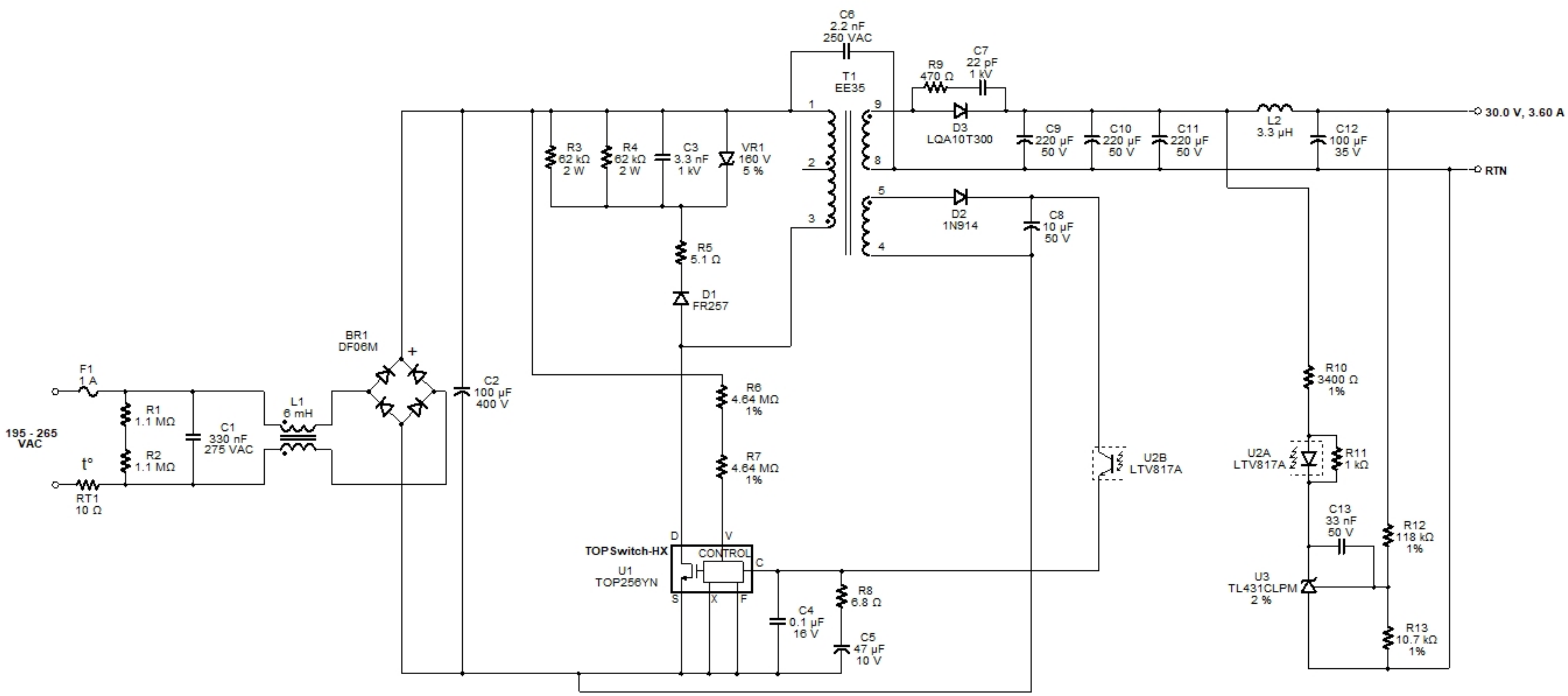


C6
2.2 nF
250 VAC
T1
EE35
R9
470 Ω
C7
22 pF
1 kV
D3
LQA10T300
30.0 V, 3.60 A
RTN
L2
3.3 µH
C9
220 µF
50 V
C10
220 µF
50 V
C11
220 µF
50 V
C12
100 µF
35 V
R3
62 kΩ
2 W
R4
62 kΩ
2 W
C3
3.3 nF
1 kV
VR1
160 V
5 %
1
2
3
9
8
5
4
D2
1N914
C8
10 µF
50 V
R5
5.1 Ω
D1
FR257
BR1
DF06M
+
F1
1 A
R1
1.1 MΩ
R2
1.1 MΩ
C1
330 nF
275 VAC
L1
6 mH
C2
100 µF
400 V
195 - 265
VAC
t°
RT1
10 Ω
R6
4.64 MΩ
1%
R7
4.64 MΩ
1%
R10
3400 Ω
1%
U2A
LTV817A
R11
1 kΩ
U2B
LTV817A
C13
33 nF
50 V
R12
118 kΩ
1%
U3
TL431CLPM
2 %
R13
10.7 kΩ
1%
D
V
TOPSwitch-HX
CONTROL
C
U1
TOP256YN
S
X
F
C4
0.1 µF
16 V
R8
6.8 Ω
C5
47 µF
10 V

## Power Supply Input

| Var | Value | Units | Description |
|---|---|---|---|
| VACMIN | 195 | V | Minimum Input AC Voltage |
| VACMAX | 265 | V | Maximum Input AC Voltage |
| FL | 50 | Hz | Line Frequency |
| TC | 1.98 | ms | Diode Conduction Time |
| Z | 0.63 | | Loss Allocation Factor |
| η | 82.0 | % | Efficiency Estimate |
| VMIN | 234.3 | V | Minimum DC Input Voltage |
| VMAX | 374.8 | V | Maximum DC Input Voltage |

## Input Section

| Var | Value | Units | Description |
|---|---|---|---|
| Fuse | 1.00 | A | Input Fuse Rated Current |
| IAVG | 0.56 | A | Average Diode Bridge Current (DC Input Current) |
| Thermistor | 10.00 | Ω | Input Thermistor |

## Device Variables

| Var | Value | Units | Description |
|---|---|---|---|
| Device | TOP256YN | | PI Device Name |
| BVDSS | 700 | | Drn-Src Bkdn Voltage |
