

Isolated 70-W Streetlight LED Driver Using UCC28810

Bharat Agrawal, Sanjay Dixit

Power Management

ABSTRACT

LED lighting is being used for residential, commercial and industrial applications. It offers various advantages over incandescent bulbs, such as lower energy consumption, longer life, attainment of full brightness without need for a warmup time, and so forth. With the advent of these lights in large numbers, regulations in a few countries require LED drivers with high power factor (greater than 0.9) and low current THD (less than 10 per cent), to have minimum effect on the grid.

Conventionally, UCC28810 operates in critical conduction mode, resulting in a high value of current THD. This application report describes use of UCC28810 in a single-stage 70-W streetlight LED driver in AC/DC Flyback topology with fixed-frequency and constant on-time switching, to achieve power factor greater than 0.9 and current THD less than 10 percent. CD74HCT14 Schmitt-triggered inverter is used to implement external oscillator, feedback sawtooth generator and short-circuit protection circuit. Output current regulation and output open-circuit protection are implemented with both secondary-side and primary-side regulation circuits. Implementation with single stage helps to reduce number of components, system size and cost.

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1 Design Specifications

Table 1 lists the UCC28810-based 70-W streetlight LED driver design specifications.

Table 1. UCC28810-based 70-W Streetlight LED Driver Design Specifications

Design Specifications					
Input voltage range (V _{IN})	Universal, 90 V–265 V AC RMS				
Output voltage (V _{OUT})	106 V				
Load current (I _{OUT})	600 mA				
Power factor	Greater than 0.9 in V _{IN} range				
Current total harmonic distortion (I _{THD})	Less than 10%				
Output short-circuit protection	Yes				
Output open-circuit protection	Yes				



2 Application Schematic

2.1 Secondary-Side Output Current Regulation

Figure 1 and Figure 2 illustrate the secondary-side output current regulation schematics.



Figure 1. Schematic for 70-W Streetlight LED Driver With Secondary-Side Regulation (Part 1)



Application Schematic

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Figure 2. Schematic for 70-W Streetlight LED Driver with Secondary-Side Regulation (Part 2)



2.2 Primary-Side Output Current Regulation

Figure 3 and Figure 4 illustrate the primary-side output current regulation schematics.



Figure 3. Schematic for 70-W Streetlight LED Driver with Primary-Side Regulation (Part 1)



Figure 4. Schematic for 70-W Streetlight LED Driver with Primary-Side Regulation (Part 2)



3 **Principle of Operation**

The UCC28810 is an off-line AC/DC controller specifically designed to drive high power LEDs for lighting applications requiring power factor correction and EMC compliance. It is designed for controlling a Flyback, single-ended primary-inductance converter (SEPIC), or Boost converter operating in critical

conduction mode. The UCC28810 features a transconductance amplifier for feedback error processing, a simple current reference generator for generating a current command proportional to the input voltage, a current-sense (PWM) comparator, PWM logic, and a totem-pole driver for driving an external FET. To overcome the issue of high I_{THD}, these subsystems internal to low-cost UCC28810 are used here to operate at fixed switching frequency with constant on-time, and achieve high power factor and low I_{THD}, less than 10 percent.

Figure 1 depicts a reference schematic describing key components in the Flyback stage. Input AC voltage is rectified using full bridge rectifier $(D_{1A}-D_{4A})$ to obtain a unidirectional AC bus. It may be noted that the input capacitor is so small (220 nF) that the input voltage is close to a rectified sinusoid, as also required to obtain high power factor. This rectified V_{IN} is connected through transformer primary winding to the drain of switching FET Q₃, whose source is connected to ground return through the current-sensing resistor R₂₄.

The transformer primary inductance, L_{0} is related to the switching frequency f_{sw} , converter output power Pout, system efficiency n, maximum on-time, ton-max at minimum input line voltage Vin rms(min) according to the equation:

$$Lp = \frac{\eta \times V_{\text{in}_rms(min)}^2 \times t_{\text{on}_max}^2}{2 P_{\text{out}} \times \frac{1}{f_{\text{sw}}}}$$

$$Lp = \frac{(0.9) \times (90)^2 \times (7.5 \ \mu s)^2}{2 \times 66 \times \frac{1}{(60,000)}} \Longrightarrow Lp = 186.4 \ \mu H$$

Primary inductance, L_{p} is chosen as 200 µH for this design. Maximum on-time at minimum input voltage is chosen as 7.5 µsec, considering maximum duty cycle of 45% at 60 kHz switching frequency.

For L_{D} =200 µH, peak input voltage at minimum AC input $V_{in_min(pk)}$ and maximum on-time at minimum V_{in}, t_{on-max}, peak current in primary winding, I_{p,pk} is calculated as:

$$I_{p,pk} = \frac{V_{in_min(pk)} \times I_{on_max}}{L_p}$$
$$I_{p,pk} = \frac{(90\sqrt{2}) \times (7.5 \ \mu s)}{200 \ \mu H} = 4.77 \ A$$
(2)

Due to large output voltage (106 V), and limitations of FET maximum drain-source voltage rating (800 V). turns ratio is selected as 1 (that is, N = 1). Hence, secondary peak current I_{snk} is equal to 4.77 A, and minimum secondary rectifier diode reverse voltage rating is 585 V. Thus, STTH1008 (800 V, 10-A rating) is selected as secondary rectifier for this design.

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(1)

Principle of Operation

3.1 Active Startup Circuit

Figure 5 illustrates the active startup circuit.



Figure 5. Active Startup Circuit

It is not possible to supply bias voltage while meeting IC current requirements for both UCC28810 and CD74HCT14 together using the resistive startup technique. In Figure 5, transistor Q8 as emitter-follower sources 17.4 V V_{DD} startup bias for UCC28810 at its emitter, which is converted to 5 V for CD74HCT14 supply using discrete, low-IQ linear regulator. Once switching begins and output voltage ramps-up, bias voltage for these ICs is sourced from primary-side auxiliary winding, which is also used to disable active-startup circuit with Q_6 . Once in steady state, it is required to disable active-startup circuit in order to minimize efficiency loss due to large voltage drop across Q_8 and IC supply current flowing through it.

3.2 Switching Oscillator

Figure 6 shows the switching oscillator circuit.



Figure 6. Switching Oscillator

The flyback stage is operating at a constant 60-kHz switching frequency, generated using CD74HCT14, Schmitt-triggered inverter, as shown in Figure 6. Equation 3 is used to calculate oscillator frequency of a Schmitt inverter-based oscillator. For $C_4 = 100 \text{ pF}$, feedback resistance R_{32} is obtained as 248 k Ω :

$$f_{\rm sw} = \frac{1}{0.67 \text{ RC}} \Longrightarrow R = \frac{1}{(0.67)} f_{\rm sw} \times C} = \frac{1}{(0.67)(60,000)(0.1 \text{ nf})} = 248 \text{ k}\Omega$$
(3)



This 60-kHz square-pulse output of U_{1D} is given to an RC high-pass filter, inverted, and fed as input to UCC28810 TZE pin to initiate the next switching cycle (t_{on}). A transition is detected when TZE input goes low, which sets the gate drive to HIGH. This pulse also discharges RC ramp generator capacitor C₁₅ at the start of t_{on} , using Q₇. Gate drive turn-on edge is triggered with 60-kHz square-pulse input to the TZE pin from the above oscillator, while gate DRV turn-off edge is determined by the output current regulation circuit (when IRAMP voltage exceeds internal multiplier output voltage). In Figure 16, frequency of waveform 2 governs f_{sw} , while the on-time of this waveform (determined by values of C₅ and R₃₃) is the time-period for which FET Q₇ discharges capacitor C₁₅.

3.3 Soft-Start Circuit

At startup, the 60-kHz switching begins as soon as bias on UCC28810 exceeds its V_{DD} turn-on threshold (15.8 V). Due to the use of the 470-nF capacitor C_{20} to slow down loop response, it is required to have soft-start operation, such that the duty cycle increases gradually from its minimum value at startup. The circuit in Figure 7 shows this implementation. As V_{CC} bias voltage (5 V) is formed during startup, RC low-pass filter ($R_{10} = 2.2$ M, $C_{11} = 4.7$ µF) charges slowly to input peak value, resulting in Q_1 pulling down error amplifier output (EAOUT) low, initially, and allowing it to reach its final value after approximately a 1-second delay. Diode D_6 helps to discharge C_{11} for next soft-start initiation on V_{DD} / system reset.



Figure 7. Soft-Start Circuit

Additionally, duty cycle limiting at nearly 45% is incorporated to mitigate stability issues, by providing DC voltage on the VINS pin as UCC28810 internal multiplier output clamp. For 60-kHz switching frequency, the feedback ramp on C_{15} reaches a level of 0.53 V at 45% duty cycle. Since UCC28810's internal multiplier has a fixed gain of 2, an input of 0.26 V DC on the VINS pin helps clamp the duty cycle at maximum 45%.

