

# **Design Example Report**

Title	8.4 W CV/CC LED Driver Using LNK606PG			
Specification	85 – 265 VAC Input; 12 V, 0.7 A Output			
Application	Low Cost LED Driver			
Author	Applications Engineering Department			
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#### Summary and Features

- Revolutionary control concept provides very low cost, low part count solution
  - Primary side control eliminates secondary side control and optocoupler
  - Provides ±5% CV and ±10% CC accuracy
  - Over-temperature protection tight tolerance (±5%) with hysteretic recovery for safe PCB temperature under all conditions
  - Auto-restart output short circuit and open-loop protection
  - Extended pin creepage distance for reliable operation in humid environments >3.2 mm minimum at package
- EcoSmart<sup>®</sup> Easily meets all current international energy efficiency standards China (CECP) / CEC / ENERGRY STAR EPS v2 / EU CoC / EISA 2007
  - No-load consumption <100 mW at 265 VAC

PATENT INFORMATION

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### **Important Note:**

Although this board is designed to satisfy safety isolation requirements, the engineering prototype has not been agency approved. Therefore, all testing should be performed using an isolation transformer to provide the AC input to the prototype board.



### 1 Introduction

This report describes an 8.4 W CV/CC, universal input, power supply for LED Applications. A LNK606PG from the LinkSwitch-II family was used.



Assembled PCB



## 2 Power Supply Specification

Description	Symbol	Min	Тур	Max	Units	Comment
<b>Input</b> Voltage Frequency No-load Input Power (230 VAC)	V <sub>IN</sub> f <sub>LINE</sub>	85 47	50/60	265 64 250	VAC Hz mW	2 Wire – no P.E.
Output Output Voltage 1 Output Ripple Voltage 1 Output Current 1 Total Output Power Continuous Output Power	V <sub>out1</sub> V <sub>ripple1</sub> I <sub>out1</sub> Pout	11.4 630	12.00 150 700 8.4	12.6 770	V mV mA W	±5% 20 MHz bandwidth ±10%
<b>Efficiency</b> Full Load Required average efficiency at 25, 50, 75 and 100 % of P <sub>OUT</sub>	η η <sub>cec</sub>	76	80		% %	Average P <sub>OUT</sub> , 25 °C (230 VAC) Per ENERGRY STAR EPS v2
Environmental Conducted EMI Safety Surge Differential Mode Common Mode		Mee Desigr	ts CISPR2 ned to mee Cla	2B / EN55 t IEC950, ss II	5022B UL1950 kV kV	1.2/50 μs surge, IEC 1000-4-5, Series Impedance: Differential Mode: 2 Ω Common Mode: 12 Ω
Ambient Temperature	Т <sub>АМВ</sub>	0		50	°C	External case ambient, free convection, sea level



## 3 Schematic



Figure 1 – LED Driver Circuit Schematic.



## 4 **Circuit Description**

This circuit is configured as a primary-side regulated flyback power supply utilizing the LNK606PG.

### 4.1 Input Filter

AC input power is rectified by diodes D1 through D4. The rectified DC is filtered by the bulk storage capacitors C1 and C2. Components L1, L2, C1 and C2 form a pi ( $\pi$ ) filter, which attenuates conducted differential-mode EMI noise. Resistors R1 and R2 damp any ringing between L1 (L2) and C1 (C2) and improve EMI.

### 4.2 LNK 606 Primary

The LNK606 device (U1) incorporates the power switching device, oscillator, CC/CV control engine, startup, and protection functions. The integrated 700 V MOSFET allows for sufficient voltage margin in universal input AC applications. The device is powered from the BP pin via the decoupling capacitor C4.

The rectified and filtered input voltage is applied to one end of the primary winding of T1. The other side of the transformer's primary winding is driven by the integrated MOSFET in U1. The leakage inductance drain voltage spike is limited by an RCD-R clamp consisting of D5, R3, R4, and C3.

D5 is used to protect the IC from negative ringing (drain voltage below source voltage) when the MOSFET is off, due to the high value of the transformer's VOR.

### 4.3 Output Rectification

The secondary of the transformer is rectified by D7, a Schottky barrier type for higher efficiency, and filtered by C7 and C8. In this application, Resistor R8 and C6 damp high frequency ringing and improve conducted and radiated EMI.

### 4.4 Output Regulation

The LNK606 regulates the output using On/Off control in the constant voltage (CV) regulation region of the output characteristic and frequency control for constant current (CC) regulation. The output voltage is sensed by a bias winding on the transformer. The feedback resistors (R5 and R6) were selected using standard 1% resistor values to center both the nominal output voltage and constant current regulation thresholds. The feedback resistors need to be tuned if the same design is used with and without a bias winding.

Resistor R9 provides a minimum load to maintain output regulation. This resistor is only for a self biased design. If the bias winding supply (D6, C5 and R7) is used no pre-load resistor is needed as the energy is absorbed by the bias winding.



## 5 PCB Layout



Figure 2 – Printed Circuit Layout.

Note: A location for a 0.1  $\mu$ F x-capacitor is shown on the PCB. This was not populated during testing nor is required to provide the EMI results shown.



## 6 Bill of Materials

Itom	0.54	Ref	Description	Mfg Port Number	Mfa
item	Qty	Des	Description	Mig Part Number	wing
1	1	C1	4.7 μF, 400 V, Electrolytic, (8 x 11.5)	TAQ2G4R7MK0811MLL3	Taicon Corporation
2	1	C2	22 μF, 400 V, Electrolytic, (12.5 x 18)	Not Provided	Samxon
3	1	C3	1 nF, 1000 V, Ceramic, X7R, 0805	C0805C102KDRACTU	Kemet
4	1	C4	1 μF, 25 V, Ceramic, X7R, 1206	ECJ-3YB1E105K	Panasonic
5	1	C5	10 μF, 25 V, Ceramic, X7R, 1206	ECJ-3YB1E106M	Panasonic
6	1	C6	2.2 nF, 50 V, Ceramic, X7R, 0805	ECJ-2VB1H222K	Panasonic
7	2	C7 C8	470 $\mu F,$ 16 V, Electrolytic, Low ESR, 90 mΩ, (10 x 12.5)	ELXZ160ELL471MJC5S	Nippon Chemi-Con
8	1	C9	1 nF, Ceramic, Y1	ECK-DNA102MB	Panasonic
10	5	D1 D2 D3 D4 D5	1000 V, 1 A, Rectifier, DO-41	1N4007-E3/54	Vishay
11	1	D6	75 V, 0.15 A, Fast Switching, 4 ns, MELF	LL4148-13	Diode Inc.
12	1	D7	60 V, 3 A, Schottky, DO-201AD	SB360	Vishay
13	1	D8	400 V, 1 A, Ultrafast Recovery, 50 ns, DO-41	UF4004-E3	Vishay
14	2	L1 L2	2200 μH, 0.21 A	SBC4-222-211	Tokin
15	2	R1 R2	5.1 kΩ, 5%, 1/4 W, Metal Film, 1206	ERJ-8GEYJ512V	Panasonic
16	1	R3	330 kΩ, 5%, 1/4 W, Metal Film, 1206	ERJ-8GEYJ334V	Panasonic
17	1	R4	300 Ω, 5%, 1/4 W, Metal Film, 1206	ERJ-8GEYJ301V	Panasonic
18	1	R5	30 kΩ, 5%, 1/8 W, Metal Film, 0805	ERJ-6GEYJ303V	Panasonic
19	1	R6	5.62 kΩ, 1%, 1/4 W, Metal Film, 1206	ERJ-8ENF5621V	Panasonic
20	1	R7	7.5 kΩ, 5%, 1/8 W, Metal Film, 0805	ERJ-6GEYJ752V	Panasonic
21	1	R8	100 Ω, 5%, 1/8 W, Metal Film, 0805	ERJ-6GEYJ101V	Panasonic
22	1	R9	5.6 kΩ, 5%, 1/8 W, Metal Film, 0805	ERJ-6GEYJ562V	Panasonic
23	1	RF1	10 Ω, 2 W, Fusible/Flame Proof Wire Wound	CRF253-4 10R	Vitrohm
24	1	T1	Bobbin, EF16, Horizontal, 8 pin, extended creepage	SP 1738 K	Kaschke
25	1	01	LINKOWICH-II, LINKOUDPG, UV/UU, DIP-80	LINKOUDPG	Power integrations



## 7 Transformer Specification

### 7.1 Electrical Diagram



Figure 3 – Transformer Electrical Diagram.

