the demand is forced upon the electrical power industry to produce and supply a clean source of electrical energy.

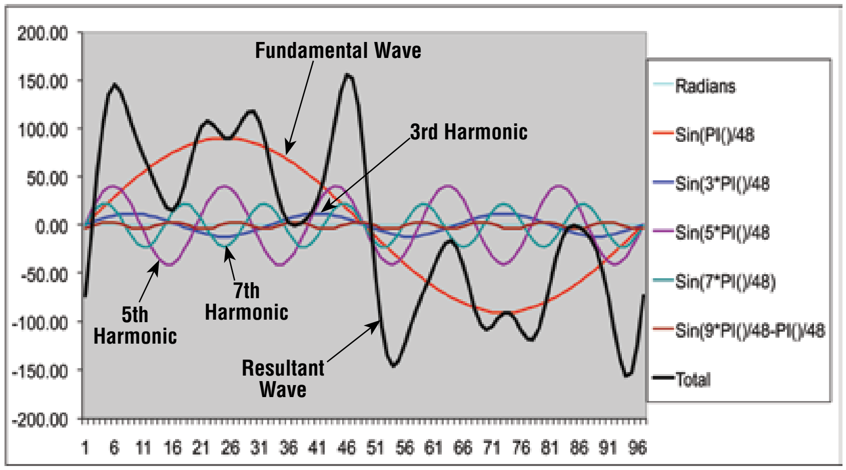
The Problem

The extensive utilization of solid state power conversion technologies has created new problems for the power industry and power engineer designer. This technology, called Switch Mode Power Supply (SMPS), consists of various types of solid state switching elements. These switching elements are solid state devices such as: SCR's, DIAC's, transistors and capacitors. These switching devices are in computers, copy machines, fax machines, tele-communications equipment, solid-state drives and controls, energy-efficient lighting ballasts, and numerous types of DC-Power Loads. These solid state elements continuously switch on and off producing non-linear or non-sinusoidal wave shapes in the current supplied from the energy source.

While a linear load uses current from the AC source continuously over the sinusoidal cycle, a non-linear load (such as the SMPS) uses current in large pulses from the AC source which creates harmonic distortion. These non-linear current pulses may exceed the nameplate ampere rating of the power source and may cause transformers to run hotter than expected, even when these transformers are supplying less than 50% of their rated nameplate capacity.

With non-linear loads, overloaded neutrals are also showing up in three-phase panel boards serving single-phase loads. In some cases the neutral conductor carries 180 Hertz currents, rather than 60 Hertz currents. This phenomenon is called triplen harmonics. Triplens are multiples of three, which do not cancel but are additive in the neutral conductor.

Figure 1
Distorted 3rd and 5th Resultant Harmonic Waveform



(Non-linear loads can produce additive 3rd order harmonic currents which may create overloaded neutral conductors.)

What Are Harmonics

As defined by ANSI/IEEE Std. 519 latest edition.

Harmonic

Harmonic components are represented by a periodic wave having a frequency that is an integral multiple of the fundamental frequency.

In other words, harmonics are voltages or currents at frequencies that are integer multiples of the fundamental (60 Hz) frequency, e.g. 120 Hz, 180 Hz, 240 Hz, 300 Hz, etc. Harmonics are designated by their harmonic number, or multiple of the fundamental frequency. Thus, a harmonic with a frequency of 180 Hz (three times the 60 Hz fundamental Frequency) is called the 3rd harmonic.

Harmonics superimpose themselves on the fundamental waveform, distorting it and changing its magnitude. For instance, when a sine wave voltage source is applied to a non-linear load connected from phase-to-neutral on a 3-phase, 4-wire wye circuit, the load itself will draw a current wave made up of the 60 Hz fundamental frequency of the voltage source plus 3rd and higher order odd harmonic (multiples of the 60 Hz fundamental frequency), which are all generated by the non-linear load. **Figure 1** shows the resultants of a distorted 3rd and 5th harmonic waveform. It is not uncommon for portions of an industrial power system to have 15 to 25% of Total Harmonic Distortion (THD). THD is calculated as the **square root of the sum of the squares** of all harmonics, divided by the normal 60 hertz value as shown in **Equation 1**.

Equation 1

$$THD = \frac{[(I_{RMS_{60}})^2+(I_{RMS_{180}})^2+\ldots+(I_{RMS_N})^2]^{1/2}}{[(I_{RMS_{60}})^2]^{1/2}}$$

This yields a root-mean-square (RMS) value of distortion as a percentage of the fundamental 60 hertz waveform.

Therefore, THD is the percent of odd harmonics (3rd, 5th, 7th, ..., 25th, ...) present in the load which can affect the transformer. This condition is called a "Non-Linear Load" or "Non-Sinusoidal Load".

For dry-type transformers, to determine what amount of harmonic content is present, a "K" factor calculation is made instead of using the THD formula.

The total amount of harmonics will determine the percentage of non-linear load, which can be specified with the following typical examples:

Transformers shall be sized to account for harmonic non-linear loads of 50% minimum (K-4), 100% (K-13), 125% (K-20), 150% (K-30).

The neutral connection shall be sized at 200% of the current rating of the phase connections.

The conductors of the transformer winding shall be sized to handle circulation of 3rd harmonic current and not exceed the rated temperature rise.

Transformers shall be capable of operating within the specified temperature rise while supplying 100% of the 60 Hertz fundamental rated current values plus the following harmonics as calculated by ANSI/IEEE 57.110-1998.

(A) 50% Non-Linear Load (K-4 Rating)

16.7% of the rated current at the 3rd Harmonic
10.0% of the rated current at the 5th Harmonic
7.1% of the rated current at the 7th Harmonic
5.6% of the rated current at the 9th Harmonic

Beyond the 9th Harmonic the percentages of the fundamental current through the 25th Harmonic shall be equal to the reciprocal of the odd harmonic number involved times 0.5

The FP Type FHK4 series transformer is designed for 100% linear load plus 50% non-linear load which can operate at a total $I_h (pu)^2 h^2$ K-factor load value of 4.0. See **Table 1**.

(B) 100% Non-Linear Load (K-13 Rating)

33.3% of the rated current at the 3rd harmonic
20.0% of the rated current at the 5th harmonic
14.3% of the rated current at the 7th harmonic
11.1% of the rated current at the 9th harmonic

Beyond the 9th Harmonic the percentages of the fundamental current through the 25th Harmonic shall be equal to the reciprocal of the odd harmonic number involved times 1.0

The FP Type FHK13 series transformer is designed for 100% linear load plus 100% non-linear load which can operate at a total ($I_h (pu)^2 h^2$) K-factor load value of 13.0. See **Table 1**.

(C) 125% Non-Linear Load (K-20 Rating)

41.7% of the rated current at the 3rd harmonic
25.0% of the rated current at the 5th harmonic
17.9% of the rated current at the 7th harmonic
13.9% of the rated current at the 9th harmonic

Beyond the 9th Harmonic the percentages of the fundamental current through the 25th Harmonic shall be equal to the reciprocal of the odd harmonic number involved times 1.25

The FP Type FHK20 series transformer is designed for 100%linear load plus 125% non-linear load which can operate at a total ($I_h (pu)^2 h^2$) K-factor load value of 20. See **Table 1**.

(D) 150% Non-Linear Load (K-30 Rating)

50.0% of the rated current at the 3rd harmonic
30.0% of the rated current at the 5th harmonic
21.4% of the rated current at the 7th harmonic
16.7% of the rated current at the 9th harmonic

Beyond the 9th Harmonic the percentages of the fundamental current through the 25th Harmonic shall be equal to the reciprocal of the odd harmonic number involved times 1.50

The FP Type FHK30 series transformer is designed for 100%linear load plus 150% non-linear load which can operate at a total ($I_h (pu)^2 h^2$) K-factor load value of 30. See **Table 1**.

***Note:** In these examples the amount of non-linear load specified, the percentage of fundamental current, and the percentage of harmonic factor are arbitrary values; actual values may vary. (Consult FP factory for your specific application or current values for each harmonic.)*

Table 1	Examples of K-Factor Loads											
	K-4			K-13			K-20			K-30		
Harmonic (h)	Current (I_h)	I_h (pu)	I_h (pu) $^2h^2$	Current (I_h)	I_h (pu)	I_h (pu) $^2h^2$	Current (I_h)	I_h (pu)	I_h (pu) $^2h^2$	Current (I_h)	I_h (pu)	I_h (pu) $^2h^2$
1	00.000%	1.000	1.000	100.000%	1.000	1.000	100.000%	1.000	1.000	100.000%	1.000	1.000
3	16.667%	0.167	0.250	33.333%	0.333	1.000	41.667%	0.417	1.563	50.000%	0.500	2.250
5	10.000%	0.100	0.250	20.000%	0.200	1.000	25.000%	0.250	1.563	30.000%	0.300	2.250
7	7.143%	0.071	0.250	14.286%	0.143	1.000	17.857%	0.179	1.563	21.429%	0.214	2.250
9	5.556%	0.056	0.250	11.111%	0.111	1.000	13.889%	0.139	1.563	16.667%	0.167	2.250
11	4.545%	0.045	0.250	9.091%	0.091	1.000	11.364%	0.114	1.563	13.636%	0.136	2.250
13	3.846%	0.038	0.250	7.692%	0.077	1.000	9.615%	0.096	1.563	11.538%	0.115	2.250
15	3.333%	0.033	0.250	6.667%	0.067	1.000	8.333%	0.083	1.563	10.000%	0.100	2.250
17	2.941%	0.029	0.250	5.882%	0.059	1.000	7.353%	0.074	1.563	8.824%	0.088	2.250
19	2.632%	0.026	0.250	5.263%	0.053	1.000	6.569%	0.066	1.563	7.895%	0.079	2.250
21	2.381%	0.024	0.250	4.762%	0.048	1.000	5.952%	0.060	1.563	7.143%	0.071	2.250
23	2.174%	0.022	0.250	4.348%	0.043	1.000	5.435%	0.054	1.563	6.522%	0.065	2.250
25	2.000%	0.020	0.250	4.000%	0.040	1.000	5.000%	0.050	1.563	6.000%	0.060	2.250

K-Factor Transformer Ratings

The K-Factor rating assigned to a transformer and marked on the transformer case in accordance with the listing of Underwriters Laboratories, is an index of the transformer's ability to supply harmonic content in its load current while remaining within its operating temperature limits. A specific K-factor rating indicates that a transformer can supply its rated KVA load output to a load of specified amount of harmonic content. At present, industry literature and commentary refers to a limited number of K-factor ratings: K-1, K-4, K-9, K-13, K-20, K-30, K-40. In theory, a transformer could be designed for other K-factor ratings in-between those values, as well as for higher values. The commonly referenced ratings calculated according to ANSI/IEEE C57.110-1998 are as follows:

K-1: This is the rating of any conventional transformer that has been designed to handle only the heating effects of eddy currents and other losses resulting from 60 Hertz, sine-wave current loading on the transformer. Such a unit may or may not be designed to handle the increased heating of harmonics in its load current.

K-4: A transformer with this rating has been designed to supply rated KVA, without overheating, to a load made-up of 100% of the normal 60 Hertz, sine-wave, fundamental current plus: 16% of the fundamental as 3rd harmonic current; 10% of the fundamental as 5th; 7% of the fundamental as 7th; 5.5% of the fundamental as 9th; and smaller percentages through the 25th harmonic. The "4" indicates its ability to accommodate four times the eddy current losses of a K-1 transformer.

K-9: A K-9 transformer can accommodate 163% of the harmonic loading of a K-4 rated transformer.

K-13: A K-13 transformer can accommodate 200% of the harmonic loading of a K-4 rated transformer.

K-20, K-30, K-40: The higher number of each of these K-factor ratings indicates ability to handle successively larger amounts of harmonic load content without overheating.

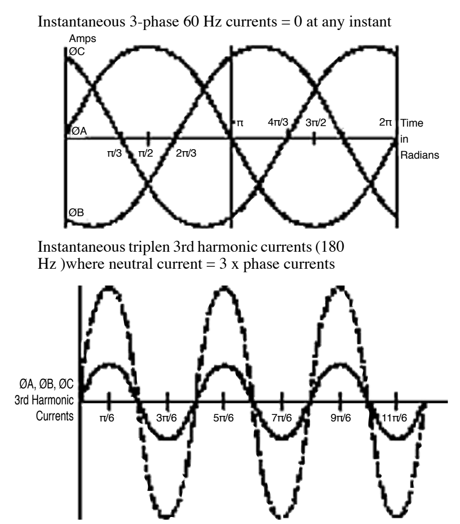
Table 1 Gives examples of K-factor loads.

Triplen Harmonics

Triplen harmonic currents are phase currents which flow from each of the phases into the fourth wire neutral and have frequencies in integer multiples of three times the 60 hertz base frequency (180Hz, 360Hz, 540Hz, etc). At each of these third multiple triplen frequencies, these triplen phase currents are in phase with each other and when flowing in the neutral as zero sequence currents, are equal to three times their RMS phase values. See ***Figure 2***.

In a 3-phase, 4-wire system, single-phase line-to-neutral currents flow in each phase conductor and return in the common neutral. Since the three 60 hertz currents are separated by 120°, when balanced they cancel each other. The measured resultant current is equal to zero. See ***Figure 2.***

Figure 2
Development of
Triplen Harmonic Current



At any given instant, the 60 Hertz currents on the three-phase legs have a vector resultant of zero and cancel in the neutral. But, the third (and other odd triplen harmonics) on the phase legs are in phase and become additive in the neutral.

Theory also states that for even harmonics, starting with the second order, when balanced the even harmonic will cancel in the common neutral.

Other odd harmonics add in the common neutral, but their magnitude is considerably less than triplens. The RMS value of the total current is the square root of the RMS value of the individual currents squared. As shown in ***Equation 2***.

Equation 2

$$I_{Total} = \sqrt{I^2_{60Hz}+I^2_{180Hz}+I^2_{300Hz}+I^2_{420Hz}+...}$$

where I = RMS

The UL Approach for Transformers Supplying Non-Sinusoidal Loads

A. A transformer intended for use with loads drawing non-sinusoidal currents shall be marked "Suitable for non-sinusoidal current load with K-factor not to exceed x. (x= 4, 9, 13, 20, 30, 40 or 50)

B. Formulas to determine eddy losses and total losses where the transformer load losses (P_{LL}) are to be determined as follows:

$$P_{LL}=P_{DC}(1+K(P_{EC}))$$

where:
P_{DC} = the total I^2R losses

K= the K-factor rating at the transformer (4, 9, 13, 20, 30, 40 or 50)

P_{EC}= assumed eddy current losses calculated as follows:

$$\frac{P_{AC}-P_{DC}}{P_{DC}}$$ for transformers rated 300 KVA or less, and

$$\frac{C\,(P_{AC}-P_{DC})}{P_{DC\text{ -I}}}$$ For transformers rated more than 300 KVA

in which:
P_{AC} = the impedance loss

C= 0.7 for transformers having a turn ratio greater than 4:1 and having one or more windings with a current rating greater than 1000 amperes, or C=0.6 for all other transformers

$P_{DC\text{-}I}$ = the I^2R losses for the inner winding

The impedance losses and the I^2R losses shall be determined in accordance with the Test Code for Dry-Type Distribution and Power Transformers, ANSI/IEEE C57.12.91.

DC Components of Load Current

As stated in ANSI/IEEE C57.110-1998.

Harmonic load currents may be accompanied by DC components in the load current which are frequently caused by the loss of a diode in a rectifier circuit. A DC component of load current will increase the transformer core loss slightly, and may increase the magnetizing current and audible sound level .

Relatively small DC components (up to the RMS magnitude of the transformer excitation current at rated voltage) are expected to have no significant effect on the load carrying capability of a transformer determined by this recommended practice. Higher DC load current components may adversely affect transformer capability and must be corrected by the user.

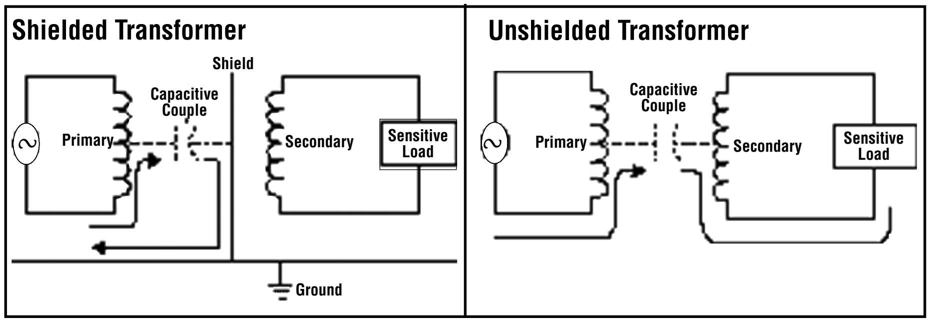
Harmonic currents flowing through transformer leakage impedance and through system impedance may also produce some small harmonic distortion in the voltage waveform at the transformer terminals. Such voltage harmonics may cause extra harmonic losses in the transformer core. However, operating experience has indicated that core temperature rise usually will not be the limiting parameter for determination of safe magnitudes of nonsinusoidal load currents.

Shielded Transformers

Electrostatically Shielded Transformers suppress common mode noise by introducing a grounded shield between its primary and secondary windings. The grounded shield provides a low impedance path to ground by capacitive coupling which prevents unwanted high frequency signals contained in the source voltage from reaching the transformer secondary.

The grounded shield between the primary and secondary windings is called an electrostatic shield. This shield does not perform any function with regard to harmonic current or voltage distortion wave forms. However the shield is extremely valuable in protecting sensitive equipment from common-mode electrical noise and transients generated on the line side of the transformer.

The ratio of the common mode noise attenuation (CMA) on the input to that of the output of the transformer is expressed in decibels as shown in **Equation 3**. An isolation transformer with an electrostatic shield can have a ratio of input noise voltage (V_{IN}) to output noise voltage (V_{OUT}) within the range of 10:1 to 1000:1 or even higher.



Test Circuit

Equation 3

$$CMA = 20\ Log_{10} \frac{V_{IN}}{V_{OUT}}\ dB$$

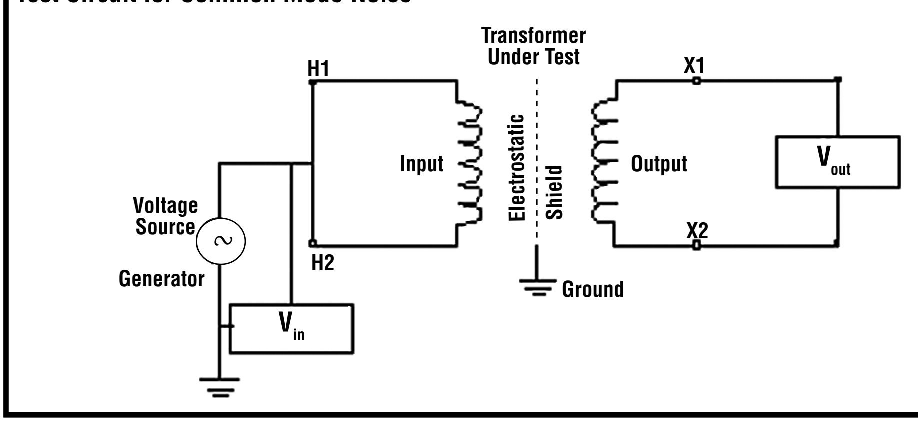
Using a Numerical Example

V_{IN} = 100.0 V at 40 kHz

V_{OUT} = 0.06 V at 40 kHz

$$CMA = 20\ Log_{10} \frac{100.0V_{IN}}{0.06\ V_{OUT}} = 64.4\ dB$$

Test Circuit for Common Mode Noise

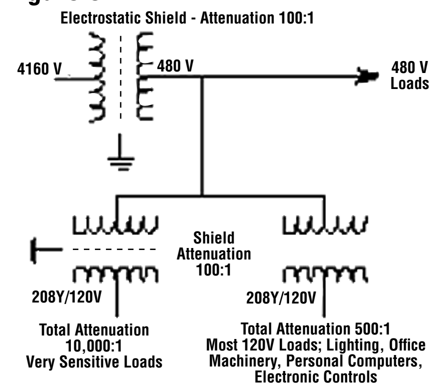


Federal Pacific Type DIT Drive Isolation Transformers are designed to meet the requirements of SCR controlled, variable speed motor drives. They are specifically constructed to withstand the mechanical forces associated with SCR drive duty cycles and to isolate the source voltage circuit from low frequency noise generated from SCR voltage spikes and transient feedback. Whereas the electrostatic shielded transformer attenuates higher frequency noise in the 10 kHz - 100 kHz range.

Multiplying Effect of Cascading Shielded Transformers

Having the presence of an upline transformer with an electrostatic shield may mean that other shielded transformers would not be required in the system. However, if a shielded transformer feeds another shielded transformer, there is an effect of the attenuation ratio multiplying as shown in **Figure 3**. If the attenuation ratio is 100:1 in each of the transformers, the total attenuation will be 100x100=10,000:1. Obviously, cascading inherently multiplies the attenuation effectiveness of shielded transformers. The term cascading means that two or more transformers are connected in series on the same system.

Figure 3



One line diagram shows system with shielded upline transformer and the attenuation ratios for various combinations with downline transformers. In most systems, only one shielded upline transformer is required.

Estimating K-Factor Loads

For the most part, each designer or installer must make his/her own decision regarding what K-factor to assign to any load or load category. The following table is intended to assist in that determination by presenting what we believe are realistic, yet conservative, K-factors for a number of loads and load categories based on their relative harmonic producing capabilities.

Calculating K-Factor Loads

1. List the KVA value for each load category to be supplied. Next, assign an I_{LK} value that corresponds to the relative level of harmonics drawn by each type of load. See Table 2.

2. Multiply the KVA of each load times the I_{LK} rating that corresponds to the assigned K-factor rating. This result is an indexed KVA-I_{LK} value:

   KVA x I_{LK}=KVA -I_{LK}

3. Tabulate the total connected load KVA for all load categories to be supplied.

4. Next, add-up the KVA-I_{LK} values for all loads or load categories to be supplied by the transformer.

5. Divide the grand total KVA-I_{LK} value by the total KVA load to be supplied. This will give an average I_{LK} for that combination of loads. (Total KVA-I_{LK}) ÷ (Total KVA) = average I_{LK}

6. From Table 3, find the K-factor rating whose I_{LK} is equal to or greater than the calculated I_{LK}.

   Corresponding to this I_{LK} is the K-factor of the transformer required.

Table 2

Load	Typical K-Factor	Typical I_{LK}
Incandescent Lighting	K-1	0.00
Electric Resistance Heating	K-1	0.00
Motors (without solid state drives)	K-1	0.00
Control Transformers/Electromagnetic Control Devices	K-1	0.00
Motor-Generators (without solid state drives)	K-1	0.00
Distribution Transformers	K-1	0.00
Electric-Discharge Lighting	K-4	25.82
UPS w/Optional Input Filter	K-4	25.82
Welders	K-4	25.82
Induction Heating Equipment	K-4	25.82
PLCs and Solid State Controls	K-4	25.82
Telecommunications Equipment (e.g. PBX)	K-13	57.74
UPS without Input Filtering	K-13	57.74
Multiwire Receptacle Circuits in General Care Areas of Health Care Facilities, Classrooms of Schools, etc	K-13	57.74
Multiwire Receptacle Circuits Supplying Inspection or Testing Equipment on an Assembly or Production Line	K-13	57.74
Main-Frame Computer Loads	K-20	80.94
Multiwire Receptacle Circuits in Critical Care, Operating and Recovery Room Areas in Hospitals	K-20	80.94
Multiwire Receptacle Circuits in Industrial, Medical and Educational Laboratories	K-30	123.54
Multiwire Receptacle Circuits in Commercial Office Spaces	K-30	123.54
Small Main Frames (mini and micro)	K-30	123.54
Other Loads Identified as Producing Very High Amounts of Harmonics	K-40	208.17

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Table 3 — Index of Load K-ratings

K-factor	K-1	K-4	K-9	K-13	K-20	K-30	K- 40
I_{LK}	0.0	25.82	44.72	57.74	80.94	123.54	208.17

Examples:

Problem 1

Calculate the overall K-factor for several non-linear loads.

Load Category	KVA Load	x	I_{LK}	=	KVA-I_{LK} Value
Discharge lighting	7.0	x	25.82	=	180.74
Receptacle circuits	2.0	x	123.54	=	247.08
Main frame computers	5.0	x	80.94	=	404.70
Motor w/drive	0.5	x	80.94	=	40.47
Motor w/o drive	1.5	x	0.00	=	0.00
Totals	16.0				872.99

Total KVA -I_{LK} / Total KVA=average I_{LK}

872.99/16 = 54.56 = average I_{LK}

From Table 3, the nearest K-factor greater than or equal to the average I_{LK} of 54.56 is K-13 with an I_{LK} of 57.74.

Problem 2

Calculate the amount of additional K-30 load that can be handled by a 25KVA, K-13 transformer with 9KVA of spare capacity.

1. Determine the available spare K-13 KVA-I_{LK}, using the I_{LK} that corresponds to the transformer's K-factor rating.

spare KVA x I_{LK} = spare KVA-I_{LK}

9 x 57.74 = 519.66 spare KVA-I_{LK}

2. Divide the spare KVA-I_{LK} by the Index of Load K-rating for the load to be supplied.

The I_{LK} for a K-30 load is 123.54

spare KVA-I_{LK} / new load I_{LK} @ K-30 =maximum additional KVA

519.66 / 123.54 = 4.2 KVA maximum additional KVA

3. Therefore, an additional 4.2 KVA of K-30 load could be added to this transformer. This additional loading represents the absolute maximum non-linear loading for that transformer.

For a transformer already partially loaded, any additional KVA loading must take into consideration the K-factor of each of the new loads to be added.

Guide Specification for 600 Volt Class Ventilated Dry-Type Transformer Non-Linear, Non-Sinusoidal Loads

1. Transformer shall be UL® 1561 listed, type "FHK". And be a Federal Pacific type FHK or approved equal.

2. Transformer shall be designed to supply rated current at 100% linear load plus carry the percent of non-linear odd order load up to the 25th harmonic as listed in **Table 4**.

Table 4
K-Factor Load Relationship

K Factor	% Linear Load	Plus	% Non Linear Load
4	100%	+	50% (1/h)
13	100%	+	100% (1/h)
20	100%	+	125% (1/h)
30	100%	+	150% (1/h)

where h = 3 through 25 for odd harmonics

3. The transformer shall be three-phase with the fundamental frequency rating of 60 hertz.

4. Primary winding shall be delta connected and secondary winding shall be wye connected.

5. The transformer windings and terminals shall be aluminum. (Copper option is readily available; please specify)

6. The primary shall have two 2.5% full capacity taps above rated voltage and four 2.5% full capacity taps below rated voltage tap.

7. The temperature rise at the rated voltage and rated K-Factor load shall not exceed 150°C when measured by the resistance method as listed in ANSI/IEEE C57.12.91 with a 220°C UL Component Recognition Insulation System. (Optional: 115°C and 80°C temperature rise K-1 through K-20 units available; please specify.)

8. Transformers designed to accomodate additional heating effect of non-linear loads.

9. The secondary neutral shall be 2x (twice) the ampacity of the secondary phase conductors for triplens and unbalanced single phase loads.

10. The Basic Impulse Level of all windings shall be 10 kV.

11. The enclosure shall be rated NEMA-1. (Optional: NEMA-3R units available.)

12. Optional: A full electrical width electrostatic shield shall be placed between the primary and secondary windings of each coil. With the shield grounded to a common point and the transformer connected under normal loaded conditions the attenuation of common mode line noise and transients shall be similar to values in Figure 4.

13. The average audible sound level shall comply with NEMA ST-20:
10 to 50 KVA - 45 dB
51 to 150 KVA - 50 dB
151 to 300 KVA - 55 dB
301 to 500 KVA - 60 dB
501 to 700 KVA - 62 dB
701 to 1000 KVA - 64 dB
1001 to 1500 KVA - 65 dB
1501 to 2000 KVA - 66 dB

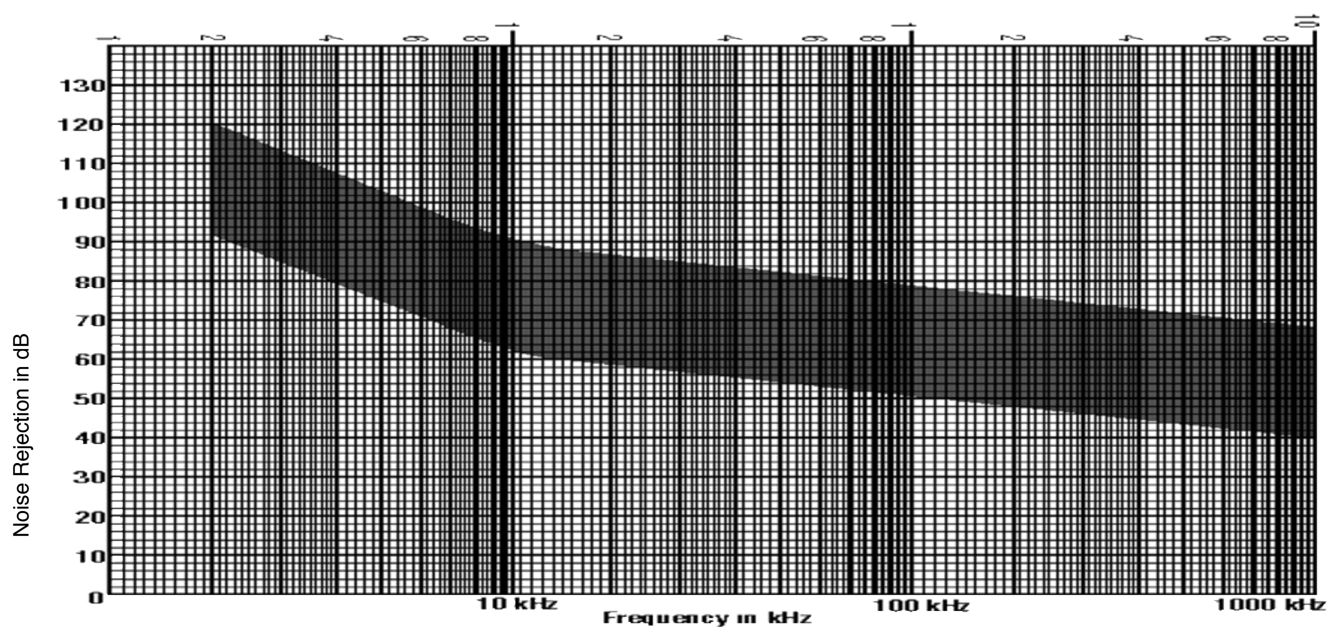
Note: Lower sound levels may be desirable for critical areas such as hospitals, schools or office areas. Contact your local Federal Pacific Representative for specific recommendations.

References:

ANSI/IEEE C57.110-1986, Recommended Practice to Establish Transformer Capability when Supplying Non-Sinusoidal Load Currents
ANSI/IEEE STD 519-1981, IEEE Guide to Harmonic Control and Reactive Compensation of Static Power Converters

McPartland, Brian J.

Figure 4. Typical Common Mode Noise Rejection Curve



FP Type FHK • K-Factor Dry-Type Transformers

K-Factor Rated • 80° C Rise • Three-Phase • K4

Type	KVA	Catalog Number	Taps	Approximate Enclosure Dimensions - Inches			Approx. Wt. in Lbs.	Weather Shield[1]	Wiring Diagram	Wall Mount Bracket
				H	W	D				
480 - 208Y/120, 60 Hz										
FHK	15	T4T15BK4E	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	22	WMB-3
	30	T4T30BK4E	+2, -4 x 2.5%	34	22.375	19.875	400	WS-4	22	WMB-3
	45	T4T45BK4E	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	22	WMB-4
	75	T4T75BK4E	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	22	WMB-4
	112.5	T4T112BK4E	+2, -4 x 2.5%	51	36	30.5	1190	WS-12A	22A	NONE
	150	T4T150BK4E	+2, -4 x 2.5%	51	42.125	26	1385	WS-12	20A	NONE
	225	T4T225BK4E	**CONSULT FACTORY**							
	300	T4T300BK4E								
	500	T4T500BK4E								
480 - 208Y/120, 60 Hz, Electrostatically Shielded										
FHK	15	T4T15BSK4E	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	18	WMB-3
	30	T4T30BSK4E	+2, -4 x 2.5%	34	22.375	19.875	400	WS-4	18	WMB-3
	45	T4T45BSK4E	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	18	WMB-4
	75	T4T75BSK4E	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	18	WMB-4
	112.5	T4T112BSK4E	+2, -4 x 2.5%	51	36	30.5	1190	WS-12A	18A	NONE
	150	T4T150BSK4E	+2, -4 x 2.5%	51	42.125	26	1385	WS-12	18A	NONE
	225	T4T225BSK4E	**CONSULT FACTORY**							
	300	T4T300BSK4E								
	500	T4J500BSK4E								
480 - 208Y/120, 60 Hz, Electrostatically Shielded, Copper										
FHK	15	T4T15BCSK4E	+2, -4 x 2.5%	34	22.375	19.875	410	WS-4	18	WMB-3
	30	T4T30BCSK4E	+2, -4 x 2.5%	34	22.375	19.875	460	WS-4	18	WMB-3
	45	T4T45BCSK4E	+2, -4 x 2.5%	37	26	19.875	645	WS-18A	18	WMB-4
	75	T4T75BCSK4E	+2, -4 x 2.5%	43	28.5	23.5	855	WS-18	18	WMB-4
	112.5	T4T112BCSK4E	+2, -4 x 2.5%	51	42.125	26	1440	WS-12	18A	NONE
	150	T4T150BCSK4E	+2, -4 x 2.5%	51	42.125	26	1440	WS-12	18A	NONE
	225	T4T225BCSK4E	**CONSULT FACTORY**							
	300	T4T300BCSK4E								
480 - 240/120, LT (Lighting Tap), 60 Hz										
FHK	15	T43T15BK4E	+2, -4 x 2.5%	29	17.125	19.375	185	WS-2	21	WMB-3
	30	T43T30BK4E	+2, -4 x 2.5%	34	22.375	19.875	400	WS-4	21	WMB-3
	45	T43T45BK4E	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	21	WMB-4
	75	T43T75BK4E	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	21	WMB-4
	112.5	T43T112BK4E	+2, -4 x 2.5%	51	36	30.5	1190	WS-12A	21A	NONE
	150	T43T150BK4E	+2, -4 x 2.5%	51	42.125	26	1385	WS-12	21A	NONE
	225	T43T225BK4E	**CONSULT FACTORY**							
	300	T43T300BK4E								
480 - 240/120, LT (Lighting Tap), 60 Hz, Electrostatically Shielded										
FHK	15	T43T15BSK4E	+2, -4 x 2.5%	29	17.125	19.375	185	WS-2	17	WMB-3
	30	T43T30BSK4E	+2, -4 x 2.5%	34	22.375	19.875	400	WS-4	17	WMB-3
	45	T43T45BSK4E	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	17	WMB-4
	75	T43T75BSK4E	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	17	WMB-4
	112.5	T43T112BSK4E	+2, -4 x 2.5%	51	36	30.5	1520	WS-12A	17A	NONE

[1]All transformer catalog numbers shown are in a NEMA 2 enclosure, which covers all the requirements of NEMA 1 by offering a degree of protection against the ingress of falling dirt and dripping liquid. The addition of a weather shield kit converts the indoor NEMA 2 transformer to an outdoor NEMA 3R.