3.4 Output Current Regulation

We need to regulate constant 600-mA output current though the LEDs. This is achieved using both secondary-side and primary-side regulation circuits. With **secondary-side output current regulation**, current through the LEDs is measured as a voltage on very small current sense resistors (R_{29} and R_{31}), and regulated with TL431's 2.495 V feedback reference. This circuit is shown in Figure 1. V_{DD} voltage for the optocoupler and TL431s is generated with a 12-V zener biased from the 106-V output voltage. During the process of locking of loop to reach regulation, when the voltage on U4 REF pin exceeds 2.495 V, the cathode of U_4 pulls down optocoupler U_3 cathode to 2.495 V, which reduces voltage on the EAOUT pin of UCC28810. Since EAOUT pin of UCC28810 is output of internal error amplifier, this pulldown with optocoupler helps to maintain duty cycle optimum for output current regulation point. Further, power loss on sense resistors is proportional to voltage across them and the current flowing through them:

$$P_{loss} = V_{sense} \times I_{LED}$$

(4)

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The U4 feedback reference of 2.495 V results in a power loss of 1.497 W for 600-mA current through sense resistors. To minimize this loss and make the system more efficient, a 2-V DC offset is added to the U4 feedback (using resistors R_{27} and R_{28}) from the 12-V zener voltage, such that sense resistor drops only 0.5 V due to the current flowing through it.

Alternatively, primary-side output current regulation within ± 2.5 percent of intended output current has been achieved with the circuit in Figure 8:





(Circuit used in only-primary-side output current regulation scheme.)

Figure 8. Alternate Implementation for Primary-Side Output Current Regulation

For transformer T₁ primary winding,

$$V_{in(inst)} = L_{p} \times \frac{dI_{p}}{dt} \Longrightarrow I_{p,pk} = \frac{V_{in(inst)} \times t_{on}}{L_{p}}$$
(5)

Where:

$$\label{eq:Vin(inst)} \begin{split} V_{in(inst)} &= instantaneous \ input \ voltage \\ L_p &= Transformer \ primary \ inductance \\ t_{on} &= On-time \ during \ time \ period \ T \end{split}$$

Further, output current in flyback converter is given by:

$$I_{out} = \frac{I_{s,pk}}{2} \times \frac{t_{off}}{T} \Rightarrow I_{out} = \frac{NI_{p,pk}}{2} \times \frac{t_{off}}{T} \Rightarrow I_{out} = \frac{N \times V_{in(inst)} \times t_{on}}{2 L_p} \times \frac{t_{off}}{T} \Rightarrow I_{out} \alpha I_{p,pk} \times \frac{t_{off}}{T}$$
(6)

Where:

 $\begin{array}{l} I_{out} = Current \ through \ LEDs \\ I_{s,pk} = Secondary-side \ peak \ current \\ t_{off} = Off-time \ during \ time \ period \ T \\ N = transformer \ turns \ ratio \\ I_{p,pk} = primary-side \ peak \ current \end{array}$



Principle of Operation



Figure 9. Primary-Side Output Current Regulation Logic

From Equation 5 and Equation 6, since primary-side peak current is sinusoidal in nature, varying in proportion to instantaneous V_{in} and T_{on} , if we generate a voltage proportional to V_{in} and t_{on} , and calculate the average for time period t_{off} (over total time T), we get a DC voltage which is proportional to output LED current.

Here, a ramp voltage (proportional to instantaneous V_{in} amplitude and t_{on}) is generated using R_{43} , R_{44} , and C_{30} during on-time, and discharged with the gate drive signal using D_{15} during t_{off} . Consecutively, this ramp is peak detected using emitter-follower transistor Q_{12} . This envelope varying in proportion to V_{in} is again buffered to obtain low output impedance using emitter-follower transistor Q_{13} , and chopped during time-interval t_{off} (to obtain a time-average over t_{off}) using flip-flop circuit as shown in Figure 10.



(Circuit used in only-primary-side output current regulation scheme.)

Figure 10. Flip-Flop Circuit to Extract Toff

This flip-flop used for T_{off} chopping is implemented using transistors Q_{10} and Q_{11} , with T_{off} waveform edges triggered by negative going transitions of FET gate drive (GDRV) and primary-side auxiliary winding (AUX_IN) waveforms, thus generating square pulse of duration T_{off} , as also depicted in Figure 19.

This resulting waveform chopped for T_{off} is averaged using RC ($R_{49} = 22 \text{ k}\Omega$, $C_{33} = 4.7 \mu\text{F}$) averaging circuit. Since the control loop needs to have a narrow bandwidth, for output current to be less sensitive to the twice mains frequency ripple, cut-off frequency for this RC low-pass filter is selected much less than 100 Hz. It may be noted that this average is two-times of that obtained from Equation 6, and this doubling factor needs to be accounted for by scaling resistor values. UCC28810 has an internal 2.5 V referenced error amplifier with VSENSE inverting input. This error amplifier is used for primary-side output current regulation. Since voltage from the primary-side current regulation circuit (output of RC averaging circuit) is less than 2.5 V (1.85 V), superposition of a DC offset from 5-V supply and RC averaging circuit output is undertaken to regulate at 2.5 V.



3.5 Output Short-Circuit Protection

At the instant of output LEDs being short-circuited, U4 immediately detects a voltage feedback greater than 2.5 V, and engages U3 to reduce duty cycle to minimum value. The 12-V bias of optocoupler and U4 (and U5) reduces to zero during this period and secondary loop loses control. Voltage on current sense resistor R_{24} is continuously monitored to detect short-circuit at output.



Figure 11. Output Short-Circuit Protection

For 64-W output power, primary peak current reaches a maximum of nearly 1 V (see Figure 17). Shortcircuit detection threshold is thus set with sufficient margin (to avoid false triggering) at 1.4 V. This subsystem is shown in Figure 11. As the voltage on R_{24} reaches 1.4 V or greater, a latch including Q_2 and U_{1A} is enabled. The 5-V output of this latch is inverted using U_{1C} to form logic LOW level at output which then pulls down voltage on capacitors C_{13} and C_{11} attached to the VSENS and EAOUT pins of UCC28810, respectively. This short-circuit protection is auto-retry type, with Schmitt inverter oscillator (U_{1B}) generating a reset pulse every 3 seconds. This auto-retry interval may be modified by adjusting R_{19} .

3.6 Output Open-Circuit Protection

In case of absence of LEDs at output (Output Open-Circuit), this design reduces power being delivered to the secondary, to prevent voltage on output capacitors from exceeding their ratings. This feature is implemented in different ways for the case of Primary-Side and Secondary-Side Output current regulation schemes.

For a **secondary-side regulated system**, output voltage is divided using resistors R_{35} and R_{40} , and fed to the REF pin of TL431 (U₅), as shown in Figure 1. These resistors are selected such that in case of an open-circuit, output voltage reaches a maximum of 110% of its nominal value. For $V_{out} = 106 \text{ V}$, $V_{out(open)} \approx 120 \text{ V}$.

From Equation 7, R_{35} and R_{40} is obtained as 1 k Ω and 47 k Ω to get 2.495 V level at the U5 REF pin.

$$V_{\mathsf{REF}(\mathsf{U5})} = \frac{V_{\mathsf{out}(\mathsf{open})}}{\mathsf{R}_{35} + \mathsf{R}_{40}} \times \mathsf{R}_{35}$$

Where:

 $V_{\text{REF(U5)}} = \text{TL431}$ reference pin 2.495-V regulation voltage $V_{\text{out(open)}} = \text{maximum voltage at output when open-circuited}$

In case of an output open-circuit, U5 enables the optocoupler, pulling the EAOUT pin of UCC28810 low, limiting duty cycle to its minimum value, and preventing voltage on output capacitors from exceeding their ratings or reaching dangerously high values.

(7)



Open-circuit protection with primary-side output current regulation is shown in Figure 12. Voltage (VC12) formed on C_{12} from primary auxiliary winding is used to detect open-circuit at output. This voltage on C_{12} (VC12) is stepped down using a zener and resistance divider (R_{39} , R_{30}), enabling transistor Q_{11} in case of open-circuit. Transistor Q_{11} , when active, pulls down the EAOUT pin of UCC28810 (which is the error amplifier output), and reduces duty cycle to its minimum value.



(Circuit used in only-primary-side output current regulation scheme.)

Figure 12. Output Open-Circuit Protection in Primary-Side Regulated System



4 Performance Data and Typical Characteristic Curves

Figure 13 through Figure 19 present some typical performance curves for the UCC28810-based 70-W LED driver design.