### 7.2 Electrical Specifications

Electrical Strength	60 second, 60Hz, from pins 1-5 to pins 6-10	3000 VAC
Primary Inductance	Pins 1-3, all other windings open, measured at 100 kHz, 0.4 VRMS	1.714 mH, ±10%
Resonant Frequency	Pins 1-3, all other winding open	500 kHz (min)
Primary Leakage Inductance	Pins 1-3, with pins 7-8 shorted, measured at 100 kHz, 0.4 VRMS	70 μH (max)

#### 7.3 Materials

ltem	Description
[1]	Core: PC44, gapped for AL of 86 nH/t2
[2]	Bobbin: Horizontal 8 pin, EF16, extended creepage
[3]	Magnet Wire: 0.15 mm diameter
[4]	Magnet Wire: 0.20 mm diameter
[5]	Triple Insulated Wire: 0.45mm diameter
[6]	Tape, 3M
[7]	Varnish





## 7.4 Transformer Build Diagram

Figure 4 – Transformer Build Diagram.

7.5 Transformer	Construction
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Bobbin Preparation	Primary side of the bobbin is placed on the left hand side, and secondary side of the bobbin is placed on the right hand side.
WD1 Shield	Primary pin side of the bobbin oriented to left hand side. Start at pin 1. Wind 27 bifilar turns of item [3] from left to right. Wind with tight tension across bobbin evenly. Cut at the end.
Insulation	2 Layers of tape [6] for insulation.
WD2 Primary	Start at Pin 3. Wind 54 turns of item [3] from left to right. Apply one layer of tape [6]. Then wind another 54 turns on the next layer from right to left. Apply one layer of tape [6]. Wind the last 33 turns from left to right. Terminate on pin 1. Wind with tight tension and spread turns across bobbin evenly.
Insulation	2 layers of tape [6] for basic insulation.
WD3 Bias	Starting at pin 5 temporarily, wind 12 trifilar turns of item [4]. Wind from right to left with tight tension spreading turns across entire bobbin width. Finish on pin 2. Flip the starting lead to pin 4.
Insulation	2 layers of tape [6] for basic insulation.
WD4 Secondary	Start at pin 8 wind 13 turns of item [5] from right to left. Spread turns evenly across bobbin. Finish on pin 7.
Insulation	2 layers of tape item [6].
Finish	Grind the core to get 1.714mH. Secure the core with tape. Vanish [7].

Note: Tape between adjacent primary winding layers reduces primary capacitance and losses.