| Device Mode | Default | | Current Limit mode for device |
| OVP_FLAG | NO | | Output Overvoltage Protection Enabled |
| PO | 108.09 | W | Total Output Power |
| VDRAIN Estimated | 604.75 | V | Actual Estimated Drain Voltage |
| VDS | 13.40 | V | On state Drain to Source Voltage |
| FS | 132000 | Hz | Switching Frequency |
| KP | 0.69 | | Continuous/Discontinuous Operating Ratio |
| KI | 1.00 | | Current Limit Reduction Factor |
| ILIMITEXT | 2.37 | A | Programmed Current Limit |
| ILIMITMIN | 2.37 | A | Minimum Current Limit |
| ILIMITMAX | 2.73 | A | Maximum Current Limit |
| PLIM_FLAG | NO | | Enable Overload Power Limiting |
| IP | 2.27 | A | Peak Primary Current (at VMIN) |
| IRMS | 0.96 | A | Primary RMS Current (at VMIN) |
| DMAX | 0.38 | | Maximum Duty Cycle |
| RTH_DEVICE | 11.92 | °C/W | PI Device Maximum Thermal Resistance |
| DEV_HSINK_TYPE | Aluminum Extruded | | PI Device Heatsink Type |
| DEV_HSINK_PN | 563202T00000 | | PI Device (Extruded) Heatsink Part Number |

## Clamp Circuit

| Var | Value | Units | Description |
|---|---|---|---|
| Clamp Type | RCD + Zener Clamp | | Clamp Circuit Type |
| VCLAMP | 95 | V | Estimated average clamping voltage |
| Estimated Clamp Loss | 1.75 | W | Clamp Dissipation |
| VC_MARGIN | 90.23 | V | Clamp Voltage Safety Margin |

## Bias Variables

| Var | Value | Units | Description |
|---|---|---|---|
| IB | 0.006 | A | Bias Current |
| PIVB | 70 | V | Bias Rectifier Max Peak Inverse Voltage |