4.1 Output Current Variation with Respect to Input Voltage

Figure 13. Output Current Variation with Respect to Input Voltage

4.2 Power Factor Variation With Respect to Input Voltage



Figure 14. Power Factor Variation With Respect to Input Voltage



4.3 Variation of Current THD with Input Voltage



Figure 15. Variation of Current THD with Input Voltage

4.4 External Oscillator and Feedback Ramp



Ch1: CD74HCT14 Inverting Schmitt 60kHz Oscillator, Ch2: 60kHz Square Pulses input to UCC28810 TZE pin, Ch3: Regulation Feedback Ramp

Figure 16. External Oscillator and Feedback Ramp



Performance Data and Typical Characteristic Curves



4.5 Primary-Side FET Gate Drive, Drain, and Current-Sense Waveforms

Ch1: Primary-Side FET Gate Drive, Ch2: Primary-Side FET Drain Waveform,

Ch3: Primary-Side Current Sense Waveform



4.6 MOSFET Drain and Primary-Side Current Sense Voltage Envelope



Ch2: Primary-Side FET Drain, Ch3: Primary-Side Current Sense Waveform



Performance Data and Typical Characteristic Curves



4.7 Gate Drive, Auxiliary Winding, and Flip-Flop T_{off} Detector Waveforms

Ch1: Primary-Side FET Gate Drive, Ch2: Transformer Auxiliary Winding, Ch3: Flip-Flop based Toff Detector

Figure 19. Primary-Side FET Gate Drive, Auxiliary Winding, and Flip-Flop Toff Detector



5 Bill of Materials

Table 2 lists the bill of materials (BOM) for the secondary-side output current regulation circuit.