FP Type FHK • K-Factor Dry-Type Transformers

K-Factor Rated • 115° C Rise • Three-Phase • K4

Type	KVA	Catalog Number	Taps	Approximate Dimensions - Inches			Approx. Wt. in Lbs.	Weather Shield[1]	Wiring Diagram	Wall Mount Bracket
				H	W	D				
480 - 208Y/120, 60 Hz										
FHK	15	T4T15FK4E	+2, -4 x 2.5%	29	17.125	19.375	185	WS-2	22	WMB-3
	30	T4T30FK4E	+2, -4 x 2.5%	34	22.375	19.875	400	WS-4	22	WMB-3
	45	T4T45FK4E	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	22	WMB-4
	75	T4T75FK4E	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	22	WMB-4
	112.5	T4T112FK4E	+2, -4 x 2.5%	46	32	28	915	WS-10B	22A	NONE
	150	T4T150FK4E	+2, -4 x 2.5%	51	36	30.5	1190	WS-12A	22A	NONE
	225	T4T225FK4E	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	22A	NONE
	300	T4T300FK4E	+2, -4 x 2.5%	72.75	53.375	36.875	2620	WS-16	22A	NONE
	500	T4T500FK4E	CONSULT FACTORY							
480 - 208Y/120, 60 Hz, Electrostatically Shielded										
FHK	15	T4T15FSK4E	+2, -4 x 2.5%	29	17.125	19.375	185	WS-2	18	WMB-3
	30	T4T30FSK4E	+2, -4 x 2.5%	34	22.375	19.875	400	WS-4	18	WMB-3
	45	T4T45FSK4E	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	18	WMB-4
	75	T4T75FSK4E	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	18	WMB-4
	112.5	T4T112FSK4E	+2, -4 x 2.5%	46	32	28	915	WS-10B	18A	NONE
	150	T4T150FSK4E	+2, -4 x 2.5%	51	36	30.5	1190	WS-12A	18A	NONE
	225	T4T225FSK4E	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	18A	NONE
	300	T4T300FSK4E	+2, -4 x 2.5%	72.75	53.375	36.875	2620	WS-16	18A	NONE
	500	T4T500FSK4E	+2, -4 x 2.5%	CONSULT FACTORY						
480 - 208Y/120, 60 Hz, Electrostatically Shielded, Copper										
FHK	15	T4T15FCSK4E	+2, -4 x 2.5%	29	17.125	19.375	230	WS-2	18	WMB-3
	30	T4T30FCSK4E	+2, -4 x 2.5%	34	22.375	19.875	410	WS-4	18	WMB-3
	45	T4T45FCSK4E	+2, -4 x 2.5%	37	26	19.875	645	WS-18A	18	WMB-4
	75	T4T75FCSK4E	+2, -4 x 2.5%	43	28.5	23.5	855	WS-18	18	WMB-4
	112.5	T4T112FCSK4E	+2, -4 x 2.5%	46	32	28	1080	WS-10B	18A	NONE
	150	T4T150FCSK4E	+2, -4 x 2.5%	51	42.125	26	1440	WS-12	18A	NONE
	225	T4T225FCSK4E	+2, -4 x 2.5%	63	46.5	30.875	1930	WS-14	18A	NONE
	300	T4T300FCSK4E	+2, -4 x 2.5%	72.75	53.375	36.875	3000	WS-16	18A	NONE
480 - 240/120, LT (Lighting Tap), 60 Hz										
FHK	15	T43T15FK4E	+2, -4 x 2.5%	29	17.125	19.375	185	WS-2	21	WMB-3
	30	T43T30FK4E	+2, -4 x 2.5%	34	22.375	19.875	400	WS-4	21	WMB-3
	45	T43T45FK4E	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	21	WMB-4
	75	T43T75FK4E	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	21	WMB-4
	112.5	T43T112FK4E	+2, -4 x 2.5%	46	32	28	915	WS-10B	21A	NONE
	150	T43T150FK4E	+2, -4 x 2.5%	51	36	30.5	1190	WS-12A	21A	NONE
	225	T43T225FK4E	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	21A	NONE
	300	T43T300FK4E	+2, -4 x 2.5%	72.75	53.375	36.875	2620	WS-16	21A	NONE
480 - 240/120, LT (Lighting Tap), 60 Hz, Electrostatically Shielded										
FHK	15	T43T15FSK4E	+2, -4 x 2.5%	29	17.125	19.375	185	WS-2	17	WMB-3
	30	T43T30FSK4E	+2, -4 x 2.5%	34	22.375	19.875	400	WS-4	17	WMB-3
	45	T43T45FSK4E	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	17	WMB-4
	75	T43T75FSK4E	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	17	WMB-4
	112.5	T43T112FSK4E	+2, -4 x 2.5%	46	32	28	915	WS-10B	17A	NONE
	150	T43T150FSK4E	+2, -4 x 2.5%	51	36	30.5	1190	WS-12A	17A	NONE

[1]All transformer catalog numbers shown are in a NEMA 2 enclosure, which covers all the requirements of NEMA 1 by offering a degree of protection against the ingress of falling dirt and dripping liquid. The addition of a weather shield kit converts the indoor NEMA 2 transformer to an outdoor NEMA 3R.

FP Type FHK • K-Factor Dry-Type Transformers

K-Factor Rated • 150° C Rise • Three-Phase • K4

Type	KVA	Catalog Number	Taps	Approximate Dimensions - Inches			Approx. Wt. in Lbs.	Weather Shield[1]	Wiring Diagram	Wall Mount Bracket
				H	W	D				
480 - 208Y/120, 60 Hz										
	15	T4T15K4E	+2, -4 x 2.5%	29	17.125	19.375	185	WS-2	22	WMB-3
	30	T4T30K4E	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	22	WMB-3
	45	T4T45K4E	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	22	WMB-4
	75	T4T75K4E	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	22	WMB-4
FHK	112.5	T4T112K4E	+2, -4 x 2.5%	46	32	28	915	WS-10B	22A	NONE
	150	T4T150K4E	+2, -4 x 2.5%	51	36	30.5	1190	WS-12A	22A	NONE
	225	T4T225K4E	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	22A	NONE
	300	T4T300K4E	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	22A	NONE
	500	T4T500K4E	+2, -4 x 2.5%	76.75	53.375	44.375	3280	NONE	22A	NONE
	750	T4T750K4E	CONSULT FACTORY							
480 - 208Y/120, 60 Hz, Electrostatically Shielded										
	15	T4T15SK4E	+2, -4 x 2.5%	29	17.125	19.375	185	WS-2	18	WMB-3
	30	T4T30SK4E	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	18	WMB-3
	45	T4T45SK4E	+2, -4 x 2.5%	37	26	19.875	575	WS-18A	18	WMB-4
	75	T4T75SK4E	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	18	WMB-4
FHK	112.5	T4T112SK4E	+2, -4 x 2.5%	46	32	28	915	WS-10B	18A	NONE
	150	T4T150SK4E	+2, -4 x 2.5%	51	36	30.5	1190	WS-12A	18A	NONE
	225	T4T225SK4E	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	18A	NONE
	300	T4T300SK4E	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	18A	NONE
	500	T4T500SK4E	+2, -4 x 2.5%	76.75	53.375	44.375	3280	NONE	18A	NONE
	750	T4T750SK4E	CONSULT FACTORY							
480 - 208Y/120, 60 Hz, Electrostatically Shielded, Copper										
	15	T4T15CSK4E	+2, -4 x 2.5%	29	17.125	19.375	230	WS-2	18	WMB-3
	30	T4T30CSK4E	+2, -4 x 2.5%	34	22.375	19.875	410	WS-4	18	WMB-3
	45	T4T45CSK4E	+2, -4 x 2.5%	34	22.375	19.875	460	WS-4	18	WMB-3
	75	T4T75CSK4E	+2, -4 x 2.5%	37	26	19.875	645	WS-18A	18	WMB-4
FHK	112.5	T4T112CSK4E	+2, -4 x 2.5%	46	32	28	1080	WS-10B	18A	NONE
	150	T4T150CSK4E	+2, -4 x 2.5%	51	42.125	26	1440	WS-12	18A	NONE
	225	T4T225CSK4E	+2, -4 x 2.5%	51	42.125	26	1440	WS-12	18A	NONE
	300	T4T300CSK4E	+2, -4 x 2.5%	63	46.5	30.875	1930	WS-14	18A	NONE
	500	T4T500CSK4E	CONSULT FACTORY							
480 - 240/120, LT (Lighting Tap), 60 Hz										
	15	T43T15K4E	+2, -4 x 2.5%	29	17.125	19.375	185	WS-2	21	WMB-3
	30	T43T30K4E	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	21	WMB-3
	45	T43T45K4E	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	21	WMB-4
FHK	75	T43T75K4E	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	21	WMB-4
	112.5	T43T112K4E	+2, -4 x 2.5%	46	32	28	915	WS-10B	21A	NONE
	150	T43T150K4E	+2, -4 x 2.5%	51	36	30.5	1190	WS-12A	21A	NONE
	225	T43T225K4E	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	21A	NONE
	300	T43T300K4E	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	21A	NONE
480 - 240/120, LT (Lighting Tap), 60 Hz, Electrostatically Shielded										
	15	T43T15SK4E	+2, -4 x 2.5%	29	17.125	19.375	185	WS-2	17	WMB-3
	30	T43T30SK4E	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	17	WMB-3
FHK	45	T43T45SK4E	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	17	WMB-4
	75	T43T75SK4E	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	17	WMB-4
	112.5	T43T112SK4E	+2, -4 x 2.5%	46	32	28	915	WS-10B	17A	NONE
	150	T43T150SK4E	+2, -4 x 2.5%	51	36	30.5	1190	WS-12A	17A	NONE

[1]All transformer catalog numbers shown are in a NEMA 2 enclosure, which covers all the requirements of NEMA 1 by offering a degree of protection against the ingress of falling dirt and dripping liquid. The addition of a weather shield kit converts the indoor NEMA 2 transformer to an outdoor NEMA 3R.

FP Type FHK • K-Factor Dry-Type Transformers

K-Factor Rated • 80° C Rise • Three-Phase • K13

Type	KVA	Catalog Number	Taps	Approximate Dimensions - Inches			Approx. Wt. in Lbs.	Weather Shield[1]	Wiring Diagram	Wall Mount Bracket
				H	W	D				
480 - 208Y/120, 60 Hz										
FHK	15	T4T15BK13E	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	22	WMB-3
	30	T4T30BK13E	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	22	WMB-4
	45	T4T45BK13E	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	22	WMB-4
	75	T4T75BK13E	+2, -4 x 2.5%	43	28.5	23.5	675	WS-18	22	WMB-4
	112.5	T4T112BK13E	CONSULT FACTORY							
	150	T4T150BK13E	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	22A	NONE
	225	T4T225BK13E	CONSULT FACTORY							
	300	T4T300BK13E								
480 - 208Y/120, 60 Hz, Electrostatically Shielded										
FHK	15	T4T15BSK13E	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	18	WMB-3
	30	T4T30BSK13E	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	18	WMB-4
	45	T4T45BSK13E	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	18	WMB-4
	75	T4T75BSK13E	+2, -4 x 2.5%	43	28.5	23.5	675	WS-18	18A	WMB-4
	112.5	T4T112BSK13E	CONSULT FACTORY							
	150	T4T150BSK13E	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	18A	NONE
	225	T4T225BSK13E	CONSULT FACTORY							
	300	T4T300BSK13E								
480 - 208Y/120, 60 Hz, Electrostatically Shielded, Copper										
FHK	15	T4T15BCSK13E	+2, -4 x 2.5%	34	22.375	19.875	410	WS-4	18	WMB-3
	30	T4T30BCSK13E	+2, -4 x 2.5%	34	22.375	19.875	460	WS-4	18	WMB-3
	45	T4T45BCSK13E	+2, -4 x 2.5%	37	26	19.875	645	WS-18A	18	WMB-4
	75	T4T75BCSK13E	+2, -4 x 2.5%	43	28.5	23.5	750	WS-18	18	WMB-4
	112.5	T4T112BCSK13E	+2, -4 x 2.5%	51	42.125	26	1440	WS-12	18A	NONE
	150	T4T150BCSK13E	+2, -4 x 2.5%	63	46.5	30.875	1930	WS-14	18A	NONE
	225	T4T225BCSK13E	CONSULT FACTORY							
	300	T4T300BCSK13E								
480 - 240/120, LT (Lighting Tap), 60 Hz										
FHK	15	T43T15BK13E	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	21	WMB-3
	30	T43T30BK13E	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	21	WMB-4
	45	T43T45BK13E	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	21	WMB-4
	75	T43T75BK13E	+2, -4 x 2.5%	43	28.5	23.5	675	WS-18	21	WMB-4
	112.5	T43T112BK13E	CONSULT FACTORY							
	150	T43T150BK13E	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	21A	NONE
	225	T43T225BK13E	CONSULT FACTORY							
480 - 240/120, LT (Lighting Tap), 60 Hz, Electrostatically Shielded										
FHK	15	T43T15BSK13E	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	17	WMB-3
	30	T43T30BSK13E	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	17	WMB-4
	45	T43T45BSK13E	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	17	WMB-4
	75	T43T75BSK13E	+2, -4 x 2.5%	43	28.5	23.5	675	WS-18	17	WMB-4
	112.5	T43T112BSK13E	CONSULT FACTORY							

[1]All transformer catalog numbers shown are in a NEMA 2 enclosure, which covers all the requirements of NEMA 1 by offering a degree of protection against the ingress of falling dirt and dripping liquid. The addition of a weather shield kit converts the indoor NEMA 2 transformer to an outdoor NEMA 3R.

FP Type FHK • K-Factor Dry-Type Transformers

K-Factor Rated • 115° C Rise • Three-Phase • K13

Type	KVA	Catalog Number	Taps	Approximate Dimensions - Inches H	W	D	Approx. Wt. in Lbs.	Weather Shield[1]	Wiring Diagram	Wall Mount Bracket
480 - 208Y/120, 60 Hz, Electrostatically Shielded										
FHK	15	T4T15FSK13E	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	18	WMB-3
	30	T4T30FSK13E	+2, -4 x 2.5%	34	22.375	19.875	400	WS-4	18	WMB-3
	45	T4T45FSK13E	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	18	WMB-4
	75	T4T75FSK13E	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	18	WMB-4
	112.5	T4T112FSK13E	+2, -4 x 2.5%	46	32	28	1180	WS-10B	18A	NONE
	150	T4T150FSK13E	+2, -4 x 2.5%	51	42.125	26	1385	WS-12	20A	NONE
	225	T4T225FSK13E	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	18A	NONE
	300	T4T300FSK13E	+2, -4 x 2.5%	72.75	53.375	36.875	2620	WS-16	18A	NONE
	500	T4T500FSK13E	**CONSULT FACTORY**							
480 - 208Y/120, 60 Hz, Electrostatically Shielded, Copper										
FHK	15	T4T15FCSK13E	+2, -4 x 2.5%	34	22.375	19.875	410	WS-4	18	WMB-3
	30	T4T30FCSK13E	+2, -4 x 2.5%	34	22.375	19.875	410	WS-4	18	WMB-3
	45	T4T45FCSK13E	+2, -4 x 2.5%	37	26	19.875	645	WS-18A	18	WMB-4
	75	T4T75FCSK13E	+2, -4 x 2.5%	43	28.5	23.5	855	WS-18	18	WMB-4
	112.5	T4T112FCSK13E	+2, -4 x 2.5%	46	32	28	1080	WS-10B	18A	NONE
	150	T4T150FCSK13E	+2, -4 x 2.5%	51	42.125	26	1440	WS-12	18A	NONE
	225	T4T225FCSK13E	**CONSULT FACTORY**							
	300	T4T300FCSK13E								
480 - 240/120, LT (Lighting Tap), 60 Hz										
FHK	15	T43T15FK13E	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	21	WMB-3
	30	T43T30FK13E	+2, -4 x 2.5%	34	22.375	19.875	400	WS-4	21	WMB-3
	45	T43T45FK13E	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	21	WMB-4
	75	T43T75FK13E	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	21	WMB-4
	112.5	T4T3112FK13E	+2, -4 x 2.5%	46	32	28	1180	WS-10B	21A	NONE
	150	T43T150FK13E	+2, -4 x 2.5%	51	42.125	26	1385	WS-12	21A	NONE
	225	T43T225FK13E	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	21A	NONE
	300	T43T300FK13E	+2, -4 x 2.5%	72.75	53.375	36.875	2620	WS-16	21A	NONE
480 - 240/120, LT (Lighting Tap), 60 Hz, Electrostatically Shielded										
FHK	15	T43T15FSK13E	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	17	WMB-3
	30	T43T30FSK13E	+2, -4 x 2.5%	34	22.375	19.875	400	WS-4	17	WMB-3
	45	T43T45FSK13E	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	17	WMB-4
	75	T43T75FSK13E	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	17	WMB-4
	112.5	T43T112FSK13E	+2, -4 x 2.5%	46	32	28	1180	WS-10B	17A	NONE
	150	T43T150FSK13E	+2, -4 x 2.5%	51	42.125	26	1385	WS-12	17A	NONE

[1]All transformer catalog numbers shown are in a NEMA 2 enclosure, which covers all the requirements of NEMA 1 by offering a degree of protection against the ingress of falling dirt and dripping liquid. The addition of a weather shield kit converts the indoor NEMA 2 transformer to an outdoor NEMA 3R.

FP Type FHK • K-Factor Dry-Type Transformers

K-Factor Rated • 150° C Rise • Three-Phase • K13

Type	KVA	Catalog Number	Taps	Approximate Dimensions - Inches			Approx. Wt. in Lbs.	Weather Shield[1]	Wiring Diagram	Wall Mount Bracket
				H	W	D				
480 - 208Y/120, 60 Hz										
	15	T4T15K13E	+2, -4 x 2.5%	29	17.125	19.375	185	WS-2	22	WMB-3
	30	T4T30K13E	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	22	WMB-3
	45	T4T45K13E	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	22	WMB-4
	75	T4T75K13E	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	22	WMB-4
FHK	112.5	T4T112K13E	+2, -4 x 2.5%	46	32	28	915	WS-10B	22A	NONE
	150	T4T150K13E	+2, -4 x 2.5%	51	36	30.5	1190	WS-12A	22A	NONE
	225	T4T225K13E	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	22A	NONE
	300	T4T300K13E	+2, -4 x 2.5%	72.75	53.375	36.875	2070	WS-16	22A	NONE
	500	T4T500K13E	CONSULT FACTORY							
480 - 208Y/120, 60 Hz, Electrostatically Shielded										
	15	T4T15SK13E	+2, -4 x 2.5%	29	17.125	19.375	185	WS-2	18	WMB-3
	30	T4T30SK13E	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	18	WMB-3
	45	T4T45SK13E	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	18	WMB-4
	75	T4T75SK13E	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	18	WMB-4
FHK	112.5	T4T112SK13E	+2, -4 x 2.5%	46	32	28	915	WS-10B	18A	NONE
	150	T4T150SK13E	+2, -4 x 2.5%	51	36	30.5	1190	WS-12A	18A	NONE
	225	T4T225SK13E	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	18A	NONE
	300	T4T300SK13E	+2, -4 x 2.5%	72.75	53.375	36.875	2070	WS-16	18A	NONE
	500	T4T500SK13E	CONSULT FACTORY							
480 - 208Y/120, 60 Hz, Electrostatically Shielded, Copper										
	15	T4T15CSK13E	+2, -4 x 2.5%	29	17.125	19.375	230	WS-2	18	WMB-3
	30	T4T30CSK13E	+2, -4 x 2.5%	34	22.375	19.875	410	WS-4	18	WMB-3
	45	T4T45CSK13E	+2, -4 x 2.5%	37	26	19.875	645	WS-18A	18	WMB-4
FHK	75	T4T75CSK13E	+2, -4 x 2.5%	37	26	19.875	645	WS-18A	18	WMB-4
	112.5	T4T112CSK13E	+2, -4 x 2.5%	46	32	28	1080	WS-10B	18A	NONE
	150	T4T150CSK13E	+2, -4 x 2.5%	51	42.125	26	1440	WS-12	18A	NONE
	225	T4T225CSK13E	+2, -4 x 2.5%	63	46.5	30.875	1930	WS-14	18A	NONE
	300	T4T300CSK13E	+2, -4 x 2.5%	72.75	53.375	36.875	2170	WS-16	18A	NONE
480 - 240/120, LT (Lighting Tap), 60 Hz										
	15	T43T15K13E	+2, -4 x 2.5%	29	17.125	19.375	185	WS-2	21	WMB-3
	30	T43T30K13E	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	21	WMB-3
	45	T43T45K13E	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	21	WMB-4
FHK	75	T43T75K13E	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	21	WMB-4
	112.5	T43T112K13E	+2, -4 x 2.5%	46	32	28	915	WS-10B	21A	NONE
	150	T43T150K13E	+2, -4 x 2.5%	51	36	30.5	1190	WS-12A	21A	NONE
	225	T43T225K13E	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	21A	NONE
	300	T43T300K13E	+2, -4 x 2.5%	72.75	53.375	36.875	2070	WS-16	21A	NONE
480 - 240/120, LT (Lighting Tap), 60 Hz, Electrostatically Shielded										
	15	T43T15SK13E	+2, -4 x 2.5%	29	17.125	19.375	185	WS-2	17	WMB-3
	30	T43T30SK13E	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	17	WMB-3
FHK	45	T43T45SK13E	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	17	WMB-4
	75	T43T75SK13E	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	17	WMB-4
	112.5	T43T112SK13E	+2, -4 x 2.5%	46	32	28	915	WS-10B	17A	NONE
	150	T43T150SK13E	+2, -4 x 2.5%	51	36	30.5	1190	WS-12A	17A	NONE

[1] All transformer catalog numbers shown are in a NEMA 2 enclosure, which covers all the requirements of NEMA 1 by offering a degree of protection against the ingress of falling dirt and dripping liquid. The addition of a weather shield kit converts the indoor NEMA 2 transformer to an outdoor NEMA 3R.

FP Type FHK • K-Factor Dry-Type Transformers

K-Factor Rated • 80° C Rise • Three-Phase • K20

Type	KVA	Catalog Number	Taps	Approximate Dimensions - Inches			Approx. Wt. in Lbs.	Weather Shield[1]	Wiring Diagram	Wall Mount Bracket
				H	W	D				
480 - 208Y/120, 60 Hz										
FHK	15	T4T15BK20E	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	22	WMB-3
	30	T4T30BK20E	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	22	WMB-4
	45	T4T45BK20E	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	22	WMB-4
	75	T4T75BK20E	+2, -4 x 2.5%	46	32	28	1180	WS-10B	22A	NONE
	112.5	T4T112BK20E								
	150	T4T150BK20E	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	22A	NONE
	225	T4T225BK20E	**CONSULT FACTORY**							
	300	T4T300BK20E								
480 - 208Y/120, 60 Hz, Electrostatically Shielded										
FHK	15	T4T15BSK20E	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	18	WMB-3
	30	T4T30BSK20E	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	18	WMB-4
	45	T4T45BSK20E	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	18	WMB-4
	75	T4T75BSK20E	+2, -4 x 2.5%	46	32	28	1180	WS-10B	18A	NONE
	112.5	T4T112BSK20E								
	150	T4T150BSK20E	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	18A	NONE
	225	T4T225BSK20E	**CONSULT FACTORY**							
	300	T4T300BSK20E								
480 - 208Y/120, 60 Hz, Electrostatically Shielded, Copper										
FHK	15	T4T15BCSK20E	+2, -4 x 2.5%	34	22.375	19.875	410	WS-4	18	WMB-3
	30	T4T30BCSK20E	+2, -4 x 2.5%	34	22.375	19.875	460	WS-4	18	WMB-3
	45	T4T45BCSK20E	+2, -4 x 2.5%	37	26	19.875	645	WS-18A	18	WMB-4
	75	T4T75BCSK20E	+2, -4 x 2.5%	43	28.5	23.5	750	WS-18	18A	WMB-4
	112.5	T4T112BCSK20E	**CONSULT FACTORY**							
	150	T4T150BCSK20E								
	225	T4T225BCSK20E								

[1]All transformer catalog numbers shown are in a NEMA 2 enclosure, which covers all the requirements of NEMA 1 by offering a degree of protection against the ingress of falling dirt and dripping liquid. The addition of a weather shield kit converts the indoor NEMA 2 transformer to an outdoor NEMA 3R.

FP Type FHK • K-Factor Dry-Type Transformers

K-Factor Rated • 115° C Rise • Three-Phase • K20

Type	KVA	Catalog Number	Taps	Approximate Dimensions - Inches			Approx. Wt. in Lbs.	Weather Shield[1]	Wiring Diagram	Wall Mount Bracket
				H	W	D				
480 - 208Y/120, 60 Hz										
FHK	15	T4T15FK20E	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	22	WMB-3
	30	T4T30FK20E	+2, -4 x 2.5%	34	22.375	19.875	400	WS-4	22	WMB-3
	45	T4T45FK20E	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	22	WMB-4
	75	T4T75FK20E	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	22	WMB-4
	112.5	T4T112FK20E	+2, -4 x 2.5%	51	36	30.5	1520	WS-12A	22A	NONE
	150	T4T150FK20E	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	22A	NONE
	225	T4T225FK20E	**CONSULT FACTORY**							
	300	T4T300FK20E								
480 - 208Y/120, 60 Hz, Electrostatically Shielded										
FHK	15	T4T15FSK20E	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	18	WMB-3
	30	T4T30FSK20E	+2, -4 x 2.5%	34	22.375	19.875	400	WS-4	18	WMB-3
	45	T4T45FSK20E	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	18	WMB-4
	75	T4T75FSK20E	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	18	WMB-4
	112.5	T4T112FSK20E	+2, -4 x 2.5%	51	36	30.5	1520	WS-12A	18A	NONE
	150	T4T150FSK20E	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	18A	NONE
	225	T4T225FSK20E	**CONSULT FACTORY**							
	300	T4T300FSK20E								
480 - 208Y/120, 60 Hz, Electrostatically Shielded, Copper										
FHK	15	T4T15FCSK20E	+2, -4 x 2.5%	34	22.375	19.875	410	WS-4	18	WMB-3
	30	T4T30FCSK20E	+2, -4 x 2.5%	34	22.375	19.875	410	WS-4	18	WMB-3
	45	T4T45FCSK20E	+2, -4 x 2.5%	37	26	19.875	645	WS-18A	18	WMB-4
	75	T4T75FCSK20E	+2, -4 x 2.5%	43	28.5	23.5	750	WS-18	18	WMB-4
	112.5	T4T112FCSK20E	+2, -4 x 2.5%	46	32	28	1330	WS-10B	18A	NONE
	150	T4T150FCSK20E	**CONSULT FACTORY**							
	225	T4T225FCSK20E								
	300	T4T300FCSK20E								

[1]All transformer catalog numbers shown are in a NEMA 2 enclosure, which covers all the requirements of NEMA 1 by offering a degree of protection against the ingress of falling dirt and dripping liquid. The addition of a weather shield kit converts the indoor NEMA 2 transformer to an outdoor NEMA 3R.

FP Type FHK • K-Factor Dry-Type Transformers

K-Factor Rated • 150° C Rise • Three-Phase • K20

Type	KVA	Catalog Number	Taps	Approximate Dimensions - Inches			Approx. Wt. in Lbs.	Weather Shield[1]	Wiring Diagram	Wall Mount Bracket
				H	W	D				
480 - 208Y/120, 60 Hz										
FHK	15	T4T15K20E	+2, -4 x 2.5%	29	17.125	19.375	185	WS-2	22	WMB-3
	30	T4T30K20E	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	22	WMB-3
	45	T4T45K20E	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	22	WMB-4
	75	T4T75K20E	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	22	WMB-4
	112.5	T4T112K20E	+2, -4 x 2.5%	46	32	28	915	WS-10B	22A	NONE
	150	T4T150K20E	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	22A	NONE
	225	T4T225K20E	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	22A	NONE
	300	T4T300K20E	+2, -4 x 2.5%	72.75	53.375	36.875	2620	WS-16	22A	NONE
	500	T4T500K20E	**CONSULT FACTORY**							
480 - 208Y/120, 60 Hz, Electrostatically Shielded										
FHK	15	T4T15SK20E	+2, -4 x 2.5%	29	17.125	19.375	185	WS-2	18	WMB-3
	30	T4T30SK20E	+2, -4 x 2.5%	34	22.375	19.875	370	WS-4	18	WMB-3
	45	T4T45SK20E	+2, -4 x 2.5%	37	26	19.875	585	WS-18A	18	WMB-4
	75	T4T75SK20E	+2, -4 x 2.5%	43	28.5	23.5	760	WS-18	18	WMB-4
	112.5	T4T112SK20E	+2, -4 x 2.5%	46	32	28	915	WS-10B	18A	NONE
	150	T4T150SK20E	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	18A	NONE
	225	T4T225SK20E	+2, -4 x 2.5%	63	46.5	30.875	1630	WS-14	18A	NONE
	300	T4T300SK20E	+2, -4 x 2.5%	72.75	53.375	36.875	2620	WS-16	18A	NONE
	500	T4T500SK20E	**CONSULT FACTORY**							
480 - 208Y/120, 60 Hz, Electrostatically Shielded, Copper										
FHK	15	T4T15CSK20E	+2, -4 x 2.5%	29	17.125	19.375	230	WS-2	18	WMB-3
	30	T4T30CSK20E	+2, -4 x 2.5%	34	22.375	19.875	410	WS-4	18	WMB-3
	45	T4T45CSK20E	+2, -4 x 2.5%	37	26	19.875	645	WS-18A	18	WMB-4
	75	T4T75CSK20E	+2, -4 x 2.5%	37	26	19.875	645	WS-18A	18	WMB-4
	112.5	T4T112CSK20E	+2, -4 x 2.5%	46	32	28	1080	WS-10B	18A	NONE
	150	T4T150CSK20E	+2, -4 x 2.5%	51	42.125	26	1440	WS-12	18A	NONE
	225	T4T225CSK20E	**CONSULT FACTORY**							
	300	T4T300CSK20E								

[1]All transformer catalog numbers shown are in a NEMA 2 enclosure, which covers all the requirements of NEMA 1 by offering a degree of protection against the ingress of falling dirt and dripping liquid. The addition of a weather shield kit converts the indoor NEMA 2 transformer to an outdoor NEMA 3R.

Accessories

Terminal Lug Kits for Type FH Transformers

Catalog Number	KVA Sizes	Terminal Lug Quantity	Lug Cable Range	Quantity Cables Per Lug	Hardware Quantity - Bolt Size	Aprox. Weight in Pounds
50400	15 - 25 1Ø 15-25 -30-37-1/2 3Ø	7	#14 - 1/0	1	(7) - 1/4 - 20 x 1"	1
50401	37 1/2 - 50 1Ø 45-50-60-75 3Ø	3 7	#14 - 1/0 #6 - 250MCM	1 1	(3) - 1/4 - 20 x 1" (7) - 5/16 - 18 x 1 1/2"	3
50402	75-100 1Ø 100-112-150 3Ø	6 6	#6 - 350MCM #6 - 350MCM	2 1	(6) - 1/2 - 13 x 2" (3) - 5/16 - 18 x 1 1/2" (6) - 3/8 - 16 x 1 1/2"	6
50403*	225 3Ø	3 4	#4 - 500MCM #2 - 600MCM	1 2	(3) - 3/8 - 16 x 1 1/2" (4) - 1/2 - 13 x 2"	6
50404*	300 3Ø	3 12	#6 - 350MCM #4 - 500MCM	2 1	(3) - 1/2 - 13 x 2" (9) - 3/8 - 16 x 2"	8
50405*	400-500 3Ø	16 3	300-800MCM #2 - 600MCM	1 2	(13) - 1/2 - 13 x 2 1/2"	15

Notes:

1. Screw type lugs suitable for aluminum or copper conductor.

**2. Catalog numbers 50403, 50404, and 50405 to be used only on transformers with one primary and one secondary (two windings total) and at lease one delta winding. Also, one winding must have a voltage of 480V or above while the other winding must have a voltage of 208V or above or be 240 Delta with a 120 lighting tap (high-leg). For example, voltages of 480-208Y/120 and 480-240/120LT are acceptable connections for these lugs.*

Weather Shield Kits for Type FH Indoor Ventilated Transformers

Catalog Number	Overhang Extension (2 top & 2 bottom)	Approximate Weight in Pounds	Catalog Number	Overhang Extension (2 top & 2 bottom)	Approximate Weight in Pounds
WS-2	2 - 1/16 inches each side	10	**WS-10A**	2 - 1/16 inches each side	16
WS-3	2 - 1/16 inches each side	10	**WS-10B**	2 - 1/16 inches each side	16
WS-4	2 - 1/16 inches each side	15	**WS-12**	2 - 1/16 inches each side	22
WS-5	2 - 1/16 inches each side	15	**WS-12A**	2 - 1/16 inches each side	20
WS-6	2 - 1/16 inches each side	16	**WS-14**	2 - 1/16 inches each side	28
WS-7	2 - 1/16 inches each side	16	**WS-16**	2 - 1/16 inches each side	35
WS-8	2 - 1/16 inches each side	17	**WS-18**	2 - 1/16 inches each side	15
WS-9	2 - 1/16 inches each side	18	**WS-18A**	2 - 1/16 inches each side	12
WS-10	2 - 1/16 inches each side	20			

WEATHERSHIELD NOTE: Weathershield catalog numbers are listed in the technical data sections for each product. Addition of a weathershield kit converts the transformer from NEMA 2 to NEMA 3R - UL® listed product.

Wall Mount Brackets

Catalog Number	Type	Approximate Weight in Pounds	Use With . . .
WMB-3	Indoor/Outdoor	24	Wall mount bracket catalog numbers are listed in technical data sections for each product.
WMB-4	Indoor/Outdoor	60	

Primary Fuse Kit

Catalog Number	Approximate Weight in Pounds	Use With . . .
FPFK-1	1	Industrial Control Transformers

Specification Guide

Lighting and Power Transformers 600 Volts and Below

Furnish and install single-phase and three-phase general purpose dry-type transformers of the two winding type, self-cooled, with ratings as indicated on the electrical plans.

All transformers shall be constructed and rated in accordance with Underwriters Laboratories, Inc. Standard 5085 or 1561as applicable, IEEE Standard C57, NEMA Standard ST-20 and the National Electrical Code.

Type FB

Transformers smaller than 15 KVA shall be totally enclosed non-ventilated with core and coil assemblies completely encapsulated in a polyester resin compound to provide a moisture-proof, shock-resistant, high dielectric seal.

Transformers shall be insulated with 180°C insulation system with 115°C rise.

Cores shall be constructed from non-aging electrical steels.

The case shall be constructed in accordance with UL specifications and shall include a wiring compartment to accommodate cable connections. All units shall be supplied with flexible cable leads marked for easy identification. Case design shall include knockouts and wall mounting brackets. All external surfaces shall be provided with a durable ANSI 61 light gray paint finish. Three-phase transformers shall include NEMA standard tap arrangements and all units shall have sound levels in accordance with NEMA standards.

Transformers shall be Federal Pacific Transformer Company Type FB or approved equal.

Type FH

Transformers rated 15 KVA and larger shall be a ventilated dry type with a UL listed 220°C insulation system. Units shall be designed to operate with a rated maximum temperature rise of 150°C (115°C) (80°C).

Cores shall be constructed from non-aging electrical steels. Core laminations shall be tightly clamped with formed steel angles. The complete core and coil assembly shall be coated with non-hygroscopic thermo-setting varnish to provide a high dielectric flame retardant seal.

Core and coil assemblies shall be braced to provide short circuit ratings as defined in ANSI and NEMA standards. The complete assembly shall be installed on vibration dampening pads to reduce noise and securely bolted to the enclosure base. A flexible grounding conductor shall be installed between the core and coil assembly and the transformer enclosure.

Enclosures shall be of heavy gauge steel, ventilated construction, finished with ANSI 61 light gray paint. All units shall be provided with suitable lifting means. Front and rear covers shall be removable to provide access to the terminal compartment. Terminals shall be fully sized to carry the transformer full load current and shall be arranged to accept required UL listed cable connectors. Units installed outdoors shall have a UL listed type 3R outdoor enclosure.

All units shall be supplied with NEMA standard taps in the high voltage windings.

Sound levels shall not exceed the following:

0 to 9 KVA	40 db
10 to 50 KVA	45 db
51 to 150 KVA	50 db
151 to 300 KVA	55 db
301 to 500 KVA	60 db
501 to 700 KVA	62 db
701 to 1000 KVA	64 db

Each transformer shall have a securely attached nameplate providing complete electrical ratings, wiring diagram, tap connections and catalog number.

Transformers shall be Federal Pacific Type FH or approved equal.

For K-Factor specifications, please refer to page 47.