## Transformer Construction Parameters

| Var | Value | Units | Description |
|---|---|---|---|
| Core Type | EE35 | | Core Type |
| Core Material | NC-2H (Nicera) or Equivalent | | Core Material |
| Bobbin Reference | Generic, 7 pri. + 7 sec. | | Bobbin Reference |
| Bobbin Orientation | Vertical | | Bobbin type |
| Primary Pins | 5 | | Number of Primary pins used |
| Secondary Pins | 2 | | Number of Secondary pins used |
| USE_SHIELDS | NO | | Use shield Windings |
| LP_nom | 428 | µH | Nominal Primary Inductance |
| LP_Tol | 10.0 | % | Primary Inductance Tolerance |
| NP | 34.2 | | Calculated Primary Winding Total Number of Turns |
| NSM | 8 | | Secondary Main Number of Turns |
| CMA | 425 | Cmils/A | Primary Winding Current Capacity |
| VOR | 135.0 | V | Reflected Output Voltage |

| | | | |
|---|---|---|---|
| BW | 15.70 | mm | Bobbin Winding Width |
| ML | 0.00 | mm | Safety Margin on Left Width |
| MR | 0.00 | mm | Safety Margin on Right Width |
| FF | 71 | % | Actual Transformer Fit Factor. 100% signifies fully utilized winding window |
| AE | 101.40 | mm² | Core Cross Sectional Area |
| ALG | 329 | nH/T² | Gapped Core Effective Inductance |
| BM | 2519 | Gauss | Maximum Flux Density |
| BP | 3033 | Gauss | Peak Flux Density |
| BAC | 871 | Gauss | AC Flux Density for Core Loss |
| LG | 0.353 | mm | Estimated Gap Length |
| L_LKG | 6.42 | µH | Estimated primary leakage inductance |
| LSEC | 20 | nH | Secondary Trace Inductance |

## Primary Winding Section 1

| *Var* | *Value* | *Units* | *Description* |
|---|---|---|---|
| NP1 | 18 | | Rounded (Integer) Number of Primary winding turns in the first section of primary |
| Wire Size | 27 | AWG | Wire size of primary winding |
| Winding Type | Bifilar (x2) | | Primary winding number of parallel wire strands |
| L | 0.94 | | Primary Number of Layers |
| DC Copper Loss | 0.08 | W | Primary 1 DC Losses |

## Primary Winding Section 2

| *Var* | *Value* | *Units* | *Description* |
|---|---|---|---|
| NP2 | 17 | | Rounded (Integer) Number of Primary winding turns in the second section of primary |
| Wire Size | 27 | AWG | Wire size of primary winding |
| Winding Type | Bifilar (x2) | | Primary winding number of parallel wire strands |
| L2 | 0.89 | | Primary Number of Layers in 2nd split winding |
| DC Copper Loss | 0.11 | W | Primary 2 DC Losses |