5.1 Secondary-Side Output Current Regulation

Table 2. Bill of Materials for Circuit with Secondary Side Regulation

1 C1 100nF Capacitor, Film, 100rF, 300VAC Radial B32023A3104M Epocos 1 C2 220nF Capacitor, ceramic, 220nF, 10V 805 Sid Sid 2 CS.C28 1nF Capacitor, ceramic, 167, 2XV Radial DEBE33D1022EB Murata 1 C4 100pF Capacitor, ceramic, 167, 10V 805 Sid Sid 2 C6,C7 220pF Capacitor, ceramic, 167, 10V 805 Sid Sid 1 C6A 220nF Capacitor, ceramic, 47, 167, 03V Radial UVR2C221MHA Nichicon 1 C10 47pF Capacitor, ceramic, 47, 17, 25V Radial UVR2C321MHA Nichicon 2 C12,C17 4.7µF Capacitor, ceramic, 10nF, 5.3V 805 Sid Sid 2 C12,C17 4.7µF Capacitor, ceramic, 10nF, 10V 805 Sid Sid 2 C13,C24 100nF Capacitor, ceramic, 10F, 10V 805 Sid Sid Sid Sid Si	Count	RefDes	Value	Description	Size	Part Number	MFR.
1 C2 220nF Capacitor, ceramic, 1nF, 2kV Radial DEBE33D1022B2B Murital 1 C4 100pF Capacitor, ceramic, 100pF, 10V 805 Std Std Std 2 C6.C22 1nF Capacitor, ceramic, 100pF, 10V 805 Std Std Std 2 C6.C2 20pF Capacitor, ceramic, 17p, 10V 805 Std Std Std 1 C6A 220nF Capacitor, electrolyitic, 220,F, 160V Radial UVR2C221MHA Nichicon 1 C10 47pF Capacitor, electrolyitic, 220,F, 160V Radial UVR2C21MHA Nichicon 2 C12,C11 4.7µF Capacitor, ceramic, 17p, 75V Radial UVR2EX2MMA Nichicon 2 C13,C24 100nF Capacitor, ceramic, 10µF, 6.3V 805 Std Std 1 C15 10nF Capacitor, ceramic, 10µF, 6.3V 805 Std Std 2 C13,C24 100nF Capacitor, ceramic, 10µF, 6.3V 805 Std	1	C1	100nF	Capacitor, Film, 100nF, 300VAC	Radial	B32023A3104M	Epcos
2 C3,C23 1 nF Capacitor, cerumic, 167, 24V Radial DEBE33D1022828 Murata 1 C4 100pF Capacitor, cerumic, 167, 10V 805 Std Std Std 2 C5,C22 1nF Capacitor, decrohytic, 220µF, 160V Radial UVR2C221MHA Nichicon 1 C6A 220µF Capacitor, decrohytic, 220µF, 160V Radial UVR2C221MHA Nichicon 1 C11 47µF Capacitor, decrohytic, 220µF, 160V Radial UVR2C221MHA Nichicon 2 C13,C24 100nF Capacitor, cerumic, 47µF, 53V Bo5 Std Std 2 C13,C24 100nF Capacitor, cerumic, 100µF, 63V 805 Std Std 1 C16 10nF Capacitor, cerumic, 20µF, 25V 805 Std Std 1 C16 2,nF Capacitor, cerumic, 20µF, 35V 805 Std Std 2 C19,AC20A 100nF Capacitor, cerumic, 20µF, 25V Radial UVR1E470MDA Nichicon <	1	C2	220nF	Capacitor, ceramic, 220nF, 10V	805	Std	Std
1 C4 100pF Capacitor, caramic, 10pF, 10V 805 Std Std 2 C6,C22 1nF Capacitor, caramic, 1nF, 10V 805 Std Std Std 1 C6,C22 1nF Capacitor, caramic, 220,F, 160V Radial DVR2C221MHA Nichicon 1 C6A 220,F Capacitor, electrolytic, 220,F, 160V Radial UVR2C221MHA Nichicon 1 C10 47,pF Capacitor, electrolytic, 47,pF, 25V Radial UVR2C221MHA Nichicon 2 C12,C17 47,µF Capacitor, electrolytic, 47,µF, 25V Radial UVR1E4247NDA Nichicon 2 C13,C24 100nF Capacitor, caramic, 10nF, 53V 805 Std Std 1 C16 10nF Capacitor, caramic, 10nF, 10V 805 Std Std 1 C16 C16 Capacitor, electrolytic, 39,F,26V Radial UVR1E30MDA Nichicon 1 C18 C29 Capacitor, electrolytic, 47,µF,25V Radial UVR1E470MDA <t< td=""><td>2</td><td>C3,C28</td><td>1nF</td><td>Capacitor, ceramic, 1nF, 2kV</td><td>Radial</td><td>DEBE33D102ZB2B</td><td>Murata</td></t<>	2	C3,C28	1nF	Capacitor, ceramic, 1nF, 2kV	Radial	DEBE33D102ZB2B	Murata
2 C5.C22 1nF Capacitor, ceramic, 1nF, 10V 805 Std Std 2 C6.C7 220µF Capacitor, electrolytic, 220µF, 160V Radial UVR2221MHA Nichicon 1 C6A 220µF Capacitor, electrolytic, 220µF, 160V Radial UVR2221MHA Nichicon 0 10 470µF Capacitor, electrolytic, 47µF, 55V Radial UVR1E4R7MDA Nichicon 2 C13.C24 100nF Capacitor, ceramic, 10µF, 6.3V 805 Std Std Std 2 C13.C24 100nF Capacitor, ceramic, 10µF, 6.3V 805 Std Std Std 1 C16 C2apacitor, ceramic, 10µF, 6.3V 805 Std Std Std Std 1 C16 C2apacitor, ceramic, 10µF, 6.3V 805 Std	1	C4	100pF	Capacitor, ceramic, 100pF, 10V	805	Std	Std
2 C66.07 220µF Capacitor, Elercoylic, 220µF, 160V Radial B82322C324M149 Nichicon 1 C6A 220µF Capacitor, Film, 220µF, 360VAC Radial UVR2C21M14A Nichicon 1 C10 47pF Capacitor, electrolytic, 27µF, 53V Radial UVR2C221M1A Nichicon 2 C12.C17 4.7µF Capacitor, electrolytic, 4.7µF, 25V Rodial UVR1EAR7MDA Nichicon 2 C12.C17 4.7µF Capacitor, ceramic, 100nF, 6.3V 805 Std Std 2 C13.C24 100nF Capacitor, ceramic, 100F, 6.3V 805 Std Std 1 C15 10nF Capacitor, ceramic, 10nF, 10V 805 Std Std Std 1 C16 33µF Capacitor, ceramic, 10nF, 10V 805 Std	2	C5,C22	1nF	Capacitor, ceramic, 1nF, 10V	805	Std	Std
1 C6A 220rF Capacitor, electrolytic, 220rF, 160V Radial B3222C3224M189 Epcos DNP C8 220rF Capacitor, electrolytic, 220rF, 160V Radial UVR2C21M1A Nichicon 1 C10 47pF Capacitor, electrolytic, 47pF, 25V Radial UVR1ER7MDA Nichicon 2 C13,C24 100nF Capacitor, ceramic, 10pF, 53V 805 Std Std 1 C16 2,2nF Capacitor, ceramic, 10pF, 53V 805 Std Std 1 C16 2,2nF Capacitor, ceramic, 10nF, 10V 805 Std Std 1 C16 2,2nF Capacitor, ceramic, 20nF, 10V 805 Std Std 2 C19,C20A 10yF Capacitor, electrolytic, 33yF, 25V Radial UVR1E30MDA Nichicon 1 C21 470nF Capacitor, electrolytic, 10yF, 35V Radial UVR1E30MDA Nichicon 1 C21 470rF Capacitor, electrolytic, 47µF, 25V Radial UVR1E470MDA Nichicon	2	C6,C7	220µF	Capacitor, electrolytic, 220µF, 160V	Radial	UVR2C221MHA	Nichicon
DNP C8 220µF Capacitor, caranic, 47pF, 6.3V Radial UVR2C21MHA Nichicon 1 C10 47pF Capacitor, caranic, 47µF, 5.3V 805 Sid Sid 2 C12,C17 4.7µF Capacitor, caranic, 47µF, 25V Radial UVR1E4R7MDA Nichicon 2 C13,C24 100nF Capacitor, caranic, 10µF, 6.3V 805 Sid Sid 1 C14 10µF Capacitor, caranic, 10µF, 6.3V 805 Sid Sid 1 C16 2.2nF Capacitor, caranic, 10µF, 6.3V 805 Sid Sid 1 C18 2.3µF Capacitor, caranic, 10µF, 5.5V Radial UVR1E33MDA Nichicon 2 C19A,C20A 10µF Capacitor, electrolytic, 3µF, 25V Radial UVR1E470MDA Nichicon 1 C20 470nF Capacitor, electrolytic, 47µF, 25V Radial UVR1E470MDA Nichicon 1 C22 47µF Capacitor, electrolytic, 47µF, 25V Radial UVR1E470MDA Nichicon	1	C6A	220nF	Capacitor, Film, 220nF, 305VAC	Radial	B32922C3224M189	Epcos
1 C10 47pF Capacitor, electrolytic, 47pF, 25V Radial UVR1E4R7MDA Nichicon 2 C12,C17 4.7µF Capacitor, earanic, 100rF, 5.3V 805 Std Std 2 C12,C17 4.7µF Capacitor, ceramic, 100rF, 5.3V 805 Std Std 1 C14 10µF Capacitor, ceramic, 10µF, 6.3V 805 Std Std 1 C15 10nF Capacitor, ceramic, 2.2nF, 10V 805 Std Std 1 C16 2.2nF Capacitor, ceramic, 3.3µF, 25V Radial UVR1E330MDA Nichicon 2 C19,C20A 10µF Capacitor, electrolytic, 3.3µF, 25V Radial UVR1E470MDA Nichicon 1 C20 470nF Capacitor, electrolytic, 47µF, 25V Radial UVR1E470MDA Nichicon 1 C21 47µF Capacitor, electrolytic, 47µF, 25V Radial UVR1E470MDA Nichicon 1 C22 47µF Capacitor, electrolytic, 47µF, 25V Radial UVR1E470MDA Nichicon <td>DNP</td> <td>C8</td> <td>220µF</td> <td>Capacitor, electrolytic, 220µF, 160V</td> <td>Radial</td> <td>UVR2C221MHA</td> <td>Nichicon</td>	DNP	C8	220µF	Capacitor, electrolytic, 220µF, 160V	Radial	UVR2C221MHA	Nichicon
1 C11 4.7µF Capacitor, electrolytic, 4.7µF, 25V Radial UVR1E4R7MDA Nichicon 2 C13,C24 100nF Capacitor, caramic, 10µF, 6.3V 805 Stid Stid 1 C14 10µF Capacitor, caramic, 10µF, 6.3V 805 Stid Stid 1 C16 2.2nF Capacitor, caramic, 10µF, 6.3V 805 Stid Stid 1 C16 2.2nF Capacitor, caramic, 2.2nF, 10V 805 Stid Stid 2 C19,C23 100nF Capacitor, caramic, 10nF, 35V Radial UVR2F100MPA Nichicon 1 C20 470nF Capacitor, caramic, 470nF, 25V Radial UVR2F100MPA Nichicon DNP C28 47µF Capacitor, electrolytic, 47µF, 25V Radial UVR1E470MDA Nichicon DNP C28 47µF Capacitor, electrolytic, 47µF, 25V Radial UVR1E470MDA Nichicon DNP C28 10µF Capacitor, electrolytic, 47µF, 10V Radial UVR1E470MDA Nichicon	1	C10	47pF	Capacitor, ceramic, 47pF, 6.3V	805	Std	Std
2 C12,C17 4.7µF Capacitor, ceramic, 4.7µF, 25V 805 Std Std 2 C13,C24 100nF Capacitor, ceramic, 100nF, 6.3V 805 Std Std 1 C14 10µF Capacitor, ceramic, 10µF, 6.3V 805 Std Std 1 C16 2.2nF Capacitor, ceramic, 2.2nF, 10V 805 Std Std 2 C19,C23 100nF Capacitor, ceramic, 32P, 73V 805 Std Std 2 C19,C23 100nF Capacitor, ceramic, 10µF, 31V 805 Std Std 1 C18 33µF Capacitor, ceramic, 10µF, 31V Radial UVR1E470MDA Nichicon 1 C20 470nF Capacitor, electrolytic, 47µF, 25V Radial UVR1E470MDA Nichicon 1 C25 10µF Capacitor, electrolytic, 47µF, 15V Radial UVR1E470MDA Nichicon 1 C25 10µF Capacitor, electrolytic, 47µF, 10V Radial UVR1E470MDA Nichicon 1	1	C11	4.7µF	Capacitor, electrolytic, 4.7µF, 25V	Radial	UVR1E4R7MDA	Nichicon