Buck-Boost Connection Diagram

Single-Phase

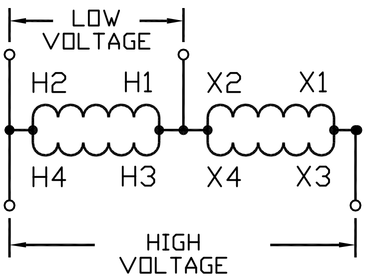


FIGURE A

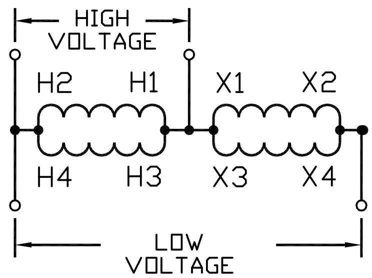


FIGURE A1

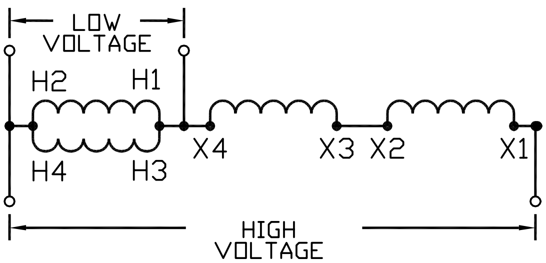


FIGURE B

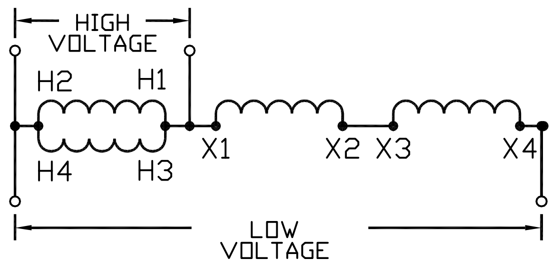


FIGURE B1

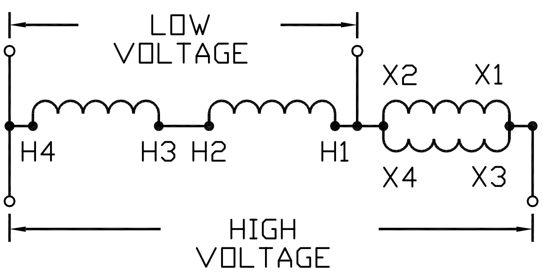


FIGURE C

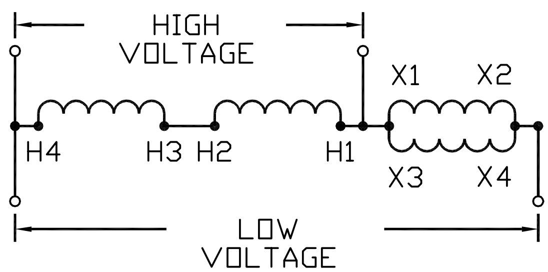


FIGURE C1

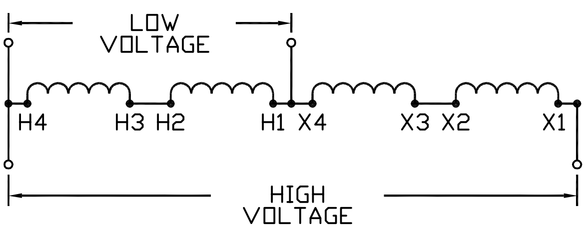


FIGURE D

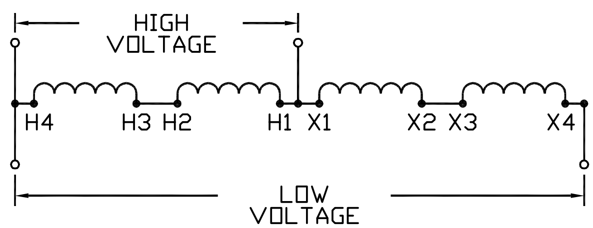


FIGURE D1

Buck-Boost Connection Diagram

Three-Phase Open Delta

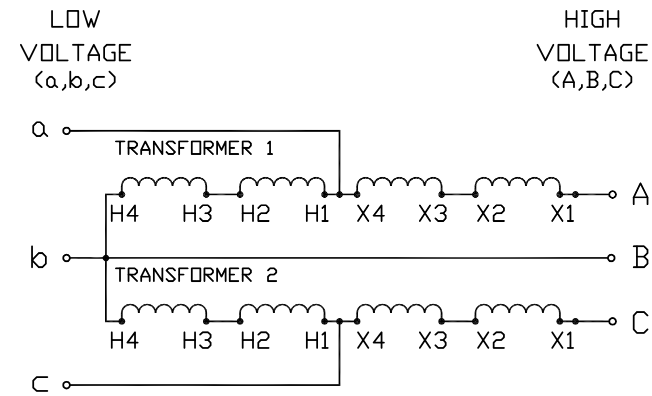


FIGURE G

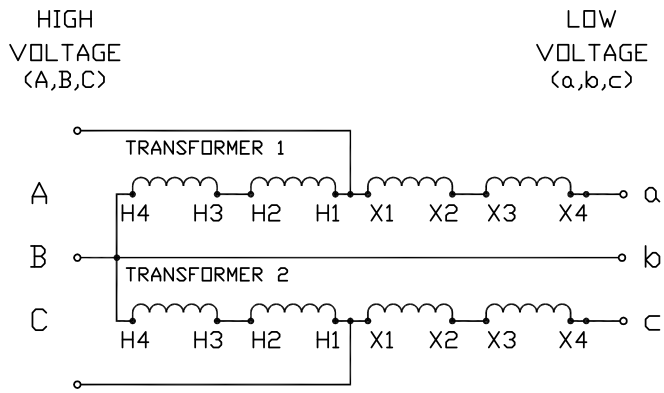


FIGURE L

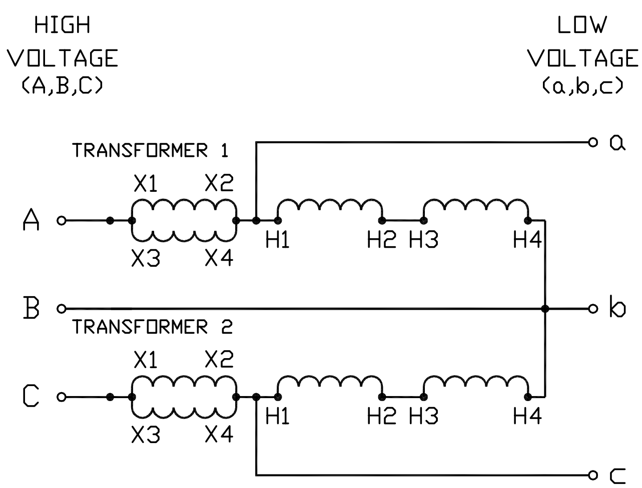


FIGURE H

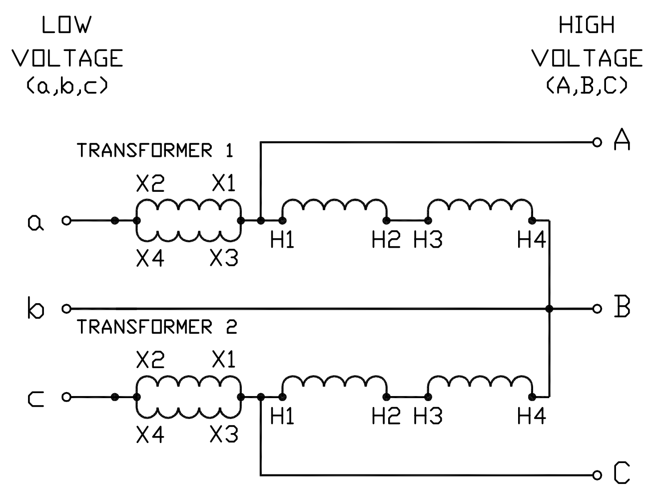


FIGURE H1

Buck-Boost Connection Diagram

Three-Phase Open Delta

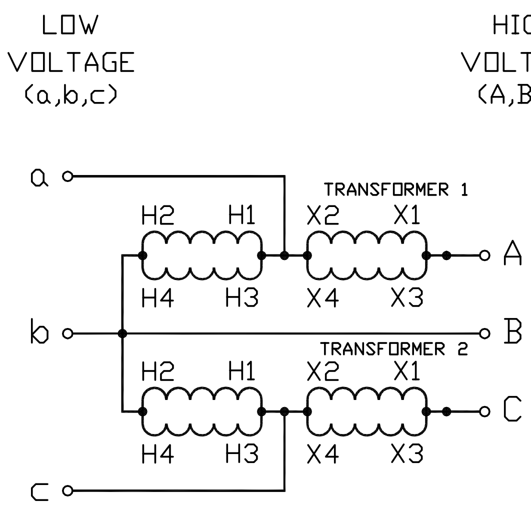


FIGURE M

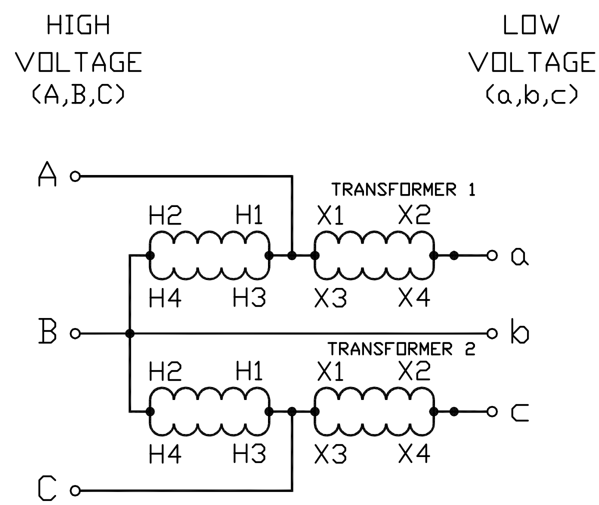


FIGURE M1

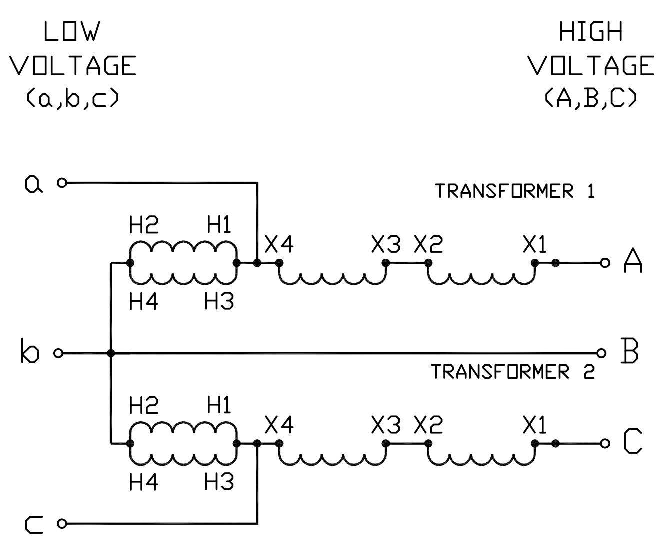


FIGURE N

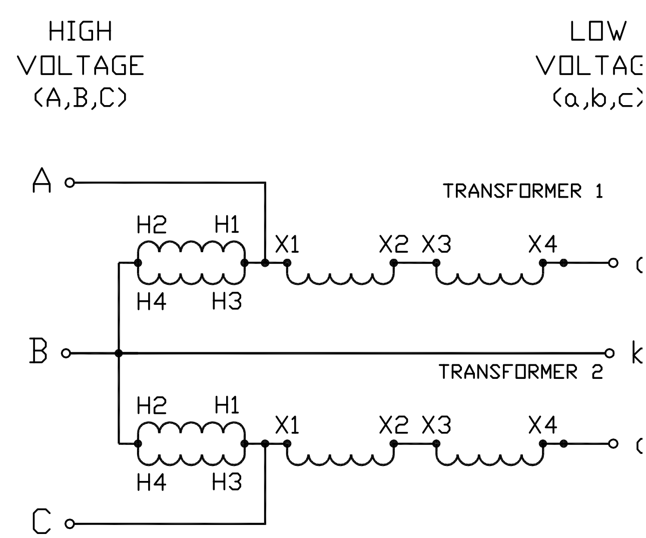


FIGURE N1

Buck-Boost Connection Diagram

Three-Phase WYE

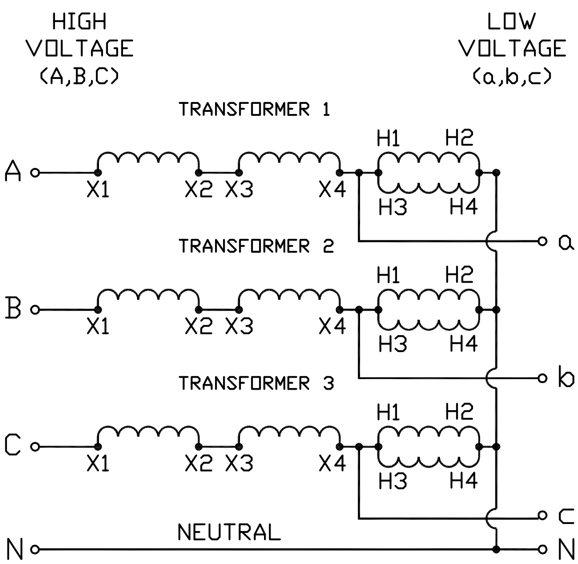


FIGURE E

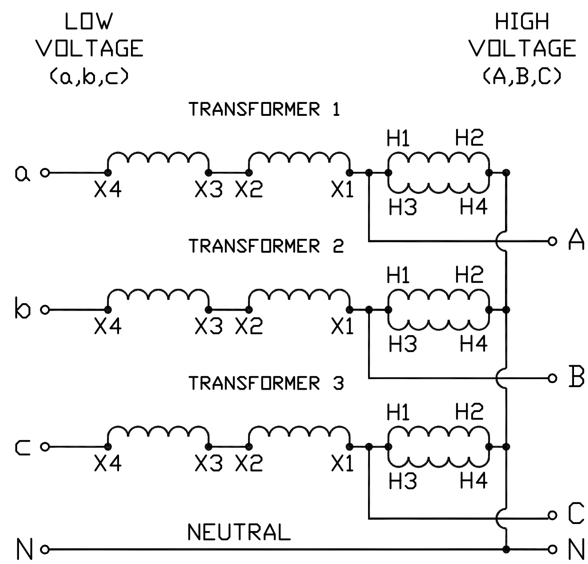


FIGURE E1

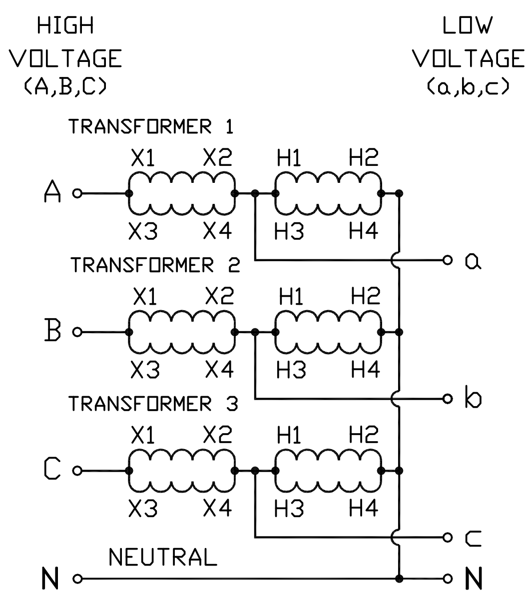


FIGURE F

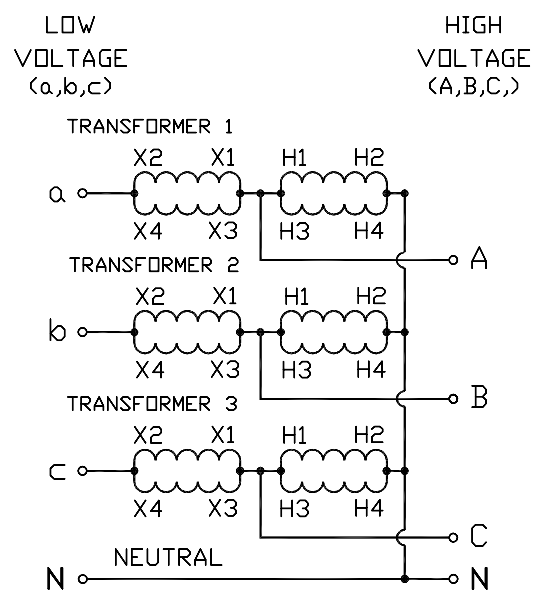


FIGURE F1

NOTE: All wye connected buck-boost connections MUST have a source neutral for proper operation. They can not be used to create or derive a neutral from a 3-phase 3-wire system.

Buck-Boost Connection Diagram

Three-Phase WYE

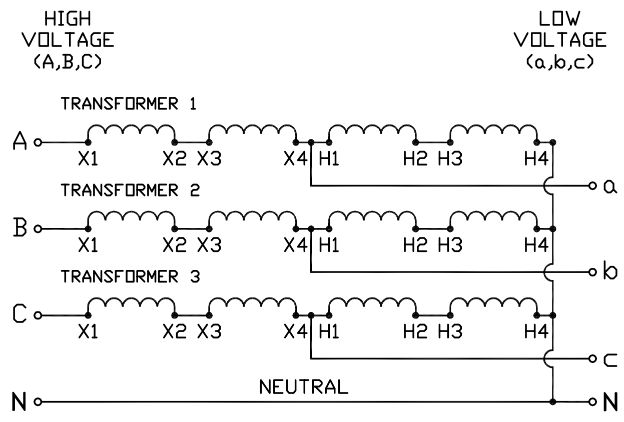


FIGURE J

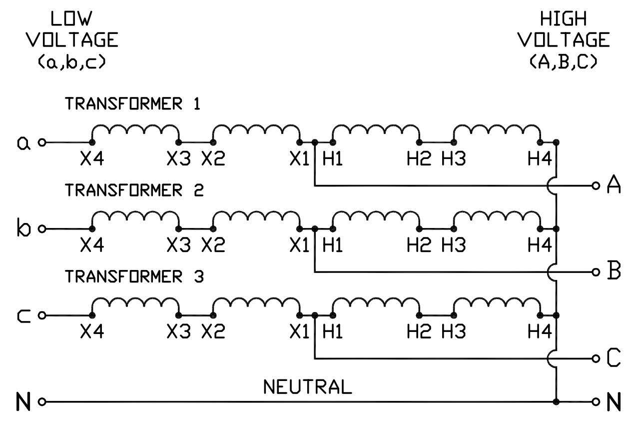


FIGURE J1

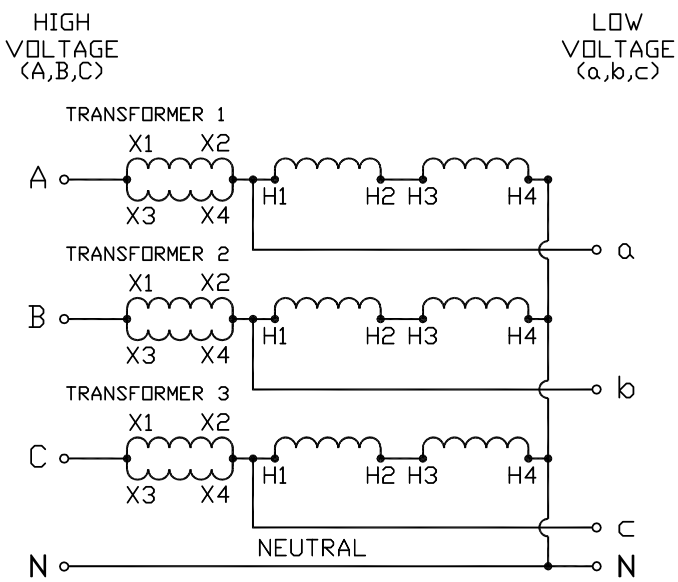


FIGURE K

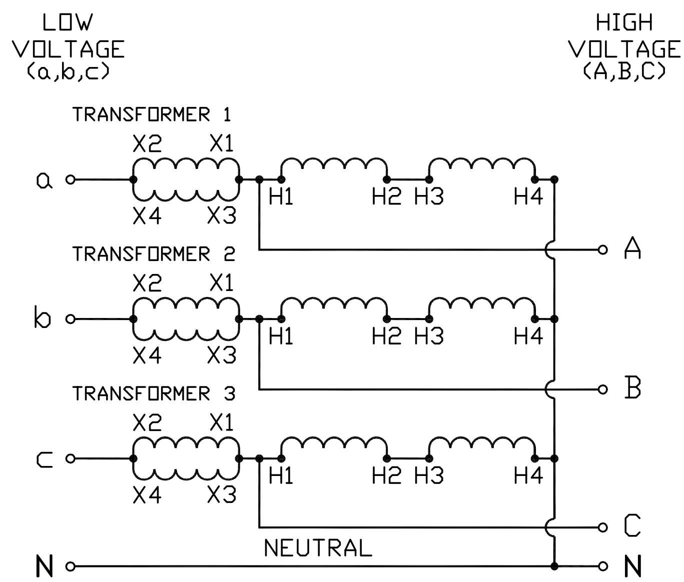


FIGURE K1

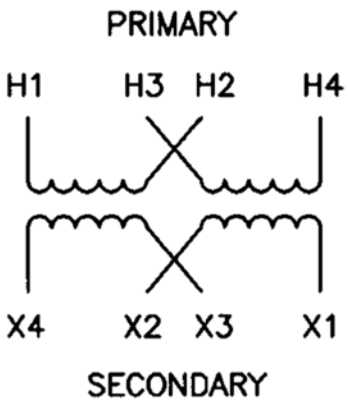
NOTE: All wye connected buck-boost connections MUST have a source neutral for proper operation. They can not be used to create or derive a neutral from a 3-phase 3-wire system.

Wiring Diagrams

Single-Phase

Diagram #1

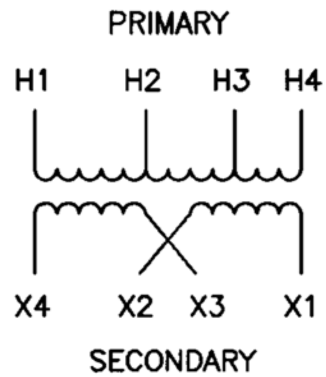
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
240 x 480	120/240	NONE



VOLTS	CONNECTIONS	LINE LEADS
480	H2 - H3	H1, H4
240	H1 - H3, H2 - H4	H1, H4
240	X2 - X3	X1, X4
240/120	X2 - X3	X1, X2, X4
120	X1 - X3, X2 - X4	X1, X4

Diagram #2

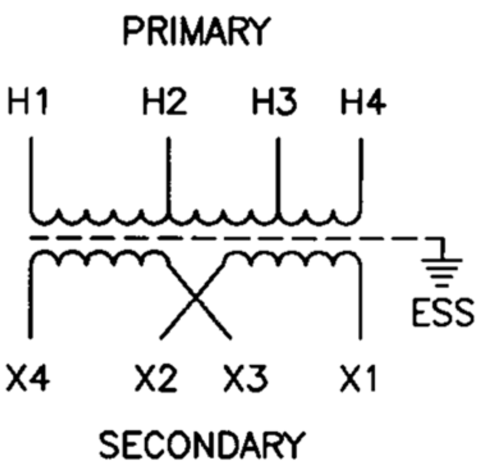
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
480	120/240	2-5% FCBN



VOLTS	CONNECTIONS	LINE LEADS
480		H1, H4
456		H1, H3
432		H1, H2
240	X2-X3	X1, X4
240/120	X2-X3	X1, X2, X4
120	X1-X3, X2-X4	X1, X4

Diagram #3

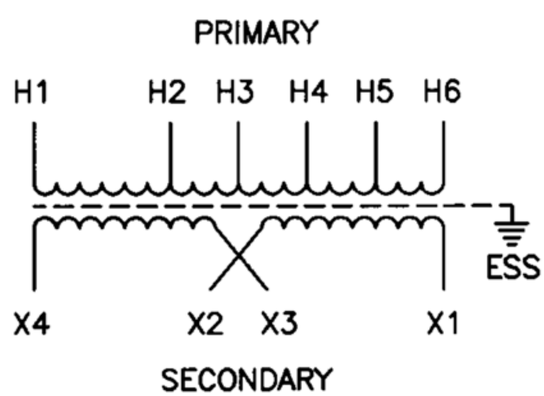
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
600	120/240	2-5% FCBN



VOLTS	CONNECTIONS	LINE LEADS
600		H1, H4
570		H1, H3
540		H1, H2
240	X2-X3	X1, X4
240/120	X2-X3	X1, X2, X4
120	X1-X3, X2-X4	X1, X4

Diagram #4

PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
600	120/240	4 - 2 1/2% FCBN

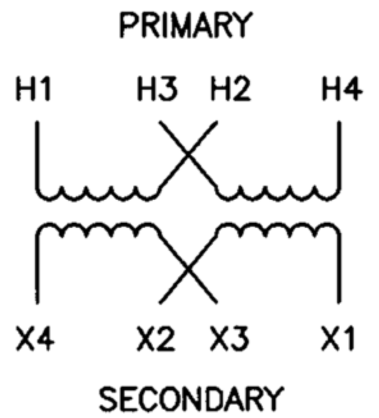


VOLTS	CONNECTIONS	LINE LEADS
600		H1, H6
585		H1, H5
570		H1, H4
555		H1, H3
540		H1, H2
240	X2-X3	X1, X4
240/120	X2-X3	X1, X2, X4
120	X1-X3, X2-X4	X1, X4

Wiring Diagrams

Diagram #5

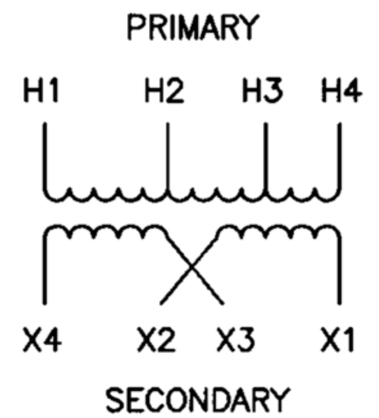
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
120 x 240	120/240	NONE



VOLTS	CONNECTIONS	LINE LEADS
240	H2-H3	H1, H4
120	H1-H3, H2-H4	H1, H4
240	X2-X3	X1, X4
240/120	X2-X3	X1, X2, X4
120	X1-X3, X2-X4	X1, X4

Diagram #6

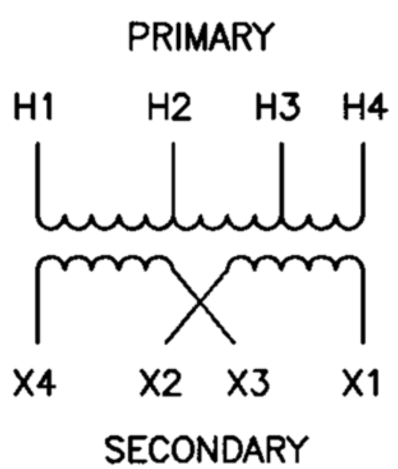
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
208	120/240	2-5% FCBN



VOLTS	CONNECTIONS	LINE LEADS
208		H1, H4
198		H1, H3
187		H1, H2
240	X2-X3	X1, X4
240/120	X2-X3	X1, X2, X4
120	X1-X3, X2-X4	X1, X4

Diagram #7

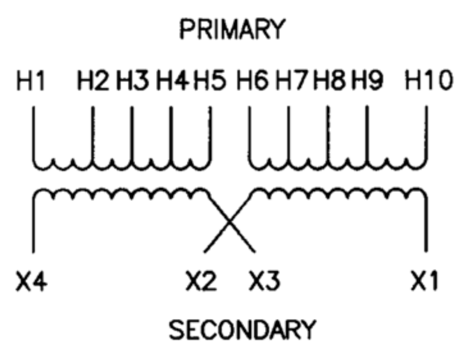
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
277	120/240	2-5% FCBN



VOLTS	CONNECTIONS	LINE LEADS
277		H1, H4
263		H1, H3
249		H1, H2
240	X2-X3	X1, X4
240/120	X2-X3	X1, X2, X4
120	X1-X3, X2-X4	X1, X4

Diagram #8

PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
240 x 480	120/240	2 - 2 1/2% FCAN & 4 - 2 1/2% FCBN

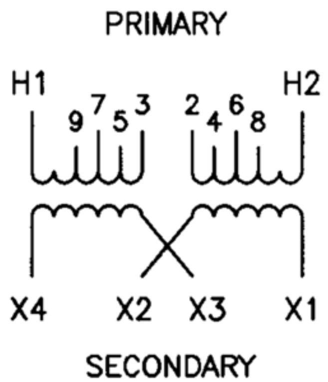


VOLTS	CONNECTIONS	LINE LEADS
252	H1-H6, H10-H5	H1, H10
240	H1-H7, H10-H4	H1, H10
228	H1-H8, H10-H3	H1, H10
216	H1-H9, H10-H2	H1, H10
504	H5-H6	H1, H10
492	H5-H7	H1, H10
480	H4-H7	H1, H10
468	H4-H8	H1, H10
456	H3-H8	H1, H10
444	H3-H9	H1, H10
432	H2-H9	H1, H10
240	X2-X3	X1, X4
240/120	X2-X3	X1, X2, X4
120	X1-X3, X2-X4	X1, X4

Wiring Diagrams

Diagram #9

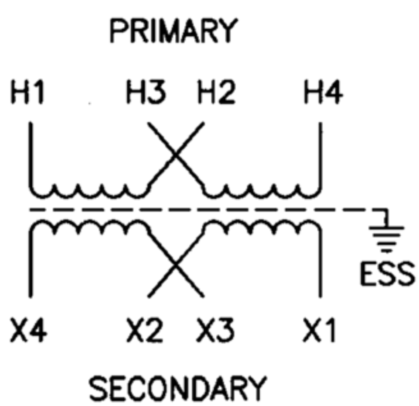
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
240 x 480	120/240	2 - 2 1/2% FCAN & 4 - 2 1/2% FCBN



VOLTS	CONNECTIONS	LINE LEADS
504	2 TO 3	H1, H2
492	3 TO 4	H1, H2
480	4 TO 5	H1, H2
468	5 TO 6	H1, H2
456	6 TO 7	H1, H2
444	7 TO 8	H1, H2
432	8 TO 9	H1, H2
252	2 TO H1, 3 TO H2	H1, H2
240	4 TO H1, 5 TO H2	H1, H2
228	6 TO H1, 7 TO H2	H1, H2
216	8 TO H1, 9 TO H2	H1, H2
240	X2 TO X3	X1, X4
240/120	X2 TO X3	X1, X2, X4
120	X1 TO X3, X2 TO X4	X1, X4

Diagram #10

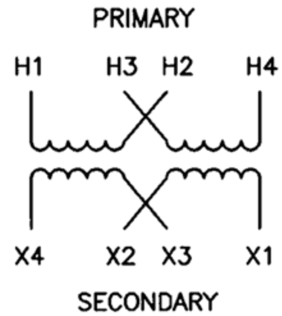
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
240 x 480	120/240	NONE



VOLTS	CONNECTIONS	LINE LEADS
480	H2-H3	H1, H4
240	H1-H3, H2-H4	H1, H4
240	X2-X3	X1, X4
240/120	X2-X3	X1, X2, X4
120	X1-X3, X2-X4	X1, X4

Diagram #10A

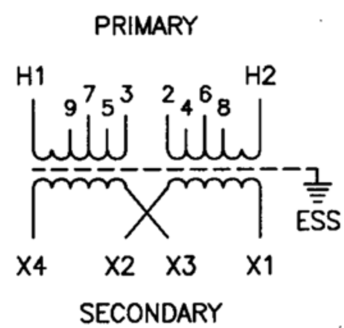
	PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
(A)	120 x 240	12/24	NONE
(B)	120 x 240	16/32	NONE
(C)	240 x 480	24/48	NONE



	(A)	
VOLTS	**CONNECTIONS**	**LINE LEADS**
240	H2-H3	H1, H4
120	H1-H3, H2-H4	H1, H4
24	X2-X3	X1, X4
12	X1-X3, X2-X4	X1, X4
	(B)	
VOLTS	**CONNECTIONS**	**LINE LEADS**
240	H2-H3	H1, H4
120	H1-H3, H2-H4	H1, H4
32	X2-X3	X1, X4
16	X1-X3, X2-X4	X1, X4
	(C)	
VOLTS	**CONNECTIONS**	**LINE LEADS**
480	H2-H3	H1, H4
240	H1-H3, H2-H4	H1, H4
48	X2-X3	X1, X4
24	X1-X3, X2-X4	X1, X4

Diagram #11

PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
600	120/240	2 - 2 1/2% FCAN & 4 - 2 1/2% FCBN

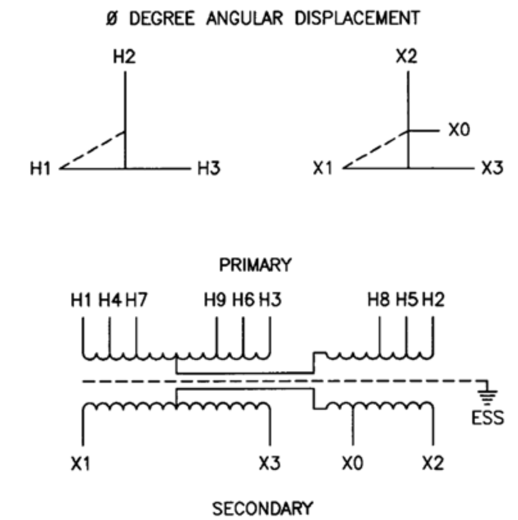


VOLTS	CONNECTIONS	LINE LEADS
630	2 TO 3	H1, H2
615	3 TO 4	H1, H2
600	4 TO 5	H1, H2
585	5 TO 6	H1, H2
570	6 TO 7	H1, H2
555	7 TO 8	H1, H2
540	8 TO 9	H1, H2
240	X2 TO X3	X1, X4
240/120	X2 TO X3	X1, X2, X4
120	X1 TO X3, X2 TO X4	X1, X4

Wiring Diagrams

Diagram #12

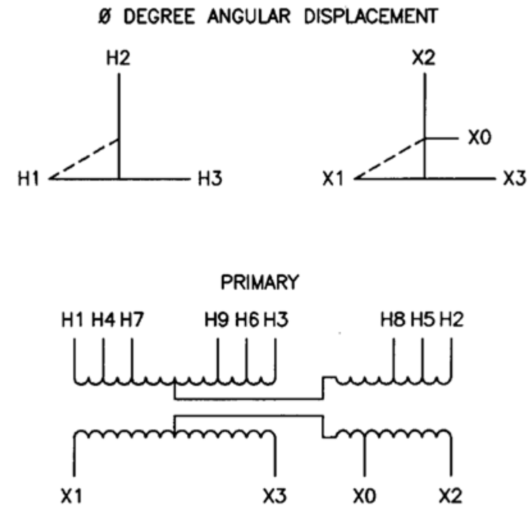
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
240Δ	208Y/120	2-5% FCBN



VOLTS	CONNECTIONS	LINE LEADS
240		H1, H2, H3
228		H4, H5, H6
216		H7, H8, H9
208Y/120		X0, X1, X2, X3

Diagram #13

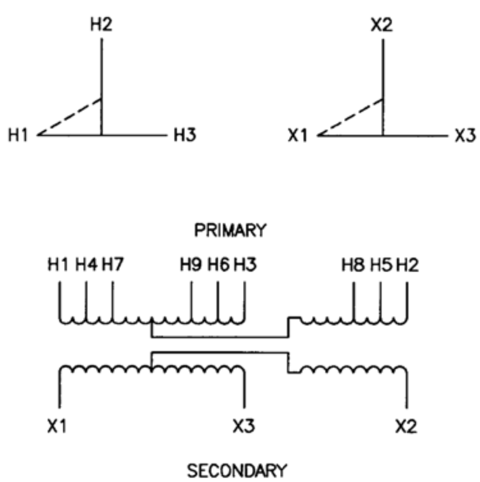
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
480Δ	208Y/120	2-5% FCBN



VOLTS	CONNECTIONS	LINE LEADS
480		H1, H2, H3
456		H4, H5, H6
432		H7, H8, H9
208Y/120		X0, X1, X2, X3

Diagram #14

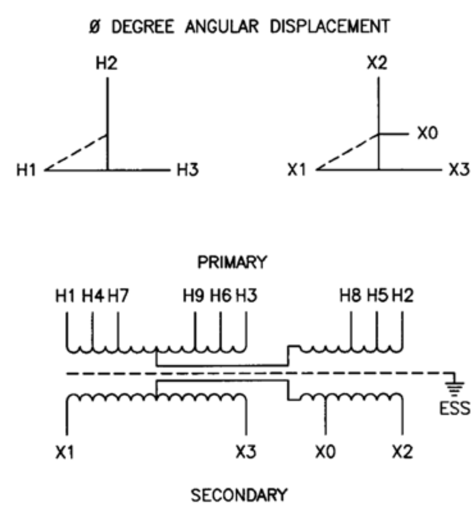
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
480Δ	240Δ	2-5% FCBN