#### **Transformer Design Spreadsheet** 8

IL de3098; Rev.1.1; Copyright Power Integrations 2008         INFO         OUTPUT         UNIT         ACDC_ LinkSwitch-II degrades fixed-0.xis; LinkSwitch-II degrades fixed-0.xis; Yanaformer Design Spreadsheet           ENTER APPL/LATION VARIABLES         Wintum AC input Voltage         Wintum AC input Voltage           VACMAX         265         V         Mintum AC input Voltage           VO         12         V         Output Voltage (at continuous power)           VO         0.76         C         AC Mains Frequency           Power         Warning         8.40         W         III Warning, Continuous Output power is too high, Use larger LinkSwitch-II device           n         0.76         C.76         Z Factor, Ratio of secondary side losses to the total losses in the power supply. Use 0.5 if no better data available         C           Z         Z         V         UF Mintum AC and a Bas winding to power the total losses in the power supply. Use 0.5 if no better data available           CIN         28.7         UF Entoper LinkSwitch-II device           Chossen Fauxetter         V         Mintum Current Linkt	ACDC_LinkSwitch-					
Inspirate Process         INPUT         INPO         OUTPUT         UNIT         Characterization of the second product precend product of the second precend product of the s	II_040908; Rev.1.1;					ACDC_LinkSwitch-II_040908_Rev1-0.xls;
Internet         Other Control         Other Control         Transitionine Topics           VACEMIN         55         V         Minigum AC Input Voltage           VACEMIN         50         V         Minigum AC Input Voltage           VACEMIN         60         V         Minigum AC Input Voltage           VACMAX         265         V         Minigum AC Input Voltage           VACMAX         265         V         Minigum AC Input Voltage           VACMAX         265         V         Minigum AC Input Voltage           VO         12         V         Output Voltage (at continuous power)           VO         0.76         A         Power Supply Output Current (orresponding to power is too high, Use 0.51 no better data available           T         0.76         0.76         Efficiency Estimate at output terminals. Under the total losses in the power supply. Use 0.51 no better data available           C         3.00         ms         Bindge Reathier Contactor Time Estimate           Chosen Device         LNK606         LNK606         Chosen LinkSwitch-II device           Chosen Device         LNK606         Chosen LinkSwitch-II device         Chosen Device Switch-II device           Chosen Device         LNK606         Chosen LinkSwitch-II device         Salect packarge (G or DG)     <	Copyright Power	INDUT	INFO	OUTPUT	LINIT	LINKSWITCHII DISCONTINUOUS Flyback
VACEMAX         265         V         Minimum AC Input Voltage           VACEMAX         265         V         Maximum AC Input Voltage           R         50         V         Maximum AC Input Voltage           R         60         V         Maximum AC Input Voltage           NO         12         V         Output Voltage (at continuous power)           IO         0.7         A         Power Suppl Output Current (corresponding to peak power)           Power         Warning         8.40         W         III Warning, Continuous power)           Power         Warning         8.40         W         III Warning, Continuous power)           Power         Warning         0.76         C         Estimate at output terminals, Under 0.7 in obter data available           Z         0.50         Z Factor. Ratio of secondray side loses to the total loses in the power supply. Use 0.5 if no better data available           RdB Bias Winding         0.67         u-F         Input Capacitance           Ad Bias Winding         LINK606         Chosen LinkSwitch-II warking to power the LinkSwitch-II warking to power the LinkSwitch-II warking to power the LinkSwitch-II device           Crimpton         0.41         A         Tripui Capacitance           Grosen Davice         PG         G7.5         S	ENTER APPLICATION VARIA	BLES	INFO	OUIFUI	UNIT	Transformer Design Spreadsheet
VACMAX         265         V         Maximum AC Input Voltage           R.         60         Hz         AC Mains Frequency           VO         12         V         Output Voltage (at continuous power)           IO         0.7         V         Output Voltage (at continuous power)           Power         Warning         8.40         W         Iff warning, Continuous Output power is too high, Use large LinkSwitch-II device           n         0.76         0.76         Efficiency Setinate at output terminals. Under U. 71 no better data available           Z         0.50         Z Factor. Ratio of secondary side losses to the total available           IC         0.50         Z Factor. Ratio of secondary side losses to the total available           IC         0.50         Z Factor. Ratio of secondary side losses to the total losses in the power supply. Use 0.51 no better data available           IC         0.67         UF         UF           CIN         26.7         UF         Input Gapacitance           ENTER LinkSwitch-II VARIABLES         Chosen Package         PG           PG         PG         Select package (PG, G'or DG)           ILIMITINN         0.45         A         Maximum Current Limit           ILIMITINA         0.45         A         Maximum Current Limit </td <td>VACMIN</td> <td>85</td> <td></td> <td></td> <td>V</td> <td>Minimum AC Input Voltage</td>	VACMIN	85			V	Minimum AC Input Voltage
IL         50         Hz         AC Mains Frequency         Mainty           IO         0.7         V. Output Vidage (at continuous power)         IO           IO         0.7         A         Power Suppl Output Current (corresponding to peak power)           Power         Warning         8.40         W         III Warning. Continuous power is too high. Use Impact LinkSwitch-I device           n         0.76         0.76         Efficiency Estimate at output terminals. Under 0.7 if no better data available           Z         0.50         Z Factor. Ratio of secondary side losses to the total losses in the power supply. Use 0.5 if no better data available           ICI         0.50         Bridge Rediffer Conduction Time Estimate total losses in the power supply. Use 0.5 if no better data available           CIN         26.7         uF         Input Capacitance           ILINSTYN	VACMAX	265			V	Maximum AC Input Voltage
VO     12     V     Output Voltage (at formuous power)       IO     0.7     A     Power Supply Output Current (corresponding to peak power)       Power     0.76     0.76     Warning     8.40     W     III Warning, Continuous Output power is too high. Use large LinkSwitch-II device       n     0.76     0.76     2.7     III Warning, Continuous Output power is too high. Use large LinkSwitch-II device       Z     0.76     0.76     2.7     III Warning, Continuous Output power is too high. Use lass with divide on the total losses in the power supply. Use 0.51 fn o better data available       IC     0.50     III Status Value 0.51 fn o better data available       CIN     26.7     UF     Input Capacitance       ENTER LinkSwitch-II VARIABLES     UNK006     Chosen Vers to add a Bias winding to power the LinkSwitch-II device       Package     PG     Select package (PG, G or DG)     III Marinum Current Limit       ILIMITTYP     0.41     A     Typical Device Switching Frequency at maximum power       VOR     Warning     135.58     V     Tracease CRAW Value Set Set Set Package Voltage to high. Increase DEVICe       VOR     Warning     135.58     V     III Warning Refereted Output Voltage to high. Increase PSMAX.       VOR     Variation     136.58     V     Increase PSMAX.       VOR     0.60     V Output Voltage is	fL	50			Hz	AC Mains Frequency
IO     0.7     A     Power Supply Quoput Current (corresponding to peek power)       Power     Warning     8.40     W     II! Warning, Control Low Correct (corresponding to power) is too high. Use larger LinkSwitch-II device       n     0.76     0.76     Efficiency Estimate a output terminals. Under U.7 if no better data available       Z     0.50     Z Factor. Ratio of secondary side losses to the total losses in the power supply. Use 0.5 if no better data available       RC     3.00     ms     Bridge Rectifier Conducton Time Estimate       Add Bias Winding     NO     Choose Pest oad ables winding to power the LinkSwitch-II VARIABLES       Chosen Device     LINK606     LINK606       ENTER LinkSwitch-II VARIABLES     Chosen Device       Chosen Device     LINK606     LINK606       ILIMITMIN     0.33     A       Mainum Current Limit     ULMITTYP       LIMITTYP     0.41     A       Typical Device Witching Frequency at maximum power     maximum power       VOR     Warning     135.58     V       VDS     3     3.00     V     LinkSwitching Frequency at maximum power       VD     0.50     V     Output Voitage to high. Increase DCON or Increase FSMAX       VDS     3     3.00     V     UnkSwitching Increase Voitage       VEP     11.54     V	VO	12			V	Output Voltage (at continuous power)
Power         Warning         8.40         W         II Warning, Continuous Output power is too high. Use larger LinkSwitch-II device           n         0.76         0.76         Efficiency Estimate at output terminals. Under 0.7 fin o better data available           Z         0.50         2 Factor. Ratio of secondary side losses to the power supply. Use 0.5 fin o better data available           Add Bias Winding         0.50         UF         Import Capacitance           CIN         26.7         0.50         Choose Yes to add a Bias winding to power the LinkSwitch-II VARIABLES           Chosen Device         LINK606         Choosen LinkSwitch-II device         Package           Package         PG         Selet package (PG. GG of DG)         Imput Capacitance           LIMITTYP         0.41         A         Typical Current Limit           LIMITTYP         0.41         A         Typical Current Limit           LIMITTYP         0.45         A         Maimum Current Limit           LIMITYP         0.45         A         Maimum Current Limit           LIMITYP         0.45         A         Maimum Current Limit           VOR         Warning         135.58         V         Iff Warning Reflected Output Voltage too high. Increase DCON on Increase FSMAX           VDS         3         3.00 <td>10</td> <td>0.7</td> <td></td> <td></td> <td>А</td> <td>Power Supply Output Current (corresponding</td>	10	0.7			А	Power Supply Output Current (corresponding
Power         Warning         8.40         W         III Warning, Control Uput power is too high. Use larger LinkSwitch-II device           n         0.76         0.76         Efficiency Estimate a output terminals. Under 0.7 fn obster data available           Z         0.50         Z Factor. Ratio of secondary side losses to the total losses in the power supply. Use 0.5 if no better data available           ICI         3.00         ms         Bridge Rectifier Conduction Time Estimate           Add Bias Winding         0.57         uF         Input Capacitance           ENTER LinkSwitch-II VARIABLES         Chosen Powies         LinkSwitch-II device           Cohsen Device         LINK606         LINK606         Chosen LinkSwitch-II device           Package         PG         Select package (PG, GG or DG)         LinkITMIN           LIMITMIN         0.41         A         Typical Current Limit           LIMITTYP         0.41         A         Mainum Current Limit           LIMITTYP         0.41         A         Mainum Current Limit           LIMITTYP         0.41         A         Mainum Current Limit           LIMITMIN         0.45         A         Maximum Current Limit           LIMITTYP         0.50         V         Univorsin Reflected Output Voltage to high. Increase DCON or Increase FSMA						to peak power)