2 C13.C24 100.FF Capacitor, ceramic, 100.F, 6.3V 805 Std Std 1 C14 10µF Capacitor, ceramic, 10µF, 6.3V 805 Std Std 1 C15 10nF Capacitor, ceramic, 2.2nF, 10V 805 Std Std 1 C16 2.2nF Capacitor, ceramic, 2.2nF, 10V 805 Std Std 2 C19.C23 100nF Capacitor, ceramic, 100.F, 35V 805 Std Std 2 C19.C23 100nF Capacitor, ceramic, 100.F, 25V Radial UVR2F100MPA Nichicon 1 C20 470nF Capacitor, electrolytic, 10µF, 25V Radial UVR1E470MDA Nichicon 1 C21 47µF Capacitor, electrolytic, 47µF, 25V Radial UVR1E470MDA Nichicon 1 C26 47µF Capacitor, electrolytic, 47µF, 10V Radial UVR1E470MDA Nichicon 1 C27 47µF 10V Capacitor, electrolytic, 47µF, 10V Radial UVR1E100MDA Nichicon <	2	C12,C17	4.7µF	Capacitor, ceramic, 4.7µF, 25V	805	Std	Std
1 C14 10µF Capacitor, ceramic, 10µF, 6.3V 805 Std Std 1 C15 10nF Capacitor, ceramic, 10nF, 10V 805 Std Std 1 C16 2.2nF Capacitor, ceramic, 2.2nF, 10V 805 Std Std 2 C19,C23 100nF Capacitor, ceramic, 2.2nF, 10V 805 Std Std Std 2 C19,C23 100nF Capacitor, ceramic, 2.2nF, 10V 805 Std Std Std 2 C19,C23 100nF Capacitor, celectrolytic, 31F, 25V Radial UVR1E70MDA Nichicon 1 C20 470nF Capacitor, electrolytic, 47µF, 25V Radial UVR1E470MDA Nichicon 1 C26 10µF Capacitor, electrolytic, 47µF, 25V Radial UVR1470MDA Nichicon 1 C26 10µF Capacitor, electrolytic, 47µF, 10V Radial UVR1470MDA Nichicon 1 C27 47µF 10V Capacitor, reletrin, 50V, 47µF, 10V Radial UVR1470MDA	2	C13,C24	100nF	Capacitor, ceramic, 100nF, 6.3V	805	Std	Std
1 C15 10nF Capacitor, ceramic, 10nF, 10V 805 Stid Stid 1 C16 2.2nF Capacitor, ceramic, 2.2nF, 10V 805 Stid Stid 2 C19,C23 100nF Capacitor, ceramic, 100nF, 35V 805 Stid Stid 2 C19,C23 100nF Capacitor, ceramic, 100nF, 35V 805 Stid Stid 1 C20 470nF Capacitor, ceramic, 470nF, 25V Radial UVR1E470MDA Nichicon DNP C25 47µF Capacitor, electrolytic, 47µF, 25V Radial UVR1E470MDA Nichicon 1 C26 10µF Capacitor, electrolytic, 47µF, 25V Radial UVR1E470MDA Nichicon 1 C27 47µF 100 Capacitor, electrolytic, 47µF, 10V Radial UVR1470MDA Nichicon DNP C2A 100nF Capacitor, electrolytic, 47µF, 10V Radial UVR1470MDA Nichicon 1 D2A 10A D2A 10A Diode, rectifier, 1000V, 1A DiODE0.4	1	C14	10µF	Capacitor, ceramic, 10µF, 6.3V	805	Std	Std
1 C16 2.2.nF Capacitor, ceramic, 2.nF, 10V 805 Std Std 1 C18 33µF Capacitor, electrolytic, 33µF, 25V Radial UVR1E330MDA Nichicon 2 C19,C23 100nF Capacitor, electrolytic, 10µF, 35V 805 Std Std 1 C20 470nF Capacitor, electrolytic, 10µF, 35V Radial UVR2F100MPA Nichicon 1 C20 470nF Capacitor, electrolytic, 47µF, 25V Radial UVR1E470MDA Nichicon 0DNP C25 47µF Capacitor, electrolytic, 47µF, 25V Radial UVR1E470MDA Nichicon 0DNP C26 10µF Capacitor, electrolytic, 47µF, 10V Radial UVR1E470MDA Nichicon 0DNP C2A 100nF Capacitor, Film, 100nF, 300VAC Radial B32023A3104M Epcos 3 D1, D2, D3 US1M Diode, rectifier, 1000V, 1A DIODE0.4 INT4472MDA Nichicon 1 D4 STTH1008DTI Diode, rectifier, 1000V, 1A DIODE0.4 <td< td=""><td>1</td><td>C15</td><td>10nF</td><td>Capacitor, ceramic, 10nF, 10V</td><td>805</td><td>Std</td><td>Std</td></td<>	1	C15	10nF	Capacitor, ceramic, 10nF, 10V	805	Std	Std
1 C18 33µF Capacitor, electrolytic, 33µF, 25V Radial UVR1E330MDA Nichicon 2 C19,C23 100nF Capacitor, ceramic, 100nF, 35V 805 Std Std 2 C19A,C20A 10µF Capacitor, ceramic, 470nF, 25V Radial UVR2F10MPA Nichicon 1 C20 470rF Capacitor, ceramic, 470nF, 25V Radial UVR1E470MDA Nichicon DNP C25 47µF Capacitor, electrolytic, 47µF, 25V Radial UVR1E470MDA Nichicon 1 C26 10µF Capacitor, electrolytic, 47µF, 10V Radial UVR1E470MDA Nichicon 1 C27 47µF 10V Capacitor, electrolytic, 47µF, 10V Radial UVR1E470MDA Nichicon 1 C27 47µF Std Nath Nohicon Nichicon 3 D1,D2,D3 US1M Diode, rectifier, 1000V, 1A DIODE.6 1N539-E3/54 Vishay 1 D4 STTH1008DTI Diode, Schottky, 30V, 200mA DO-34 BAT85,113 NXP	1	C16	2.2nF	Capacitor, ceramic, 2.2nF, 10V	805	Std	Std
2 C19,C23 100nF Capacitor, ceramic, 100nF, 35V 805 Std Std 2 C19A,C20A 10µF Capacitor, electrolytic, 10µF, 315V Radial UVR2F100MPA Nichicon 1 C20 470nF Capacitor, electrolytic, 47µF, 25V Radial UVR1E470MDA Nichicon DNP C25 47µF Capacitor, electrolytic, 47µF, 25V Radial UVR1E470MDA Nichicon 1 C26 10µF Capacitor, electrolytic, 47µF, 25V Radial UVR1E470MDA Nichicon 1 C27 47µF 10V Capacitor, electrolytic, 47µF, 10V Radial UVR1E470MDA Nichicon DNP C2A 100nF Capacitor, electrolytic, 47µF, 10V Radial B32023A3104M Epcos 3 D1,D2,D3 US1M Diode, rectifier, 1000V, 1A DIODE0.4 US1M Diodes Inc. 4 D1A, D2A, D3,D4A N5399 Diode, rectifier, 1000V, 1.5A DIODE0.6 1N5399-E3/54 Vishay 1 D4 STTH1008DTI Diode, zener, 12V, 1W DI	1	C18	33µF	Capacitor, electrolytic, 33µF, 25V	Radial	UVR1E330MDA	Nichicon
2 C19A,C20A 10μF Capacitor, electrolytic, 10μF, 315V Radial UVR2F100MPA Nichicon 1 C20 470nF Capacitor, electrolytic, 470F, 25V Radial Std Std 1 C21 47µF Capacitor, electrolytic, 47µF, 25V Radial UVR1E470MDA Nichicon 1 C26 17µF Capacitor, electrolytic, 47µF, 25V Radial UVR1E470MDA Nichicon 1 C26 10µF Capacitor, electrolytic, 47µF, 10V Radial UVR1E470MDA Nichicon DNP C2A 100nF Capacitor, electrolytic, 47µF, 10V Radial UVR1E470MDA Nichicon DNP C2A 100nF Capacitor, film, 100nF, 300VAC Radial B32023A3104M Epcos 3 D1, D2, D3 US1M Diode, rectifier, 1000V, 1.5A DIODE0.4 US1M Diodes inc. 1 D4 STTH1008DTI Diode, rectifier, 700V, 10A DODE0.4 1N4742A-TP MCC 1 D11 12V Diode, rectifier, 70V, 15M DiODE.4	2	C19,C23	100nF	Capacitor, ceramic, 100nF, 35V	805	Std	Std
1 C20 470rF Capacitor, ceramic, 470rF, 25V Radial Std Std 1 C21 47µF Capacitor, electrolytic, 47µF, 25V Radial UVR1E470MDA Nichicon DNP C25 47µF Capacitor, electrolytic, 47µF, 25V Radial UVR1E470MDA Nichicon 1 C26 10µF Capacitor, electrolytic, 47µF, 10V Radial UVR1470MDA Nichicon 1 C27 47µF 10V Capacitor, electrolytic, 47µF, 10V Radial UVR1470MDA Nichicon DNP C2A 100nF Capacitor, electrolytic, 47µF, 10V Radial UVR1A70MDA Nichicon 3 D1,D2,D3 US1M Diode, rectifier, 1000V, 1.A DIODE0.4 US1M Diodes Inc. 4 D1A,DAA 1N5399 Diode, rectifier, 1000V, 1.5A DIODE0.4 1N1472A-TP MCC 1 D4 STTH1008DTI Diode, rectifier, 70V, 150mA DOD20.4 1N448X-TP MCC 1 D1 D1 12V Diode, Schottky 30V, 200mA SOF23	2	C19A,C20A	10µF	Capacitor, electrolytic, 10µF, 315V	Radial	UVR2F100MPA	Nichicon
1 C21 47µF Capacitor, electrolytic, 47µF, 25V Radial UVR1E470MDA Nichicon DNP C25 47µF Capacitor, electrolytic, 47µF, 25V Radial UVR1E470MDA Nichicon 1 C26 10µF Capacitor, electrolytic, 47µF, 25V Radial UVR1E470MDA Nichicon 1 C27 47µF 10V Capacitor, electrolytic, 47µF, 10V Radial UVR1470MDA Nichicon DNP C2A 100nF Capacitor, electrolytic, 47µF, 10V Radial UVR1470MDA Nichicon 3 D1, D2, D3 US1M Diode, rectifier, 1000V, 1.5A DIODE0.4 US1M Diodes Inc. 4 D3A, D4A INS399 Diode, rectifier, 70, 100V, 1.5A DIODE0.6 1N5399-82/54 Vishay 1 D4 STTH1008DTI Diode, schottky, 30V, 200mA DO-34 BAT85,113 NXP 2 D7.D8 IN4148 Diode, Schottky 30V, 200mA SOD523 1N4148X-TP MCC 1 D9A BAT54 Diode, Schottky 30V, 200mA SOD123	1	C20	470nF	Capacitor, ceramic, 470nF, 25V	Radial	Std	Std
DNP C25 47µF Capacitor, electrolytic, 47µF, 25V Radial UVR1E470MDA Nichicon 1 C26 10µF Capacitor, electrolytic, 10µF, 25V Radial UVR1E100MDA Nichicon 1 C27 47µF 10V Capacitor, electrolytic, 47µF, 10V Radial UVR1470MDA Nichicon DNP C2A 100nF Capacitor, electrolytic, 47µF, 10V Radial B32023A3104M Epcos 3 D1, D2, D3 US1M Diode, rectifier, 1000V, 1A DIODE0.4 US1M Diodes Inc. 4 D1A, D2A, D3A, D4A 1N5399 Diode, rectifier, 1000V, 1.5A DIODE0.6 1N5399-E3/54 Vishay 1 D4 STTH1008DTI Diode, rectifier, 1000V, 1.5A DIODE0.4 1N4742A-TP MCC 1 D11 12V Diode, Schottky, 30V, 200mA DO-34 BAT85,113 NXP 2 D7,D8 IN4148 Diode, schottky 30V, 200mA SOT-23 BAT64S-TP MCC 1 D9 BAT54 Diode, Schottky 30V, 200mA SOT-23 <t< td=""><td>1</td><td>C21</td><td>47µF</td><td>Capacitor, electrolytic, 47µF, 25V</td><td>Radial</td><td>UVR1E470MDA</td><td>Nichicon</td></t<>	1	C21	47µF	Capacitor, electrolytic, 47µF, 25V	Radial	UVR1E470MDA	Nichicon