VOLTS	CONNECTIONS	LINE LEADS
480		H1, H2, H3
456		H4, H5, H6
432		H7, H8, H9
240		X1, X2, X3

Diagram #15

PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
480Δ	208Y/120	2-5% FCBN

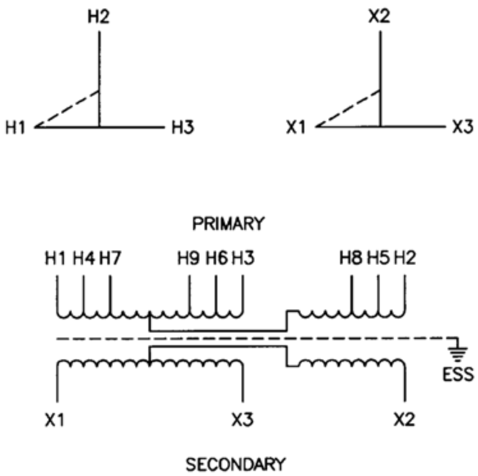


VOLTS	CONNECTIONS	LINE LEADS
480		H1, H2, H3
456		H4, H5, H6
432		H7, H8, H9
208Y/120		X0, X1, X2, X3

Wiring Diagrams

Diagram #16

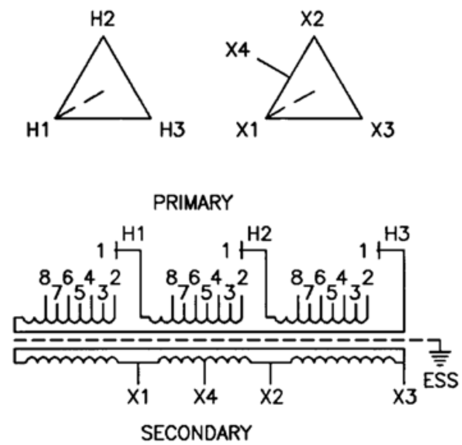
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
480Δ	240	2-5% FCBN



VOLTS	CONNECTIONS	LINE LEADS
480		H1, H2, H3
456		H4, H5, H6
432		H7, H8, H9
240		X1, X2, X3

Diagram #17

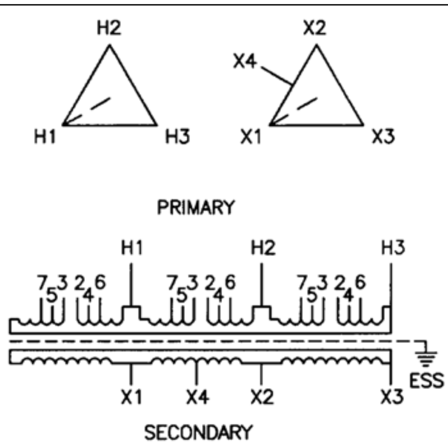
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
480Δ	240Δ/120 LT	2-2 1/2% FCAN & 4-2 1/2% FCBN



VOLTS	CONNECTIONS	LINE LEADS
504	1 TO 2	H1, H2, H3
492	1 TO 3	H1, H2, H3
480	1 TO 4	H1, H2, H3
468	1 TO 5	H1, H2, H3
456	1 TO 6	H1, H2, H3
444	1 TO 7	H1, H2, H3
432	1 TO 8	H1, H2, H3
240		X1, X2, X3

Diagram #17A

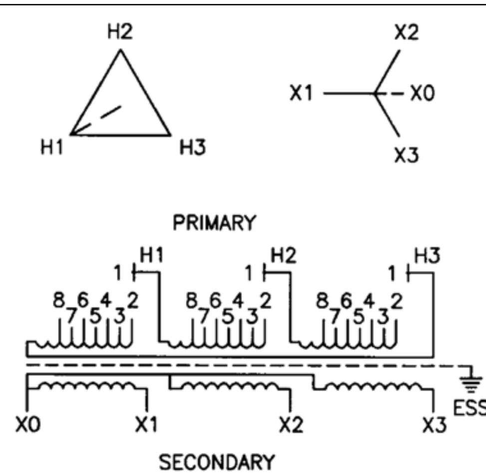
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
480Δ	240Δ/120 LT	2-2 1/2% FCAN & 4-2 1/2% FCBN



VOLTS	CONNECTIONS	LINE LEADS
504	2 TO 3	H1, H2, H3
492	2 TO 5	H1, H2, H3
480	3 TO 4	H1, H2, H3
468	4 TO 5	H1, H2, H3
456	5 TO 6	H1, H2, H3
444	4 TO 7	H1, H2, H3
432	6 TO 7	H1, H2, H3
240		X1, X2, X3

Diagram #18

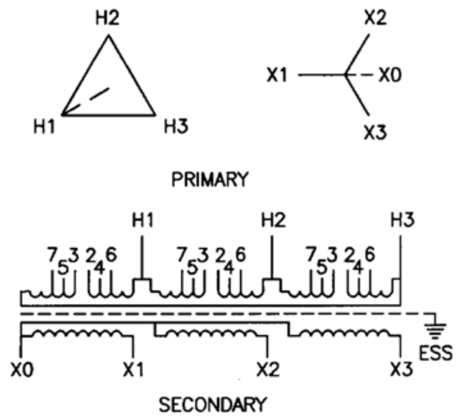
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
480Δ	208Y/120	2-2 1/2% FCAN & 4-2 1/2% FCBN



VOLTS	CONNECTIONS	LINE LEADS
504	1 TO 2	H1, H2, H3
492	1 TO 3	H1, H2, H3
480	1 TO 4	H1, H2, H3
468	1 TO 5	H1, H2, H3
456	1 TO 6	H1, H2, H3
444	1 TO 7	H1, H2, H3
432	1 TO 8	H1, H2, H3
208Y/120		X0, X1, X2, X3

Diagram #18A - 18B

PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
480Δ	208Y/120	(A) 2-2 1/2% FCAN & 4-2 1/2% FCBN (B) 2-3% FCAN & 2-3% FCBN

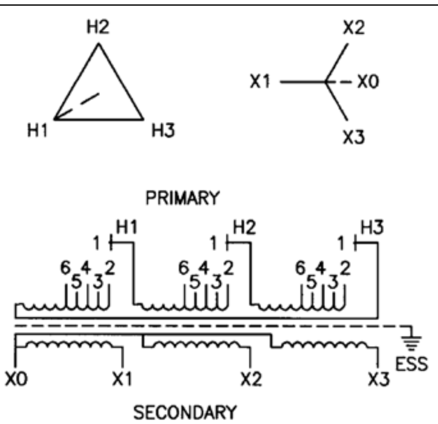


VOLTS	(A) CONNECTIONS	LINE LEADS
504	2 TO 3	H1, H2, H3
492	2 TO 5	H1, H2, H3
480	3 TO 4	H1, H2, H3
468	4 TO 5	H1, H2, H3
456	5 TO 6	H1, H2, H3
444	4 TO 7	H1, H2, H3
432	6 TO 7	H1, H2, H3
208Y/120		X0, X1, X2, X3

VOLTS	(B) CONNECTIONS	LINE LEADS
509	2 TO 3	H1, H2, H3
494	2 TO 5	H1, H2, H3
480	3 TO 4	H1, H2, H3
466	4 TO 5	H1, H2, H3
451	5 TO 6	H1, H2, H3
208Y/120		X0, X1, X2, X3

Diagram #19

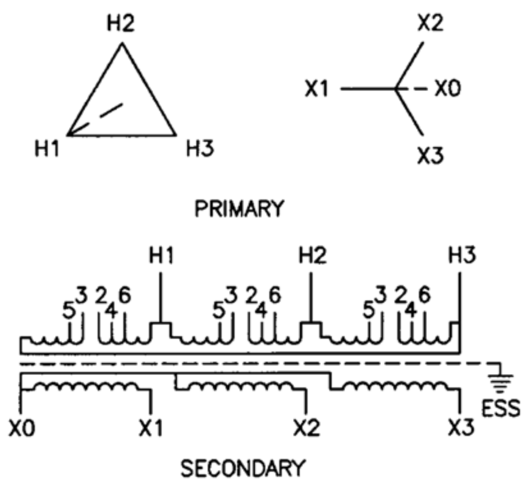
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
208Δ	208Y/120	2-2 1/2% FCAN & 4-2 1/2% FCBN



VOLTS	CONNECTIONS	LINE LEADS
218	1 TO 2	H1, H2, H3
213	1 TO 3	H1, H2, H3
208	1 TO 4	H1, H2, H3
203	1 TO 5	H1, H2, H3
198	1 TO 6	H1, H2, H3
208Y/120		X0, X1, X2, X3

Diagram #19A - 19E

PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
208Δ	208Y/120	(A) 2-2 1/2% FCAN & 4-2 1/2% FCBN (B) 2-3% FCAN & 2-3% FCBN (C) 2-3 1/2% FCAN & 2-3 1/2% FCBN (D) 1-4% FCAN & 1-4% FBCN (E) 1-5% FCAN & 1-5% FCBN



VOLTS	(A) CONNECTIONS	LINE LEADS
218	2 TO 3	H1, H2, H3
213	2 TO 5	H1, H2, H3
208	3 TO 4	H1, H2, H3
203	4 TO 5	H1, H2, H3
198	5 TO 6	H1, H2, H3
208Y/120		X0, X1, X2, X3

VOLTS	(B) CONNECTIONS	LINE LEADS
220	2 TO 3	H1, H2, H3
214	2 TO 5	H1, H2, H3
208	3 TO 4	H1, H2, H3
202	4 TO 5	H1, H2, H3
196	5 TO 6	H1, H2, H3
208Y/120		X0, X1, X2, X3

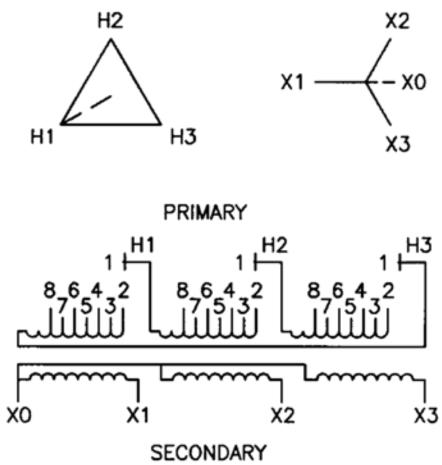
VOLTS	(C) CONNECTIONS	LINE LEADS
223	2 TO 3	H1, H2, H3
215	2 TO 5	H1, H2, H3
208	3 TO 4	H1, H2, H3
201	4 TO 5	H1, H2, H3
193	5 TO 6	H1, H2, H3
208Y/120		X0, X1, X2, X3

VOLTS	(D) CONNECTIONS	LINE LEADS
216	2 TO 3	H1, H2, H3
208	3 TO 4	H1, H2, H3
200	4 TO 5	H1, H2, H3
208Y/120		X0, X1, X2, X3

VOLTS	(E) CONNECTIONS	LINE LEADS
218	2 TO 3	H1, H2, H3
208	3 TO 4	H1, H2, H3
198	4 TO 5	H1, H2, H3
208Y/120		X0, X1, X2, X3

Diagram #20

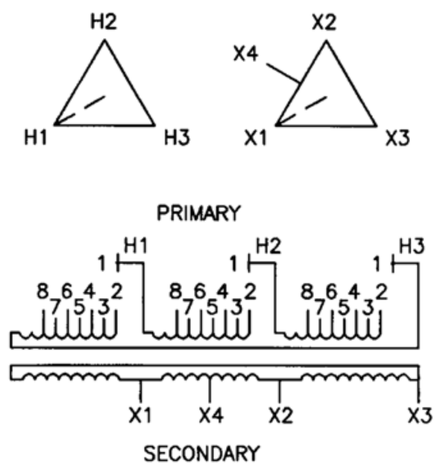
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
480Δ	480Y/277	2-2 1/2% FCAN & 4-2 1/2% FCBN



VOLTS	CONNECTIONS	LINE LEADS
504	1 TO 2	H1, H2, H3
492	1 TO 3	H1, H2, H3
480	1 TO 4	H1, H2, H3
468	1 TO 5	H1, H2, H3
456	1 TO 6	H1, H2, H3
444	1 TO 7	H1, H2, H3
432	1 TO 8	H1, H2, H3
408Y/277		X0, X1, X2, X3

Diagram #21

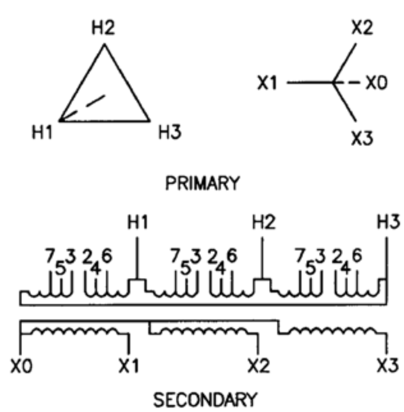
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
480Δ	240Δ/120 LT	2-2 1/2% FCAN & 4-2 1/2% FCBN



VOLTS	CONNECTIONS	LINE LEADS
504	1 TO 2	H1, H2, H3
492	1 TO 3	H1, H2, H3
480	1 TO 4	H1, H2, H3
468	1 TO 5	H1, H2, H3
456	1 TO 6	H1, H2, H3
444	1 TO 7	H1, H2, H3
432	1 TO 8	H1, H2, H3
240		X1, X2, X3

Diagram #20A

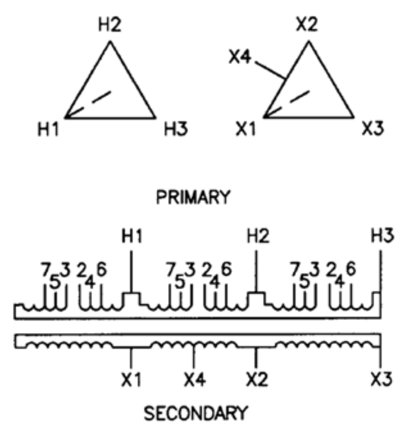
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
480Δ	480Y/277	2-2 1/2% FCAN & 4-2 1/2% FCBN



VOLTS	CONNECTIONS	LINE LEADS
504	2 TO 3	H1, H2, H3
492	2 TO 5	H1, H2, H3
480	3 TO 4	H1, H2, H3
468	4 TO 5	H1, H2, H3
456	5 TO 6	H1, H2, H3
444	4 TO 7	H1, H2, H3
432	6 TO 7	H1, H2, H3
480Y/277		X0, X1, X2, X3

Diagram #21A

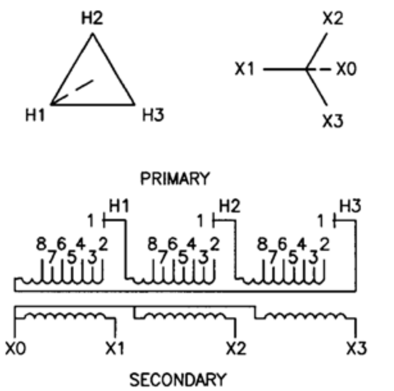
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
480Δ	240Δ/120 LT	2-2 1/2% FCAN & 4-2 1/2% FCBN



VOLTS	CONNECTIONS	LINE LEADS
504	2 TO 3	H1, H2, H3
492	2 TO 5	H1, H2, H3
480	3 TO 4	H1, H2, H3
468	4 TO 5	H1, H2, H3
456	5 TO 6	H1, H2, H3
444	4 TO 7	H1, H2, H3
432	6 TO 7	H1, H2, H3
240		X1, X2, X3

Diagram #22

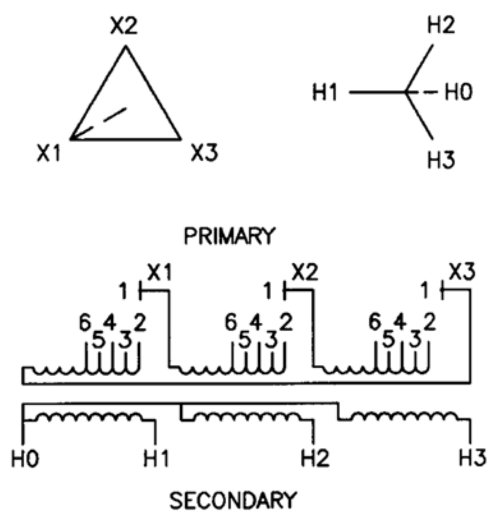
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
480Δ	208Y/120	2-2 1/2% FCAN & 4-2 1/2% FCBN



VOLTS	CONNECTIONS	LINE LEADS
504	1 TO 2	H1, H2, H3
492	1 TO 3	H1, H2, H3
480	1 TO 4	H1, H2, H3
468	1 TO 5	H1, H2, H3
456	1 TO 6	H1, H2, H3
444	1 TO 7	H1, H2, H3
432	1 TO 8	H1, H2, H3
208Y/120		X0, X1, X2, X3

Diagram #23

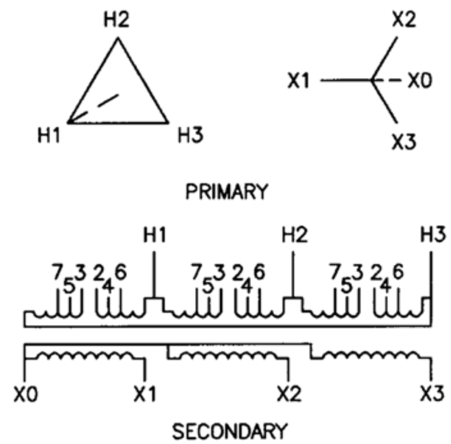
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
208Δ	480Y/277	2-2 1/2% FCAN & 2-2 1/2% FCBN



VOLTS	CONNECTIONS	LINE LEADS
218	1 TO 2	X1, X2, X3
213	1 TO 3	X1, X2, X3
208	1 TO 4	X1, X2, X3
203	1 TO 5	X1, X2, X3
198	1 TO 6	X1, X2, X3
480Y/277		H0, H1, H2, H3

Diagram #22A - 22B

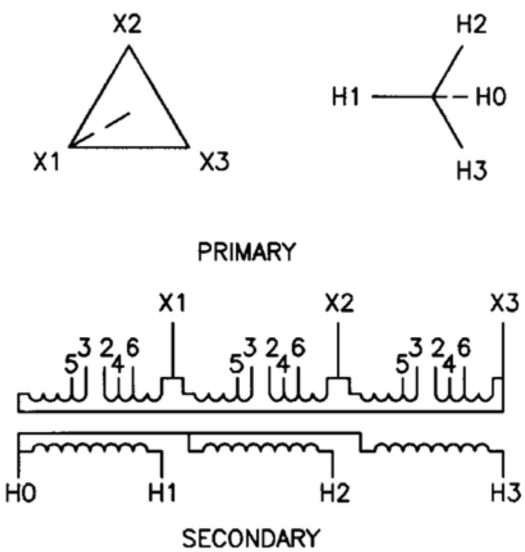
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
480Δ	208Y/120	(A) 2-2 1/2% FCAN & 4-2 1/2% FCBN (B) 2-3% FCAN & 2-3% FCBN



	(A)	
VOLTS	CONNECTIONS	LINE LEADS
504	2 TO 3	H1, H2, H3
492	2 TO 5	H1, H2, H3
480	3 TO 4	H1, H2, H3
468	4 TO 5	H1, H2, H3
456	5 TO 6	H1, H2, H3
444	4 TO 7	H1, H2, H3
432	6 TO 7	H1, H2, H3
208Y/120		X0, X1, X2, X3
	(B)	
VOLTS	CONNECTIONS	LINE LEADS
509	2 TO 3	H1, H2, H3
494	2 TO 5	H1, H2, H3
480	3 TO 4	H1, H2, H3
466	4 TO 5	H1, H2, H3
451	5 TO 6	H1, H2, H3
208Y/120		X0, X1, X2, X3

Diagram #23A-23E

PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
208Δ	480Y/277	(A) 2-2 1/2% FCAN & 2-2 1/2% FCBN (B) 2-3% FCAN & 2-3% FCBN (C) 2-3 1/2% FCAN & 2-3 1/2% FCBN (D) 1-4% FCAN & 1-4% FCBN (E) 1-5% FCAN & 1-5% FCBN



(A)

VOLTS	CONNECTIONS	LINE LEADS
218	2 TO 3	X1, X2, X3
213	2 TO 5	X1, X2, X3
208	3 TO 4	X1, X2, X3
203	4 TO 5	X1, X2, X3
198	5 TO 6	X1, X2, X3
480Y/277		H0, H1, H2, H3

(B)

VOLTS	CONNECTIONS	LINE LEADS
220	2 TO 3	X1, X2, X3
214	2 TO 5	X1, X2, X3
208	3 TO 4	X1, X2, X3
202	4 TO 5	X1, X2, X3
196	5 TO 6	X1, X2, X3
480Y/277		H0, H1, H2, H3

(C)

VOLTS	CONNECTIONS	LINE LEADS
223	2 TO 3	X1, X2, X3
215	2 TO 5	X1, X2, X3
208	3 TO 4	X1, X2, X3
201	4 TO 5	X1, X2, X3
193	5 TO 6	X1, X2, X3
480Y/277		H0, H1, H2, H3

(D)

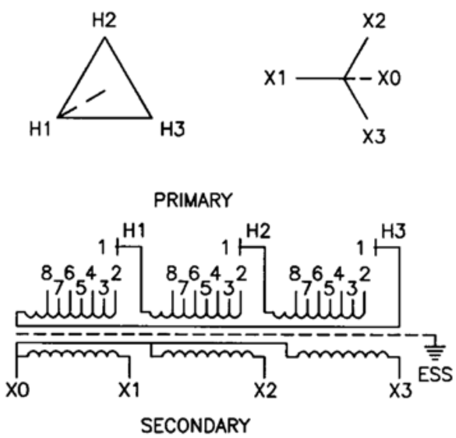
VOLTS	CONNECTIONS	LINE LEADS
216	2 TO 3	X1, X2, X3
208	3 TO 4	X1, X2, X3
200	4 TO 5	X1, X2, X3
480Y/277		H0, H1, H2, H3

(E)

VOLTS	CONNECTIONS	LINE LEADS
218	2 TO 3	X1, X2, X3
208	3 TO 4	X1, X2, X3
198	4 TO 5	X1, X2, X3
480Y/277		H0, H1, H2, H3

Diagram #24

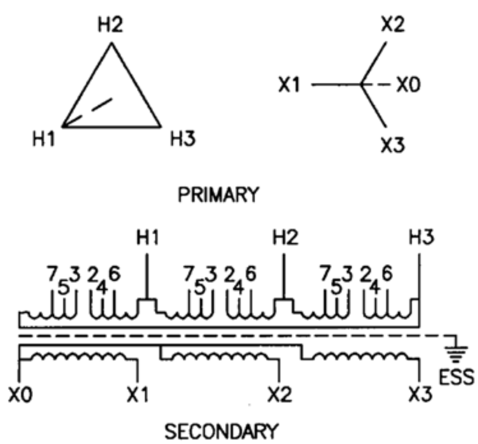
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
600Δ	208Y/120	2-2 1/2% FCAN & 4-2 1/2% FCBN



VOLTS	CONNECTIONS	LINE LEADS
630	1 TO 2	H1, H2, H3
615	1 TO 3	H1, H2, H3
600	1 TO 4	H1, H2, H3
585	1 TO 5	H1, H2, H3
570	1 TO 6	H1, H2, H3
555	1 TO 7	H1, H2, H3
540	1 TO 8	H1, H2, H3
208Y/120		X0, X1, X2, X3

Diagram #24A

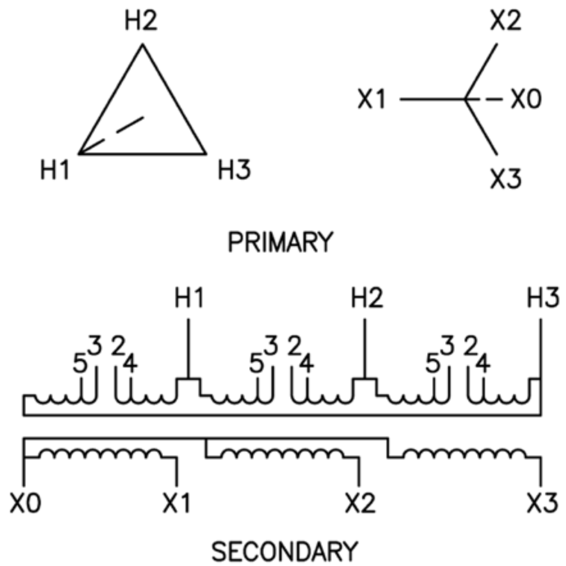
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
600Δ	208Y/120	2-2 1/2% FCAN & 4-2 1/2% FCBN



VOLTS	CONNECTIONS	LINE LEADS
630	2 TO 3	H1, H2, H3
615	2 TO 5	H1, H2, H3
600	3 TO 4	H1, H2, H3
585	4 TO 5	H1, H2, H3
570	5 TO 6	H1, H2, H3
555	4 TO 7	H1, H2, H3
540	6 TO 7	H1, H2, H3
208Y/120		X0, X1, X2, X3

Wiring Diagrams

Diagram #25



Catalog Numbers AEMD, AFMD, AHMD

Volts	Connections	Line Leads
242	2 TO 3	H1, H2, H3
230	3 TO 4	H1, H2, H3
219	4 TO 5	H1, H2, H3
Secondary*		X0, X1, X2, X3

Catalog Numbers CEMD, CFMD, CHMD

Volts	Connections	Line Leads
483	2 TO 3	H1, H2, H3
460	3 TO 4	H1, H2, H3
437	4 TO 5	H1, H2, H3
Secondary*		X0, X1, X2, X3

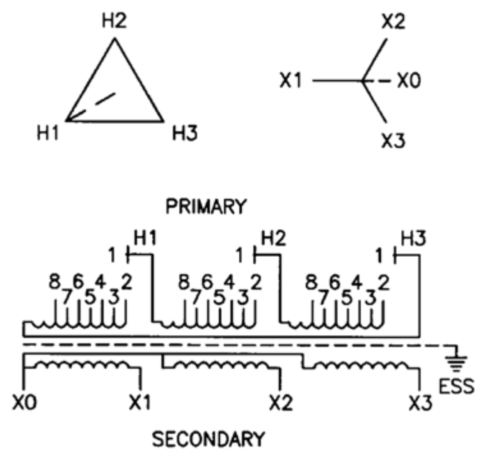
Catalog Numbers DEMD, DFMD, DHMD

Volts	Connections	Line Leads
604	2 TO 3	H1, H2, H3
575	3 TO 4	H1, H2, H3
546	4 TO 5	H1, H2, H3
Secondary*		X0, X1, X2, X3

**Secondary voltages in accordance with catalog number.*

Diagram #26

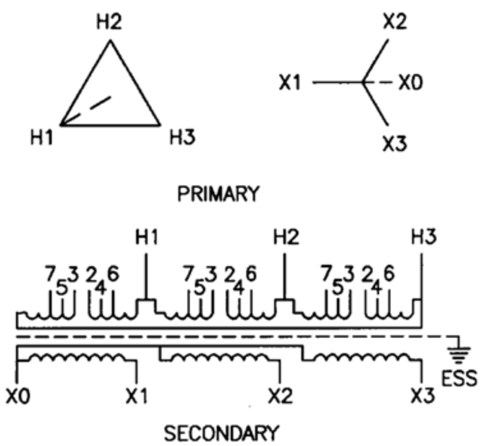
PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
240Δ	208Y/120	2-2 1/2% FCAN & 4-2 1/2% FCBN



VOLTS	CONNECTIONS	LINE LEADS
252	1 TO 2	H1, H2, H3
246	1 TO 3	H1, H2, H3
240	1 TO 4	H1, H2, H3
234	1 TO 5	H1, H2, H3
228	1 TO 6	H1, H2, H3
222	1 TO 7	H1, H2, H3
216	1 TO 8	H1, H2, H3
208Y/120		X0, X1, X2, X3

Diagram #26A - 26D

PRIMARY VOLTAGE	SECONDARY VOLTAGE	TAPS
240Δ	208Y/120	(A) 2-2 1/2% FCAN & 4-2 1/2% FCBN (B) 2-3% FCAN & 2-3% FCBN (C) 2-3 1/2% FCAN & 2-3 1/2% FCBN (D) 1-4% FCAN & 1-4% FBCN



(A)

VOLTS	CONNECTIONS	LINE LEADS
252	2 TO 3	H1, H2, H3
246	2 TO 5	H1, H2, H3
240	3 TO 4	H1, H2, H3
234	4 TO 5	H1, H2, H3
228	5 TO 6	H1, H2, H3
222	4 TO 7	H1, H2, H3
216	6 TO 7	H1, H2, H3
208Y/120		X0, X1, X2, X3

(B)

VOLTS	CONNECTIONS	LINE LEADS
254	2 TO 3	H1, H2, H3
247	2 TO 5	H1, H2, H3
240	3 TO 4	H1, H2, H3
233	4 TO 5	H1, H2, H3
226	5 TO 6	H1, H2, H3
208Y/120		X0, X1, X2, X3

(C)

VOLTS	CONNECTIONS	LINE LEADS
256	2 TO 3	H1, H2, H3
248	2 TO 5	H1, H2, H3
240	3 TO 4	H1, H2, H3
232	4 TO 5	H1, H2, H3
224	5 TO 6	H1, H2, H3
208Y/120		X0, X1, X2, X3

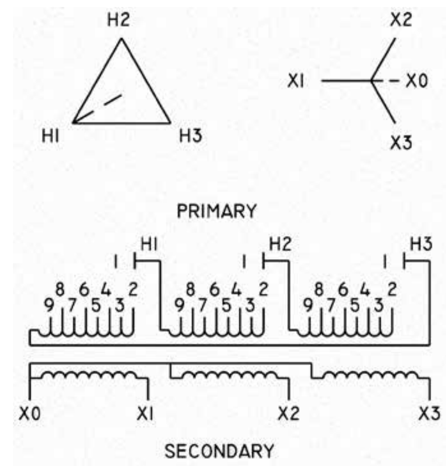
(D)

VOLTS	CONNECTIONS	LINE LEADS
250	2 TO 3	H1, H2, H3
240	3 TO 4	H1, H2, H3
230	4 TO 5	H1, H2, H3
208Y/120		X0, X1, X2, X3

Diagram #27

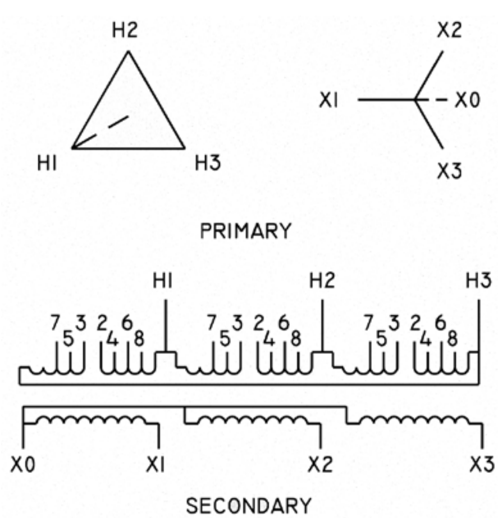
Not Used

Diagram #28



VOLTS	CONNECTIONS	LINE LEADS
504	1 TO 2	H1, H2, H3
492	1 TO 3	H1, H2, H3
480	1 TO 4	H1, H2, H3
468	1 TO 5	H1, H2, H3
456	1 TO 6	H1, H2, H3
440	1 TO 7	H1, H2, H3
432	1 TO 8	H1, H2, H3
420	1 TO 9	H1, H2, H3
220Y/127		X0, X1, X2, X3

Diagram #29



VOLTS	CONNECTIONS	LINE LEADS
504	2 TO 3	H1, H2, H3
492	2 TO 5	H1, H2, H3
480	3 TO 4	H1, H2, H3
468	4 TO 5	H1, H2, H3
456	5 TO 6	H1, H2, H3
440	4 TO 7	H1, H2, H3
428	6 TO 7	H1, H2, H3
420	7 TO 8	H1, H2, H3
220Y/127		X0, X1, X2, X3

High Voltage, General Purpose Transformers

2.4 Thru 15 kV Class
DOE 2010 Efficiency Compliant

FEDERAL PACIFIC™

ISO 9001:2008
REGISTERED

Specifications

Three Phase — 150° C Rise — 2.4KV Thru 15KV

Medium voltage dry-type transformers must comply with the new Department of Energy efficiency regulations published in Table 1.2 of the Federal Register/ Vol. 72, No. 197 / Friday, October 12, 2007. This is the DOE 10 CFR 431 Section 196.

Core & Coil
Wire or strip wound coils on high grade silicon electrical steel cores. Complete assembly isolated from enclosure through vibration dampening pads.

Insulation
220° C insulation system.

Enclosure
Indoor ventilated heavy gauge steel enclosure with removable front and rear panels. Arranged for standard floor or platform mounting.

Finish
Electrostatically applied baked light grey polyurethane powder paint.

Terminals
Wiring compartments located behind removable covers with fully sized terminals arranged to accept installer's cable connectors. Flexible grounding strap provided between core and coil assembly and enclosure with stud or ground pad for system ground connection.

Taps
Units provided with full capacity primary taps. (2) @ 2-1/2% FCAN and (2) @ 2-1/2% FCBN.

Nameplate
Diagrammatic nameplate includes all rating data and provides wiring diagram with connection point identification.

Standards
ANSI - C57.12
NEMA ST-20

Sound Levels
Transformers meet the maximum sound level requirements established by IEEE as follows:

10- 50	KVA	45 db
51- 150	KVA	50 db
151- 300	KVA	55 db
301- 500	KVA	60 db
501- 700	KVA	62 db
701-1000	KVA	64 db
1001-1500	KVA	65 db

Style A

Style B

Catalog Number Selection - High Voltage General Purpose (HVGP)

USS Approximate Dimensions and Weights - Indoor Only (DOE 2010 Efficiency Compliant)

(Basic Design without any special features or listings.)

Three Phase — 150° C Rise — 2.4 KV, 5 KV, 7.2 KV, 8.6 KV and 15 KV

Table I (2.4 KV and 5 KV Class)		
KVA	**Catalog Number[1]**	**Enclosure Style**
15	GT ( ) S15H	A
30	GT ( ) S30H	A
45	GT ( ) S45H	A
75	GT ( ) S75H	A
112	GT ( ) S112H	A
150	GT ( ) S150H	A
225	GT ( ) S225H	A
300	GT ( ) S300H	A
500	GT ( ) S500H	A
750	GT ( ) S750H	B
1000*	GT ( ) S1000H	B
1500*	GT ( ) S1500H	B

For dimensions and weights see catalog page 78.

Table I Voltage Codes		
2.4KV Class - 20KV BIL		
Primary	Secondary	Code
2400 Delta	240 Delta	A2
	480 Delta	A3
	208Y/120	A4
	480Y/277	A5
5KV Class - 30KV BIL		
Primary	Secondary	Code
4160 Delta	240 Delta	B2
	480 Delta	B3
	208Y/120	B4
	480Y/277	B5
4800 Delta	240 Delta	C2
	480 Delta	C3
	208Y/120	C4
	480Y/277	C5

Table II (7.2 KV, 8.6 KV and 15 KV Class)		
KVA	**Catalog Number[1]**	**Enclosure Style**
75	GT ( ) S75H	B
112.5	GT ( ) S112H	B
150	GT ( ) S150H	B
225	GT ( ) S225H	B
300	GT ( ) S300H	B
500	GT ( ) S500H	B
750	GT ( ) S750H	B
1000[2]	GT ( ) S1000H	B
1500[2]	GT ( ) S1500H	B

For dimensions and weights see catalog page 79.