## Output 1

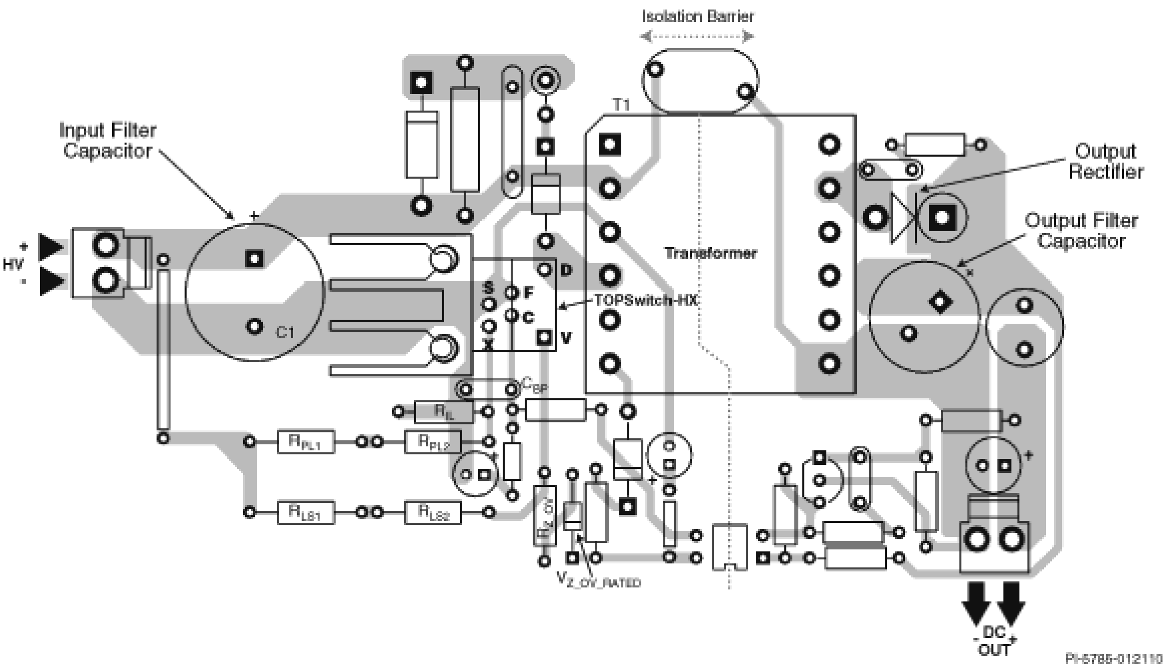
| *Var* | *Value* | *Units* | *Description* |
|---|---|---|---|
| VO | 30.00 | V | Output Voltage |
| IO | 3.60 | A | Output Current |
| VOUT_ACTUAL | 30.00 | V | Actual Output Voltage |
| NS | 8 | | Secondary Number of Turns |
| Wire Size | 25 | AWG | Wire size of secondary winding |
| Winding Type | Quadfilar (x4) | | Output winding number of parallel strands |
| L_S_OUT | 1.32 | | Secondary Output Winding Layers |
| DC Copper Loss | 0.38 | W | Secondary DC Losses |
| VD | 1.58 | V | Output Winding Diode Forward Voltage Drop |
| PIVS | 116 | V | Output Rectifier Maximum Peak Inverse Voltage |
| ISP | 9.68 | A | Peak Secondary Current |
| ISRMS | 5.22 | A | Secondary RMS Current |
| RTH_DIODE | 9.39 | °C/W | Output Diode Maximum Thermal Resistance |
| OD_HSINK_TYPE | Aluminum Extruded | | Output Diode Heatsink Type |
| OD_HSINK_PN | 508222B00000G | | Output Diode (Extruded) Heatsink Part Number |
| CO | 220 x 3 | µF | Output Capacitor |
| IRIPPLE | 3.78 | A | Output Capacitor RMS Ripple Current |
| Expected Lifetime | 35635 | hr | Expected Lifetime of Output Capacitor |

## Feedback Circuit

| *Var* | *Value* | *Units* | *Description* |
|---|---|---|---|
| DUAL_OUTPUT_FB_FLAG | NO | | Dual Output Feedback regulations use flag |
| SF_FLAG | NO | | Soft Finish Circuits use flag |
| TYPE_3CTRL_FLAG | NO | | Phase Boost Network flag |

**The regulation and tolerances do not account for thermal drifting and component tolerance of the output diode forward voltage drop and voltage drops across the LC post filter. The actual voltage values are estimated at full load only.**