1 C26 10µF Capacitor, electrolytic, 10µF, 25V Radial UVR1E100MDA Nichicon 1 C27 47µF 10V Capacitor, electrolytic, 47µF, 10V Radial UVR14470MDA Nichicon DNP C2A 100nF Capacitor, electrolytic, 47µF, 10V Radial B32023A3104M Epcos 3 D1, D2, D3 US1M Diode, rectifier, 1000V, 1A DiODE0.4 US1M Diodes lnc. 4 D1A, D2A, D3A, D4A 1N5399 Diode, rectifier, 1000V, 1.5A DiODE0.4 IN5399-E3/54 Vishay 1 D4 STTH1008DTI Diode, rectifier, 75V, 150 TO220AC STTH1008DTI STMicro 1 D6 BAT85 Diode, Zener, 12V, 1W DIODE0.4 1N4742A-TP MCC 1 D6 BAT85 Diode, Schottky 30V, 200mA SOD523 1N4148X-TP MCC 1 D9 BAT54 Diode, Schottky 30V, 200mA SOT-23 BAT854S-TP MCC 1 D10 18V Diode, Zener, 18V, 1W SOD123 MMS25266BT1G	DNP	C25	47µF	Capacitor, electrolytic, 47µF, 25V	Radial	UVR1E470MDA	Nichicon
1 C27 47µF 10V Capacitor, electrolytic, 47µF, 10V Radial UVR1A470MDA Nichicon DNP C2A 100nF Capacitor, Film, 100nF, 300VAC Radial B32023A3104M Epcos 3 D1, D2, D3 US1M Diode, rectifier, 1000V, 1A DIODE0.4 US1M Diodes Inc. 4 D1A, D2A, D3A, D4A 1N5399 Diode, rectifier, 1000V, 1.SA DIODE0.6 1N5399-E3/54 Vishay 1 D4 STTH1008DTI Diode, hyperfast, 800V, 10A TO220AC STTH1008DTI STMicro 1 D4 STTH1008DTI Diode, chertifier, 712V, 1W DIODE0.4 1N4742A-TP MCC 1 D6 BAT85 Diode, Schottky, 30V, 200mA DO-34 BAT54, TP MCC 1 D9 BAT54 Diode, Schottky, 30V, 200mA SOT-23 BAT54-STP MCC 1 D9A IN4007 Diode, certifier, 1000V, 1A DIODE0.4 1N4007-TP MCC 1 D9A IN4007 Diode, Schottky 30V, 200mA SOT-23 BAT54.STP	1	C26	10µF	Capacitor, electrolytic, 10µF, 25V Radial		UVR1E100MDA	Nichicon
DNP C2A 100nF Capacitor, Film, 100nF, 300VAC Radial B32023A3104M Epcos 3 D1, D2, D3 US1M Diode, rectifier, 1000V, 1A DIODE0.4 US1M Diodes Inc. 4 D1A, D2A, D3A, D4A 1NS399 Diode, rectifier, 1000V, 1.5A DIODE0.6 1N5399-E3/54 Vishay 1 D4 STTH1008DTI Diode, hyperfast, 800V, 10A TO220AC STTH1008DTI STMicro 1 D11 12V Diode, cener, 12V, 1W DIODE0.4 1N4742A-TP MCC 1 D6 BAT85 Diode, Schottky, 30V, 200mA DO-34 BAT85,113 NXP 2 D7,D8 IN4148 Diode, centifier, 75V, 150mA SOD523 1N4148X-TP MCC 1 D9 BAT54 Diode, cener, 8V, 1W SMA SMA218-13-F Diodes Inc. 1NP D12 68V Diode, Zener, 8V, 1W SOD123 MMS25266BT1G On Semi DNP D13 56V Diode, Zener, 68V, 1/2W SOD123 MMS25266BT1G On Semi <	1	C27	47µF 10V	Capacitor, electrolytic, 47µF, 10V Radial		UVR1A470MDA	Nichicon
3 D1, D2, D3 US1M Diode, rectifier, 1000V, 1A DIODE0.4 US1M Diodes Inc. 4 D1A, D2A, D3A, D4A 1N5399 Diode, rectifier, 1000V, 1.5A DIODE0.6 1N5399-E3/54 Vishay 1 D4 STTH1008DTI Diode, hyperfast, 800V, 10A T0220AC STTH1008DTI STMicro 1 D4 STTH1008DTI Diode, Zener, 12V, 1W DIODE0.4 1N4742A-TP MCC 1 D6 BAT85 Diode, Schottky, 30V, 200mA DO-34 BAT85,113 NXP 2 D7,D8 IN4148 Diode, rectifier, 75V, 150mA SOD523 1N4148X-TP MCC 1 D9 BAT54 Diode, Schottky 30V, 200mA SOT-23 BAT54S-TP MCC 1 D9A 1N4007 Diode, zener, 18V, 1W SMA SMAZ18-13-F Diodes Inc. DNP D12 68V Diode, Zener, 68V, 1/2W SOD123 MMSZ52668T1G On Semi 1 D14 18V Diode, Zener, 18V, 1W DIODE0.4 1N4746A-TP MCC	DNP	C2A	100nF	Capacitor, Film, 100nF, 300VAC	Radial	B32023A3104M	Epcos
4 D1A, D2A, D3A, D4A 1N5399 Diode, rectifier, 1000V, 1.5A DIODE0.6 1N5399-E3/54 Vishay 1 D4 STTH1008DTI Diode, hyperfast, 800V, 10A TO220AC STTH1008DTI STMicro 1 D11 12V Diode, Zener, 12V, 1W DIODE0.4 1N4742A-TP MCC 1 D6 BAT85 Diode, Schottky, 30V, 200mA DO-34 BAT85,113 NXP 2 D7,D8 IN4148 Diode, rectifier, 75V, 150mA SOD523 1N4148X-TP MCC 1 D9 BAT54 Diode, Schottky 30V, 200mA SOT-23 BAT54S-TP MCC 1 D9A 1N4007 Diode, rectifier, 1000V, 1A DIODE0.4 1N407-TP MCC 1 D10 18V Diode, Zener, 18V, 1W SMA SMA218-13-F Diodes Inc. DNP D12 68V Diode, Zener, 68V, 1/2W SOD123 MMSZ5266BT1G On Semi 1 D14 18V Diode, Zener, 18V, 1W DIODE0.4 1N4746A-TP MCC	3	D1, D2, D3	US1M	Diode, rectifier, 1000V, 1A	DIODE0.4	US1M	Diodes Inc.
1 D4 STTH1008DTI Diode, hyperfast, 800V, 10A TO220AC STTH1008DTI STMicro 1 D11 12V Diode, Zener, 12V, 1W DIODE0.4 1N4742A-TP MCC 1 D6 BAT85 Diode, Schottky, 30V, 200mA DO-34 BAT85,113 NXP 2 D7,D8 IN4148 Diode, schottky, 30V, 200mA SOD523 1N4148X-TP MCC 1 D9 BAT54 Diode, Schottky 30V, 200mA SOT-23 BAT54S-TP MCC 1 D9A 1N4007 Diode, centifier, 1000V, 1A DIODE0.4 1N4007-TP MCC 1 D9A 1N4007 Diode, Zener, 18V, 1W SMA SMAZ18-13-F Diodes Inc. DNP D12 68V Diode, Zener, 68V, 1/2W SOD123 MMSZ5268BT1G On Semi 1 D14 18V Diode, Zener, 18V, 1W DIODE0.4 1N4746A-TP MCC 1 D14 18V Diode, Zener, 18V, 1W DIODE0.4 1N4746A-TP MCC 1 J1	4	D1A, D2A, D3A, D4A	1N5399	Diode, rectifier, 1000V, 1.5A	DIODE0.6	1N5399-E3/54	Vishay
1 D11 12V Diode, Zener, 12V, 1W DIODE0.4 1N4742A-TP MCC 1 D6 BAT85 Diode, Schottky, 30V, 200mA DO-34 BAT85,113 NXP 2 D7,D8 IN4148 Diode, rectifier, 75V, 150mA SOD523 1N4148X-TP MCC 1 D9 BAT54 Diode, Schottky 30V, 200mA SOT-23 BAT54S-TP MCC 1 D9A 1N4007 Diode, rectifier, 1000V, 1A DIODE0.4 1N4007-TP MCC 1 D10 18V Diode, Zener, 18V, 1W SMA SMAZ18-13-F Diodes Inc. DNP D12 68V Diode, Zener, 68V, 1/2W SOD123 MMSZ5266BT1G On Semi 1 D14 18V Diode, Zener, 56V, 1/2W SOD123 MMSZ5263BT1G On Semi 1 D14 18V Diode, Zener, 18V, 1W DIODE0.4 1N4746A-TP MCC 1 D14 18V Diode, Zener, 18V, 1W DIODE0.4 1N4746A-TP MCC 1 J1 TC	1	D4	STTH1008DTI	Diode, hyperfast, 800V, 10A	TO220AC	STTH1008DTI	STMicro
1 D6 BAT85 Diode, Schottky, 30V, 200mA DO-34 BAT85,113 NXP 2 D7,D8 IN4148 Diode, rectifier, 75V, 150mA SOD523 1N4148X-TP MCC 1 D9 BAT54 Diode, Schottky 30V, 200mA SOT-23 BAT54S-TP MCC 1 D9A 1N4007 Diode, Schottky 30V, 200mA DIODE0.4 1N4007-TP MCC 1 D9A 1N4007 Diode, credifier, 1000V, 1A DIODE0.4 1N4007-TP MCC 1 D10 18V Diode, Zener, 18V, 1W SMA SMAZ18-13-F Diodes Inc. DNP D12 68V Diode, Zener, 68V, 1/2W SOD123 MMSZ5268BT1G On Semi 1 D14 18V Diode, Zener, 18V, 1W DIODE0.4 1N4746A-TP MCC 1 D14 18V Diode, Zener, 18V, 1W DIODE0.4 1N4746A-TP MCC 1 J1 TC03236200J0G Terminal Block, 15A, 5.1mm 200-3 TC03236200J0G FCI 1 J3	1	D11	12V	Diode, Zener, 12V, 1W	DIODE0.4	1N4742A-TP	MCC
2 D7,D8 IN4148 Diode, rectifier, 75V, 150mA SOD523 1N4148X-TP MCC 1 D9 BAT54 Diode, Schottky 30V, 200mA SOT-23 BAT54S-TP MCC 1 D9A 1N4007 Diode, rectifier, 1000V, 1A DIODE0.4 1N4007-TP MCC 1 D10 18V Diode, Zener, 18V, 1W SMA SMAZ18-13-F Diodes Inc. DNP D12 68V Diode, Zener, 68V, 1/2W SOD123 MMSZ5266BT1G On Semi DNP D13 56V Diode, Zener, 68V, 1/2W SOD123 MMSZ5263BT1G On Semi 1 D14 18V Diode, Zener, 18V, 1W DIODE0.4 1N4746A-TP MCC 1 F1 39213150000 Fuse, 3.15A, 250V Radial, Box 39213150000 Littelfuse 1 J1 TC03236200J0G Terminal Block, 15A, 5.1mm 200-3 TC03236200J0G FCI 1 J3 5010 Test point, red, thru hole 0.125 × 0.125 in 5010 Keystone 1<	1	D6	BAT85	Diode, Schottky, 30V, 200mA	DO-34	BAT85,113	NXP
1 D9 BAT54 Diode, Schottky 30V, 200mA SOT-23 BAT54S-TP MCC 1 D9A 1N4007 Diode, rectifier, 1000V, 1A DIODE0.4 1N4007-TP MCC 1 D10 18V Diode, Zener, 18V, 1W SMA SMAZ18-13-F Diodes Inc. DNP D12 68V Diode, Zener, 68V, 1/2W SOD123 MMSZ5266BT1G On Semi DNP D13 56V Diode, Zener, 56V, 1/2W SOD123 MMSZ5263BT1G On Semi 1 D14 18V Diode, Zener, 18V, 1W DIODE0.4 1N4746A-TP MCC 1 F1 39213150000 Fuse, 3.15A, 250V Radial, Box 39213150000 Littlefluse 1 J1 TC03236200J0G Terminal Block, 15A, 5.1mm 200-3 TC03236200J0G FCI 1 J3 5010 Test point, red, thru hole 0.125 x 0.125 in 5011 Keystone 1 J4 5011 Test point, black, thru hole 0.125 x 0.125 in 5011 Keystone <	2	D7,D8	IN4148	Diode, rectifier, 75V, 150mA	SOD523	1N4148X-TP	MCC