n     0.76     0.76     Cfficiency Estimate at output terminals. Under 0.71 in o better data available       Z     0.50     Z Factor. Ration 5 escondary side losses to the total losses in the power supply. Use 0.51 no better data available       IC     3.00     ms     Bridge Rectifier Conduction Time Estimate total losses in the power supply. Use 0.51 no better data available       CIN     26.7     uF     uF     Input Capacitance       ENTER LinkSwitch-II VARIABLES     Choosen LinkSwitch-II device     Package       Consen Device     LINK506     Choosen LinkSwitch-II device       Package     PG     PG     Select package (PG, GG or DG)       ILIMITYP     0.41     A     Typical Current Limit       ILIMITMAX     67.5     67.50     KHz     Typical Current Limit       ILIMITMAX     67.5     67.50     KHz     Typical Device Switching Frequency at maximum power       VOR     Warning     135.58     V     III Warning. Reflected Output Voltage too high. Increase ICAN or increase FSMAX       VDS     3     3.00     V     LinkSwitch-II on source Voltage.       VD     1.88     Ensure KOP > 1.3 for discontinuous mode operation       FEEDBACK WINDING PARAMETERS     Feedback winding turns       VFLY     11.54     V     Flyback Voltage is greater than 10 V. The feedback winding is not reguired.	Power		Warning	8.40	W	III Warning. Continuous Output power is too high. Use larger LinkSwitch-II device
Z     0.50     Z Factor. Raio of secondary side losses to the total losses in the power supply. Use 0.5 if no better data available       IC     3.00     ms     Bridge Rectifier Conduction Time Estimate       Add Bias Winding     NO     Choose V to ad a Bias winding to power the LinkSwitch-II.       CIN     26.7     uF     Input Capacitance       ENTER LinkSwitch-II VARIABLES     Choosen Device     LNK606     Chosen LinkSwitch-II.       Chosen Device     LNK606     Chosen LinkSwitch-II.     Chosen Conduction Time Estimate       Reading     PG     O.39     A     Minimum Current Limit       LIMITTYP     0.41     A     Typical Current Limit       LIMITTYP     0.45     A     Maximum Current Limit       LIMITTYP     0.45     A     Maximum Current Limit       LIMITTMAX     67.5     67.50     KHz     Typical Current Limit       LIMITTMAX     67.5     67.50     KHz     Typical Device Switching Frequency at maximum power       VOR     Warning     135.58     V     Warning Diode Forward Voltage to high. Increase ICAN or Increase ISMAX       VD     1.88     Ensure KOP > 1.3 for discontinuous mode operation     Second Particle Output Voltage to print to Source Voltage       VFLY     11.54     V     Flyback Voltage     Forward Voltage       VFLY     11	n	0.76		0.76		Efficiency Estimate at output terminals. Under 0.7 if no better data available
Ideal assess in the power supply. Use 0.5 fr no better data available       IC     3.00     ms     Bridge Rectifier Conduction Time Estimate       Add Bias Winding     NO     Choose Yes to add a Bias winding to power the LinkSwitch-II.       CitN     26.7     uF     Input Capacitance       ENTER LinkSwitch-II VARIABLES     UF     Input Capacitance       Chosen Device     LNK606     Chosen LinkSwitch-II device       Package     PG     PG     Select package (PG, GO rDG)       LIMITMN     0.39     A     Minimum Current Limit       LIMITTYP     0.41     A     Typical Carent Limit       LIMITTYP     0.41     A     Typical Device Switching Frequency at maximum power       VOR     Warning     135.58     V     I!!! Warning, Reflected Output Voltage too high. Increase DCON or Increase FSMAX       VDS     3     3.00     V     LinkSwitch-II on-state Drain to Source Voltage Drop Source Voltage Drop       FEEDBACK WINDING PARAMETERS     12.00     Feedback winding turns       NFB     12.00     Feedback winding turns       VFLY     11.54     V     Flyback Voltage       VFOR     7.92     V     Forward voltage       N/A     Bias Winding number of turns     Ersure KDP > 1.3 for discontinuous mode operation       DESION PARAMETERS     N/A     <	Z			0.50		Z Factor. Ratio of secondary side losses to the
IC     Index analysis       Add Bias Winding     NO     ms     Bridge Rectifier Conduction Time Estimate       Add Bias Winding     NO     Chose ves to add a Bias winding to power the LinkSwitch-II.       CIN     26.7     uF     Input Capacitance       ENTER LinkSwitch-II VARIABLES     uF     Input Capacitance       ENTER LinkSwitch-II VARIABLES     Chosen LinkSwitch-II.     device       Chosen Device     LNK606     Chosen LinkSwitch-II.     device       PG     PG     Select package (PG, GG or DG)       LIMITTY     0.41     A     Typical Current Limit       LIMITTYP     0.41     A     Maximum Current Limit       FS     67.5     67.50     KHz       YOR     Warning     135.58     V     III Warning. Reflected Output Voltage too high.       VOR     Warning     135.58     V     Increase DCON or Increase FSMAX.       VD     0     0.50     V     Output Winding Diode Forward Voltage too high.       FEEDBACK WINDING PARAMETERS     12.00     Feedback winding turns       VFLY     11.54     V     Flyback Voltage       VFOR     7.92     V     Forward voltage       BIAS WINDING PARAMETERS     VIA     Bias Winding number of turns       DEGON 4.5     4.50     us						total losses in the power supply. Use 0.5 if no
1C       3.00       ms       Bridge Rectifier Conduction Time Estimate         Add Bias Winding       NO       Choose Yes to add a Bias winding to power the LinkSwitch-II.         CIN       26.7       uF       Input Capacitance         CIN       26.7       uF       Input Capacitance         ENTER LinkSwitch-II VARIABLES       Entert Extension       Chosen LinkSwitch-II device         Chosen Device       LNK606       Chosen LinkSwitch-II device         Package       PG       PG       Select package (PG, GG or DG)         LIMITTIN       0.41       A       Typical Device Switching Frequency at maximum Current Limit         LIMITTYP       0.41       A       Typical Device Switching Frequency at maximum power         VOR       Warning       135.58       V       I!! Warning Reflected Output Voltage too high. Increase DCON or Increase FSMAX         VDS       3       3.00       V       LinkSwitch-II on-state Drain to Source Voltage         VD       0.50       V       Output Winding Diode Forward Voltage Torp         KP       11.88       Ensure KDP > 1.3 for discontinuous mode operation         VFLY       11.54       V       Flyback Voltage         VFLY       11.54       V       Flyback Voltage         VFLY       11.54						better data available
Add Bias Winding       NO       Choose Pes to add a Bias winding to power the LinkSwitch-II.         CIN       26.7       uF       UF       Input Capacitance         ENTER LinkSwitch-II VARIABLES       Chosen Davice       LNK606       Chosen LinkSwitch-II device         Chosen Davice       LNK606       Chosen LinkSwitch-II device       Package       PG       Select package (PG, GG or DG)         ILIMITTYP       0.41       A       Typical Current Limit       Initial Constraint Con	tC			3.00	ms	Bridge Rectifier Conduction Time Estimate
CIN         26.7         uF         Input Capacitance           ENTER LinkSwitch-II VARIABLES         Chosen Device         LNK606         Chosen LinkSwitch-II device           Package         PG         PG         Select package (PG, GG or DG)           LIMITTN         0.39         A         Minimum Current Limit           LIMITTYP         0.41         A         Typical Current Limit           LIMITTYP         0.45         A         Maximum Current Limit           ILIMITTYP         0.45         A         Maximum Current Limit           ILIMITTYP         0.45         A         Maximum power           VOR         67.5         67.50         kHz         Typical Device Switching Frequency at maximum power           VOR         0         0.50         V         Utput Voltage too high. Increase DCON or Increase FSMAX           VDS         3         3.00         V         LinkSwitch-II or-state Drain to Source Voltage too high. Increase DCON or Increase FSMAX           VDS         3         0.00         V         Utput Winding tode Forward Voltage Torain to Source Voltage           VFLY         1.88         Ensure KOP > 1.3 for discontinuous mode operation         Feedback winding turns           FEEDBACK WINDING PARAMETERS         12.00         Feedback winding itsel	Add Bias Winding			NO		Choose Yes to add a Bias winding to power the LinkSwitch-II.
ENTER LinkSwitch-II VARIABLES           Chosen Device         LNK606         Chosen LinkSwitch-II device           Package         PG         PG         Select package (PG, GG or DG)           LIMITTNIN         0.39         A         Minimum Current Limit           LIMITTYP         0.41         A         Trypical Current Limit           LIMITTYP         0.43         A         Maximum Current Limit           LIMITTYA         0.45         A         Maximum Dower           VOR         67.5         67.50         kHz         Trypical Device Switching Frequency at maximum power           VOR         Warning         135.58         V         II!! Warning, Reflected Output Voltage too high. Increase ESMAX           VDS         3         3.00         V         LinkSwitch-II on-state Drain to Source Voltage           VD         0.50         V         Output Winding Diode Forward Voltage Drop           KP         1.88         Ensure KDP > 1.3 for discontinuous mode operation           VFLY         11.54         V         Flyback Voltage           VFOR         7.92         V         Forward voltage           VFOR         7.92         V         Forward voltage           VB         N/A         V <td< td=""><td>CIN</td><td>26.7</td><td></td><td></td><td>uF</td><td>Input Capacitance</td></td<>	CIN	26.7			uF	Input Capacitance
ENTER         LinkSwitch-II VARIABLES           Chosen Device         LINK606         LNK606         Chosen LinkSwitch-II device           Package         PG         96         Select package (PG, GG or DG)           ILIMITYN         0.39         A         Minimum Current Limit           ILIMITYP         0.41         A         Typical Current Limit           ILIMITYP         0.41         A         Minimum Current Limit           ILIMITYP         0.45         A         Maximum Current Limit           ILIMITYP         0.45         A         Maximum Current Limit           ILIMITYP         0.45         A         Maximum Current Limit           VOR         Warning         135.58         V         II!! Warning, Reflected Output Voltage too high. Increase DCON or Increase FSMAX           VDS         3         3.00         V         LinkSwitch-II on-state Drain to Source Voltage           VD         0.50         V         Output Winding Diode Forward Voltage Torpo           KP         11.54         V         Flyback Voltage           VFOR         7.92         V         Forward voltage           VFOR         7.92         V         Forward voltage is greater than 10 V. The           BIAS WINDING PARAMETERS						