**Please verify cross regulation performance on the bench.**



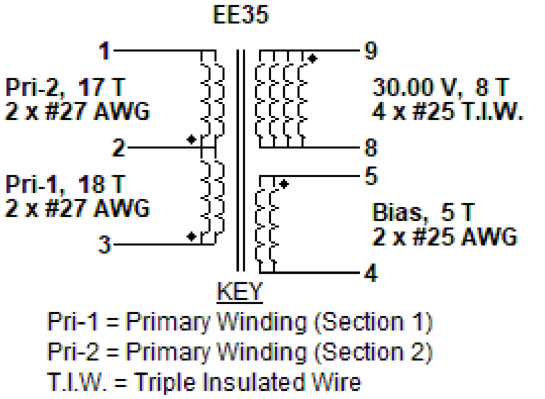

*Click on the "Show me" icon to highlight relevant areas on the sample layout.*

| | ***Description*** | ***Show Me*** |
|---|---|---|
| 1 | Minimize loop area formed by drain, clamp and transformer | |
| 2 | Bias winding and bias capacitor are a power connection and therefore returned to Kelvin connection at SOURCE pin | |
| 3 | V and X pin node areas minimized, line sensing (R1 & R2) and power limiting (R3 & R4) close to device. Connections to V and X pin nodes should be away from noisy switching nodes (drain, clamp and bias) | |
| 4 | Place CONTROL pin decoupling capacitor directly across CONTROL and SOURCE pins | |
| 5 | Y capacitor connected between output RTN and B+ | |
| 6 | Minimize loop area formed by secondary winding, the output diode and the output filter capacitor | |
| 7 | Kelvin connection at SOURCE pins: power and signal currents kept separate | |
| 8 | B+ connection of RLS or RPL resistor should be on input side of capacitor to prevent switching noise injection | |