1 D9A 1N4007 Diode, rectifier, 1000V, 1A DIODE0.4 1N4007-TP MCC 1 D10 18V Diode, Zener, 18V, 1W SMA SMAZ18-13-F Diodes Inc. DNP D12 68V Diode, Zener, 68V, 1/2W SOD123 MMSZ5266BT1G On Semi DNP D13 56V Diode, Zener, 56V, 1/2W SOD123 MMSZ5263BT1G On Semi 1 D14 18V Diode, Zener, 56V, 1/2W SOD123 MMSZ5263BT1G On Semi 1 D14 18V Diode, Zener, 18V, 1W DIODE0.4 1N4746A-TP MCC 1 J1 TC03236200J0G Furninal Block, 15A, 5.1mm 200-3 TC03236200J0G FCI 1 J3 5010 Test point, red, thru hole 0.125 x 0.125 in 5010 Keystone 1 J4 5011 Test point, black, thru hole 0.125 x 0.125 in 5011 Keystone 1 L1 10mH Inductor, Common-Mode, 10mH, 3A, TH UU10.5 Custom Custom <t< td=""><td>1</td><td>D9</td><td>BAT54</td><td>Diode, Schottky 30V, 200mA</td><td>SOT-23</td><td>BAT54S-TP</td><td>MCC</td></t<>	1	D9	BAT54	Diode, Schottky 30V, 200mA	SOT-23	BAT54S-TP	MCC
1 D10 18V Diode, Zener, 18V, 1W SMA SMAZ18-13-F Diodes Inc. DNP D12 68V Diode, Zener, 68V, 1/2W SOD123 MMSZ5266BT1G On Semi DNP D13 56V Diode, Zener, 56V, 1/2W SOD123 MMSZ5263BT1G On Semi 1 D14 18V Diode, Zener, 18V, 1W DIODE0.4 1N4746A-TP MCC 1 F1 39213150000 Fuse, 3.15A, 250V Radial, Box 39213150000 Littelfuse 1 J1 TC03236200J0G Terminal Block, 15A, 5.1mm 200-3 TC03236200J0G FCI 1 J3 5010 Test point, red, thru hole 0.125 x 0.125 in 5010 Keystone 1 J4 5011 Test point, black, thru hole 0.125 x 0.125 in 5011 Keystone 2 L2,L3 100uH Inductor, Common-Mode, 10mH, 3A, TH UU10.5 Custom Custom 1 MOV1 B72207S271K321 MOV, 387V, 1.2kA Disc 7mm B72207S271K321 Epcos	1	D9A	1N4007	Diode, rectifier, 1000V, 1A	DIODE0.4	1N4007-TP	MCC
DNP D12 68V Diode, Zener, 68V, 1/2W SOD123 MMSZ5266BT1G On Semi DNP D13 56V Diode, Zener, 56V, 1/2W SOD123 MMSZ5263BT1G On Semi 1 D14 18V Diode, Zener, 18V, 1W DIODE0.4 1N4746A-TP MCC 1 F1 39213150000 Fuse, 3.15A, 250V Radial, Box 39213150000 Littelfuse 1 J1 TC03236200J0G Terminal Block, 15A, 5.1mm 200-3 TC03236200J0G FCI 1 J3 5010 Test point, red, thru hole 0.125 × 0.125 in 5010 Keystone 1 J4 5011 Test point, black, thru hole 0.125 × 0.125 in 5011 Keystone 1 L1 10mH Inductor, Common-Mode, 10mH, 3A, TH UU10.5 Custom Custom 2 L2,L3 100uH Inductor, Differential, 100µH, 3A, TH TH Custom Custom 1 MOV1 B72207S271K321 MOV, 387V, 1.2kA Disc 7mm B72207S271K321 Epcos <td>1</td> <td>D10</td> <td>18V</td> <td>Diode, Zener, 18V, 1W</td> <td>SMA</td> <td>SMAZ18-13-F</td> <td>Diodes Inc.</td>	1	D10	18V	Diode, Zener, 18V, 1W	SMA	SMAZ18-13-F	Diodes Inc.
DNP D13 56V Diode, Zener, 56V, 1/2W SOD123 MMSZ5263BT1G On Semi 1 D14 18V Diode, Zener, 18V, 1W DIODE0.4 1N4746A-TP MCC 1 F1 39213150000 Fuse, 3.15A, 250V Radial, Box 39213150000 Littelfuse 1 J1 TC03236200J0G Terminal Block, 15A, 5.1mm 200-3 TC03236200J0G FCI 1 J3 5010 Test point, red, thru hole 0.125 x 0.125 in 5010 Keystone 1 J4 5011 Test point, black, thru hole 0.125 x 0.125 in 5011 Keystone 1 L1 10mH Inductor, Common-Mode, 10mH, 3A, TH UU10.5 Custom Custom 2 L2,L3 100uH Inductor, Differential, 100µH, 3A, TH TH Custom Custom 1 MOV1 B72207S271K321 MOV, 387V, 1.2kA Disc 7mm B72207S271K321 Epcos 1 Q1 BC857 Transistor, PNP, 45V, 100mA SOT-23 BC847CLT3G On Semi </td <td>DNP</td> <td>D12</td> <td>68V</td> <td>Diode, Zener, 68V, 1/2W</td> <td>SOD123</td> <td>MMSZ5266BT1G</td> <td>On Semi</td>	DNP	D12	68V	Diode, Zener, 68V, 1/2W	SOD123	MMSZ5266BT1G	On Semi
1 D14 18V Diode, Zener, 18V, 1W DIODE0.4 1N4746A-TP MCC 1 F1 39213150000 Fuse, 3.15A, 250V Radial, Box 39213150000 Littelfuse 1 J1 TC03236200J0G Terminal Block, 15A, 5.1mm 200-3 TC03236200J0G FCI 1 J3 5010 Test point, red, thru hole 0.125 x 0.125 in 5010 Keystone 1 J4 5011 Test point, black, thru hole 0.125 x 0.125 in 5011 Keystone 1 J4 5011 Test point, black, thru hole 0.125 x 0.125 in 5011 Keystone 1 L1 10mH Inductor, Common-Mode, 10mH, 3A, TH UU10.5 Custom Custom 2 L2,L3 100uH Inductor, Differential, 100µH, 3A, TH TH Custom Custom 1 MOV1 B72207S271K321 MOV, 387V, 1.2kA Disc 7mm B72207S271K321 Epcos 1 Q1 BC857 Transistor, PNP, 45V, 100mA SOT-23 BC847CLT3G On Semi	DNP	D13	56V	Diode, Zener, 56V, 1/2W	SOD123	MMSZ5263BT1G	On Semi
1 F1 39213150000 Fuse, 3.15A, 250V Radial, Box 39213150000 Littelfuse 1 J1 TC03236200J0G Terminal Block, 15A, 5.1mm 200-3 TC03236200J0G FCI 1 J3 5010 Test point, red, thru hole 0.125 × 0.125 in 5010 Keystone 1 J4 5011 Test point, black, thru hole 0.125 × 0.125 in 5011 Keystone 1 L1 10mH Inductor, Common-Mode, 10mH, 3A, TH UU10.5 Custom Custom 2 L2,L3 100uH Inductor, Differential, 100µH, 3A, TH TH Custom Custom 1 MOV1 B72207S271K321 MOV, 387V, 1.2kA Disc 7mm B72207S271K321 Epcos 1 Q1 BC857 Transistor, PNP, 45V, 100mA SOT-23 BC857BLT3G On Semi 3 Q2,Q4,Q5 BC847 Transistor, NPN, 45V, 100mA SOT-23 BC847CLT3G On Semi	1	D14	18V	Diode, Zener, 18V, 1W	DIODE0.4	1N4746A-TP	MCC
1 J1 TC03236200J0G Terminal Block, 15A, 5.1mm 200-3 TC03236200J0G FCI 1 J3 5010 Test point, red, thru hole 0.125 × 0.125 in 5010 Keystone 1 J4 5011 Test point, black, thru hole 0.125 × 0.125 in 5011 Keystone 1 L1 10mH Inductor, Common-Mode, 10mH, 3A, TH UU10.5 Custom Custom 2 L2,L3 100uH Inductor, Differential, 100µH, 3A, TH TH Custom Custom 1 MOV1 B72207S271K321 MOV, 387V, 1.2kA Disc 7mm B72207S271K321 Epcos 1 Q1 BC857 Transistor, PNP, 45V, 100mA SOT-23 BC857BLT3G On Semi 3 Q2,Q4,Q5 BC847 Transistor, NPN, 45V, 100mA SOT-23 BC847CLT3G On Semi	1	F1	39213150000	Fuse, 3.15A, 250V	Radial, Box	39213150000	Littelfuse
1 J3 5010 Test point, red, thru hole 0.125 × 0.125 in 5010 Keystone 1 J4 5011 Test point, black, thru hole 0.125 × 0.125 in 5011 Keystone 1 J4 5011 Test point, black, thru hole 0.125 × 0.125 in 5011 Keystone 1 L1 10mH Inductor, Common-Mode, 10mH, 3A, TH UU10.5 Custom Custom 2 L2,L3 100uH Inductor, Differential, 100µH, 3A, TH TH Custom Custom 1 MOV1 B72207S271K321 MOV, 387V, 1.2kA Disc 7mm B72207S271K321 Epcos 1 Q1 BC857 Transistor, PNP, 45V, 100mA SOT-23 BC857BLT3G On Semi 3 Q2,Q4,Q5 BC847 Transistor, NPN, 45V, 100mA SOT-23 BC847CLT3G On Semi	1	J1	TC03236200J0G	Terminal Block, 15A, 5.1mm	200-3	TC03236200J0G	FCI
1 J4 5011 Test point, black, thru hole 0.125 x 0.125 in 5011 Keystone 1 L1 10mH Inductor, Common-Mode, 10mH, 3A, TH UU10.5 Custom Custom 2 L2,L3 100uH Inductor, Differential, 100µH, 3A, TH TH Custom Custom 1 MOV1 B72207S271K321 MOV, 387V, 1.2kA Disc 7mm B72207S271K321 Epcos 1 Q1 BC857 Transistor, PNP, 45V, 100mA SOT-23 BC857BLT3G On Semi 3 Q2,Q4,Q5 BC847 Transistor, NPN, 45V, 100mA SOT-23 BC847CLT3G On Semi	1	J3	5010	Test point, red, thru hole	0.125 × 0.125 in	5010	Keystone
1 L1 10mH Inductor, Common-Mode, 10mH, 3A, TH UU10.5 Custom Custom 2 L2,L3 100uH Inductor, Differential, 100µH, 3A, TH TH Custom Custom 1 MOV1 B72207S271K321 MOV, 387V, 1.2kA Disc 7mm B72207S271K321 Epcos 1 Q1 BC857 Transistor, PNP, 45V, 100mA SOT-23 BC857BLT3G On Semi 3 Q2,Q4,Q5 BC847 Transistor, NPN, 45V, 100mA SOT-23 BC847CLT3G On Semi	1	J4	5011	Test point, black, thru hole	0.125 × 0.125 in	5011	Keystone
2 L2,L3 100uH Inductor, Differential, 100µH, 3A, TH TH Custom Custom 1 MOV1 B72207S271K321 MOV, 387V, 1.2kA Disc 7mm B72207S271K321 Epcos 1 Q1 BC857 Transistor, PNP, 45V, 100mA SOT-23 BC857BLT3G On Semi 3 Q2,Q4,Q5 BC847 Transistor, NPN, 45V, 100mA SOT-23 BC847CLT3G On Semi	1	L1	10mH	Inductor, Common-Mode, 10mH, 3A, TH	UU10.5	Custom	Custom
1 MOV1 B72207S271K321 MOV, 387V, 1.2kA Disc 7mm B72207S271K321 Epcos 1 Q1 BC857 Transistor, PNP, 45V, 100mA SOT-23 BC857BLT3G On Semi 3 Q2,Q4,Q5 BC847 Transistor, NPN, 45V, 100mA SOT-23 BC847CLT3G On Semi	2	L2,L3	100uH	Inductor, Differential, 100µH, 3A, TH	ТН	Custom	Custom
1 Q1 BC857 Transistor, PNP, 45V, 100mA SOT-23 BC857BLT3G On Semi 3 Q2,Q4,Q5 BC847 Transistor, NPN, 45V, 100mA SOT-23 BC847CLT3G On Semi	1	MOV1	B72207S271K321	MOV, 387V, 1.2kA	Disc 7mm	B72207S271K321	Epcos
3 Q2,Q4,Q5 BC847 Transistor, NPN, 45V, 100mA SOT-23 BC847CLT3G On Semi	1	Q1	BC857	Transistor, PNP, 45V, 100mA	SOT-23	BC857BLT3G	On Semi
	3	Q2,Q4,Q5	BC847	Transistor, NPN, 45V, 100mA	SOT-23	BC847CLT3G	On Semi