Chosen Device         LNK606         LNK606         Chosen LinkSwitch-II device           Package         PG         Select package (PG, Go r DG)           LIMITTNIN         0.39         A         Minimum Current Limit           ILIMITTYP         0.41         A         Typical Current Limit           ILIMITAX         0.45         A         Maximum Current Limit           ILIMITAX         0.45         A         Maximum Current Limit           ISIMITMAX         0.45         A         Maximum Current Limit           ISIMITMAX         0.45         A         Maximum Current Limit           ISIMITMAX         0.45         A         Maximum Current Limit           ISIMITAX         0.45         A         Maximum Current Limit           ISIMITAX         0.45         A         Maximum Current Limit           ISIMITAX         0.45         A         Maximum Current Limit           INGR         Werning         135.58         V         III Warning, Reflected Output Voltage to high.           VD         0.50         V         LinkSwitch-II drives Paral Voltage Drop         ISIMITA           VE         11.88         Ensure KDP > 1.3 for discontinuous mode operation         Output Voltage to thigh.           VFLY	ENTER LinkSwitch-II VARIAB	LES				T
Package     PG     PG     Select package (PG, GG or DG)       LIMITMIN     0.39     A     Minimum Current Limit       LIMITTYP     0.41     A     Typical Current Limit       ILMITTMAX     0.45     A     Maximum Current Limit       VOR     Warning     135.58     V     Illingin, Reflected Output Voltage too high.       VDS     3     3.00     V     IllinSwitch-II on-state Drain to Source Voltage Drop envart Voltage	Chosen Device	LNK606		LNK606		Chosen LinkSwitch-II device
ILIMITYP       0.39       A       Minimum Current Limit         ILIMITYP       0.41       A       Typical Current Limit         ILIMITYP       0.45       A       Maximum power         VOR       Warning       135.58       V       III Warning. Reflected Output Voltage too high. Increase EDCN or Increase FSMAX         VDS       3       3.00       V       UnkSwitch-II on-state Drain to Source Voltage Topo         KP       1.88       Ensure KDP > 1.3 for discontinuous mode operation       operation         VFLY       11.54       V       Flyback Voltage         VFOR       7.92       V       Forward voltage         VB       N/A       V       Output Voltage is greater than 10 V. The feedback winding itself can be used to provide exteral bias to the LinkSwitch. Additional Bias winding is not required.         NB       N/A       V       Output voltage is greater than 10 V. The feedback winding itself can	Package	PG		PG		Select package (PG, GG or DG)
LIMITYP       0.41       A       Typical Current Limit         LIMITYMAX       0.45       A       Maximum Current Limit         FS       67.5       67.50       KHz       Typical Device Switching Frequency at maximum power         VOR       Warning       135.58       V       III Warning, Reflected Output Voltage too high. Increase DCON or Increase FSMAX         VDS       3       3.00       V       LinkSwitch-II on-state Drain to Source Voltage         VD       0.50       V       Output Winding Diode Forward Voltage Drop         KP       1.88       Ensure KDP > 1.3 for discontinuous mode operation         FEEDBACK WINDING PARAMETERS         NFB       12.00       Feedback winding turns         VFLY       11.54       V       Flyback Voltage         VFOR       7.92       V       Forward voltage         BIAS WINDING PARAMETERS         VFB       11.54       V       Flyback Voltage         VFOR       7.92       V       Forward voltage         BIAS WINDING PARAMETERS         VB       N/A       V       Output Voltage is greater than 10 V. The feedback winding itself can be used to provide external bias to the LinkSwitch. Additional Bias winding is not required.         NB       N/A <td></td> <td></td> <td></td> <td>0.39</td> <td>A</td> <td>Minimum Current Limit</td>				0.39	A	Minimum Current Limit
ILIMINAX     Imaximum Dover       FS     67.5     67.50       KHz     Trypical Device Switching Frequency at maximum power       VOR     Warning       135.58     V       VDS     3       3     3.00       VD     Uncrease DCON or Increase FSMAX       VDS     3       0.50     V       VD     Uncrease DCON or Increase FSMAX       VD     0.50       KP     1.88       Ensure KDP > 1.3 for discontinuous mode operation       VFLY     11.54       VFLY     11.54       VFOR     7.92       VFOR     7.92       VB     N/A       DESIGN PARAMETERS       DCON     4.5       DCON     4.5       0.45     us       0.00     feedback winding is not required.       NB     N/A       DESIGN PARAMETERS       DCON     4.5       0.45     4.50       0.00     Upper resistor in resistor divider       1.00     6.46				0.41	A	Typical Current Limit
PS     67.5     67.30     KHZ     Typical Device Switching Prequency at maximum power       VOR     Warning     135.58     V     II!! Warning. Reflected Output Voltage too high. Increase DCON or Increase FSMAX       VDS     3     3.00     V     LinkSwitch-II on-state Drain to Source Voltage       VD     0.50     V     Output Winding Diode Forward Voltage Drop       KP     1.88     Ensure KDP > 1.3 for discontinuous mode operation       Feedback winding turns       YPEN       VELY       VFD       VFD       VELY       VFD       VE       VFD       Output Voltage is		07.5		0.45	A	Maximum Current Limit
VORWarning135.58VI!! Warning. Reflected Output Voltage too high. Increase DCON or Increase FSMAXVDS33.00VLinkSwitch-II on-state Drain to Source VoltageVD0.50VOutput Vinding Diode Forward Voltage DropKP1.88Ensure KDP > 1.3 for discontinuous mode operationFEEDBACK WINDING PARAMETERSNFB12.00Feedback winding turnsVFLY11.54VVFLY7.92VVFCR7.92VFeedback winding turnsVFCRBIAS WINDING PARAMETERSVBN/AVVBN/AOutput Voltage is greater than 10 V. The feedback winding itself can be used to provide exteral bias to the LinkSwitch. Additional Bias winding is not required.NBN/ABias Winding number of turnsDESIGN PARAMETERSDCON4.54.50usOUPPER30.79k-ohmUpper resistor in Feedback resistor dividerRUPPER5.69k-ohmLower resistor in resistor dividerRUPPERRLOWEREF16Enter Transformer Core. Based on the output power the recommended core sizes are EEL19 or EEL22BobbinEF16_Generic EF16_BOBBIN	F5	67.5		67.50	KHZ	maximum power
VDS       3       3.00       V       LinkSwitch-II on-state Drain to Source Voltage         VD       0.50       V       Output Winding Diode Forward Voltage Drop         KP       1.88       Ensure KOP > 1.3 for discontinuous mode operation         FEEDBACK WINDING PARAMETERS         MFB       12.00       Feedback winding turns         VFLY       11.54       V       Flyback Voltage         VFOR       7.92       V       Forward voltage         BIAS WINDING PARAMETERS         VB       N/A       V       Flyback Voltage is greater than 10 V. The feedback winding itself can be used to provide exteral bias to the LinkSwitch. Additional Bias winding is not required.         NB       N/A       N/A       Bias Winding number of turns         DESIGN PARAMETERS         DCON       4.5       4.50       us         Output diode conduction time         TON       6.46       us       LinkSwitch-II On-time (calculated at minimum inductance)         RUPPER       30.79       k-ohm       Upper resistor in Feedback resistor divider         ENTER TRANSFORMER CORE/CONSTRUCTION VARIABLES         Core Type       Enter Transformer Core. Based on the output power the recommended core sizes are EEL19 or EEL22	VOR		Warning	135.58	V	Ill Warning. Reflected Output Voltage too high. Increase DCON or Increase FSMAX
VD       0.50       V       Output Winding Diode Forward Voltage Drop         KP       1.88       Ensure KDP > 1.3 for discontinuous mode operation         FEEDBACK WINDING PARAMETERS         MFB       12.00       Feedback winding turns         VFLY       11.54       V       Flyback Voltage         VFDR       7.92       V       Forward voltage         BIAS WINDING PARAMETERS         VB       N/A       V       Output Voltage is greater than 10 V. The feedback winding itself can be used to provide exteral bias to the LinkSwitch. Additional Bias winding is not required.         NB       N/A       Bias Winding number of turns         DESIGN PARAMETERS         UPER         Output diode conduction time         OUtput diode conduction time         TOR         OUTput diode conduction time         TOR       Solape resistor in resistor divider<	VDS	3		3.00	V	LinkSwitch-II on-state Drain to Source Voltage
KP       1.88       Ensure KDP > 1.3 for discontinuous mode operation operation         FEEDBACK WINDING PARAMETERS       12.00       Feedback winding turns         VFLY       11.54       V       Flyback Voltage         VFOR       7.92       V       Forward voltage         BIAS WINDING PARAMETERS         VB       N/A       V       Forward voltage         BIAS WINDING PARAMETERS         VB       N/A       V       Output Voltage is greater than 10 V. The feedback winding itself can be used to provide exteral bias to the LinkSwitch. Additional Bias winding is not required.         NB       N/A       Bias Winding number of turns         DESIGN PARAMETERS         DCON       4.5       4.50       us         DCON       4.5       4.50       us       Output diode conduction time         TON       6.46       us       LinkSwitch-II On-time (calculated at minimum inductance)         RUPPER       30.79       k-ohm       Upper resistor in resistor divider         ENTER TRANSFORMER CORE/CONSTRUCTION VARIABLES         Core Type       Image: Core State Core S	VD			0.50	V	Output Winding Diode Forward Voltage Drop
FEEDBACK WINDING PARAMETERS         NFB       12.00       Feedback winding turns         VFLY       11.54       V       Flyback Voltage         VFOR       7.92       V       Forward voltage         BIAS WINDING PARAMETERS         VB       N/A       V       Output Voltage is greater than 10 V. The feedback winding itself can be used to provide exteral bias to the LinkSwitch. Additional Bias winding is not required.         NB       N/A       Bias Winding number of turns         DESIGN PARAMETERS         DCON       4.5       4.50       us       Output diode conduction time         TON       6.46       us       LinkSwitch-II On-time (calculated at minimum inductance)         RUPPER       30.79       k-ohm       Lover resistor in resistor divider         ENTER TRANSFORMER CORE/CONSTRUCTION VARIABLES         Core       EF16       Enter Transformer Core. Based on the output power the recommended core sizes are EEL19 or EEL22         Bobbin       EF16_       Generic EF16_BOBBIN	КР			1.88		Ensure KDP > 1.3 for discontinuous mode operation
FEEDBACK WINDING PARAMETERS         NFB       12.00       Feedback winding turns         VFLY       11.54       V       Flyback Voltage         VFOR       7.92       V       Forward voltage         BIAS WINDING PARAMETERS         VB       N/A       V       Output Voltage is greater than 10 V. The feedback winding itself can be used to provide exteral bias to the LinkSwitch. Additional Bias winding is not required.         NB       N/A       Bias Winding number of turns         DESIGN PARAMETERS         DCON       4.5       4.50       us       Output diode conduction time         TON       6.46       us       LinkSwitch-II On-time (calculated at minimum inductance)         RUPPER       30.79       k-ohm       Upper resistor in Feedback resistor divider         RLOWER       5.69       k-ohm       Lower resistor in resistor divider         Core Type         Core       EF16       EF16       Enter Transformer Core. Based on the output power the recommended core sizes are EEL19 or EEL22         Bobbin       EF16_       Generic EF16_BOBBIN						