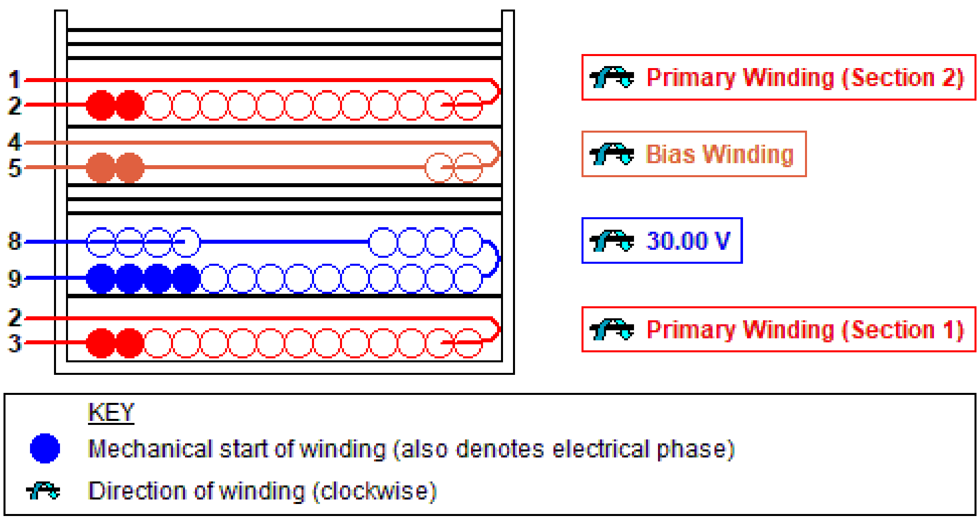
## Bill Of Materials

| Item # | Quantity | Part Ref | Value | Description | Mfg | Mfg Part Number |
|---|---|---|---|---|---|---|
| 1 | 1 | BR1 | DF06M | 600 V, 1 A, Standard Recovery Bridge, DFM | International Rectifier | DF06M |
| 2 | 1 | C1 | 330 nF | 330 nF, 275 VAC, Film, X Class | Panasonic | ECQ-UAAF334K |
| 3 | 1 | C2 | 100 µF | 100 µF, 400 V, High Voltage Al Electrolytic, (30 mm x 16 mm) | United Chemi-Con | EPAG400VB101M16X30LL |
| 4 | 1 | C3 | 3.3 nF | 3.3 nF, 1 kV, High Voltage Ceramic | NIC Components Corp | NCD332M1KVZ5U |
| 5 | 1 | C4 | 0.1 µF | 0.1 µF, 16 V, Ceramic, X7R | TDK | C1005X7R1C104K |
| 6 | 1 | C5 | 47 µF | 47 µF, 10 V, Electrolytic, Gen Purpose, 1040 mΩ, (11 mm x 5 mm) | United Chemi-Con | KME10VB47RM5X11LL |
| 7 | 1 | C6 | 2.2 nF | 2.2 nF, 250 VAC, Ceramic, Y Class | TDK | CD12-E2GA222MYNS |
| 8 | 1 | C7 | 22 pF | 22 pF, 1 kV, High Voltage Ceramic | Panasonic | ECC-D3A220JGE |
| 9 | 1 | C8 | 10 µF | 10 µF, 50 V, Electrolytic, Gen Purpose, 1050 mΩ, (11.5 mm x 5 mm) | Panasonic | ECA-1HHG100 |
| 10 | 3 | C9, C10, C11 | 220 µF | 220 µF, 50 V, Electrolytic, Super Low ESR, 42 mΩ, (16 mm x 10 mm) | United Chemi-Con | EKZE500ELL221MJ16S |
| 11 | 1 | C12 | 100 µF | 100 µF, 35 V, Electrolytic, Low ESR, 180 mΩ, (15 mm x 6.3 mm) | United Chemi-Con | ELXZ350ELL101MF15D |
| 12 | 1 | C13 | 33 nF | 33 nF, 50 V, Ceramic, X7R | Murata | RPER71H333K2P1A03B |
| 13 | 1 | D1 | FR257 | 1000 V, 2.5 A, Fast Recovery, 500 ns, R-3 | Rectron | FR257 |
| 14 | 1 | D2 | 1N914 | 100 V, 0.3 A, Fast Recovery, 4 ns, DO-35 | Vishay | 1N914 |
| 15 | 1 | D3 | LQA10T300 | 300 V, 10 A, Ultrafast Recovery, 12.6 ns, TO-220AC | Power Integrations | LQA10T300 |
| 16 | 1 | F1 | 1 A | 250 VAC, 1 A, Radial TR5, Time Lag Fuse | Littelfuse / Wickmann(R) | 37411000410 |
| 17 | 1 | HS1 | 563202T00000 | 9.4 °C/W TO-220. Heatsink for use with Device U1. | Aavid | 563202T00000 |
| 18 | 1 | HS2 | 508222B00000G | 7.4 °C/W TO-220. Heatsink for use with Diode D3. | Aavid | 508222B00000G |
| 19 | 1 | L1 | 6 mH | 6 mH, 1.6 A | Panasonic | ELF18N016 |
| 20 | 1 | L2 | 3.3 µH | 3.3 µH, 5.5 A | Bourns Inc. | RL622-3R3K-RC |
| 21 | 2 | R1, R2 | 1.1 MΩ | 1.1 MΩ, 5 %, 0.25 W, Carbon Film | Generic | |
| 22 | 2 | R3, R4 | 62 kΩ | 62 kΩ, 5 %, 2 W, Metal Oxide Film | Generic | |
| 23 | 1 | R5 | 5.1 Ω | 5.1 Ω, 5 %, 0.25 W, Carbon Film | Generic | |
| 24 | 2 | R6, R7 | 4.64 MΩ | 4.64 MΩ, 1 %, 0.25 W, Metal Film | Generic | |
| 25 | 1 | R8 | 6.8 Ω | 6.8 Ω, 5 %, 0.125 W, Carbon Film | Generic | |
| 26 | 1 | R9 | 470 Ω | 470 Ω, 5 %, 0.25 W, Carbon Film | Generic | |
| 27 | 1 | R10 | 3400 Ω | 3400 Ω, 1 %, 0.125 W, Metal Film | Generic | |
| 28 | 1 | R11 | 1 kΩ | 1 kΩ, 5 %, 0.125 W, Carbon Film | Generic | |
| 29 | 1 | R12 | 118 kΩ | 118 kΩ, 1 %, 0.125 W, Metal Film | Generic | |
| 30 | 1 | R13 | 10.7 kΩ | 10.7 kΩ, 1 %, 0.125 W, Metal Film | Generic | |
| 31 | 1 | RT1 | 10 Ω | NTC Thermistor 10 Ω, 1.7 A | Thermometrics | CL-120 |
| 32 | 1 | T1 | EE35 | NC-2H (Nicera) or Equivalent Core Material<br>See Transformer Construction’s Materials List for complete information | TDK | PC40EI35-Z |
| 33 | 1 | U1 | TOP256YN | TOPSwitch-HX, TOP256YN, TO-220 | Power Integrations | TOP256YN |
| 34 | 1 | U2 | LTV817A | Optocoupler LTV817A, 35 V, CTR 80 - 160 %, 4-DIP | Liteon | LTV817A |
| 35 | 1 | U3 | TL431CLPM | 2.495 V, Shunt Regulator IC, 2 %, TO-92 | Texas Instruments | TL431CLPM |
| 36 | 1 | VR1 | P6KE160A | 160 V, 5 W, 5 %, DO-204AC, TVS | Vishay | P6KE160A |