Table II Voltage Codes		
7.2KV Class - 45KV BIL		
Primary	Secondary	Code
7200 Delta	240 Delta	D2
	480 Delta	D3
	208Y/120	D4
	480Y/277	D5
8.6KV Class - 45KV BIL		
Primary	Secondary	Code
8320 Delta	240 Delta	G2
	480 Delta	G3
	208Y/120	G4
	480Y/277	G5
15KV Class - 60KV BIL		
Primary	Secondary	Code
12000 Delta	240 Delta	J2
	480 Delta	J3
	208Y/120	J4
	480Y/277	J5
12470 Delta	240 Delta	K2
	480 Delta	K3
	208Y/120	K4
	480Y/277	K5
13200 Delta	240 Delta	L2
	480 Delta	L3
	208Y/120	L4
	480Y/277	L5
13800 Delta	240 Delta	M2
	480 Delta	M3
	208Y/120	M4
	480Y/277	M5

[1]***NOTE:*** *Insert correct code from Table 1 or Table 2 for required HV and LV voltage combination in the parenthesis to complete catalog number.*

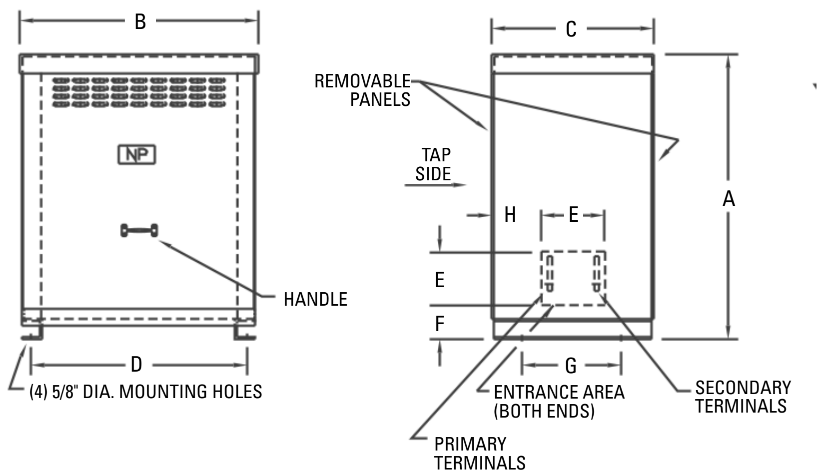
[2] *Dimensions on catalog pages 78 and 79 are for secondary voltage of 480 volts only. Consult factory for other voltages.*

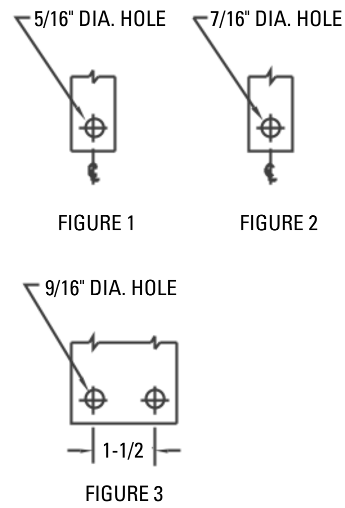
High Voltage General Purpose

Dimensional Data

USS Approximate Dimensions and Weights - Indoor Only (DOE 2010 Efficiency Compliant)

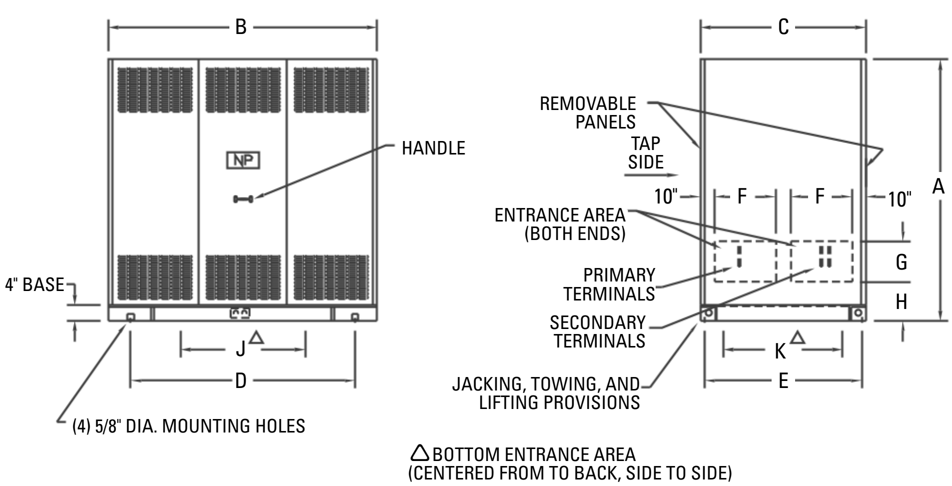
Three Phase — 150° C Rise — 2.4 KV and 5 KV

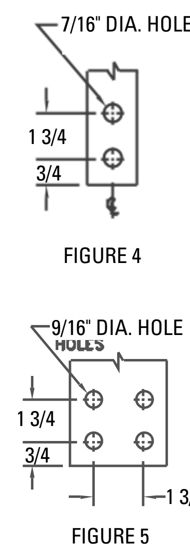




Style A

KVA	Net Wt. in Lbs.	A	B	C	D	E	F	G	H	Terminal Spade	
										Primary	Secondary
15	680	48	36	20	34.125	6	5.75	16.75	7	Fig. 1	Fig. 1
30	715	48	36	20	34.125	6	5.75	16.75	7	Fig. 1	Fig. 1
45	750	48	36	20	34.125	6	5.75	16.75	7	Fig. 1	Fig. 2
75	1050	49	39	23	37.125	8	5.75	19.75	7.5	Fig. 1	Fig. 2
112.5	1540	57	45	26	43.125	10	6.75	22.75	8	Fig. 2	Fig. 2
150	1640	57	45	26	43.125	10	6.75	22.75	8	Fig. 2	Fig. 2
225	2050	59	46.5	30.875	43.25	10	6.75	25	10.437	Fig. 2	Fig. 3
300	2680	65	50	30.875	46.75	10	6.75	25	10.437	Fig. 2	Fig. 3
500	3760	72.75	53.375	36.875	49.625	12	7.5	32	12.437	Fig. 2	Fig. 3





Style B

KVA	Net Wt. in Lbs.	A	B	C	D	E	F	G	H	J	K	Terminal Spade	
												Primary	Secondary
750	5475	90	64	48	54	44.75	12.5	12	4.25	30	39	Fig. 4	Fig. 5
1000*	5725	90	64	48	54	44.75	12.5	12	4.25	30	39	Fig. 4	Fig. 5
1500*	7825	90	72	48	62	44.75	12.5	12	4.25	30	39	Fig. 4	Fig. 5

* *Dimensions for secondary voltage of 480 volts only. Consult factory for other voltages.*

Dimensional Data

USS Approximate Dimensions and Weights - Indoor Only (DOE 2010 Efficiency Compliant)

Three Phase — 150° C Rise — 7.2 kV, 8.6 kV & 15 kV

Notes:

1. Covers and all panels are removable
2. Grounding block (welded to base) (2) 1/2 - 13 tapped holes
3. Lift eyes are a welded integral part of the base

FIGURE 1

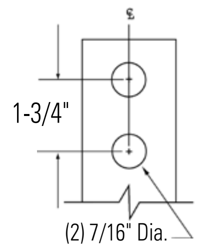
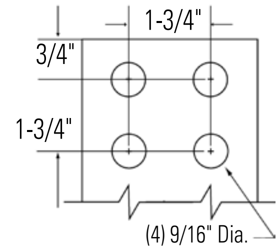


FIGURE 2

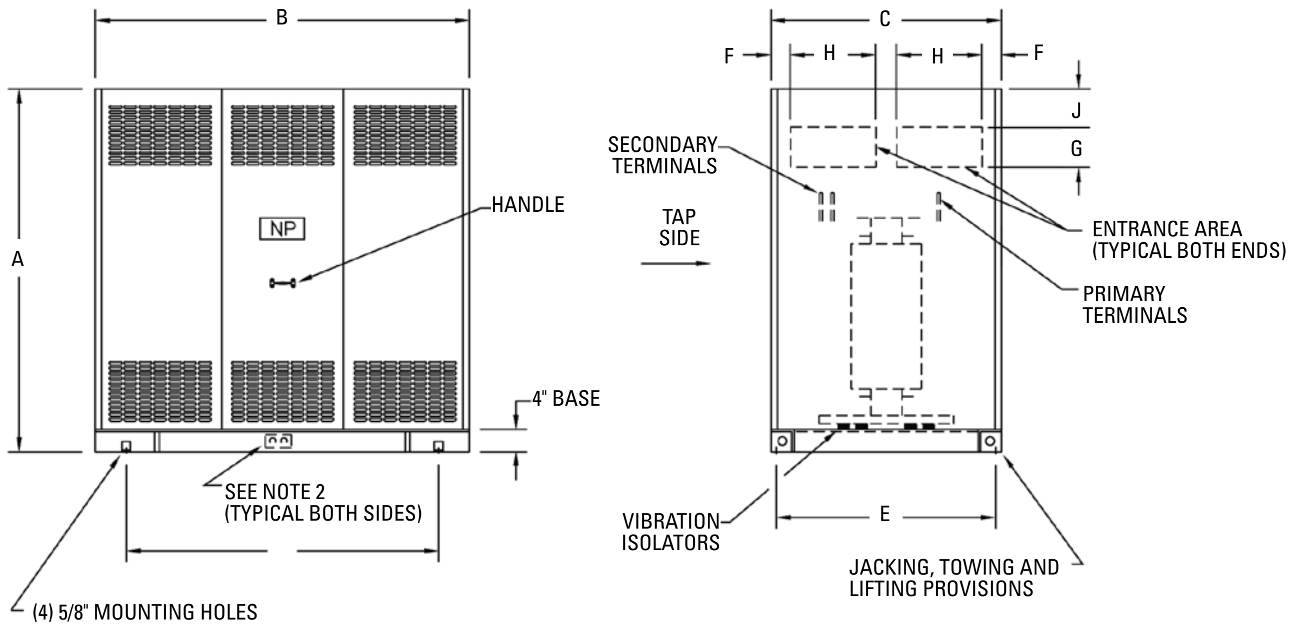


Terminal Material: Tin Plated Aluminum

Terminal Spade Figure

KVA	208V	480V	7.2kV, 8.6kV, 15kV
75	1	1	1
112.5	1	1	1
150	1	1	1
225	2	1	1
300	2	1	1
500	2	1	1
750	2	2	1
1000	—	2	1
1500	—	2	1

Style B



KVA	Net Wt. in Lbs.	A	B	C	D	E	F	G	H	J
75	2525	80	53	48	43	44.75	6	8	16.5	4
112.5	2600	80	64	48	43	44.75	6	8	16.5	4
150	3130	80	64	48	54	44.75	6	8	16.5	4
225	3430	80	64	48	54	44.75	6	8	16.5	4
300	4230	80	72	48	62	44.75	6	8	16.5	4
500	5400	90	72	48	62	44.75	6	8	16.5	4
750	6600	90	78	48	62	44.75	6	8	16.5	4
1000*	7600	90	78	48	68	44.75	6	8	16.5	4
1500*	9900	106.5	86	54	76	50.75	6	8	19.5	4

* *Dimensions for secondary voltage of 480 volts only. Consult factory for other voltages.*

Notes

Unit Substation Transformers

5 and 15 kV Class
DOE 2010 Efficiency Compliant

FEDERAL PACIFIC™

ISO 9001:2008
REGISTERED

General Information

Description

Federal Pacific unit substation transformers are available in a wide variety of types and ratings to provide reliable and versatile electrical distribution.

Medium voltage dry-type transformers must comply with the new Department of Energy efficiency regulations published in Table 1.2 of the Federal Register/Vol. 72, No. 197 / Friday, October 12, 2007. This is the DOE 10 CFR 431 Section 196.

The changing needs and variable load densities of industrial and commercial power systems create the need to locate transformers close to the electrical center of the load — providing flexibility for change and economical distribution of power.

Federal Pacific dry-type transformers are ideally suited for these applications. The ventilated air-cooled construction eliminates the concern for contamination and toxicity of cooling liquids. They do not require the expensive vaults, fluid leakage containment provisions, or fire protection systems needed for liquid filled units to satisfy National Electric Code requirements.

Lower installed costs and minimum maintenance requirements make Federal Pacific Dry-Type Substation Transformers an ideal choice for new or existing installations.

Transformers are available in three phase ratings from 15 KVA to 10000 KVA. All standard primary and secondary voltage ratings are provided to match load requirements to the distribution system.

Units can be arranged for standard direct connection to high voltage and low voltage distribution protective equipment or provided as individual transformers.

Industry Standards

Federal Pacific Unit Substation Transformers are designed and tested in accordance with the following standards:

- IEEE C57.12.01 General Requirements for Distribution, Power and Regulating Transformers.
- IEEE C57.12.91 Standard Test Code for Dry-Type Distribution and Power Transformers.
- NEMA 210 Secondary Unit Substations.
- NEMA ST-20 Dry-Type Transformers for General Applications.
- NEMA TR-27 Commercial, Institutional and Industrial Dry-Type Transformers.
- IEEE 693-2005 Seismic

Tested Performance

A high level of transformer reliability for trouble-free installation and operation, all transformers manufactured by Federal Pacific are tested in accordance with NEMA and IEEE Standards:

Ratio Test is performed on rated voltage connection and tap connections to assure proper turns ratio on all connections.

Polarity Test and phase relation tests are made to ensure proper polarity and marking because of their importance in paralleling or banking two or more transformers.

No-load (excitation) Loss Test determines the losses of a transformer which is excited at rated voltage and frequency, but which is not supplying a load. Transformer excitation loss consists mainly of the iron loss in the transformer core.

Load Loss Test determines the amount of losses in the transformer when carrying full rated load. These losses consist primarily of I^2R losses in the primary and secondary winding and ensure that specifications of the transformer design are met.

Excitation Current Test determines the current necessary to maintain transformer excitation.

Resistance Test is performed on the transformer windings and is used to determine I^2R loss.

Impedance Test is made to insure that transformer design standards are attained.

Dielectric Test (applied and induced potential) checks the insulation and workmanship to demonstrate that the transformer has been designed and manufactured to meet the insulation tests required by the standards.

Applied Potential Tests are made by impressing between windings and between each winding and ground, a low frequency voltage in accordance with the following:

Rated Voltage of Winding, Volts	Test Potential, RMS kV
250	4.0
600	4.0
2500	10.0
5000	12.0
8700	19.0
15000	34.0

Induced Potential Tests call for over-exciting the transformer by applying between the terminals on one winding a voltage of twice the normal voltage developed in the winding for a period of 7200 cycles. Partial Discharge (PD) Test is performed during the induced potential test.

Unit Substation Arrangements

Arrangements

Federal Pacific unit substation transformers meet a wide variety of application requirements with the highest degree of service reliability. Federal Pacific substations are coordinated, engineered electrical centers designed to safely step down distribution voltage to utilization voltage.It usually supplies secondary voltages ranging from 208Y/120 to 600 volts and primary voltages of 2400 to 13800 volts. They typically provide power to industrial plants, office buildings, commercial buildings, public buildings, hospitals and schools. The form, rating, and characteristics of unit substations and their transformers are determined by the design of the electrical distribution system and the requirements of the particular loads and installation conditions.

Incoming Line Air Interrupter Switch

The Type Auto-jet II® air interrupter switch, two position (open-close), three pole with manually operated, stored-energy mechanism provides quick-make, quick-break operation for disconnecting the transformer incoming line. Utilized with power or current limiting fuses, the switch provides safe, fast, and reliable protection for high voltage circuits. The Auto-jet II® switch is rated 600 or 1200 amp continuous, 600 or 1200 amp load-break with a high fault closing capacity of 40,000 amp asymmetrical.

The 1200A switch is available with 61,000 amp asymmetrical rating (optional).

The switch compartment is bolted directly to the high voltage side of the transformer section. Cable entrance can be at top or bottom for either single or loop feed. Fuses, when specified, are located in a compartment under the interrupter switch. A hinged door allows access to fuses and is provided with a mechanical interlock to prevent the door opening unless the switch is in the "open" position. Standard fuses, when supplied, are the current limiting, non-disconnect type. Lightning arresters and key interlocks are optionally available.

Incoming Line Terminal Compartment

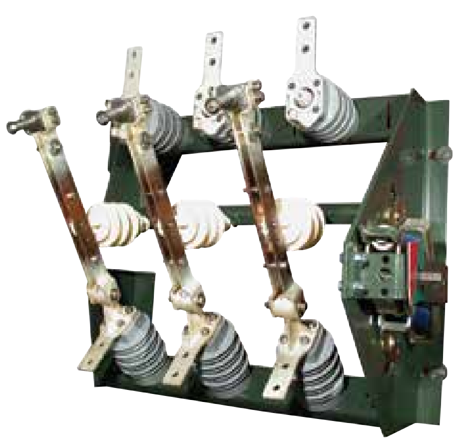
When a disconnect or overcurrent device is not required as an integral part of the lineup, an air-filled terminal compartment (ATC) is bolted directly to the high voltage end of the transformer section. The metal-enclosed ATC terminal compartment matches the height and depth of the transformer section and is provided with bolt-on end panels for accessibility to terminal connections. The compartment can be arranged for single or loop feed with potheads or clamp-type terminals for either top or bottom cable entrance. Lightning arresters can be supplied when required for protection against voltage surges.

Low Voltage Distribution Sections

A complete selection of distribution and protective equipment is available to meet application requirements. Unit substation transformers are arranged for direct connection to a variety of equipment including low voltage drawout switchgear, distribution switchboards, group mounted power panelboards and motor control centers.

For those applications where secondary distribution equipment is not required, an outgoing air-filled terminal compartment (ATC) can be provided for top or bottom cable entrance. The compartment bolts directly to the transformer and has removable end panels for accessibility. Provisions can also be made to accommodate busway.

NEMA 3-R



Auto- jet II® Switch

Features of Typical 15 kV Substation Transformer

1. Round cylindrical coils assure proper ventilation and provide mechanical strength for fault stresses. The units are either barrel wound or disc wound (depending on voltage) using aluminum conductor with insulated coil supports.
2. Core structures are fabricated in a "stepped" configuration from special high-grade, cold rolled, silicon steel. The steel laminations are clamped at the top and bottom to absorb vertical stresses on the core.
3. 220°C insulation systems using Nomex® paper and resin glass laminates provides long operating life and quiet operation. The complete core and coil assembly is impregnated with polyester varnish and oven cured to make the assembly highly resistant to moisture.
4. High dielectric interphase barriers assure positive phase to phase insulating characteristics.
5. High voltage tap connections are easily accessible by removal of front panels. The centrally located taps are changed by moving jumpers between connection points when the transformer is de-energized.
6. Rugged enclosure base with provisions for lifting, jacking, towing, skidding or rolling for installation.
7. Rigidly braced low voltage bus bars arranged for proper electrical connections to the transformer. The low voltage bus is equipped with flexible connectors to the core and coil assembly to reduce transmission of vibration to the connected equipment.
8. Diagrammatic nameplate provides complete rating and connection information.
9. Vibration isolation pads isolate core and coil assembly from the base structure to reduce sound levels.
10. Optional fan cooling equipment to provide an additional 33-1/3% KVA capacity for units with self-cooled ratings of 300 KVA and above. (Provisions for future forced air cooling are provided as standard — including sufficient current-carrying capacity on internal bus bars.) Fans and controls can be installed at the factory or can be shipped for installation at the jobsite.

Core and Coil Assembly

Core Construction

The transformer cores are made of high grade silicon electrical steel laminations with high magnetic permeability. Precision steel cutting machines are used to cut the steel laminations with precise squareness and miter and to be free of burrs.

Laminations are hand stacked to computer generated specifications to assure correct positioning for close fitting joints to minimize noise and core loss. Each lamination has an insulating coating bonded to both sides to minimize eddy-current losses.

The core legs are arranged in a "stepped" configuration to accommodate the coils and to provide maximum cooling and strength. The completed three-leg core assembly is rigidly clamped with steel members to prevent movement and to provide support for the coils.

Coil Construction

Coils are precision wound in a **circular** configuration using aluminum conductor material as standard. Copper conductors can also be provided as an option.

On low voltage where possible, sheet-wound secondary windings are used. The windings are separated by insulation layers and spacers. These sheet windings offer the advantage of virtually eliminating axial short circuit stresses.

Nomex® insulated wire-wound primary windings are placed directly over the secondary windings with a suitable insulating barrier between the coils consisting of spacers and sheet insulation applied to the proper thickness. Primary windings may be random-wound or disc-wound depending upon the design requirements. All coils are adequately braced for full short circuit capability.

Assembly

The completed coil units are placed on the core legs. Top core yokes are put into place and securely clamped. Electrical connections are made using welded aluminum or brazed copper, to ensure reliable service.

Coils may be vacuum pressure impregnated, when specified. After installation of the mounting hardware, the complete core and coil assembly is submersed and impregnated with an insulating varnish. The assembly is completely coated to provide moisture and dirt resistance as well as high dielectric strength. After dipping, the varnish is fully cured in a drying oven.

Completed core and coil assemblies receive a final inspection and testing prior to installation in the enclosure. When installed, vibration isolation pads are provided to isolate the core and coil assembly from the base structure. All structural parts are grounded to prevent induced voltage buildup.

Construction

FP transformers utilize a 220° C insulation system that combines inorganic materials and resins to provide a fire resistant, high dielectric capability. All materials have been thoroughly tested and proven with respect to their stability at required operating temperatures.

The major components of the 220° C system include Nomex® paper for conductor insulation plus resin-glass laminates, silicon rubber and polyester varnish. The combination of materials is specifically chosen to assure long operating life and quiet operations

Nomex® is a Registered Trademark of Dupont Co.

Taps

Primary windings are furnished with full capacity tap connections to provide adjustment to accommodate variations in the incoming high voltage. All units include, as standard, two (2) 2-1/2% taps full capacity above normal (FCAN) and two (2) 2-1/2% taps full capacity below normal (FCBN).

The tap connections are located in a vertical arrangement on the side of each coil. Accessible behind removable covers, the taps can easily be changed by moving jumpers between connection points when the transformer is de-energized.

Complete Core and Coil Assembly

Step-Lap Mitre Core Construction

Step-Lap Mitre Core Construction

Forced Air Cooled System

Forced-Air Cooled System Operation

Unit substation transformers with self-cooled ratings of 300 KVA and above can be supplied with fans and controls to obtain additional KVA capacity. Forced circulation of air correctly applied permits the self-cooled KVA rating of the transformer to be increased by an additional 33-1/3%. (Class FA rating)

The winding transformer monitor is equipped with necessary controls for the operation of the fans:

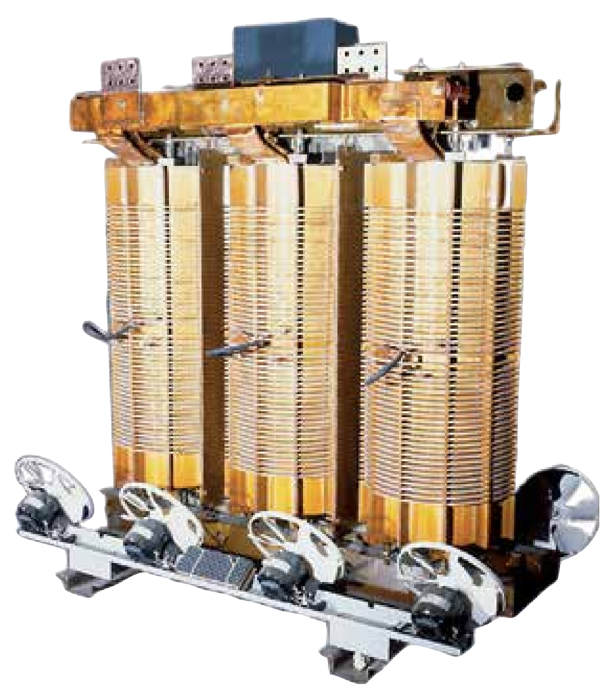
1. Winding temperature indicator
2. Configurable fan exerciser
3. Temperature sensing device
4. Fuses
5. Green light (auxiliary power "On")
6. Amber light (fan operation)
7. Red light (excessive temperature)
8. MODBUS Communication via RS-485
9. Universal iput power 80-380 VAC 50/60 HZ

The winding temperature indicator is furnished with three (3) sets of normally open contacts. Each contact closes as the average winding temperature reaches factory preset temperature values.

Sequence of operation is as follows:

1. When the winding indicator reaches 190° C (based on 150° C average winding rise temperature in a maximum 40° C ambient), the fan relay is energized which closes the fan-relay contact. The fans operate resulting in 33-1/3% additional KVA capacity.
2. Should the temperature increase to 200° C, the red light and remote alarm (if connected) operate.
3. A further increase in winding temperature to 210° C will operate contacts that can be used to trip the primary or secondary main breaker.

Transformer Monitor



Core and Coil Assembly 15 KV Class, Fan Cooled

Rating Information

Three Phase Transformer Standard Ratings

High Voltage Ratings (Delta) 60 Hz	High Voltage Taps (Volts at Rated KVA) +5%	+2-1/2%	-2-1/2%	-5%
2400	2520	2460	2340	2280
4160	4368	4264	4056	3952
4800	5040	4920	4680	4560
6900	7245	7073	6728	6555
7200	7560	7380	7020	6840
12000	12600	12300	11700	11400
12470	13094	12782	12158	11847
13200	13860	13530	12870	12540
13800	14490	14145	13455	13110

Low Voltage Ratings 60 Hz			
208Y/120 240		480Y/277 480\600\	
KVA Ratings			
Self Cooled (AA)	Forced Air Cooled (FA)	Self Cooled (AA)	Forced Air Cooled (FA)
112-1/2	—	112-1/2	—
150	—	150	—
225	—	225	—
300	300/400	300	300/400
500	500/667	500	500/667
750	750/1000	750	750/1000
1000	1000/1333	1000	1000/1333
		1500	1500/2000
		2000	2000/2667
		2500	2500/3333
		3000	3000/4000

BIL (Basic Insulation Level

Designs can be furnished to meet individual system requirements. Federal Pacific construction incorporates high short-circuit capabilities with the following BIL ratings:

Primary Voltage Class	IEEE Standard BIL	FP Standard BIL	FP Hi-Pulse BIL
2.5 KV	20 KV	20 KV	30
5.0 KV	30 KV	30 KV	45
7.2 KV	45 KV	45 KV	95
15 KV	60 KV	60 KV	95

The standard rating for 15 kV class dry-type transformers is 60 kV BIL.

Federal Pacific designed and developed the Hi-Pulse Ventilated Dry-Type Transformer which has a basic insulation level of 95 kV BIL. The application of a Hi-Pulse Transformer in a 15 kV installation eliminates the potential weak-link and provides 58% additional surge protection over the conventional 60 kV BIL dry-type transformer. The 95 kV BIL ventilated dry-type transformer provides a fully rated, air insulated 15 kV installation

Transformer Nominal Impedance and Sound Levels

KVA	Percent Impedance - 3 Phase		Audible Sound Levels (db)	
	5 kV Class (30 kV BIL)	15kV Class (60 kV BIL)	Self Cooled (AA) Average	Forced Air Cooled (FA) Average
112-1/2	Consult Factory	Consult Factory	50	—
150	Consult Factory	Consult Factory	50	—
225	Consult Factory	Consult Factory	55	—
300	5.00	5.00	55	67
500	5.75	5.75	60	67
750	5.75	5.75	64	67
1000	5.75	5.75	64	67
1500	5.75	5.75	65	68
2000	5.75	5.75	66	69
2500	5.75	5.75	68	71
3000	5.75	5.75	68	71

Temperature Rise

The rated KVA of a transformer is the output based on average winding temperature rise above an average 30° C ambient not to esceed 40° C during a one (1) hour period. Standard transformers are designed to operate with a 150° C temperature rise.

Designs are optionally available with either 80° C or 115° C rise that can provide long life performance per IEEE C57.96 with lower losses and minimize operating costs on systems with a continuous high loading operation.

Full Load Current Ratings

Three Phase Self-Cooled Transformers

KVA Rating	Primary Full Load Current (Amperes)								
	2400V	4160V	4800V	7200V	12000V	12470V	13200V	13800V	14400V
112.5	27.1	15.6	13.5	9.0	5.4	5.2	4.9	4.7	4.5
150	36.1	20.8	18.0	12.0	7.2	6.9	6.6	6.3	6.0
225	54.1	31.2	27.1	18.1	10.8	10.4	9.8	9.4	9.0
300	72.2	41.6	36.1	24.1	14.4	13.9	13.1	12.6	12.0
500	120	69.4	60.1	40.1	24.1	23.1	21.9	20.9	20.0
750	180	104	90.2	60.1	36.1	34.7	32.8	31.4	30.1
1000	241	139	120	80.2	48.1	46.3	43.7	41.8	40.1
1500	361	208	180	120	72.2	69.4	65.6	62.8	60.1
2000	481	278	241	160	96.2	92.6	87.5	83.7	80.2
2500	601	347	301	200	120	116	109	105	100
3000	722	416	361	241	144	139	131	126	120

KVA Rating	Secondary Full Load Current (Amperes)			
	208V	240V	480V	600V
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
750	2082	1804	902	722
1000	2776	2406	1203	962
1500	4164	3608	1804	1443
2000	5551	4811	2406	1925
2500	6939	6014	3007	2406
3000	8327	7217	3608	2887

$$\text{Three-Phase KVA} = \frac{\text{Volts x Load Amperes x 1.7321}}{1000}$$

Primary Switch Ratings

Type Auto-jet II® Load Interrupter Switch Ratings

Voltage Ratings			Current Ratings				
Maximum Design kV	Withstand 60 Hz kV	Withstand BIL kV	Continuous Amps	Interrupting Amps	Fault Closing Asym. Amps	Momentary Asym. Amps	3-Second Short-Time Sym. Amps
5.0	19	60	600	600	40,000 61,000	40,000 61,000	25,000 38,000
15.0	36	95	600	600	40,000 61,000	40,000 61,000	25,000 38,000

Suggested Minimum Current Limiting Fuse Ratings for Three Phase Self-Cooled Dry-Type Transformers*

KVA	4160 V		7200 V		12470 V		13200 V		13800 V	
	G.E.	Cutler Hammer	G.E.	Cutler Hammer	G.E.	Cutler Hammer	G.E.	Cutler Hammer	G.E.	Cutler Hammer
112-1/2	40E	25E	30E	15E	20E	8E	20E	8E	20E	8E
150	40E	30E	40E	18E	20E	10E	20E	10E	20E	10E
225	65E	45E	50E	25E	30E	15E	30E	15E	30E	15E
300	80E	60E	65E	35E	40E	25E	40E	20E	40E	18E
500	125E	100E	100E	60E	65E	40E	65E	30E	65E	30E
750	150E	150E	125E	100E	80E	60E	80E	45E	80E	45E
1000	200E	200E	150E	125E	100E	75E	100E	65E	100E	60E
1500	300E	300E	200E	200E	125E	100E	125E	100E	125E	100E
2000	375	400X	—	250E	150E	150E	150E	150E	125E	125X
2500	400	600E	—	—	175E	175E	175E	175E	150E	175E

*Fuse selections are based on recommendations of the listed fuse manufacturers and are minimum sizes suggested to allow for transformer magnetizing current inrush. Ratings are shown for the following types:

General Electric Co. — Type EJ-1 and EJO-1

Cutler-Hammer — Type CLE

Application Guide - Nominal System Suggested Arrester Rating†

Line-to-Line Voltage	4 Wire Multi-Grounded Neutral System	3 Wire Delta or WYE[1] Low Impedance Ground	3 Wire Delta or WYE[1] High Impedance or Ungrounded
4160	3	6	6
4800	6	6	6
6640	6	6	9
7200	6	9	9
7620	6	9	9
8320	6	9	10
9960	9	9	12
11000	9	10	12
11500	9	10	15
12000	9	12	15
12470	9	12	15
13200	10	12	15
13800	10	12	18
14400	12	15	18
17250	15	15	21
19750	15	18	21
20780	15	18	24
22860	18	21	27
24940	18	24	30
26400	21	24	30
27700	21	27	30
34500	27	30	36
36200	27	36	—

[1]Application of specified rating may be permissible for ungrounded or resistance grounded systems where a single phase ground may be tolerated for a period of time not to exceed the arrester's power frequency overvoltage capability.

† Source: GE Buylog®, January 2008. Used by permission.

Approximate Dimensions and Weights - Indoor Only

USS Approximate Dimensions and Weights - Indoor Only (DOE 2010 Efficiency Compliant)

Data based on standard aluminum wound indoor transformer, having 480 volts low voltage. Contact factory for dimensions on NEMA 3R outdoor units. Contact factory for depth dimensions on transformers having 208 volts low voltage.

150° C Rise (Indoor Only)

KVA	5kV - 30kV BIL H (in.)	W (in.)	D (in.)	Wt. (lbs.)
112.5	90	72	48	2190
150	90	72	48	2375
225	90	72	48	2500
300	90	72	48	2875
500	90	78	48	3325
750	90	78	48	5000
1000	90	78	48	6125
1500	90	90	48	7550
2000	90	102	58	9940
2500	90	102	58	10430
3000	102	112	58	13750

KVA	15kV- 60kV BIL H (in.)	W (in.)	D (in.)	Wt. (lbs.)
112.5	90	78	48	2450
150	90	78	48	2500
225	90	78	48	2925
300	90	78	48	3700
500	90	90	58	5040
750	90	90	58	6290
1000	90	90	58	7540
1500	90	102	58	8810
2000	102	112	58	11400
2500	102	112	58	12000
3000	110	120	58	14950

115° C Rise (Indoor Only)

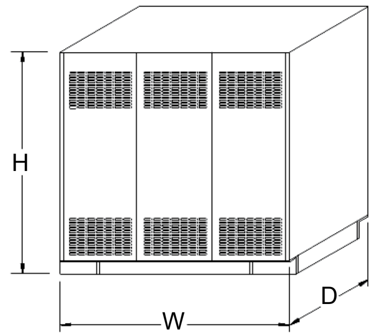
KVA	5kV - 30kV BIL H (in.)	W (in.)	D (in.)	Wt. (lbs.)
112.5	90	72	48	2245
150	90	72	48	2425
225	90	72	48	2550
300	90	78	48	2950
500	90	78	48	3450
750	90	78	48	5050
1000	90	78	48	6150
1500	90	90	48	7615
2000	90	102	58	10000
2500	102	102	58	11275
3000	102	112	58	13900

KVA	15kV- 60kV BIL H (in.)	W (in.)	D (in.)	Wt. (lbs.)
112.5	90	78	48	2690
150	90	78	48	2750
225	90	78	48	3125
300	90	78	48	3950
500	90	90	58	5200
750	90	90	58	6450
1000	90	90	58	7700
1500	90	102	58	8920
2000	102	112	58	11700
2500	110	112	58	13580
3000	110	120	58	16250

80° C Rise (Indoor Only)

KVA	5kV - 30kV BIL H (in.)	W (in.)	D (in.)	Wt. (lbs.)
112.5	90	72	48	2275
150	90	72	48	2450
225	90	72	48	2575
300	90	78	48	3000
500	90	78	48	3500
750	90	78	48	5100
1000	90	78	48	6175
1500	90	90	48	8420
2000	102	102	58	10025
2500	102	112	58	12125
3000	102	112	58	14125

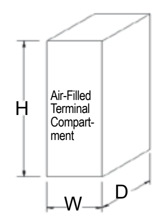
KVA	15kV- 60kV BIL H (in.)	W (in.)	D (in.)	Wt. (lbs.)
112.5	90	78	48	2950
150	90	78	48	3000
225	90	78	48	3375
300	90	78	48	4190
500	90	90	58	5400
750	90	90	58	6900
1000	90	90	58	8400
1500	102	112	58	9940
2000	102	112	58	12900
2500	110	112	58	14170
3000	110	120	58	17650



I. Air-Filled Terminal Compartment - Low Voltage Outgoing Line Section

The depth and height of the air-filled cable terminal compartment will match the corresponding ventilated dry-type transformer dimensions.

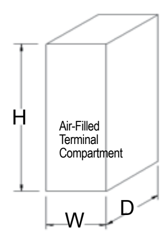
Voltage Class	Cable Termination	Width (Inches)	Weight (lbs.) H = 90"	H = 102"	H = 110"
600V	Clamp-type	18	350	440	470



II. Air-Filled Terminal Compartment - High-Voltage Incoming Line Section (HV Switch Not Required)

The depth and height of the air-filled terminal compartment will match the transformer.