NFB       12.00       Feedback Winding turns         VFLY       11.54       V       Flyback Voltage         VFOR       7.92       V       Forward voltage         BIAS WINDING PARAMETERS         VB       N/A       V       Output Voltage is greater than 10 V. The feedback winding itself can be used to provide exteral bias to the LinkSwitch. Additional Bias winding is not required.         NB       N/A       Bias Winding number of turns         DESIGN PARAMETERS         DCON       4.5       4.50       us       Output diode conduction time         TON       6.46       us       LinkSwitch-II On-time (calculated at minimum inductance)         RUPPER       30.79       k-ohm       Upper resistor in Feedback resistor divider         ENTER TRANSFORMER CORE/CONSTRUCTION VARIABLES       Core Type       Enter Transformer Core. Based on the output power the recommended core sizes are EEL19 or EEL22         Bobbin       EF16       EF16       Generic EF16_BOBBIN	FEEDBACK WINDING PARAM	IETERS		10.00		The address is the statement
VFLY       Image: Transformer Core. Based on the output         VFOR       11.34       V       Flyback Voltage         VFOR       7.92       V       Forward voltage         BIAS WINDING PARAMETERS         VB       N/A       V       Output Voltage is greater than 10 V. The feedback winding itself can be used to provide exteral bias to the LinkSwitch. Additional Bias winding is not required.         NB       N/A       Bias Winding number of turns         DESIGN PARAMETERS         DCON       4.5       4.50       us       Output diode conduction time         TON       6.46       us       LinkSwitch-II On-time (calculated at minimum inductance)         RUPPER       30.79       k-ohm       Upper resistor in Feedback resistor divider         ENTER TRANSFORMER CORE/CONSTRUCTION VARIABLES       Enter Transformer Core. Based on the output power the recommended core sizes are EEL19 or EL22         Bobbin       EF16       EF16       Generic EF16_BOBBIN				12.00	N/	Feedback winding turns
BIAS WINDING PARAMETERS       N/A       V       Output Voltage is greater than 10 V. The feedback winding itself can be used to provide exteral bias to the LinkSwitch. Additional Bias winding is not required.         NB       N/A       V       Output Voltage is greater than 10 V. The feedback winding itself can be used to provide exteral bias to the LinkSwitch. Additional Bias winding is not required.         NB       N/A       Bias Winding number of turns         DESIGN PARAMETERS       DCON       4.5       4.50       us       Output diode conduction time         TON       6.46       us       LinkSwitch-II On-time (calculated at minimum inductance)         RUPPER       30.79       k-ohm       Upper resistor in Feedback resistor divider         ENTER TRANSFORMER CORE/CONSTRUCTION VARIABLES       Core Type       Enter Transformer Core. Based on the output power the recommended core sizes are EEL19 or FEL22         Bobbin       EF16       EF16       Generic EF16_BOBBIN				7.02	V	Flyback Voltage
BIAS WINDING PARAMETERS         VB       N/A       V       Output Voltage is greater than 10 V. The feedback winding itself can be used to provide exteral bias to the LinkSwitch. Additional Bias winding is not required.         NB       N/A       Bias Winding number of turns         DESIGN PARAMETERS         DCON       4.5       4.50       us       Output diode conduction time         TON       6.46       us       LinkSwitch-II On-time (calculated at minimum inductance)         RUPPER       30.79       k-ohm       Upper resistor in Feedback resistor divider         RLOWER       5.69       k-ohm       Lower resistor in resistor divider         Core Type         Core       EF16       EF16       Enter Transformer Core. Based on the output power the recommended core sizes are EEL19 or EEL22         Bobbin       EF16_       EF16_       Generic EF16_BOBBIN	VFOR			1.92	v	Forward voltage
VB       N/A       V       Output Voltage is greater than 10 V. The feedback winding itself can be used to provide exteral bias to the LinkSwitch. Additional Bias winding is not required.         NB       N/A       Bias Winding number of turns         DESIGN PARAMETERS       U       Output diode conduction time         DCON       4.5       4.50       us       Output diode conduction time         TON       6.46       us       LinkSwitch-II On-time (calculated at minimum inductance)         RUPPER       30.79       k-ohm       Upper resistor in Feedback resistor divider         RLOWER       5.69       k-ohm       Lower resistor in resistor divider         Core       EF16       EF16       Enter Transformer Core. Based on the output power the recommended core sizes are EEL19 or EEL22         Bobbin       EF16_       EF16_       Generic EF16_BOBBIN		\$				
NB       N/A       Subplice of the link of the freedback winding itself can be used to provide exteral bias to the LinkSwitch. Additional Bias winding is not required.         NB       N/A       Bias Winding number of turns         DESIGN PARAMETERS       0utput diode conduction time         DCON       4.5       4.50       us         TON       6.46       us       LinkSwitch-II On-time (calculated at minimum inductance)         RUPPER       30.79       k-ohm       Upper resistor in Feedback resistor divider         ENTER TRANSFORMER CORE/CONSTRUCTION VARIABLES       5.69       k-ohm       Lower resistor in resistor divider         Core       EF16       EF16       Enter Transformer Core. Based on the output power the recommended core sizes are EEL19 or EEL22         Bobbin       EF16_       EF16_       Generic EF16_BOBBIN		5		N/A	V	Output Voltage is greater than 10 V. The
NB       N/A       Bias Winding is not required.         DESIGN PARAMETERS       N/A       Bias Winding number of turns         DCON       4.5       4.50       us       Output diode conduction time         TON       6.46       us       LinkSwitch-II On-time (calculated at minimum inductance)         RUPPER       30.79       k-ohm       Upper resistor in Feedback resistor divider         RLOWER       5.69       k-ohm       Lower resistor in resistor divider         Core Type       0       1       1       1         Core       EF16       EF16       Enter Transformer Core. Based on the output power the recommended core sizes are EEL19 or EEL22         Bobbin       EF16_       EF16_       Generic EF16_BOBBIN					, , , , , , , , , , , , , , , , , , ,	feedback winding itself can be used to provide exteral bias to the LinkSwitch. Additional Bias
NB       N/A       Bias Winding number of turns         DESIGN PARAMETERS         DCON       4.5       4.50       us       Output diode conduction time         TON       6.46       us       LinkSwitch-II On-time (calculated at minimum inductance)         RUPPER       30.79       k-ohm       Upper resistor in Feedback resistor divider         RLOWER       5.69       k-ohm       Lower resistor in resistor divider         ENTER TRANSFORMER CORE/CONSTRUCTION VARIABLES         Core Type         EF16         Core       EF16       EF16       Enter Transformer Core. Based on the output power the recommended core sizes are EEL19 or EEL22         Bobbin       EF16_       EF16_       Generic EF16_BOBBIN						winding is not required.
DESIGN PARAMETERS         DCON       4.5       4.50       us       Output diode conduction time         TON       6.46       us       LinkSwitch-II On-time (calculated at minimum inductance)         RUPPER       30.79       k-ohm       Upper resistor in Feedback resistor divider         RLOWER       5.69       k-ohm       Lower resistor in resistor divider         ENTER TRANSFORMER CORE/CONSTRUCTION VARIABLES         Core Type         Core       EF16       EF16       Enter Transformer Core. Based on the output power the recommended core sizes are EEL19 or EEL22         Bobbin       EF16_       EF16_       Generic EF16_BOBBIN	NB			N/A		Bias Winding number of turns
DCON       4.5       4.50       us       Output diode conduction time         TON       6.46       us       LinkSwitch-II On-time (calculated at minimum inductance)         RUPPER       30.79       k-ohm       Upper resistor in Feedback resistor divider         RLOWER       5.69       k-ohm       Lower resistor in resistor divider         ENTER TRANSFORMER CORE/CONSTRUCTION VARIABLES       Enter Transformer Core. Based on the output power the recommended core sizes are EEL19 or EEL22         Bobbin       EF16       EF16_       Generic EF16_BOBBIN	DESIGN PARAMETERS					
TON       6.46       us       LinkSwitch-II On-time (calculated at minimum inductance)         RUPPER       30.79       k-ohm       Upper resistor in Feedback resistor divider         RLOWER       5.69       k-ohm       Lower resistor in resistor divider         ENTER TRANSFORMER CORE/CONSTRUCTION VARIABLES         Core Type         Core       EF16       EF16         EF16       EF16       Enter Transformer Core. Based on the output power the recommended core sizes are EEL19 or EEL22         Bobbin       EF16_       Generic EF16_BOBBIN	DCON	4.5		4.50	us	Output diode conduction time
RUPPER       30.79       k-ohm       Upper resistor in Feedback resistor divider         RLOWER       5.69       k-ohm       Lower resistor in resistor divider         ENTER TRANSFORMER CORE/CONSTRUCTION VARIABLES         Core Type       Image: Core Core Core Core Core Core Core Core	TON			6.46	us	LinkSwitch-II On-time (calculated at minimum inductance)
RLOWER       5.69       k-ohm       Lower resistor in resistor divider         ENTER TRANSFORMER CORE/CONSTRUCTION VARIABLES       Enter Transformer Core. Based on the output power the recommended core sizes are EEL19 or EEL22         Bobbin       EF16       EF16_       Generic EF16_BOBBIN	RUPPER			30.79	k-ohm	Upper resistor in Feedback resistor divider
ENTER TRANSFORMER CORE/CONSTRUCTION VARIABLES         Core Type       Enter Transformer Core. Based on the output power the recommended core sizes are EEL19 or EEL22         Bobbin       EF16       EF16_       Generic EF16_BOBBIN	RLOWER			5.69	k-ohm	Lower resistor in resistor divider
ENTER TRANSFORMER CORE/CONSTRUCTION VARIABLES         Core Type       Enter Transformer Core. Based on the output power the recommended core sizes are EEL19 or EEL22         Bobbin       EF16       EF16_       Generic EF16_BOBBIN						
Core Type       EF16       EF16       Enter Transformer Core. Based on the output power the recommended core sizes are EEL19 or EEL22         Bobbin       EF16_       Generic EF16_BOBBIN	ENTER TRANSFORMER COR	E/CONSTRU	CTION VAR	IABLES		
Core     EF16     EF16     Enter Transformer Core. Based on the output power the recommended core sizes are EEL19 or EEL22       Bobbin     EF16_     Generic EF16_BOBBIN	Core Type					
Bobbin EF16_ Generic EF16_BOBBIN	Core	EF16		EF16		Enter Transformer Core. Based on the output power the recommended core sizes are EEL19 or EEL22
	Bobbin			EF16		Generic EF16_BOBBIN