## Electrical Diagram




## Mechanical Diagram




## Winding Instruction

**Primary Winding (Section 1)**

Start on pin(s) 3 and wind 18 turns (x 2 filar) of item [5]. in 1 layer(s) from left to right. On the final layer, spread the winding evenly across entire bobbin. Finish this winding on pin(s) 2.

Add 1 layer of tape, item [3], for insulation.

**Secondary Winding**

Start on pin(s) 9 and wind 8 turns (x 4 filar) of item [6]. Spread the winding evenly across entire bobbin. Wind in same rotational direction as primary winding. Finish this winding on pin(s) 8.

Add 3 layers of tape, item [3], for insulation.

**Bias Winding**

Start on pin(s) 5 and wind 5 turns (x 2 filar) of item [7]. Wind in same rotational direction as primary winding. Spread the winding evenly across entire bobbin. Finish this winding on pin(s) 4.

Add 1 layer of tape, item [3], for insulation.

**Primary Winding (Section 2)**

Start on pin(s) 2 and wind 17 turns (x 2 filar) of item [5]. in 1 layer(s) from left to right. On the final layer, spread the winding evenly across entire bobbin. Finish this winding on pin(s) 1.

Add 3 layers of tape, item [3], for insulation.

**Core Assembly**

Assemble and secure core halves. Item [1].

**Varnish**

Dip varnish uniformly in item [4]. Do not vacuum impregnate.

## Comments

**1. Use of a grounded flux-band around the core may improve the EMI performance.**

**2. For non margin wound transformers use triple insulated wire for all secondary windings.**

## Materials

| *Item* | *Description* |
|---|---|
| [1] | **Core: EE35, NC-2H (Nicera) or Equivalent, gapped for ALG of 329 nH/T²** |
| [2] | **Bobbin: Generic, 7 pri. + 7 sec.** |
| [3] | **Barrier Tape: Polyester film [1 mil (25 µm) base thickness], 15.70 mm wide** |
| [4] | **Varnish** |
| [5] | **Magnet Wire: 27 AWG, Solderable Double Coated** |
| [6] | **Triple Insulated Wire: 25 AWG** |
| [7] | **Magnet Wire: 25 AWG, Solderable Double Coated** |

## Electrical Test Specifications

| ***Parameter*** | ***Condition*** | ***Spec*** |
|---|---|---|
| Electrical Strength, VAC | **60 Hz 1 second, from pins 1,2,3,4,5 to pins 8,9.** | **3000** |
| Nominal Primary Inductance, μH | **Measured at 1 V pk-pk, typical switching frequency, between pin 1 to pin 3, with all other Windings open.** | **428** |
| Tolerance, ±% | **Tolerance of Primary Inductance** | **10.0** |
| Maximum Primary Leakage, μH | **Measured between Pin 1 to Pin 3, with all other Windings shorted.** | **6.42** |

**Although the design of the software considered safety guidelines, it is the user's responsibility to ensure that the user's power supply design meets all applicable safety requirements of user's product.**

## Design Passed (Optimization Done)

| | *Description* | *Fix* | *Ref. #* |
|---|---|---|---|
| | Drain voltage close to BVDSS at maximum OV threshold. | Verify BVDSS during line surge, decrease VUVON_MAX or reduce VOR. | 237 |