Voltage Class	Cable Termination	Width (Inches)	Weight (lbs.) H = 90"	H = 102"	H = 110"
5 kV 30 kV BIL	Clamp-type	18	360	400	425
	Clamp-type with Lightning Arresters	18	360	400	425
	Pothead (3/1/C or 3/C)	18	360	400	425
15 kV 60 kV BIL	Clamp-type	18	360	400	425
	Clamp-type with Lightning Arresters	18	360	400	425
	Pothead (3/1/C or 3/C)	18	360	400	425

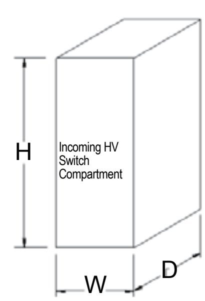


III. Non-Segerated Cable Termination Area (<u>Indoor</u> - Cable Entrance: Top or Bottom <u>Outdoor</u> - Cable Entrance: Bottom only)

- Non-Segregated Cable Termination Area is an alternate to Air Terminal Chamber.
- For the width dimension of a transformer with a Non-Segerated Cable Termination Area (HV only, LV only, both HV & LV), use the width dimension of the next KVA size up.

IV. The Auto-jet® Switch Compartment (HV Air Filled Terminal Compartment Not Required)

Voltage Class	Cable Termination	Height (Inches)	Width[1] (Inches)	Depth[2] (Inches)	Weight (lbs.)
5 kV 60 kV BIL	Two position switch and CL fuse	90	36	46	1200
	Two position switch,expulsion fuse, arresters	90	41	46	1000
	Two position switch, CL fuses and arresters	90	36	46	1300
15 kV 95 kV BIL	Two position switch and CL fuse	90	36	46	1300
	Two position switch,expulsion fuse, arresters	90	41	46	1200
	Two position switch, CL fuses ad arresters	90	36	46	1400



[1]For a side entry termination cabinet add 20 inches to the width.
[2]For a rear entry termination cabinet add 16 inches to the depth.

Specification Guide

General Specification Guide

The transformer shall be ventilated, open, dry-type construction cooled by the circulation of air through the windings. The unit shall be mounted in an indoor or outdoor enclosure finished in the manufacturer's standard ANSI 61 light gray paint with provisions for direct connection to the primary and secondary equipment as specified.

The transformer shall be designed, manufactured, and tested in accordance with the applicable NEMA, ANSI, and IEEE standards

The facility in which the transformers are manufactured shall be an ISO 9001:2000 registered facility.

Basic Rating

(Refer to the Transformer Specification Checklist Page, Items 1-12, for specifying basic ratings).

Insulation Materials

All insulation materials for the primary and secondary coil assembly shall be rated for continuous 220° C total temperature (Class H).

Insulation on the rectangular wire conductor shall be Nomex® or equivalent, which has a UL Listed 220°C insulation system having suitable overlapping to keep dielectric volts/mil stress within limits recommended by the insulation supplier.

Layer insulation for LV strip windings shall be Nomex® or equivalent, which is in a UL Listed 220°C insulation system having a thickness to keep volts/mil stress values no higher than values recommended by the insulation supplier.

Core and Coil Assembly

The core shall be constructed of non-aging, cold-rolled, high permeability silicon steel. All core laminations shall be step-lap mitred cut, free of burrs and stacked without gaps. The core framing structure shall be of rigid construction to provide full clamping pressure upon the core and provide the support points for the coils. Butt lap construction shall not be acceptable for power ratings above 1000 KVA.

The HV and LV coils shall be cylindrically wound (not rectangular) as an assembly with the HV coil wound directly over the LV coil. Coils shall be adequately braced for full short circuit capability to pass short circuit tests in accordance with IEEE C57.12.91.

Final Dip and Bake

Upon completion of the VPI process of the coils and their assembly on the core, the core top yokes are stacked, the core is clamped and all necessary leads are welded (if aluminum) or brazed (if copper) to the LV and MV bus components. At this time the complete core and coil assembly is dipped into a soft solvent based varnish of Isonel® 51 or equivalent to provide a protective coating from oxidation for all bare metal parts like core laminations and core clamping hardware. The varnish used for this process must not be a hard varnish like a 100% solids material. This core and coil assembly is then baked at the proper time and temperature (usually 4-8 hours @ 175°C) to cure all of the varnish.

Transformer Enclosure and Base

The transformer base shall be welded construction and shall be constructed to permit 4 point lifting using 1-1/2" diameter and 1" thick lifting eyes along the base of the transformer. The enclosure shall include provisions for rolling, skidding, lifting, and jacking for installation.

Removable panels shall not exceed 70 pounds in weight and shall contain suitably strong handles for lifting and placing. If installation space is adequate, hinged doors may be provided, when specified.

The enclosure shall be constructed of heavy gauge sheet steel equipped with removable parts for access to the core and coils on the front and rear. Ventilated openings shall be furnished to meet NEMA standards. The cabinet metal must be at least 14 gauge thickness. Whenever the cabinet must be outdoors (103R) the ventilation openings must be constructed as "back-to-back" channels as shown in the 103R Unit Substation of the Federal Pacific Transformer Catalog. (For 103R Lip Slots for ventilation are not acceptable).

Paint for the transformer enclosure shall be an ANSI-61 light grey color of a polyurethane powder coating that is electrostatically applied conforming to UL 1332 specifications. For installation areas within highly corrosive environments stainless steel enclosures may be furnished as an option as shown in Item 13(a) of the Transformer Specification Checklist Page.

The manufacturer of the Unit Substation Transformer shall be responsible for all the drawings and mechanical provisions for the proper coordination and attachment of the closely coupled switchgear on both the HV and LV ends of the transformer. Special attention needs to be given to item 14 in the Transformer Specification Checklist page for this requirement.

Vibration dampening pads shall be provided to isolate the core/coil assembly from the base structure.

High Voltage Taps

Each coil shall have taps at nominally rated voltage and an additional 4 taps: 2-2-1/2 % above and below rated nominal voltage.

Tap leads shall be terminated at the coils and equipped with provisions for changing taps under de- energized conditions.

Sound Level

The transformer shall be designed to meet the sound level standards for dry-type transformers as defined in IEEE C57.12.01 -1998 or NEMA ST-20.

Forced-Air Cooling

(Refer to the Transformer Specification Checklist Page, Item 3)

When forced-air cooling is specified, the forced-air cooling package (fans and controller shall be provided for automatically increasing the self-cooled rating by 33-1/3%. The system shall contain 120 VAC single phase fans and a control panel with indicating lights, temperature indicator, configurable fan exerciser, and alarm mode selector switch.

Accessories as specified

(Refer to Basic Medium Voltage Open Dry Transformer Rating Information.)

Winding Temperature Monitor shall be Qualitrol or equivalent. Provisions for grounding shall be provided to be welded Ground Pads or special termination hardware.

Final Tests

Final Test Reports in the proper IEEE format can be furnished for each unit upon request, documenting the successful passing of all required testing.
Optional Testing may be specified in the Basic Medium Voltage Open Dry Transformer Rating Information.

Basic Medium Voltage Open Dry Transformer Rating Information

Ship To Destination:

City ______________________ **State** ______________

Customer Name: ______________________

Power Rating Self-Cooled (AA) ____________ **KVA** ☐ **Three Phase**

Power Rating Self-Cooled (AA/FA) ____________ **KVA** ☐ **Single Phase**

(If fans are required)

Frequency: ☐ 60 Hz ☐ 50 Hz

UL® Listed: ☐ Yes ☐ No

Primary Transformer Protection (check one)

☐ HV Fused Switch
☐ Vacuum Circuit Breaker (VCB)
☐ Other

☐ Customer will **buy NEW** Switch or VCB
☐ Customer will **use EXISTING** Switch or VCB

Enclosure:

❑ **Indoor (NEMA 1)** ❑ **Outdoor (IEEE 103R)**

Special K-Factor

☐ **Yes** ⟶ ☐ **K-4** ☐ **K-9** ☐ **K-13** ☐ **K-20** ☐ **Other**
☐ **No**

Fans or Provisions for Fans Required: ☐ **Yes** ☐ **No**

☐ Furnish 1ø CPT (480V OR 208V) **with Fans**

☐ <u>No CPT</u> Power for Fans and controller <u>by others</u>

☐ Provisions for fans (**no** wiring, **no** controller)

☐ Provisions for fans (**with** wiring, **no** controller)

☐ Provisions for fans (**with** wiring, **with** controller)

Sound Level: ☐ STD ☐ Special Sound in db:

DOE 2010 Energy Efficient (USA Requirement) ☐ Yes ☐ No

C802.2 Energy Efficient (Canadian Only) ☐ Yes ☐ No

Primary Voltage: ______________ **Volts** ☐ **Delta** ☐ **Wye** **BIL in kV:** ____________

Secondary Voltage: ______________ **Volts** ☐ **Delta** ☐ **Wye** **BIL in kV:** ____________

Average Winding Temperature Rise °C: ☐ 150 ☐ 115 ☐ 80 ☐ Other ______________

HV Taps: ☐ Standard Full Capacity: 2-2-1/2% Above and 2-2-1/2% Below Rated Primary Voltage

☐ Other Taps

Impedance: ☐ **Standard** ☐ **Other** ______________

Windings: ☐ Aluminum ☐ Copper

Electrostatic Shield Between Primary and Secondary Windings: ☐ Yes ☐ No

Transformer Construction

☐ **High Voltage General Purpose, HVGP** ("Cable In" and "Cable Out' <u>without</u> Air Terminal Compartments) ☐ **Stub Up** ☐ **Stub Down**

☐ **Unit Substation**

Unit Substation Primary Side

☐ Close Coupled to Switchgear (Flange)
☐ Full Height Terminal Chamber
☐ Non-Segregated Cable Termination Chamber
☐ Throat
☐ Bolted Panel Only

Unit Substation Secondary Side

☐ Close Coupled to Switchgear (Flange)
☐ Full Height Terminal Chamber
☐ Non-Segregated Cable Termination Chamber
☐ Throat
☐ Bolted Panel Only

☐ **Pad-Mount** Tamper Resistant Low Profile per IEEE C57.12.28

☐ **Core and Coil Replacement** **Height"** ____________ **Width"**____________ **Depth"** ____________

Seismic Bracing Required: ☐ Yes ☐ No

If "Yes": ☐ Zone 1 ☐ Zone 2 ☐ Zone 3 ☐ Zone 4 ☐ Other ______________

Basic Medium Voltage Open Dry Transformer Rating Information

TESTING:

Standard (IEEE C57.12.91) ☐ Yes ☐ No

Optional Special Tests ☐ Yes ☐ No

QC Impulse	☐ Yes	☐ No
IEEE C57.12.91 Impulse	☐ Yes	☐ No
Audible Sound	☐ Yes	☐ No
Heat Run (Temperature)	☐ Yes	☐ No
Partial Discharge	☐ Yes	☐ No
Other	☐ Yes	☐ No If Yes Please Specify ____________

Primary Arresters

☐ Distribution kV ____________

☐ Intermediate kV ____________

☐ Station kV ____________

Secondary Arresters

☐ Distribution kV ____________

☐ Intermediate kV ____________

☐ Station kV ____________

Other Features

VPI Coils	☐ Yes	☐ No
VPI Coils with Epoxy Shield	☐ Yes	☐ No
Copper Ground Bus	☐ Yes	☐ No
Altitude Above 3300 Feet	☐ Yes	☐ No Altitude in ____________ Feet
Digital Temperature Monitor	☐ Yes	☐ No
Space Heaters With Thermostat	☐ Yes	☐ No
Dust Filters	☐ Yes	☐ No
Rodent Proofing	☐ Yes	☐ No

Losses Needed With Quotation ☐ Yes ☐ No ☐ Typical ☐ Guaranteed

NL Watts ____________

Load Watts ____________

Total Watts ____________

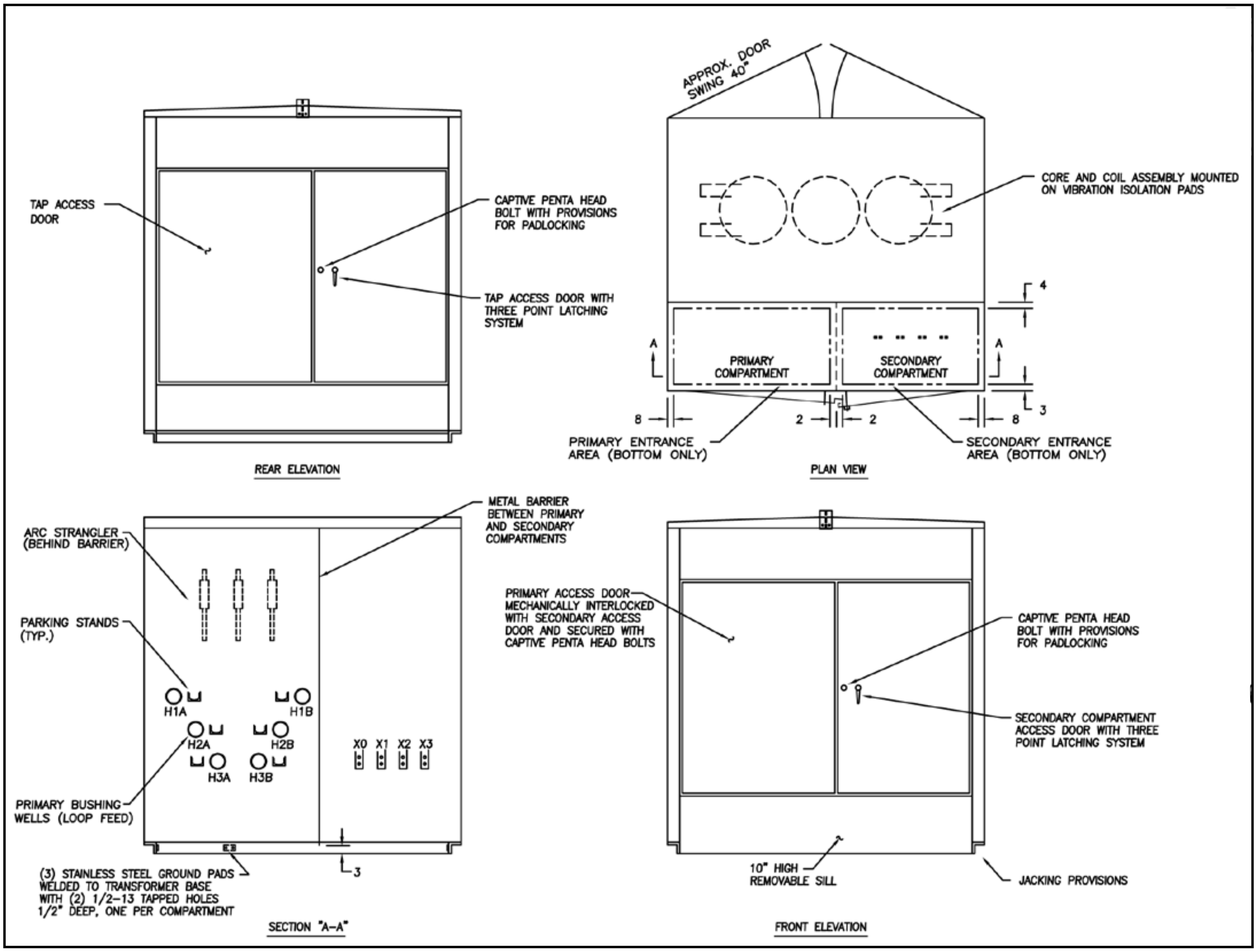
Dimensions Needed With Quote ☐ Yes ☐ No

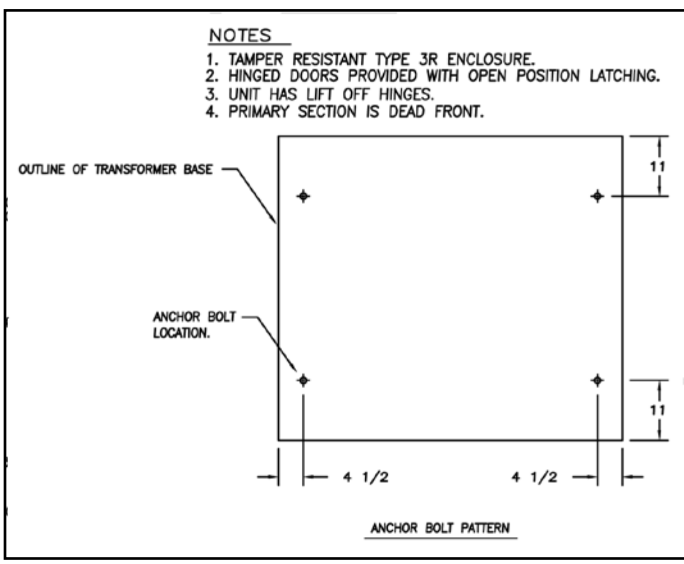
Height in inches ____________

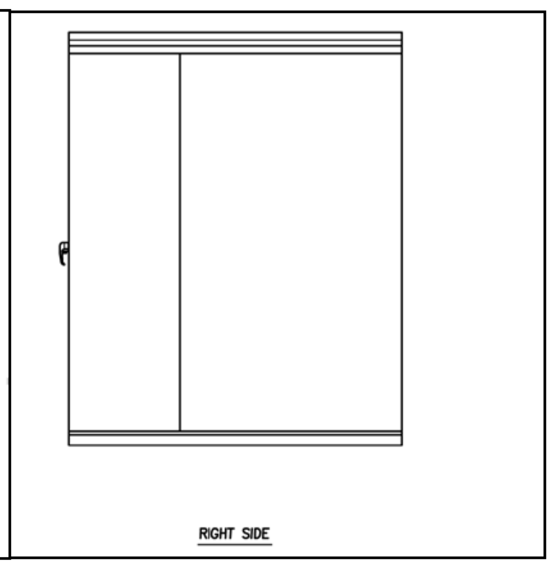
Width in inches ____________

Depth in inches ____________

Weight Needed With Quote ☐ Yes ☐ No

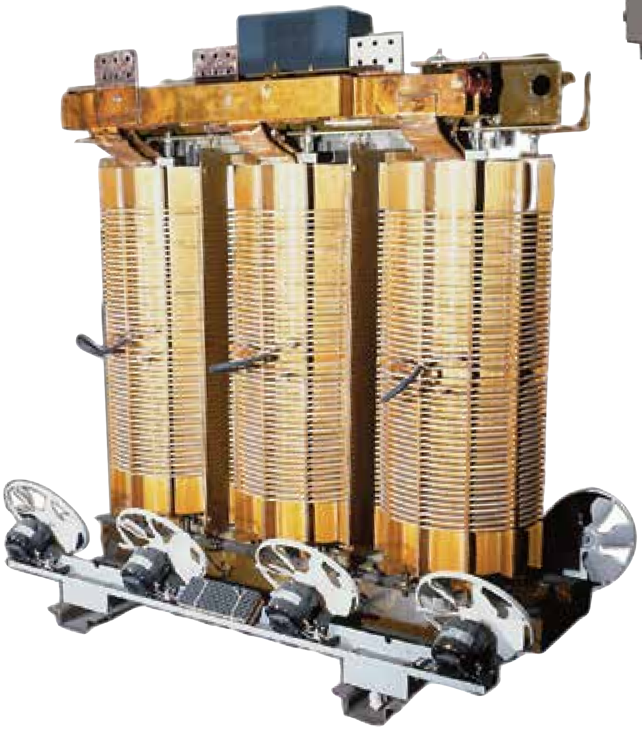






Typical Pad-Mount Transformer Configuration

VPI & Epoxy Shielded Dry-Type Transformers



VPI & Epoxy Shielded

FEDERAL PACIFIC™

ISO 9001:2008
REGISTERED

VPI and Epoxy Shielded

Federal Pacific vacuum pressure impregnated (VPI) transformers combine a performance proven dry-type transformer design with the environmental protection of a polyester coil encapsulation process. This combination ensures reliable transformer operation in hostile environments containing moisture, dust, dirt, chemicals and other contaminants.

The VPI process fully penetrates and seals the coils into a high strength composite unit for complete environmental protection. Since the coil protection is created using vacuum pressure impregnation rather than molding, maximum design flexibility is achieved to allow conformance to the most stringent application requirements.

The vacuum impregnation of the polyester resin eliminates winding voids to reduce essentially to zero any corona generation due to insulation voids. Corona, particularly in conjunction with corrosive environments, accelerates the degradation of the insulation materials and will cause the transformer to fail prematurely.

Federal Pacific VPI and Epoxy Shielded transformers are available in sizes from 7.5 KVA to 10,000 KVA and voltages from 600 through 34,500 volts. The most popular standard KVA and voltages are available, as well as custom sizes.

Benefits

Federal Pacific Epoxy Shielded vs. Cast Coil:

- Lower initial cost
- Flexibility of design
- Elimination of cracking epoxy
- Higher thermal overload
  Cast = 17% @ 80/115° C rise
  VPI = 30% @ 80/150° C rise
- Less weight for easier handling and installation
- Smaller dimensions to save valuable floor space
- Outstanding environmental protection

The Product

A high quality electrical transformer with excellent resistance to dust, fumes and moisture. Superior resistance to cracking from thermal cycling. Maximum design flexibility. All at less cost than cast coil transformers.

The Material

Federal Pacific uses high performance 100% solid, precatalized, solventless varnish. This varnish, when applied, imparts a clear, tough, high bond strength coating to the coil assembly. It also adds high dielectric strength as well as mechanical bond strength and unparalleled thermal endurance.

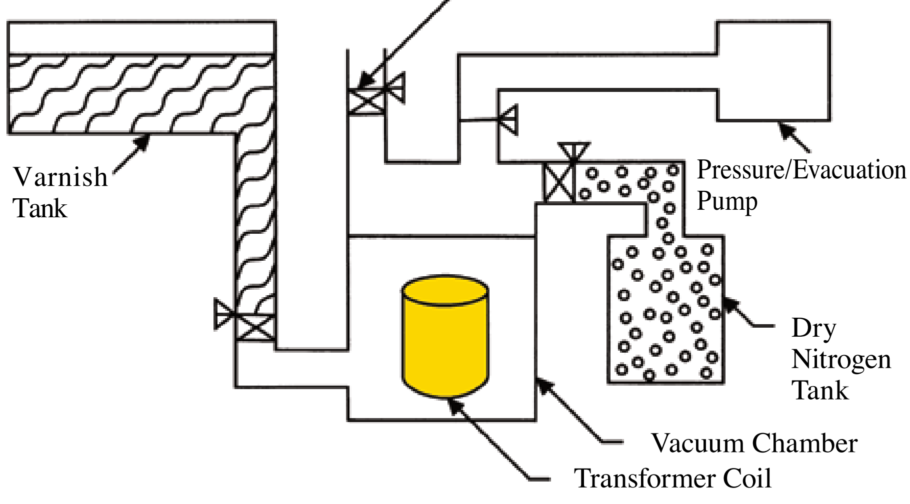
Coil Construction

Circular coil construction is used to assure proper ventilation and maximum short circuit strength. Coils are constructed using a 220° C Nomex ® insulation system that for many years has had proven performance in dielectric strength, temperature stability and long life. The high voltage coils are wound directly over the low voltage coils to form a complete assembly. The coil assembly is completely insulated and mechanically braced to pass all ANSI standard test prior to encapsulation. The coil does not depend on the encapsulation process and its material to provide electrical and mechanical strength. The VPI process provides an additional margin of insulation and strength.

The Process

1. Transformer coils preheated for improved resin penetration into coils
2. Coils placed into special pressure vessel
3. Apply dry vacuum to remove trapped moisture from coils
4. Polyester Resin is pumped into pressure vessel to completely submerge coils
5. Vacuum broken followed by application of high pressure forcing the resin to penetrate into the transformer coils thereby removing air voids
6. Resin evacuated from pressure vessel and reurned to storage tank
7. Coils allowed to drain
8. Coils baked in oven to cure resin forming a barrier to airborn contaminants and enhancing the dielectric strength of the insulation system

Piping Diagram



Epoxy Shielded Transformer

Federal Pacific offers, in addition to VPI, the Epoxy Shielded Transformer, a product superior to the more expensive and larger cast coil transformer.

Federal Pacific's Epoxy Shielded design has the same benefits of unequaled environmental protection, high Basic Impulse Levels, low sound, and superior short circuit strength, as cast coil transformers. But the Epoxy Shielded transformers has the added benefits of lower cost, greater design flexibility, elimination of cracking, higher thermal overloads, smaller dimensions and less weight.

The Federal Pacific design begins with a quality VPI transformer. To this we add 2 mils minimum of modified epoxy varnish and the result is a premium transformer ready to handle the really tough environments. The Federal Pacific Epoxy Shielded Transformer is ideal for environments polluted with chlorides, acids, alkalies, salt water and high humidity.

Federal Pacific uses high viscosity (40-60 sec. #4 Fordcup) formulated epoxy. This specially formulated epoxy is designed for greater film dry thickness than most epoxies in use today. The epoxy used has a high percentage of solids, yet has a relatively low cure weight. This unique combination allows high mechanical bond strength and a low overall unit weight.

Where your environmental concerns are the greatest, specify the best epoxy transformer on the market today - Federal Pacific's Epoxy Shielded transformer.

Specification Guide

The transformer(s) shall be open dry-type with both primary and secondary coils encapsulated with polyester resin using a vacuum pressure impregnation (VPI) process (optional VPI with Epoxy Shield). The transformer shall be fire resistant, and cooled by the natural circulation of air through the windings.

The unit shall be mounted in an indoor (optional outdoor/103R) ventilated enclosure, finished in the manufacturer's standard light gray paint.

The transformer will be designed, manufactured and tested in accordance with applicable ANSI, NEMA and IEEE standards.

Conductor Material

The conductor shall be electrical grade aluminum or copper.

Insulation Material

All insulation materials for the primary and secondary coils shall be rated for continuous 220° C operation.

Optional Forced Air Cooling

A complete forced air cooling system shall be provided for automatically increasing the self cooled rating by 33-1/3%. The system shall contain 120 VAC single phase fans and a control panel with indicating lights, temperature indicator, configurable fan exerciser and alarm mode selector switch.

Ratings

The transformer shall be rated as follows:

KVA ________ self-cooled AA
________ (optional FA or FFA)
Phase ______________________
Hertz ______________________
Primary Voltage _____________
Delta (Wye) ________________
Secondary Voltage
Wye (Delta) ________________
Primary Taps 2 ± 2-1/2% full capacity
Primary Basic Impulse Level
_____________________ kV
Maximum Temperature Rise:
❑ 80° C ❑ 115° C ❑ 150° C

Coil Assembly

The high and low voltage coils shall be round, concentrically wound as an integral assembly. The insulated coil assembly shall be capable of passing all standard IEEE and NEMA tests, including impulse test before the coils are encapsulated.

High Voltage Taps

Taps shall be terminated at the coils and equipped with provisions for changing taps under de-energized conditions.

Encapsulation System

The coil assembly shall be encapsulated using a VPI process. This process shall utilize heat, vacuum and pressure to completely seal and bind the windings. The VPI encapsulating material shall be solventless polyester. (An additional shielding of high viscosity insulating epoxy may be applied after the VPI process for protection against environments containing corrosive elements).

Core Structure

The core structure shall be of non-aging, cold rolled, grain oriented, high permeability silicon steel. All core laminations shall be free of burrs and stacked without gaps. The core framing structure shall be of rigid construction to provide full clamping pressure upon the core and provide support points for the coils.

Cores to be constructed in a butt-lap construction, or as an option, a miter type construction.

Vibration dampening pads shall be provided to isolate the core and coil assembly from the base structure.

The outside surfaces of the core shall be varnish dipped to protect against corrosion.

Enclosure

The enclosure shall be constructed of 14 gauge minimum sheet steel equipped with removable panels for access to the core and coils on the front and rear. Ventilated openings shall meet NEMA and IEEE standards. The enclosure shall include provisions for rolling, skidding, jacking and lifting.

Finish to be an electrostatic powder coating using a U.L. approved outdoor polyurethane paint.

Sound Level

The transformer shall be designed to meet or exceed the standards for dry-type transformers per IEEE and NEMA standards.

Tests

Each transformer shall be tested in accordance with IEEE C57.12.91.

The VPI or Epoxy Shielded transformer shall be as manufactured by Federal Pacific.

Other Products Available

TRANSFORMERS

600 Volt and Below Dry-Type Transformers

- Encapsulated/compound filled transformers
- Industrial control transformers
- Buck-Boost transformers
- General purpose, lighting and control power transformers
- Open core and coil transformers
- Electrostatically shielded transformers
- Motor drive isolation transformers
- Energy saving 115° C and 80° C designs
- K-Factor transformers
- Wall mounting, dripshield and terminal lug accessories

High Voltage Dry-Type Transformers

- Core and coil transformers
- General purpose transformers
- Outdoor designs
- Unit substation transformers
- Motor drive isolation transformers
- K-Factor transformers
- Padmounted transformers
- Vacuum pressure impregnation (VPI) transformers
- VPI/epoxy shielded transformers
- UL® listed high voltage transformers

Specialty Transformers

Federal Pacific will custom engineer your specialty transformer requirements.

Type FEC Epoxy Encapsulated, Copper-Wound Industrial Control Transformers

Industrial Control

FEDERAL PACIFIC

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Industrial Control Transformer Selector Guide

Voltage Index

Regulation & Inrush

Selecting a transformer for industrial control circuit applications requires knowledge of the following terms:

INRUSH VA is the product of load voltage **(V)** multiplied by the current **(A)** that is required during circuit start-up. It is calculated by adding the **inrush VA** requirements of all devices (contactors, timers, relays, pilot lights, solenoids, etc.), which will be energized together. **Inrush VA** requirements are best obtained from the component manufacturer.

SEALED VA is the product of load voltage **(V)** multiplied by the current **(A)** that is required to operate the circuit after initial start-up or under normal operating conditions. It is calculated by adding the **sealed VA** requirements of all electrical components of the circuit that will be energized at any given time. **SEALED VA** requirements are best obtained from the component manufacturer. **SEALED VA** is also referred to as steady state VA.

PRIMARY VOLTAGE is the voltage available from the electrical distribution system and its operational frequency, which is connected to the transformer supply voltage terminals.

SECONDARY VOLTAGE is the voltage required for load operation which is connected to the transformer load voltage terminals.

Once the circuit variables have been determined, transformer selection is a simple 5-step process as follows:

1. Determine the Application Inrush VA by using the following industry accepted formula:

$$\textbf{Application Inrush VA} = \sqrt{(\textbf{INRUSH VA})^2 + (\textbf{SEALED VA})^2}$$

2. Refer to the Regulation Data Chart. If the primary voltage is basically stable and does not vary by more than 5% from nominal, the 90% secondary voltage column should be used. If the primary voltage varies between 5 and 10% of nominal, the 95% secondary voltage column should be used.

3. After determining the proper secondary voltage column, read down until a value equal to or greater than the Application Inrush VA is found. In no case should a figure less than the Application Inrush VA be used.

4. Read left to the Transformer VA Rating column to determine the proper transformer for this application. As a final check, make sure that the Transformer VA rating is equal to or greater than the total sealed requirements. If not, select a transformer with a VA rating equal to or greater than the total sealed VA.

5. Refer to the specification section of this catalog to determine the proper catalog number based on the transformer VA, and primary and secondary voltage requirements.

To comply with NEMA standards, which require all magnetic devices to operate successfully at 85% of rated voltage, the 90% secondary voltage column is most often used in selecting a transformer.

Regulation and Inrush Data Chart

Transformer VA Rating	Inrush VA at 20% Power Factor		
	95% Sec. Voltage	90% Sec. Voltage	85% Sec. Voltage
25	100	130	150
50	170	200	240
75	310	410	540
100	370	540	730
150	780	930	1150
200	810	1150	1450
250	1400	1900	2300
300	1900	2700	3850
350	3100	3650	4800
500	4000	5300	7000
750	8300	11000	14000

Type FEC Epoxy Encapsulated Copper-Wound Industrial Control Transformers

- Laminations of the finest silicon steel minimize core losses and increase performance and efficiency.
- Copper magnet wire assures efficient operation.
- UL 506 Listed
- CSA Certified
- Insulation materials of the highest rating available for the temperature class.
- Mounting brackets are heavy gauge steel to add strength to core construction and provide stable mounting. Slotted mounting feet permit easy installation.
- Attractive black finish; easy-to read nameplate with complete rating data and wiring diagram.

Features

- Epoxy encapsulated coils
- Secondary fuse clips where applicable
- Optional Primary Fusing
- Molded terminal barriers
- 10-32 screw terminals
- Molded-in terminals
- Phil-slot screws

Construction Diagrams

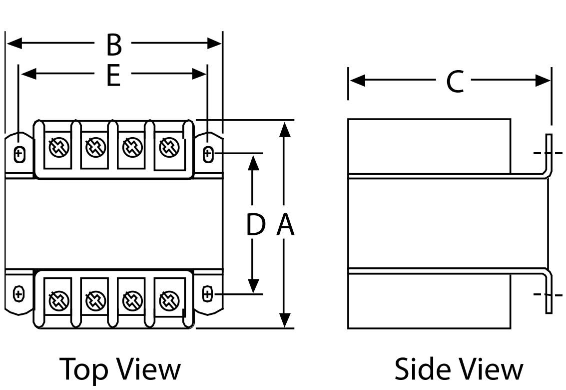


Figure A
Class 105° C Insulation System
55° C Temperature Rise
Epoxy Encapsulated Coils

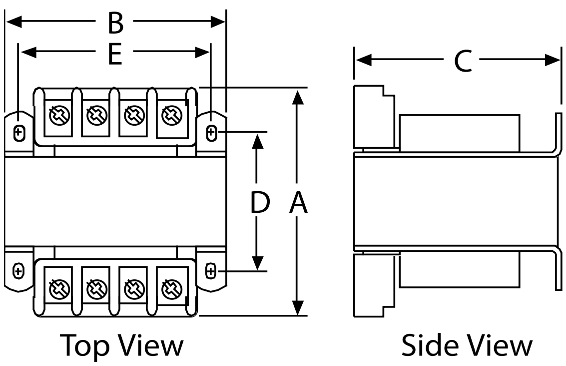


Figure B
Class 105° C Insulation System
55° C Temperature Rise
Epoxy Encapsulated Coils

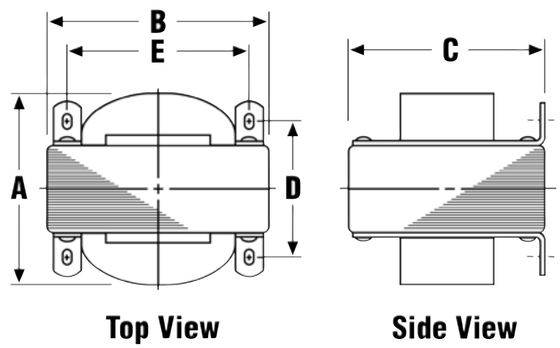


Figure E
Class 105° C Insulation System
55° C Temperature Rise
Epoxy Encapsulated Coils

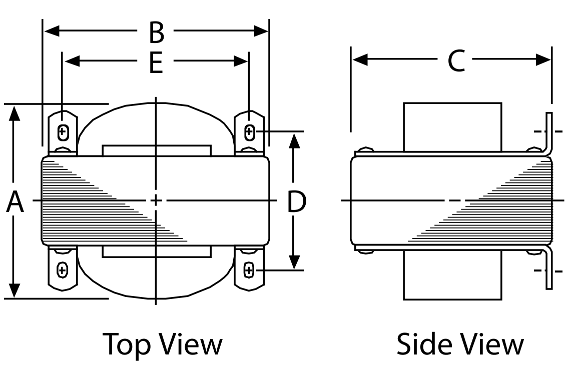


Figure C
Class 105° C Insulation System
55° C Temperature Rise
Epoxy Encapsulated Coils

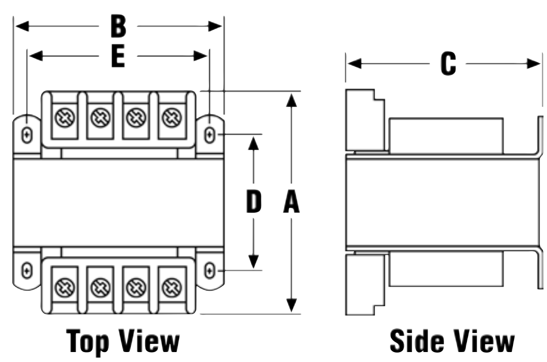
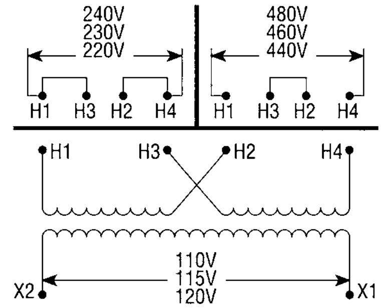


Figure V
Class 105° C Insulation System
55° C Temperature Rise
Epoxy Encapsulated Coils

Group A

Primary Volts.....240 x 480, 230 x 460, 220 x 440
Secondary Volts .... 120 • 115 • 110

UL LISTED **and** CSA® **Certified** **50 / 60 HZ**



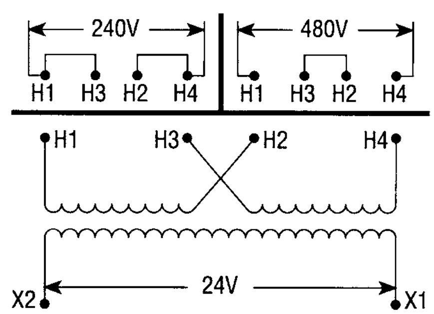
VA Rating	Catalog Number	Construction Figure	Output Amps	Dimensions					Mounting Slots	Approx. Wt. (lbs)
				A	B	C	D	E		
50	FA050JK	B	0.43	3	3	2.562	2	2.5	.203 x .375	2.6
75	FA075JK	B	0.65	3.5	3	2.562	2.5	2.5	.203 x .375	3.5
100	FA100JK	B	0.87	3.375	3.375	2.875	2.375	2.812	.203 x .375	4.2
150	FA150JK	B	1.30	4	3.75	3.187	2.875	3.125	.203 x .375	6.7
200	FA200JK	B	1.74	4	4.5	3.812	2.5	3.75	.203 x .375	8.5
250	FA250JK	B	2.17	4.375	4.5	3.812	2.875	3.75	.203 x .375	10.0
300	FA300JK	B	2.61	4.75	4.5	3.812	3.25	3.75	.203 x .375	11.3
350	FA350JK	B	3.04	5.25	4.5	3.812	3.75	3.75	.203 x .375	13.6
500	FA500JK	B	4.35	5.5	5.25	4.75	4.25	4.375	.312 x .687	19.2
750	FA750JK	B	6.52	7	5.25	4.75	5.75	4.375	.312 x .687	28.1

JK suffix denotes transformer supplied with primary J-2 jumpers and secondary fuse clips for a 13/32 x 1-1/2 fuse.
Construction Figure E units rated for 60 Hz at 240 x 480 input and do not come with secondary fuse clips.