## DER-215 12 V, 0.7 A, LNK606PG CV/CC LED Driver

		Г	BOBBIN		
AF			20.10	mm^2	Core Effective Cross Sectional Area
IE			37.60	mm^2	Core Effective Path Length
			1100.00	nH/turn^2	Ungapped Core Effective Inductance
BW			10.00	mm	Bobbin Physical Winding Width
M			0.00	mm	Safety Margin Width (Half the Primary to
101			0.00		Secondary Creenage Distance)
1	3		3.00		Number of Primary Layers
	5		13.00		Number of Secondary Turps, To adjust
110			13.00		Secondary number of turns change DCON
					Secondary humber of turns change DOON
	ETERS				
		г	02.02	V	Minimum DC hus voltage
			93.03	V	Maximum DC bus voltage
VIVIAA			374.77	v	Maximum DC bus voltage
		TEDE			
		IERS	0.44	1	Maximum duty avala measured at VMIN
			0.44	٨	
IAVG			0.12	A	Input Average current
			0.39	A	Peak primary current
IR			0.39	A	Primary ripple current
IRMS			0.17	A	Primary RMS current
TRANSFORMER PRIMARY D	ESIGN PAR	AMETERS		T	
LPMIN			1542.94	uH	Minimum Primary Inductance
LPTYP			1714.38	uH	Typical Primary inductance
LP_TOLERANCE			10.00		Tolerance in primary inductance
NP			141.00		Primary number of turns. To adjust Primary
					number of turns change BM_TARGET
ALG			86.23	nH/turn^2	Gapped Core Effective Inductance
BM_TARGET	2490		2490.00	Gauss	Target Flux Density
BM			2480.14	Gauss	Maximum Operating Flux Density (calculated at
					nominal inductance), BM < 2500 is
					recommended
BP		Warning	3000.97	Gauss	III Warning. Peak Flux density exceeds 3000
		Ŭ			Gauss and is not recommended. Reduce BP
					by increasing NS
BAC			1240.07	Gauss	AC Flux Density for Core Loss Curves (0.5 X
					Peak to Peak)
ur			163.75		Relative Permeability of Ungapped Core
LG			0.30	mm	Gap Length (LG > 0.1 mm)
BWE			30.00	mm	Effective Bobbin Width
OD			0.21	mm	Maximum Primary Wire Diameter including
					insulation
INS			0.04		Estimated Total Insulation Thickness (= 2 * film
					thickness)
DIA			0.17	mm	Bare conductor diameter
AWG	1		34.00		Primary Wire Gauge (Rounded to next smaller
					standard AWG value)
СМ	1	1 1	40.32	İ	Bare conductor effective area in circular mils
CMA			234.48		Primary Winding Current Capacity (200 < CMA
Shin (			201110		< 500)
	1				
TRANSFORMER SECONDAR					
Lumped parameters	DEGIGITI				
ISP	1	+ +	4 22	Δ	Peak Secondary Current
	1	+ +	1 54	~	Secondary DMS Current
		┼───┼	1.04	A	Output Capacitor PMS Displa Current
		┼───┼	1.30	A	Culput Capacitor Kivis Ripple Current
CIVIS			308.90		Secondary Bare Conductor minimum circular
414/00	ł	┼───┼	05.00	<u> </u>	milis Occasidade Miliae Comerci (Doministrational)
AWGS		1	25 00		Secondary Wire Gauge (Rounded up to next
			20.00		
			_0.00		larger standard AWG value)
			20.00		larger standard AWG value)
VOLTAGE STRESS PARAME	TERS				larger standard AWG value)
VOLTAGE STRESS PARAME	TERS		679.48	V	larger standard AWG value) Maximum Drain Voltage Estimate (Assumes
VOLTAGE STRESS PARAME VDRAIN	TERS		679.48	V	larger standard AWG value) Maximum Drain Voltage Estimate (Assumes 20% clamping voltage tolerance and an