Group B

Primary Volts...240 x 480
Secondary Volts 24

UL LISTED **and** CSA® **Certified** **50 / 60 HZ**



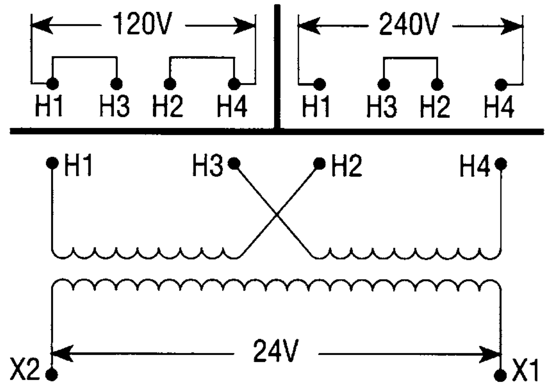
VA Rating	Catalog Number	Construction Figure	Output Amps	Dimensions					Mounting Slots	Approx. Wt. (lbs)
				A	B	C	D	E		
50	FB050JK	B	2.08	3	3	2.562	2	2.5	.203 x .375	2.7
75	FB075JK	B	3.13	3.5	3	2.562	2.5	2.5	.203 x .375	3.5
100	FB100JK	B	4.17	3.375	3.375	2.875	2.375	2.812	.203 x .375	4.2
150	FB150JK	B	6.25	4	3.75	3.187	2.875	3.125	.203 x .375	6.7
200	FB200JK	B	8.33	4	4.5	3.812	2.5	3.75	.203 x .375	8.5
250	FB250JK	B	10.42	4.375	4.5	3.812	2.875	3.75	.203 x .375	10.1
300	FB300JK	B	12.50	4.75	4.5	3.812	3.25	3.75	.203 x .375	11.4
350	FB350JK	B	14.58	5.25	4.5	3.812	3.75	3.75	.203 x .375	13.4
500	FB500JK	B	20.83	5.625	5.25	4.75	4.125	4.375	.312 x .687	17.5

JK suffix denotes transformer supplied with primary J-2 jumpers and secondary fuse clips for a 13/32 x 1-1/2 fuse.

Group C

Primary Volts..120 x 240
Secondary Volts 24

UL LISTED and SP® Certified   **50 / 60 HZ**

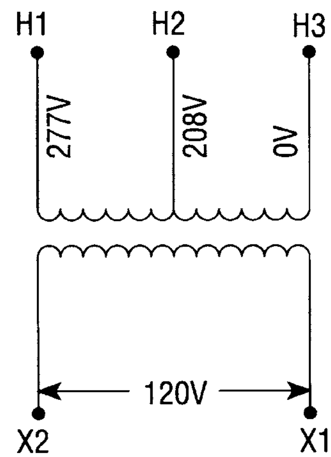


VA Rating	Catalog Number	Construction Figure	Output Amps	Dimensions					Mounting Slots	Approx. Wt. (lbs)
				A	B	C	D	E		
50	FC050JK	B	2.08	3	3	2.562	2	2.5	.203 x .375	2.6
75	FC075JK	B	3.13	3.5	3	2.562	2.5	2.5	.203 x .375	3.6
100	FC100JK	B	4.17	3.375	3.375	2.875	2.375	2.812	.203 x .375	4.4
150	FC150JK	B	6.25	4	3.75	3.187	2.875	3.125	.203 x .375	6.7
200	FC200JK	B	8.33	4	4.5	3.812	2.5	3.75	.203 x .375	8.3
250	FC250JK	B	10.42	4.375	4.5	3.812	2.875	3.75	.203 x .375	10.1
300	FC300JK	B	12.50	4.75	4.5	3.812	3.25	3.75	.203 x .375	11.2
350	FC350JK	B	14.58	5.25	4.5	3.812	3.75	3.75	.203 x .375	13.2
500	FC500JK	B	20.83	5.625	5.25	4.75	4.125	4.375	.312 x .687	17.5
JK suffix denotes transformer supplied with primary J-2 jumpers and secondary fuse clips for a 13/32 x 1-1/2 fuse.										

Group F

Primary Volts.. 208 / 277
Secondary Volts 120

UL LISTED and SP® Certified   **50 / 60 HZ**

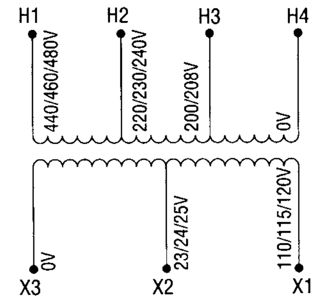


VA Rating	Catalog Number	Construction Figure	Output Amps	Dimensions					Mounting Slots	Approx. Wt. (lbs)
				A	B	C	D	E		
50	FF050XK	B	0.42	3	3	2.562	2	2.5	.203 x .375	2.9
75	FF075XK	B	0.63	3.5	3	2.562	2.5	2.5	.203 x .375	3.8
100	FF100XK	B	0.83	3.375	3.375	2.875	2.375	2.812	.203 x .375	4.5
150	FF150XK	B	1.25	4	3.75	3.187	2.875	3.125	.203 x .375	6.9
200	FF200XK	B	1.67	4	4.5	3.812	2.5	3.75	.203 x .375	8.7
250	FF250XK	B	2.08	4.375	4.5	3.812	2.875	3.75	.203 x .375	10.2
300	FF300XK	B	2.50	4.75	4.5	3.812	3.25	3.75	.203 x .375	11.4
350	FF350XK	B	2.92	5.25	4.5	3.812	3.75	3.75	.203 x .375	13.7
500	FF500XK	B	4.17	5.375	5.25	4.75	4.125	4.375	.312 x .687	17.2
750	FF750XK	B	6.25	7	5.25	4.75	5.75	4.375	.312 x .687	25.7
XK suffix denotes transformer supplied with secondary fuse clips for a 13/32 x 1-1/2 fuse; primary jumpers not applicable.										

Group J

Primary Volts....200 / 220 / 440, 208 / 230 / 460, 240 / 480
Secondary Volts .... 23 / 110, 24 / 115, 25 / 120

UL LISTED and CSA® Certified **50 / 60 HZ**

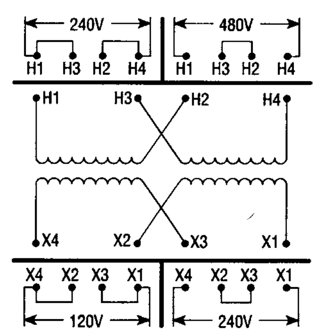


VA Rating	Catalog Number	Construction Figure	Output Amps	Dimensions					Mounting Slots	Approx. Wt. (lbs)
				A	B	C	D	E		
50	FJ050XK	B	2.08/0.44	3.25	3	2.562	2.25	2.5	.203 x .375	3.4
75	FJ075XK	B	3.13/0.65	3.5	3.375	2.875	2.5	2.812	.203 x .375	4.8
100	FJ100XK	B	4.17/0.87	3.625	3.75	3.187	2.5	3.125	.203 x .375	5.9
150	FJ150XK	B	6.25/1.30	4.375	3.75	3.187	3.25	3.125	.203 x .375	7.9
200	FJ200XK	B	8.33/1.74	4.5	4.5	3.812	3	3.75	.203 x .375	10.6
250	FJ250XK	B	10.42/2.17	5.25	4.5	3.812	3.75	3.75	.203 x .375	13.9
300	FJ300XK	B	12.50/2.61	5.125	5.25	4.75	3.875	4.375	.312 x .687	15.5
350	FJ350XK	B	14.58/3.04	5.375	5.25	4.75	4.125	4.375	.312 x .687	16.8
500	FJ500XK	B	20.84/4.35	6.875	5.25	4.75	5.25	4.375	.312 x .687	23.4
XK suffix denotes transformer supplied with secondary fuse clips for a 13/32 x 1-1/2 fuse; primary jumpers not applicable.										

Group K

Primary Volts..240 x 480
Secondary Volts ....120 x 240

UL LISTED and CSA® Certified **50 / 60 HZ**



VA Rating	Catalog Number	Construction Figure	Output Amps	Dimensions					Mounting Slots	Approx. Wt. (lbs)
				A	B	C	D	E		
50	FK050JJ	B	0.42/0.21	3	3	2.562	2	2.5	.203 x .375	2.6
75	FK075JJ	B	0.63/0.31	3.5	3	2.562	2.5	2.5	.203 x .375	3.5
100	FK100JJ	B	0.83/0.42	3.375	3.375	2.875	2.375	2.812	.203 x .375	4.2
150	FK150JJ	B	1.25/0.63	4	3.75	3.187	2.875	3.125	.203 x .375	6.7
200	FK200JJ	B	1.67/0.83	4	4.5	3.812	2.5	3.75	.203 x .375	8.5
250	FK250JJ	B	2.08/1.04	4.375	4.5	3.812	2.875	3.75	.203 x .375	10.0
300	FK300JJ	B	2.50/1.25	4.875	4.5	3.812	3.375	3.75	.203 x .375	11.8
350	FK350JJ	B	2.92/1.46	5.25	4.5	3.812	3.75	3.75	.203 x .375	13.6
500	FK500JJ	B	4.17/2.08	5.25	5.25	4.75	4.125	4.375	.312 x .687	17.5
750	FK750JJ	B	6.25/3.12	7	5.25	4.75	5.75	4.375	.312 x .687	26.4
JJ suffix denotes transformer supplied with primary and secondary J-2 jumpers ; secondary fuse clips not applicable.										

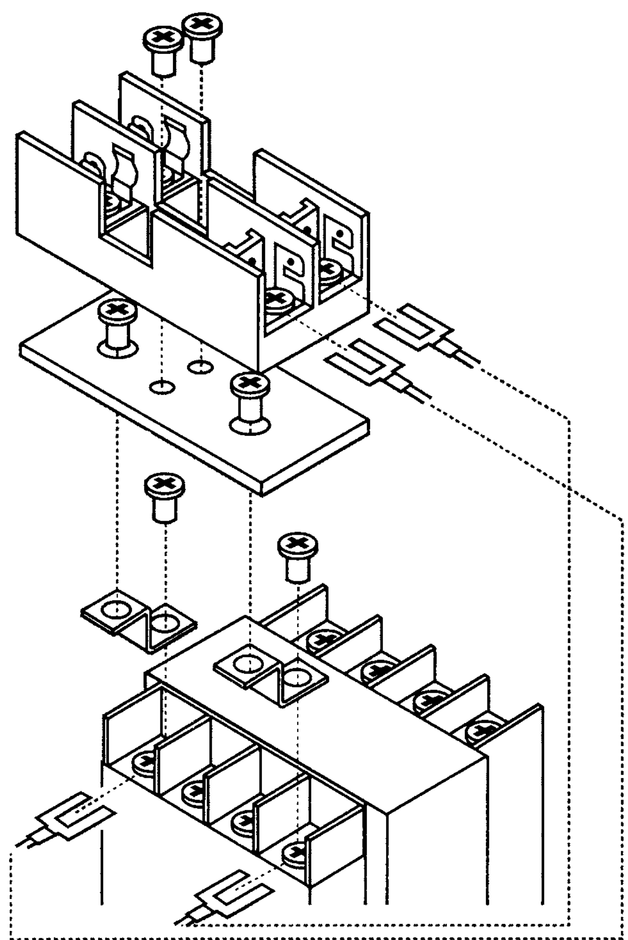
Primary Fusing

Primary Fusing Capability

In compliance with the requirements of UL508 and the National Electrical Code, Intertran® transformers, rated 50VA and larger, can be ordered with the provision for factory-mounted dual primary class cc fusing capability. The primary fuse block is mounted by the customer on the transformer and wired to the primary terminals. The primary fusing option will add 1-3/8" to the "C" dimension of the transformer.

Primary Fuse Kit

In addition to factory installed primary fusing capability, Federal Pacific offers a primary fuse kit for field installation. The primary fuse kit includes a 2-pole class cc fuse block, instructions and all associated mounting and wiring hardware. Additionally, this fuse kit will fit most competitor's units. To order this kit, use catalog number FPFK-1. The primary fuse kit, when installed, will add a maximum of 11/16" to the transformer "A" dimension and 1-15/16" to the "C" dimension.



Typical Primary Fuse Kit Installation

Primary Overcurrent Protection for Transformers

Overcurrent protection on both the primary and secondary sides of transformers is specified in UL508 and the National Electrical Code. The maximum acceptable ratings are shown below. Due to high inrush currents present when a transformer is initially energized, it is recommended that the primary fuse be time delay, to prevent nuisance trips during startup.

MAXIMUM ACCEPTABLE RATING OF PRIMARY OVERCURRENT PROTECTION

Primary Voltage	50	75	100	150	200	250	300	350	500	750
115	1-1/4 (2)	1-8/10 (3-2/10)	2-1/2 (4)	3-1/2 (6-1/4)	5 (8)	5	6-1/4	7-1/2	10	15
120	1-1/4 (2)	1-8/10 (3)	2-1/4 (4)	3-1/2 (6-1/4)	5 (8)	5	6-1/4	7	10	15
200	3/4 (1-1/4)	1-1/8 (1-8/10)	1-1/2 (2-1/2)	2-1/4 (3-1/2)	3 (5)	3-1/2 (6-1/4)	4-1/2 (7-1/2)	5 (8)	6-1/4	9
208	6/10 (1-1/8)	1 (1-8/10)	1-4/10 (2-1/4)	2 (3-1/2)	2-8/10 (4-1/2)	3-1/2 (6)	4 (7)	5 (8)	6	9
220	6/10 (1-1/8)	1 (1-6/10)	1-1/4 (2-1/4)	2 (3-2/10)	2-1/2 (4-1/2)	3-2/10 (5-6/10)	4 (6-1/4)	4-1/2 (7-1/2)	5-6/10	8
230	6/10 (1)	8/10 (1-6/10)	1-1/4 (2)	1-8/10 (3-2/10)	2-1/2 (4)	3-2/10 (5)	3-1/2 (6-1/4)	4-1/2 (7-1/2)	5	8
240	6/10 (1)	8/10 (1-1/2)	1-1/4 (2)	1-8/10 (3)	2-1/2 (4)	3 (5)	3-1/2 (6-1/4)	4 (7)	5	7-1/2
277	1/2 (8/10)	8/10 (1-1/4)	1 (1-8/10)	1-6/10 (2-1/2)	2 (3-1/2)	2-1/2 (4-1/2)	3-2/10 (5)	3-1/2 (6/1/4)	5 (9)	6-1/4
380	3/10 (6/10)	1/2 (8/10)	3/4 (1-1/4)	1-1/8 (1-8/10)	1-1/2 (2-1/2)	1-8/10 (3-2/10)	2-1/4 (3-1/2)	2-1/2 (4-1/2)	3-1/2 (6-1/4)	5-6/10 (9)
400	3/10 (6/10)	1/2 (8/10)	3/4 (1-1/4)	1-1/8 (1-8/10)	1-1/2 (2-1/2)	1-8/10 (3)	2-1/4 (3-1/2)	2-1/2 (4)	3-1/2 (6-1-4)	5-6/10 (9)
415	3/10 (6/10)	1/2 (8/10)	6/10 (1-1/8)	1 (1-8/10)	1-4/10 (2-1/4)	1-8/10 (3)	2 (3-1/2)	2-1/2 (4)	3-1/2 (6)	5 (9)
440	3/10 (1/2)	1/2 (8/10)	6/10 (1-1/8)	1 (1-6/10)	1-1/4 (2-1/4)	1-6/10 (2-8/10)	2 (3-2/10)	2-1/4 (3-1/2)	3-2/10 (5-6/10)	5 (8)
460	3/10 (1/2)	4/10 (8/10)	6/10 (1)	8/10 (1-6/10)	1-1/4 (2)	1-6/10 (2-1/2)	1-8/10 (3-2/10)	2-1/4 (3-1/2)	3-2/10 (5)	4-1/2 (8)
480	3/10 (1/2)	4/10 (3/4)	6/10 (1)	8/10 (1-1/2)	1-1/4 (2)	1-1/2 (2-1/2)	1-8/10 (3)	2 (3-1/2)	3 (5)	4-1/2 (7-1/2)
550	1/4 (4/10)	4/10 (6/10)	1/2 (8/10)	8/10 (1-1/4)	1 (1-8/10)	1-1/4 (2-1/4)	1-6/10 (2-1/2)	1-8/10 (3)	2-1/2 (4-1/2)	4 (6-1/4)
575	1/4 (4/10)	3/10 (6/10)	1/2 (8/10)	3/4 (1-1/4)	1 (1-6/10)	1-1/4 (2)	1-1/2 (2-1/2)	1-8/10 (3)	2-1/2 (4)	3-1/2 (6-1/4)
600	2/10 (4/10)	3/10 (6/10)	1/2 (8/10)	3/4 (1-1/4)	8/10 (1-6/10)	1-1/4 (2)	1-1/2 (2-1/2)	1-6/10 (2-8/10)	2-1/4 (4)	3-1/2 (6-1/4)

If the rated primary current is less than 2 amps, the maximum rating of the overcurrent device is 300% for power circuits, shown above, or 500% for control circuits, shown above in *(brackets)*. If the rated primary current is 2 amps or more, the maximum rating of the overcurrent device is 250%.

All figures assume secondary overcurrent protection per UL/NEC.

Reference: NEC 430 - 72(c) exception #2, 450 - 3(b) 1 & 2, UL508 32.7, UL845 11.16 & 11.17

Secondary Overcurrent Protection for Transformers

MAXIMUM ACCEPTABLE RATING OF SECONDARY OVERCURRENT PROTECTION

Primary Voltage	50	75	100	150	200	250	300	350	500	750
23	3-1/2	5	7	10	12	15	20	20	30	45
24	3-2/10	5	6-1/4	10	12	15	20	20	30	40
25	3-2/10	5	6-1/4	10	12	15	15	20	25	40
90	8/10	1-1/4	1-8/10	2-1/2	3-1/2	4-1/2	5	6-1/4	9	12
95	8/10	1-1/4	1-6/10	2-1/2	3-1/2	4	5	6	8	12
100	8/10	1-1/4	1-6/10	2-1/2	3-2/10	4	5	5-6/10	8	12
110	3/4	1-1/8	1-1/2	2-1/4	3	3-1/2	4-1/2	5	7-1/2	10
115	6/10	1	1-4/10	2	2-8/10	3-1/2	4	5	7	10
120	6/10	1	1-1/4	2	2-1/2	3-2/10	4	4-1/2	6-1/4	10
220	3/10	1/2	3/4	1-1/8	1-1/2	1-8/10	2-1/4	2-1/2	3-1/2	5-6/10
230	3/10	1/2	6/10	1	1-4/10	1-8/10	2	2-1/2	3-1/2	5
240	3/10	1/2	6/10	1	1-1/4	1-6/10	2	2-1/4	3-2/10	5

If the rated secondary current is less than 9 amps, the maximum rating of the overcurrent device is 167%.
If the rated secondary current is 9 amps or more, the maximum rating of the overcurrent device is 125%.
If 125% does not correspond to a standard fuse rating, the next highest standard rating may be used.
Reference: NEC 430 - 72(c) exception #2, 450 - 3(b) 1 & 2, UL508 32.7, UL845 11.16 & 11.17.

Notes

Understanding Transformer Noise

FEDERAL PACIFIC

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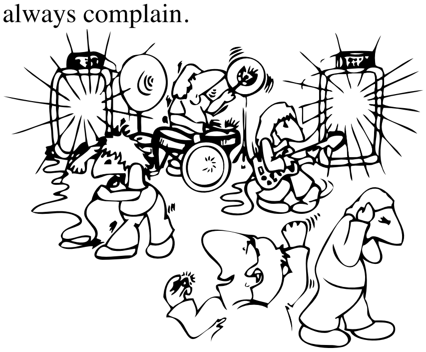
UNDERSTANDING TRANSFORMER NOISE

Noise is defined as unwanted sound. But, what is unwanted sound? A mellow sound to some, can be completely unacceptable to others. Attending rock concerts with noise levels at eardrum rattling levels is totally stimulating to many people. Put those same people in a different environment, possibly next to a transformer, and there will be wild protestations. The difference then between noise and sound is in the "ear of the hearer". Since it is necessary to place electrical apparatus alongside a wide spectrum of people we have to accept the inevitable, that even under normal conditions, somebody will always complain.

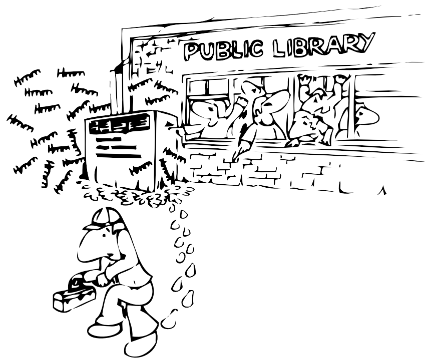


Transformer "humming" has been known to soothe people (which makes it a sound) but generally it is reckoned to be a nuisance (which makes it a noise).

The causes and reduction of transformer noise has been the subject of many learned papers for at least two generations. It has come to prominence again, mainly because transformers are placed closer to the populace—in high rise office buildings, apartments, shopping malls and in their gardens. It is becoming even more necessary to locate these units carefully and some planning, preferably ahead of time, is needed.

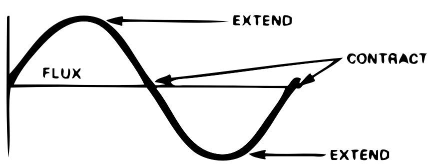
The remedies we use to counter possible objections to transformer noises are varied and in some cases, expensive, because we cannot produce a blanket remedy to cover all situations. It is absolutely necessary to consider each case on its merits, to apply the general rules of acoustic technology and to be familiar with the causes of transformer noise. The techniques can be explained simply enough for anyone to understand and the rules are, in the main easy to apply.

The BEST RULE however is to PLAN AHEAD. Finding out you have a noise problem (or vibration problem) after the placement of the unit is costly, time consuming and frustrating.



WHAT MAKES A TRANSFORMER HUM?

Transformer noise is caused by a phenomenon called magnetostriction. In very simple terms this means that if a piece of magnetic sheet steel is magnetized it will extend itself. When the magnetization is taken away, it goes back to its original condition. A transformer is magnetically excited by an alternating voltage and current so that it becomes extended and contracted twice during a full cycle of magnetization.



This extension and contraction is not uniform, consequently the extension and contraction varies all over a sheet.

A transformer core is made from many sheets of special steel. It is made this way to reduce losses and to reduce the consequent heating effect. If the extensions and contractions described above are taking place erratically all over a sheet, and each sheet is behaving erratically with respect to its neighbor, then you can get a picture of a moving, writhing construction when it is excited. Of course, these extensions are only small dimensionally, and therefore cannot usually be seen by the naked eye. They are, however, sufficient to cause a vibration, and as a result noise.

The act of magnetization by applying a voltage to a transformer produces a flux, or magnetic lines of force in the core. The degree of flux will determine the amount of magnetostriction (extensions and contractions) and hence, the noise level.

REDUCING TRANSFORMER NOISE AT THE SOURCE

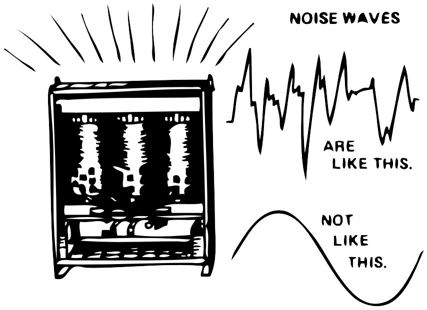
The obvious question is why not reduce the noise in the core by reducing the amount of flux. Why? Because it is not that simple.

Transformer voltages are fixed by system requirements, and the amount of magnetization, by the ratio of these voltages to the number of turns in the winding. The decision on what this ratio of voltage to turns will be, is made for reasons, mainly economic. It means that the amount of flux at the normal voltage is invariably fixed, thus setting the noise and vibration level. Also, increasing (or decreasing) magnetization does not increase or decrease the magnetostriction by the same amount. In technical terms the relationship is not linear. Therefore, when we are asked, as we invariably are,– "can you reduce the noise level at the source?" – the answer is that it can be done, at a cost and for not much improvement in noise level.

TRANSFORMER NOISE FREQUENCIES

We have established that the transformer hum is caused by the extension and contraction of the core laminations when magnetized. Under alternating fluxes, we can expect this extension and contraction to take place twice during a normal voltage or current cycle. This means that the transformer is vibrating at twice the frequency of the supply, i.e. for 60 cycles per second supply frequency, the noise or vibration is moving at 120 cycles per second. This is called the fundamental noise frequency.

Nothing in this world is ever perfect and so it is with transformer cores. Since the core is not symmetrical and the magnetic effects do not behave in a simple way, the resultant noise is not pure in tone. That is the noise or vibration produced is not only composed of a 20c/s frequency, we find from practical work that transformer noise is made up of frequencies of odd multiples of the fundamental known as 1st, 3rd, 5th and 7th harmonics.



This means we get noise frequencies of 120 (1st), 360 (3rd), 600 (5th), 840 (7th) cycles per second. They are not equally important for we find that the first and third harmonics predominate and produce most of the transformer sound.

It is important to know this because, with this knowledge, we can measure the amount of noise at these frequencies and determine whether amongst a number of other noises, we really are picking up a transformer noise.

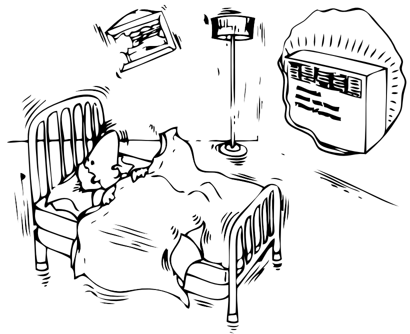
WHAT ABOUT A TRANSFORMER ON LOAD?

It is usually asked – "what proportion of the transformer noise is contributed by the windings and does the noise increase as the load increases?". There are, of course, mechanical forces existing between individual conductors in a winding when the transformer is excited. These forces will produce a vibration and a noise, but only one which is pure in tone, i.e. at twice the exciting frequency –120 cps. This, however, is swamped by the fundamental and harmonics produced by the core.

The difference between no load and full load, at constant flux density is usually no greater than 1 or 2dB. An exception to this is when special flux shields are placed inside a transformer tank to reduce stray flux effects.

VIBRATION-DON'T FORGET IT

It has been explained that the noise from a transformer is caused by mechanical movement of the individual lamination of the core under magnetization. The pulsation will cause not only air disturbances, thus producing noise, but also physical vibration of the core structure and everything attached to it. The vibration will have similar frequencies to those measured in the noise analysis.



Reducing (attenuating) these mechanical pressure pulsations is vital to noise and vibration control and consequently, isolating the core and coils of a transformer, either in the tank or through a tank, or just as the core and coils, is important. Baffling transformer noise and forgetting to isolate the vibrations will only lead to a disappointing result and is something which should not be done.

Remember noise is usually air borne. Vibration is ground borne. They are very much connected.

LET US STOP AND SUMMARIZE

- Transformer noise is produced by the core.
- The amount of noise is generally fixed by the design of the transformer.
- Adjustments to a design to reduce the noise level can be made at cost but don't expect a large reduction in the noise level.
- Loading a transformer has little effect on the noise level.
- Vibrations are produced as well as noise and these are just as important as the noise.

TRANSFORMER TYPES

We have established that the core and coils of a transformer will, when magnetized, produce a hum (noise) and mechanical vibrations, but, the transformer category will also have an effect on what happens once the noise and vibration is produced.

There are three basic categories currently in use:

- Those immersed in liquids - oils, silicones, etc.
- Those immersed in vapors and gases – nitrogen, fluro-carbons, etc.
- Those mounted in air.

A basic statement can be that irrespective of how transformer core and coils are surrounded, noise and vibration will still be transmitted. Oil is incompressible, and gas and air, we know, transmit sound very effectively. Until we put units in absolute vacuums, we have to accept that they will transmit sound almost as if all were in air.

However, each type requires special consideration and treatments, and it is important that these are understood. Transformer size, requirements, and it is important that these are understood. Transformer size, requirements and applications will determine more exactly where and how a transformer is placed, but there are certain treatments which are common to all type. First, let us consider how transformer noise is measured.

MEASURING TRANSFORMER NOISE

We talk about dB's (decibels) but what do they really mean? In simple terms, we are trying to take what we hear and relate it to scientifically measurable terms. The decibel as used in acoustics is a measurement comparing the pressure generated by a noise against some standard level. These decibels will vary according to the frequency of the noise, but this is taken care of in the noise level meter.

We refer to dB. The "A" part refers to a position on a sound level meter which more closely follows the human ear. It is important when taking measurements to specify if the noise level was taken on the "A" weighted scale.

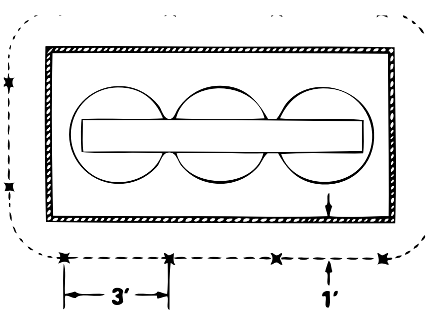
Since the transformer is not necessarily symmetrical, we cannot take one reading of noise level from a sound level meter and call the noise level of the unit. It is necessary to take many readings around the transformer and to average them. The resultant will become the transformer noise level.

Standards are laid down on how this should be done. The main ones are ANSI Standard C57-12-90 or NEMA Standard TRI-2-068-1954.

What happens is that you imagine a string following the contours of the transformer. You step back 1 foot from that contour line with the unit excited at the normal voltage, and record a measurement. You take these measurements at 3 foot intervals along the imaginary string. The measurements are totaled and then averaged. The result is the transformer noise level.

To measure amounts of noise in each frequency range you need a frequency analyzer. This is a worthwhile acquisition.

It is always necessary to measure the background (ambient) noise level before you start and when you finish the tests. There has to be a difference between the ambient reading and the average noise level of 7dB or better, for it to be valid, otherwise you could be increasing the actual reading of the transformer. This sometimes makes night owls of the testers!



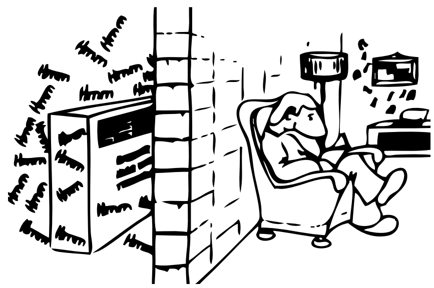
SO NOW WE KNOW WHERE THE NOISE COMES FROM AND HOW TO MEASURE IT. WHAT CAN WE DO ABOUT IT?

First of all, accept that there is a noise and you are stuck with it. We have to consider how to avoid making it a nuisance to people. The most obvious strategy is to place the transformer in a field miles away from habitation. The noise level drops away as the square of the distance from the noise, but even so, it would take a very large field to hide it. However, we invariably have to place transformers near people and we must face up to that fact.

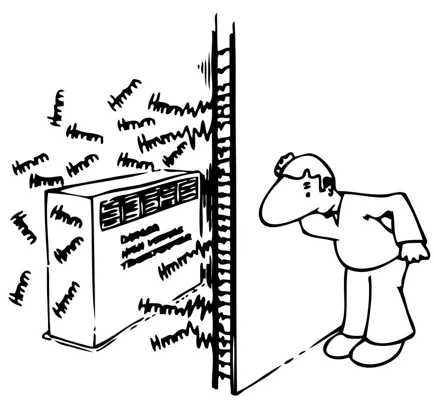
We have both noise and vibration to worry about and as we have said NOISE is usually air borne, VIBRATION is structure borne.

METHODS OF CUTTING AIR BORNE NOISE

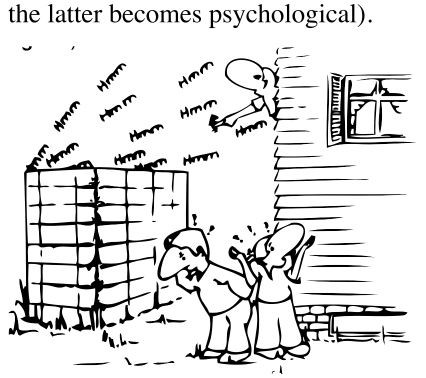
• Put the object in room in which the walls, floor are massive enough to reduce the noise to a person listening on the other side. Noise is usually reduced (attenuated) as it tries to pass through a massive wall. Walls can be of brick, steel, concrete, lead, etc.



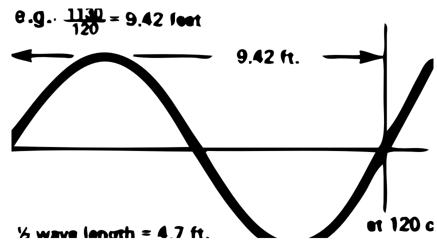
• Put the object inside an enclosure which uses a limp wall technique. This is a method which uses two thin plates separated by viscous (rubbery) material. The noise hits the inner sheet – its energy (some) is used up inside the viscous material. The outer sheet should not vibrate.



• Build a screen wall around the unit. This is cheaper than a full room. It will reduce the noise to those near the wall, but the noise will get over the screen and fall elsewhere (at a lower level). Screens have been made from wood, concrete, brick and with dense bushes (although the latter becomes psychological).



• Do not make any reflecting surface coincident with half the wave length of the frequency. What does this mean? Well, every frequency has a wave length. To find the wave length in air, for instance, you divide the speed of sound, in air (generally reckoned as 1130 feet/second) by the frequency.

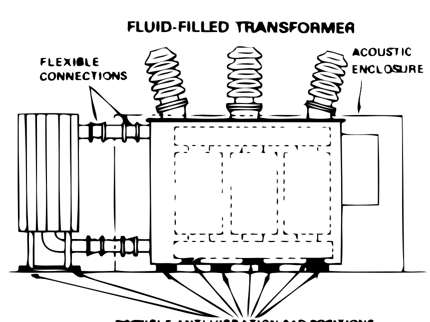


If a noise hits a reflecting surface at these dimensions it will produce what is called a standing wave. Standing waves will cause reverberations (echoes) and an increase in the sound level. If you hit these dimensions and get echoes you have to apply absorbent materials to the offending walls (fiberglass, wool, etc.).

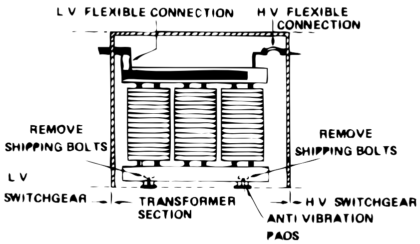
METHODS OF CUTTING STRUCTURE BORNE VIBRATION

• Isolate the core and coils of the transformer from the ground. In air cooled dry types this means to isolate the core and coil from its support on the ground. For an oil filled unit it means to isolate the core and coil from its tank base, and isolate its tank base from the supporting ground.

• Use isolating materials guaranteed to eliminate transformer frequencies (at 120 cps upwards). This is important. Not many materials can do this. Seek advice on the best anti-vibration pads to use.

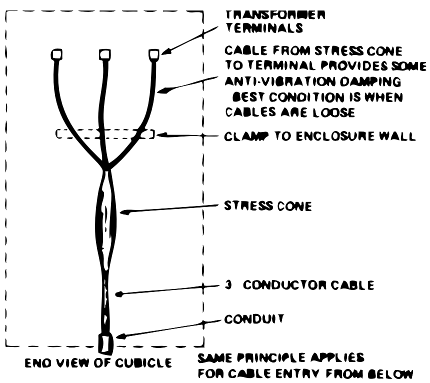


TYPICAL TRANSFORMER CONNECTIONS — DRY-TYPE TRANSFORMERS



• Make sure all connections to a solid reflecting surface are flexible. This includes incoming cables, busbars, stand off insulators, etc. Any solid connection from the vibrating transformer to a solid structure will transmit vibration.

TYPICAL ARRANGEMENT FOR H. V. ENTRY FROM BELOW



- Make sure shipping bolts are removed so that they do not short circuit anti-vibration pads.
- Additional information is given in ANSI C57.94, Section 4.10.

WHAT CAN THE MANUFACTURER DO?

The manufacturer must first insure that he achieves the noise level as specified by the appropriate specification. If something unusual is required by way of a very low noise level then there should be discussions and agreement between the manufacturer and the user, as to what steps to take. Remember the only course left to the manufacturer is usually to lower the flux density and this means increased cost. There have to be trade-offs between cost and noise annoyance or treatments.

If the manufacturer is only supplying core and coils, then what happens next is in the hands of the user, assuming all noise level requirements have been met. If the core and coil is mounted in a containing cabinet then the manufacturer has some precautions to take.

He must insure that the core and coils are correctly resiliently mounted, for it they are not, the noise level will increase. The stiffness of the mounts must be such that they do not weaken the installation by being too soft or spoil their attenuation properties by being too hard.

The choice of the resilient must be carefully considered. It has to absorb transformer frequencies which, by most commercial shock absorber systems are very low. "Shore" hardness (resilience), ability to withstand the environment and stiffness sufficient to carry the unit, are all important design parameters.

Busbar or other connections to the core must not transmit vibrations. Flexibility is the key. Ventilators must be carefully positioned. The core must be designed to avoid transformer frequencies of half wave-length dimensions, or multiples of these dimensions. If this cannot be achieved, then consideration of damping material applied to the case, is required. This is an added cost and must be part of the arrangement with the user.

Now comes the interface with the user. For shipment purposes, it is often necessary to "block out" the core and coils against the case, to avoid shipping damage. This can include holding down bolts which if left in a fastened condition, can short circuit the anti-vibration effects of the resilient mounts. The manufacturer can draw attention to these bolts by painting them with a florescent paint, and advising his customer to remove all such marked bolts before use. All other blocking and wedging, not part of the design, should be carefully removed since these might interfere with the vibration isolation. The user should be made aware of any of these requirements. After this, it is up to the USER!

WHAT CAN THE USER DO?

The user thinking should start at the conceptual stage. If he can, he must consider if he has a noise problem before he specifies his transformer. If he does, a noise survey including frequency analysis, would be advisable. If for instance, a building is only in the conceptual stage, then a little thought beforehand will make sure that transformers are not placed in small reverberant rooms next to a proposed board room, sleeping areas, study areas or other occupied areas where the normal sound level is low. Closets under stairs seem, very popular for dry type transformers – but are usually acoustically bad. Some discussion with the manufacturer is useful at this point.

A word of warning here. The noise level as measured and given by the transformer manufacturer is usually for the core and coils inside a cubicle. There is no way that the manufacturer can assess the effect on the transformer noise level by the location in which the unit will be place. It is advisable that if a user wants to maintain a particular noise level in a particular environment they should work backwards.

First of all assess what level is tolerable (say 65dBA). Allow for the effect of the room (say 3dB). Allow for the efficiency of all the connections (say 2dB) and as a result ask for a transformer to meet 60dBA! This will ensure that the required noise level is met. Advice on how to assess these corrections is available within Federal Pacific.

The design of the room to house the transformer is the next consideration. Avoiding half wave-lengths of transformer noise, or multiples thereof, is advisable. This includes dimensions in all directions, including the ceiling. If these dimensions cannot be avoided, then damping treatment is required remembering that transformer frequencies are involved. This is a caution against using acoustical treatments which are only effective for speech frequencies. Choose damping materials for the noise frequencies to be damped.

Isolation of the transformer from the ground is vital.

Installation instructions must ensure that nobody tightens down shipping bolts – but removes them. Connecting cables must be as flexible as possible. Ventilation ducts must be placed in positions where these are effective thermally without affecting the acoustic performance.

After taking all the precautions, a noise survey after installation, with the transformer excited might be useful.

The most profitable thing a USER can do is 'THINK AHEAD!"

Save money, time and future headaches by considering where to put a transformer and if necessary consult the manufacturer for advice. Do that even if is only to warn the manufacturer of an impending problem. It will avoid conflicts later on.

A SUMMARY - THE DO'S AND THE DON'TS

It might be useful to review the salient points and give some extra pointers:

1. **Transformer noise is difficult to change at the source.** Flux density reduction is the main thrust, but this means increased cost.
2. **Transformer core constructions help to a degree.** Reputable manufacturers will use good joints, flat steel, consistent thickness, good core supports, few bolts, etc.
3. **Transformer current loading has little or no effect** on the noise level.
4. **Placing transformers in liquid (oil) does not help** since oils are incompressible.
5. **Vibration – isolating core and coils within a tank does assist vibration isolation** although isolation of the whole tank is still needed.
6. **Noise reduction by distance is the simplest form of attenuation.** If it can be achieved without cost– excellent. Usually it cannot.
7. **Noise reduction by screens, bushes, etc., is the next simplest** but use should be made of the topography of the site. Remember the shadow effect means the noise could be heard outside the shadow of that screen.
8. **Full enclosure is usually the only option left to a troublesome transformer.**
9. **Full enclosure can be made of any material with a high mass/weight ratio.** Brick, concrete, steel have been used. Expect 25-30dBA reductions.
10. **Full enclosures using masonry products are not easily demountable.** Prefabricated concrete block is the best for this application.
11. **Steel, mass or limp panel techniques make good demountable enclosures.** A 15 – 20dBA reduction is possible with properly designed enclosures.
12. **External cooling to the enclosure requires flexible treatments to the connecting pipework.**
13. **Enclosure mounts should be separate from the transformer base – or at least, isolated somehow.**
14. **All connections - cables, etc. to enclosed transformers should be flexible.**
15. **Remember bushings vibrate and losses (acoustic) are experienced through them.** Flexible acoustic protection between enclosure and bushings are needed.
16. **Bushings used in an enclosure might have to have a longer ground sleeve to accommodate the enclosure roof distances.**
17. **Pay close attention to access doors and removable covers on enclosures.** Tight fits are essential.
18. **Watch the dimensions of rooms in which units are mounted.** Damp them if necessary, suitable for transformer frequencies.
19. **Damping materials are needed if standing waves or reverberations are possible.**
20. **Choose damping materials compatible with trans former frequencies.**
21. **If steel plates are used for enclosures** ensure that they are gasketed. Isolate the fastening down bolts.
22. **Carry out sound surveys before and after installations.** Remember to do a frequency analysis so that transformer noise can be differentiated.
23. **Anticipate transformer noise problems when accommodating them inside a building -** especially for dry types.
24. **Pay careful attention to removing unnecessary bolting or stiffening used originally for shipping.** Make sure the manufacturer identifies what can and cannot be used or removed.
25. **Remember transformers need cooling air in rooms.** Be careful (acoustically) when you position air ducts, ventilators and grilles, etc.
26. **Pay attention to flexible connections inside rooms containing transformers.**
27. **Make sure the vibration isolators are correctly mounted** and will accommodate transformer frequencies.
28. **Select rooms which are not near potential complaint areas.**
29. **Check the voltage on the system.** Increased flux density by having a higher than normal system voltage will raise the noise level.
30. When assessing the required noise level of a transformer work backwards from the required noise level at a location. Consider the inefficiencies of the site.
31. Consider very carefully where transformers will be mounted. Resilient structures such as wooden mezzanines might be harmful.

It has not been possible to give all the points and suggestions that might assist a user in producing a trouble free (noise) site. However, we are always available for assistance.

The purpose of this leaflet is to make people aware of the important points. If we have encouraged users to plan ahead with their noise problems then we have succeeded.

ABS Type Approved or Unit Certified Transformers

Proudly Manufactured in the United States for Offshore Mobile Drilling Units and Shipboard Applications

Federal Pacific Transformer has exceeded basic ABS quality requirements with both an RQS and PQA rating. The RQS (Recognized Quality System) rating acknowledges Federal Pacific as a world class ISO 9001-2008 manufacturer. The PQA (Product Quality Assurance) rating is a higher quality rating which allows Federal Pacific to perform tests and surveys on products without the need for an onsite ABS surveyor.

Commercial Ship Applications

- Type FH, 600 VAC, Single-Phase and Three-Phase Transformers
  - Distribution
  - Motor Drive Isolation
  - 12-24 Pulse Source for Rectification Circuits
- Medium Voltage Dry-Type Transformers, 5-15 kV, BIL Ratings 30-95 kV
  - Unit Substation
  - Rectifier Applications
  - High Voltage General Purpose

Off and Near Shore Applications

ABS
TYPE APPROVED PRODUCT

ABS Certified Marine-Duty Transformers

Medium Voltage and Low Voltage Dry-Type Transformers for Marine, Petro-Chem and Offshore Applications

The harsh marine environments found onboard commercial and military ships, offshore oil rigs and near-shore operations require Federal Pacific's ABS Certified Type Approved Dry-Type Transformers.

For more than 36 years, Federal Pacific has been designing and manufacturing transformers and substations for use throughout the world in some of the harshest environments, underground and above ground. The ABS Type Approved Dry-Type Transformer is a product of the same ISO 9001-2000 manufacturing facility and staff of experienced engineers. ABS Certification parallels Federal Pacific's UL® Certification for Low Voltage and Medium Voltage Transformers. Federal Pacific's Medium Voltage Transformers are currently installed aboard commercial and military ships, in shipyards, critical industrial locations and in underground mining operations covering a wide spectrum of severe environments.

Technical Specifications	
kVA	Up to 7500
Primary Voltage	600 to 15,000
Secondary Voltage	Up to 15,000
Primary BIL	10 kV to 95 kV
Winding Material	Copper or Aluminum
Insulation System	220° C
Winding Temperature Rise	80° C, 115° C, 150° C,
Minimum Ambient Temperature	-40° C
Operation Environment	2005 Steel Vessel Rules 1-1-4/3.7; 4-8-2/3.7.2 & 5.1.2; 4-8-3/7; 4-8-5/3.7.5 & 5.17.10; 2001 MODU Rules 4-3-4/9

2500 KVA, Three Phase, 60 Hz ABS Certified Transformer, 6600-Volt Delta Copper Primary - 480 Volt Delta Copper Secondary With Custom Primary Take-Off, Custom Base Designed for Installation on Customer Platform and Door Mounted Heater Controls.

Repair, Rebuild, Refurbish, kVA Upgrade, Voltage Upgrade

Quick Turnaround ISO 9001 Registered Facility
Built and Tested to IEEE C57 12.01 and IEEE C57 12.91

Federal Pacific will refurbish, repair and upgrade medium-voltage ventilated dry transformers from 15 KVA through 3750 KVA with HV ratings @ 5, 15, 25, and 35 kV having BIL ratings of 30 kV - 150 kV.

Large KVA 600V transformers in the range of 300-1500KVA are also economical to repair.

When the transformer inside your facility:

- Has failed.
- Requires higher efficiency
- Requires an increased KVA output
- Requires new high voltage from 4160 to 13800 or similar
- Needs a back-up core & coil
- Is a Liquid or PCB Filled Transformer

Then, Federal Pacific will have your answer.

To repair, rebuild or upgrade your existing dry-type transformer, Federal Pacific will need the basic rating information contained on the transformer's nameplate.

A repaired, refurbished or upgraded transformer is not subject to the DOE transformer efficiency guidelines that went into effect for Low Voltage on January 1, 2007 and the DOE efficiency Medium Voltage guidelines that will go into effect on January 1, 2010.

When a Transformer Has Failed
Critical data needed is indicated on the Nameplate Form shown on page 122. Contact Federal Pacific to obtain a RMA for sending the Transformer to the Bristol factory for repair.

Federal Pacific will offer recommendations with estimated repair costs and turnaround times, usually within 24 hours from receiving your information.

Upgrade - Efficiency
Also, it may be possible, while keeping the original core, to design the repaired transformer to have lower core losses than the original transformer.

Upgrade - KVA
Historically, one of the strong incentives for repairing a transformer is to increase the KVA power output of the unit. With today's high temperature, 220° C insulation materials, and better knowledge of duct spacing and coil construction Federal Pacific can provide an increased KVA rating or a rewound transformer with a longer life expectancy than the original design. Sometimes this increased KVA output will have to be achieved by increasing the average winding temperature rise or by substituting copper conductor for aluminum.

Upgrade - Voltage (4160 → 13,800)
In some cases the utility plans to increase the service voltage to a facility, typically from 4160 volts to 13,800 volts. In this situation the 4160 volt transformer has to be replaced or converted to the higher voltage, say 13,800 volts. Or perhaps the closing of a plant in another location has left the customer with an unusable transformer that has the wrong voltage. Federal Pacific in most cases can rebuild the existing transformer with the required **higher voltage** ratings and higher BIL without having to reduce the KVA output.

Wherever possible, Federal Pacific will work toward providing **increased KVA, increased Efficiency, and upgraded Voltage Rating** during the repair of the defective transformer.

Core and Coil Back-Up
For critical loads being served by a medium-voltage dry-type transformer in your facility, you can have Federal Pacific build a "duplicate" back-up core and coil that can quickly replace the present core and coil, should it fail.

Liquid Filled or PCB Replacement
Federal Pacific can replace your present liquid-filled transformer with a ventilated dry-type transformer having a higher temperature rated insulation system that contains **no** liquid and **does not** require the EPA Spill Prevention Control Countermeasures (SPCC) plan.

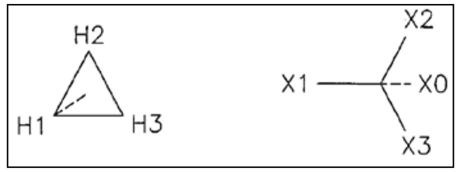
Level of Repair, Rebuild, Replacement
1. **Basic Repair** (fix only the defective coil(s). In this instance only the activities related to "fixing" the damaged coil(s) will be undertaken.

2. **Replacing all coils with brand new coils** and new bus, if required, and repainting the enclosure. For this level of refurbishing, Federal Pacific will bring the transformer back to "as new" condition with a standard repair warranty.

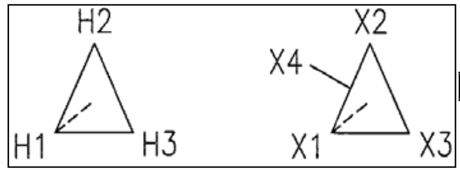
3. **Uprating the Efficiency, Voltages, and/or the Power KVA.** A standard repair warranty will be included with this level.

NAMEPLATE FORM

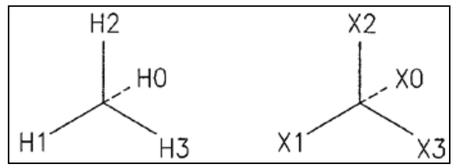
Transcriber's Manufacturer:



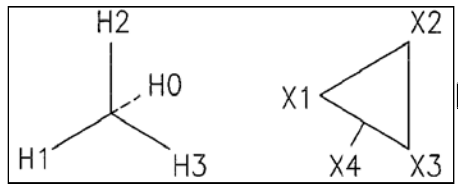
☐ **Delta Wye**



☐ **Delta Delta**



☐ **Wye Wye**



☐ **Wye Delta**

Transformer Manufacturer:

____

Rated KVA ____________________

Phase: ☐ Three ∅ (If 3 ∅ Check Diagram at Right)

☐ Single ∅

Pri Volts ____________________

Pri BIL ____________________

Pri Taps ☐ **Yes** ☐ **No**

Sec Volts ____________________

Sec BIL ____________

Temp Rise (°C) ☐ **150** ☐ **115** ☐ **80**

% Impedance ____________________________

Freq (Hz) ☐ **60** ☐ **50**

Windings ☐ **AL** ☐ **CU**

Approx. Weight (Lbs.) ____________________

Enclosure ☐ **Indoor**

☐ **Outdoor**

☐ **Other**

Other Information ________________________

____

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Terms and Conditions of Sale

These terms shall control the sale of all products of Electro-Mechanical Corporation and its divisions: Federal Pacific Company, Federal Pacific Transformer Company, Line Power Manufacturing Corporation, Electric Motor Repair and Sales, and PRJ (herein collectively "The Seller"). Purchaser's order is expressly subject hereto, and Purchaser accepts these Terms and Conditions which may not be changed except in writing signed by an authorized official of the Seller. Additional or different terms in any documents or communication from Purchaser are objected to by Seller and shall not be effective unless expressly agreed to in writing by an authorized official of Seller.

Warranties: Seller warrants that the product(s) to be delivered will be of the kind and quality described in its quotation and that Purchaser shall take good and merchantable title. Services rendered shall be performed in a workmanlike manner and shall comply with industry standards and/or customer specifications. No other warranties, express, or implied, shall arise from this transaction. If a deviation from the specifications in the quotation appears within the warranty period, the Purchaser shall notify the Seller immediately. Upon notice and confirmation of the defect, Seller agrees to remedy, F.O.B. factory, all such defects by repair or replacement of the defective parts without charge. The warranty shall not cover "in and out" charges, which shall remain the responsibility of the Purchaser.

THIS WARRANTY SHALL BE IN LIEU OF ALL OTHER WARRANTIES OF ANY SORT, EXPRESS OR IMPLIED, NOTWITHSTANDING ANY PURPORTED TERMS PRINTED ON ANY DOCUMENTS PREPARED BY PURCHASER IN CONNECTION WITH THE SALE.

The warranty shall not apply to, and Seller shall bear no responsibility for, any product:

1) that has been subject to accident, negligence or misuse, including the effects of transient voltage or attempts to operate the product above rated capacity;
2) that has not been properly installed; or
3) that has been the subject of repairs or modifications accomplished by other than the Seller's factory representative.

This warranty shall extend for a period of twenty-four (24) months from date of shipment for pad-mounted switchgear and twelve (12) years from shipment for stock low voltage transformers. For all other products, it shall extend for a twelve (12) month period from the date of shipment. The warranty shall apply to products and parts manufactured or repaired by the Seller. Products which Seller furnishes, but does not manufacture, carry only the warranty of the original manufacturer of such products. Where other manufacturers' or suppliers' products used in Seller's products prove defective, Seller's liability shall exist only to the extent that Seller is able to recover for the defect from such manufacturers or suppliers.

Compliance with Standards and Regulations: The Seller's products, as built, are intended to comply with ANSI and NEMA standards, MSHA regulations, and other Federal laws and regulations as each may apply to the respective product(s). Seller is willing to comply with other local, state and foreign laws, regulations or standards that may be deemed applicable to the respective products, but will only accept this responsibility upon written notification from Purchaser, prior to order acceptance, of the existence and requirements of such laws, regulations, or standards and written acceptance from an authorized official of Seller setting forth the conditions, if any, for such compliance.

Limitation of Liability: Seller's liability for any claim of any kind shall not exceed the purchase price of the product(s) furnished or the purchase price of the portion of such product(s) which gives rise to the claim. In no event shall the Seller be liable for special, indirect, incidental, or consequential damages, including, but not limited to, loss of profits or revenue; loss of use of equipment or any associated equipment; cost of capital; cost of substitute equipment, facilities or services; or lost value added to the product(s) after receipt and acceptance by the customer.

UNDER NO CIRCUMSTANCES SHALL SELLER BEAR RESPONSIBILITY FOR ANY PENALTIES OR LIQUIDATED DAMAGES UNLESS THAT LIABILITY SHALL BE ACCEPTED IN WRITING THAT MAKES SPECIFIC REFERENCE TO THE TRANSACTION CONTEMPLATED, THAT ITEMIZES THE EXTENT OF THE PENALTY OR LIQUIDATED DAMAGES TO BE ACCEPTED, AND THAT IS SIGNED BY AN AUTHORIZED OFFICIAL OF THE SELLER. NOTWITHSTANDING THE EXISTENCE OF SUCH AN AGREEMENT ON LIQUIDATED DAMAGES, THE FORCE MAJEURE PROVISIONS OF THE FOLLOWING PARAGRAPH SHALL APPLY IN ALL EVENTS.

Seller shall have no responsibility for the cost of any repairs performed by persons other than a factory representative or such independent contractors as may be designated in writing in advance by an authorized official of the Seller.

Force Majeure: The Seller shall not be liable for loss, damage, detention and delay resulting from causes beyond its reasonable control or caused by fire, strike or other labor disturbances, civil or military authority, restrictions of any government or department, branch or representation thereof, insurrection or riot, embargoes, wrecks or delays in transportation, or inability to obtain necessary labor or materials due to failure of suppliers to perform or other causes beyond Seller's reasonable control. In the event of the occurrence of such events, extraordinary measures will be undertaken by Seller only upon Purchaser's written request and agreement to bear the extra expense incurred.

Seller reserves the right to furnish suitable substitutes which cannot be obtained for any of the causes set forth above.

Taxes: Prices as quoted are exclusive of all taxes which may relate in any way to the transaction. In addition to any price specified, Purchaser shall pay any present or future sales, use, excise, value added or similar tax applicable to the price, sale or delivery of any products furnished.

Cancellation: An order may only be terminated upon written consent of the Seller and payment of reasonable termination charges.

Pricing and Escalation Policies: Published prices are subject to change without notice. Quoted prices are firm for acceptance within thirty (30) days from the date of quotation, or such longer period as may be specified in the quotation, but may be withdrawn upon notice.

All catalog and quoted pricing shall be in U.S. Dollars.

If delay is requested beyond the normal delivery period, the price quoted shall escalate at the rate of 1-1/2% per month or prorate part of any month for the time of the delay. Orders amounting to less than $100.00 net will be billed at $100.00 PLUS TRANSPORTATION COSTS.

Prices quoted do not include costs of installation, training, start-up service, coordination, or other on-site services. Such items may be included or quoted separately upon request.

Payment/Credit Terms: Terms are net within thirty (30) days from date of invoice unless otherwise specifically agreed in writing. If, in the discretion of the Seller, the financial condition of the Purchaser does not justify the terms of payment specified, the Seller may require other conditions including but not limited to full or partial payment in advance. The product shall remain the personal property of the Seller until full payment is received. A late charge at the rate of one and one-half percent (1-1/2%) per month will be applicable to past due balances. If shipment is delayed by the Purchaser, the invoice shall issue when Seller is prepared to ship. In the event of default, the Purchaser shall be responsible for all collection costs and reasonable attorney's fees incurred by the Seller. If the Purchaser is not a corporation, the Homestead Exemption is hereby waived. Any disputed amount reflected on the invoice must be directed to the attention of: Controller, Electro-Mechanical Corporation, P.O. Box 8200, Bristol, VA 24203-8200. Payment of other than the exact amount invoiced shall not be deemed satisfaction unless authorized in writing by the Controller.

Delivery and Storage: Delivery shall be made F.O.B. point of shipment with freight prepaid and added to invoice unless otherwise specified in the quotation. Shipping dates in the quotation are approximate and are based upon prompt receipt of all necessary information from Purchaser. Any delay in receipt of complete information shall extend the delivery date for a reasonable time based on the condition of the factory.

Risk of loss or damage shall pass to Purchaser at delivery to the carrier. The Seller takes great care in packing its products and shall not be responsible for breakage or damage in transit after having received "in good order" receipts. Seller will, however, give assistance to Purchaser in any effort to secure a satisfactory adjustment of any claim.

Equipment on which manufacture or delivery is delayed due to any cause beyond Seller's control may be placed in storage by Seller for the Purchaser's account. All risk of loss, charges, and expenses in connection therewith shall be borne by purchaser. However, if in Seller's opinion, it is unable to obtain or continue with such storage, Purchaser will, upon notice, provide or arrange for suitable storage facilities and assume directly all costs and risk connected thereto.

Changes In Specifications: Changes or revisions from specifications upon which the quotation is issued shall be charged to and paid by the Purchaser at the Seller's applicable rates. The Seller's time for performance shall be extended to cover any additional design or production time necessitated by changes requested. Purchaser shall hold Seller harmless from any and all claims, liability, and damage arising from any such extension.

Returns: Products may be returned only with Seller's prior written consent. Only upon return, the material will be inspected and maximum possible credit — less allowance for freight, restocking, restoration to first-class condition, non-stock parts and obsolescence — will be allowed. Unauthorized returns shall remain the property of the Purchaser, and Seller shall have no responsibility for any loss or damage thereto.

Only unused transformers as currently manufactured which have been invoiced to the Purchaser within one (1) year prior will be considered for return. For all other products this return consideration period shall be ninety (90) days from invoice.

Seller reserves the right to refuse any material returned for credit if factory conditions warrant the refusal. Material built to order is not subject to return for credit.

Full credit including all transportation charges will be allowed on returns caused through the fault of the Seller.

General: All orders and contracts are subject to acceptance by Seller at its factory.

Seller reserves the right to correct all clerical and stenographical errors or omissions in quotations, acknowledgments, invoices, and other documents of sale.

Catalog-listed weights, dimensions, and other such specifications are approximate, subject to change without notice, and are not guaranteed.

Any controversy arising under this agreement shall be controlled by the law of the State of Virginia and the exclusive forum for the filing of any litigation shall be in the courts of the City of Bristol, Virginia.

SF 40T103
Rev. 03/06/2012

GLOSSARY

A

Air-Cooled - A transformer cooled by the natural circulation of air over and/or through the core and coils or forced air by using fans.
Ambient Noise Level - The sound level of the surrounding area of a transformer as measured in decibels.
Ambient Temperature - Temperature of the surrounding air which comes in contact with the transformer.
Ampere - Unit of current flow.
ANSI - American National Standards Institute.
ANSI-61 - A light grey paint used on dry type transformers.
ASTM - American Society for Testing Materials.
Autotransformer - A transformer in which at least two windings have a common section.

B

Banked Transformers - When two or more single-phase transformers are connected together to supply a three-phase load.
BIL -Acronym for basic impulse insulation levels, a specific insulation level expressed in kilovolts of the crest value of a standard lightning impulse.
Buck-Boost Transformers -An insulating transformer which has two primary windings and two secondary windings. These windings can be interconnected so that the transformer will be changed from an insulating transformer to a "bucking" or "boosting" autotransformer.

C

C° - Temperature in degrees Centigrade (Celsius).
Cast-coil Transformer - A transformer with coils cast in an epoxy resin.
Center Tap - A reduced-capacity tap at the mid-point in a winding.
Coil - A number of turns of wire wound on a form.
Conductor Losses - Losses caused by the resistance of a transformer winding, measured at 25, 50, 75, and 100 per cent of load.
Continuous Duty - A requirement of service that demands operation at a constant load for an indefinite period.
Continuous Rating - The load that a transformer can handle indefinitely without exceeding the specified temperature rise.
Control Transformer - A transformer which is designed for good voltage regulation characteristics when low power factor, large inrush currents are drawn.
Core - The steel which carries the magnetic flow.
Core Loss - Losses caused by a magnetization of the core and its resistance to magnetic flux.
Current Transformer - A transformer designed to have its primary winding connected in series with the circuit and used for transforming current into a value suitable for measurement of control.

D

Decibel - (DB) The standard unit for the measurement of sound intensity.
Delta - (Δ) A standard three-phase connection with the ends of each phase winding connected in series to form a closed loop, 120 degrees from the other.
Delta-Wye - (Δ-Y) A term used indicating the method of connection for both primary (Δ) and secondary (Y) windings of a three-phase transformer bank.
Dielectric Test - A test conducted at higher than rated nameplate voltage to determine the effectiveness of insulating materials and electrical clearances.
Distribution Transformer - A transformer for transferring electrical energy from a primary distribution circuit to a consumer service circuit.
Dry-Type Transformer - A transformer that is cooled by air as opposed to a transformer that is immersed in oil.
Dual Winding - A winding that consists of two separate windings connected in series to handle a specific voltage and KVA, or in parallel to handle the same KVA at one half the series connected voltage.

E

Electrostatic Shield - A grounded conductor sheet placed between the primary and secondary winding to reduce or eliminate line-to-line or line-to-ground noise.
Exciting Current - (No-Load Current) Current which flows in any winding used to excite the transformer when all other windings are open-circuited, expressed in per cent of the rated current of a winding.

F

FCAN - Full capacity above normal taps.
FCBN - Full capacity below normal taps.
Fan Cooled - A mechanical means of accelerating heat dissipation to lower the temperature rise of the transformer.
Frequency - The number of times an AC voltage will alternate from positive to negative and back again within a specified period of time, expressed in cycles per second and identified as Hz.
Full Capacity Tap - A tap designed to deliver the rated capacity of the transformer.

G

Ground - Connected to earth or to some conducting body that serves in place of earth.
Grounding Transformer - A special three-phase autotransformer for establishing a neutral on a three-wire delta secondary. (Also referred to as a "zig-zag transformer".)

H

Hertz - A term meaning cycles per second, abbreviated Hz.
High Voltage Windings - A term applied to two winding transformers, designates the winding with greater voltage, identified by H1, H2, etc.
Hi Pot - A standard test on dry-type transformers consisting of extra-high potentials (high voltage) impressed on the windings.

I

IEEE - Institute of Electrical and Electronic Engineers.
Impulse Tests- Dielectric tests consisting of the application of a high-frequency steep-wave-front voltage between windings and between windings and ground. (Used to determine BIL.)
Impedance - The vector sum of resistance and reactance which limits the current flow in an AC circuit. Impedance is identified in percentage and is used to determine the interrupting capacity of circuit breakers which protect the primary circuit. (Symbol Z)
Induced Potential Test - A standard dielectric test which verifies the integrity of insulating materials and electrical clearances between turns and layers of a transformer winding.
Insulating Materials - Those materials used to electrically insulate the transformer windings from each other and ground. (Rated 80° C rise, 115° C rise and 150° C rise.)
Insulating Transformer - A transformer that insulates the primary from the secondary winding. (Also called an isolating transformer.)

K

KVA - Kilovolt Ampere rating designates the output which a transformer can deliver at rated voltage and frequency without exceeding a specified temperature rise.

L

Line Conditioner - Portable or hard wire devices that will stabilize voltage, suppress electrical noise and act as surge suppressors against lightning discharges.
Liquid Transformer - A transformer with core and coils immersed in liquid (as opposed to a dry-type transformer).
Load - The KVA or VA requirement which the transformer must supply.
Load Losses - The losses which are the result of a current flowing to the load. Load losses would include all losses incurred above and beyond the no-load losses.

M

Mid-tap - A reduced-capacity tap midway in a winding, usually the secondary.
Multiple Winding - A winding which consists of two or more sections that can be paralleled for a specific mode of operation.

N

NEC- National Electric Code.
NEMA - National Electrical Manufacturers Association.
Noise Isolation Transformer - A transformer that is designed to provide both common and transverse mode noise attenuation.
Noise Level - The relative intensity of sound, measured in db.
No-Load Losses - The losses incurred when a transformer is excited but without a load connected to the secondary. These include core loss, dielectric loss, and exciting current I^2R loss.

O

OSHA - Occupational Safety and Health Act. Federal regulation setting minimum safety standards for compliance in industrial and commercial installations.

P

Parallel Operation - Transformers may be connected in parallel, provided that the electrical characteristics are suitable for such operation.
Percent IR - (%IR) Percent Resistance. The voltage drop due to conductor resistance at rated current expressed in percent of rated voltage.
Percent IX - (%IX) Percent Reactance. The voltage drop due to reactance at rated current expressed in percent of rated voltage.
Percent IZ - (%IZ) Percent Impedance. The voltage drop due to impedance at rated current expressed in percent of rated voltage.
Phase - Classification of an AC circuit. Usually, circuits are rated single-phase two wire or three wire or three-phase three wire or four wire. Single-phase transformers can be used on a three-phase source when two wires of the three-phase system are connected to the primary of the transformer. The secondary will be single-phase.
Polarity Tests - A standard test on transformers to determine instantaneous direction of the voltages in the primary compared to the secondary.
Potential Transformer - A transformer that is designed to have its primary winding connected parallel with a circuit and used for transforming voltage to a value suitable for measurement or control.
Power Conditioning - The means to correct voltage fluctuations and electrical noise problems common to incoming power sources.
Power Factor - The ratio of watts to volt amperes in a circuit. (% watts/VA)
Primary Voltage - The input circuit voltage for which the primary winding is designed.

R

Rating - The characteristics such as volt-ampere capacity, voltages, frequency and temperature rise that a transformer is designed to.
Ratio Test - A standard test of transformers to determine the ratio of the primary to the secondary voltage.
Reactance - A component of impedance produced by either inductance or capacitance in an AC circuit.
Reactor - A device for introducing inductive reactance into a circuit for motor starting, operating transformers in parallel and controlling current.
Regulation - The per cent change in output voltage from full load to no-load.

S

Scott Connection - A transformer connection usually used to get a two-phase output from the secondary of a transformer with a three-phase input to the primary or vice versa. It can also be used to provide three-phase to three-phase transformation.
Secondary Voltage Rating - Designates the load-circuit voltage for which the secondary winding is designated.
Series/multiple - A winding of two similar coils that can be connected for series operation or multiple (parallel) operation.
Star Connection - Same as WYE connection.
Step Down Transformer - High voltage winding is connected to the power source input and the low voltage winding to the output load.
Step Up Transformer - Low voltage winding is connected to the power source (input) and the high voltage winding is connected to the output load.

T

T-Connection - A Scott connected three-phase transformer utilizing two primary and two secondary coils.
Tap - A connection in a transformer winding which has the effect of changing the nominal voltage ratio of the transformer. (Taps are usually placed on the high voltage winding to correct for high or low voltage conditions found on the low voltage output side.)
Temperature Rise - The increase over ambient temperature of the winding due to energizing and loading.
Total Losses - Losses represented by the sum of the no-load and the load losses.
Transformer - A transformer is a static electrical device, which by electro-magnetic induction, transfers electrical energy from one circuit to another circuit, usually with changed values of voltage and current.

U

UL - Underwriters' Laboratories. Establishes standards for transformers.
Universal Taps - A combination of six primary voltage taps consisting of 4-2 1/2% FCBN and 2-2 1/2% FCAN.

V

Volt Amperes - The current flowing in a circuit multiplied by the voltage of that circuit. (The output rating of a transformer.)

W

WYE Connection (Y) - A three-phase connection in which similar ends of each phase winding are connected together at a common point which forms the electrical neutral and is often grounded.

Z

Zig-Zag Transformer - Commonly used term for a grounding transformer.