PIVS		46.55	V	Output Rectifier Maximum Peak Inverse Voltage
FINE TUNING				
RUPPER_ACTUAL	30		k-ohm	Actual Value of upper resistor (RUPPER) used on PCB
RLOWER_ACTUAL	5,6		k-ohm	Actual Value of lower resistor (RLOWER) used on PCB
Actual (Measured) Output Voltage (VDC)			V	Measured Output voltage from first prototype
Actual (Measured) Output Current (ADC)			Amps	Measured Output current from first prototype
RUPPER_FINE		30.00	k-ohm	New value of Upper resistor (RUPPER) in Feedback resistor divider. Nearest standard value is 30,1 k-ohms
RLOWER_FINE		5.60	k-ohm	New value of Lower resistor (RLOWER) in Feedback resistor divider. Nearest standard value is 5,62 k-ohms

Note: Spreadsheet values may be different from values generated from different spreadsheet revisions.

The spreadsheet flags 3 warnings:

- 1) PO The data sheet figures for maximum output power is 6 W. This power was recommended for a 5 V output. As this design is for a 12 V output and the thermal performance is acceptable, this warning can be ignored.
- 2) VOR This warning appears if VOR > 135 V. As in this design, the peak drain voltage VDRAIN < 680 V, this warning can be ignored.
- BP This warning shows up if BP > 3000 Gauss. In this design, this guideline is only slightly violated. Since no transformer saturation was seen, this warning can be ignored.



## 9 Performance Data

All measurements performed at room temperature unless otherwise specified, 50 Hz input frequency.

### 9.1 Efficiency



Figure 5 – Efficiency vs. Output Power.



### 9.2 Active Mode Efficiency

Percent of Full Load	Efficiency (%)		
	115 VAC	230 VAC	
25	78.8	77.5	
50	80.4	80.3	
75	79.8	81.3	
100	79.3	81.6	
Average	79.6	80.1	
US EISA (2007) requirement	79.5		
ENERGY STAR 2.0 requirement	79.5		

Figure 6 – Efficiency vs. Input Voltage and Load, Room Temperature, 50 Hz.

### 9.3 Energy Efficiency Requirements

The external power supply requirements below all require meeting active mode efficiency and no-load input power limits. Minimum active mode efficiency is defined as the average efficiency of 25, 50, 75 and 100% of output current (based on the nameplate output current rating).

For adapters that are single input voltage only then the measurement is made at the rated single nominal input voltage (115 VAC or 230 VAC), for universal input adapters the measurement is made at both nominal input voltages (115 VAC and 230 VAC).

To meet the standard the measured average efficiency (or efficiencies for universal input supplies) must be greater than or equal to the efficiency specified by the standard.

The test method can be found here:

<u>http://www.energystar.gov/ia/partners/prod\_development/downloads/power\_supplies/EP</u> <u>SupplyEffic\_TestMethod\_0804.pdf</u>

For the latest up to date information please visit the PI Green Room:

http://www.powerint.com/greenroom/regulations.htm



### 9.3.1 USA Energy Independence and Security Act 2007

This legislation mandates all single output single output adapters, including those provided with products, manufactured on or after July 1<sup>st</sup>, 2008 must meet minimum active mode efficiency and no load input power limits.

Active Mode Efficiency Standard Models

Nameplate Output (P <sub>o</sub> )	Minimum Efficiency in Active Mode of Operation	
< 1 W	$0.5 \times P_{O}$	
$\geq$ 1 W to $\leq$ 51 W	0.09 × ln (P <sub>o</sub> ) + 0.5	
> 51 W	0.85	
	In - natural logarithm	

In = natural logarithm

#### No-load Energy Consumption

Nameplate Output (P <sub>o</sub> )	Maximum Power for No-load AC-DC EPS
All	$\leq$ 0.5 W

This requirement supersedes the legislation from individual US States (for example CEC in California).

### 9.3.2 ENERGY STAR EPS Version 2.0

This specification takes effect on November 1<sup>st</sup>, 2008.

Active Mode Efficiency Standard Models

Nameplate Output (P <sub>o</sub> )	Minimum Efficiency in Active Mode of Operation	
≤ 1 W	$0.48 \times P_{O} + 0.14$	
$>$ 1 W to $\leq$ 49 W	0.0626 × ln (P <sub>O</sub> ) + 0.622	
> 49 W	0.87	

In = natural logarithm

### Active Mode Efficiency Low Voltage Models (V<sub>0</sub><6 V and I<sub>0</sub> $\ge$ 550 mA)

Nameplate Output (P <sub>o</sub> )	Minimum Efficiency in Active Mode of Operation	
≤ 1 W	0.497 × P <sub>O</sub> + 0.067	
$>$ 1 W to $\leq$ 49 W	0.075 × ln (P <sub>o</sub> ) + 0.561	
> 49 W	0.86	

In = natural logarithm

### No-load Energy Consumption (both models)

Nameplate Output (P <sub>o</sub> )	Maximum Power for No-load AC-DC EPS	
0 to < 50 W	≤ 0.3 W	
$\geq$ 50 W to $\leq$ 250 W	$\leq$ 0.5 W	





### 9.4 No-Load Input Power



#### 9.5 Regulation







## **10 Thermal Performance**

ltem	115 VAC	230 VAC
Ambient	25 <sup>0</sup> C	25 <sup>0</sup> C
LNK606PG (U1)	52 °C	56 <sup>0</sup> C
T1 Transformer	49 <sup>0</sup> C	50 <sup>0</sup> C

Measurements made at full load, 50Hz electric system.



## 11 Waveforms



#### 11.1 Drain Voltage and Current, Normal Operation

### 11.2 Output Voltage Start-up Profile













### 11.3 Drain Voltage and Current Start-up Profile









#### 11.4 Output Ripple Measurements

#### 11.4.1 Ripple Measurement Technique

For DC output ripple measurements, a modified oscilloscope test probe must be utilized in order to reduce spurious signals due to pickup. Details of the probe modification are provided below.

The 5125BA probe adapter is affixed with two capacitors tied in parallel across the probe tip. The capacitors include one (1) 0.1  $\mu$ F/50 V ceramic type and one (1) 10  $\mu$ F/50 V aluminum electrolytic. *The aluminum electrolytic type capacitor is polarized, so proper polarity across DC outputs must be maintained (see below).* 



Figure 15 – Oscilloscope Probe Prepared for Ripple Measurement (End Cap and Ground Lead Removed).



Figure 16 – Oscilloscope Probe with Probe Master 5125BA BNC Adapter (Modified with Wires for Probe Ground for Ripple measurement and Two Parallel Decoupling Capacitors Added).



#### 11.4.2 Measurement Results









## **12 Conducted EMI**

All Conducted EMI tests were made using the artificial hand connected to the secondary return.





Figure 21 – Conducted EMI, 230 VAC, Line, Full Load, EN55022Q: QP limit; EN55022A: Average Limit; Blue: QP Scan; Black: Average Scan.



Figure 22 – Conducted EMI, 230 VAC, Neutral, Full load, EN55022Q: QP Limit; EN55022A: Average Limit; Blue: QP Scan; Black: Average Scan.



## **13 Revision History**

Date	Author	Revision	Description & changes	Reviewed
01-May-09	RP	1.0	Initial Release	Apps & Mktg



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