Texas Instruments

Table 2. Bill of Materia	als for Circuit with	Secondary Side	Regulation	(continued)
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Count	RefDes	Value	Description	Size	Part Number	MFR.
1	Q3	STP8N80K5	Transistor, N-ch FET, 800V, 6A	TO-220-3	STP8N80K5	STMicro
1	Q6	BC547	Transistor, NPN, 45V, 100mA	TO-92	BC547CZL1G	On Semi
1	Q7	BSS123	Transistor, N-ch FET, 100V, 170mA	SOT-23	BSS123LT1G	On Semi
1	Q8	FJP5027OTU	Transistor, NPN, 800V, 3A	TO-220-3	FJP5027OTU	Fairchild
2	R1,R28	33K	Resistor, chip, 1/4W, 1%	1206	Std	Std
1	R2	330K	Resistor, chip, 1/4W, 1%	1206	Std	Std
2	R3,R40	47kΩ	Resistor, chip, 1/4W, 1%	1206	Std	Std
1	R4	220kΩ	Resistor, axial,1/4W, 1%	AXIAL0.4	Std	Std
DNP	R4A	220kΩ	Resistor, axial,1/4W, 1%	AXIAL0.4	Std	Std
1	R5	100K	Resistor, axial,1/4W, 1%	AXIAL0.4	Std	Std
1	R5A	100K	Resistor, chip, 1/4W, 1%	1206	Std	Std
1	R6	22kΩ	Resistor, axial,1/4W, 1%	AXIAL0.4	Std	Std
2	R7,R8	22kΩ	Resistor, chip, 1/4W, 1%	1206	Std	Std
1	R9	12kΩ	Resistor, axial,1/4W, 1%	AXIAL0.4	Std	Std
1	R10	2.2ΜΩ	Resistor, chip, 1/4W, 1%	1206	Std	Std
DNP	R10A,R20A	2.2ΜΩ	Resistor, chip, 1/4W, 1%	1206	Std	Std
1	R11	12kΩ	Resistor, chip, 1/4W, 1%	1206	Std	Std
2	R12,R13	5.6kΩ	Resistor, chip, 1/4W, 1%	1206	Std	Std
1	R15	8.2kΩ	Resistor, axial,1/4W, 1%	AXIAL0.4	Std	Std
1	R16	8.2kΩ	Resistor, chip, 1/4W, 1%	1206	Std	Std
1	R17	0E	Resistor, axial,1/4W, 1%	AXIAL0.4	Std	Std
2	R18,R19	1ΜΩ	Resistor, chip, 1/4W, 1%	1206	Std	Std
1	R20	56kΩ	Resistor, chip, 1/4W, 1%	1206	Std	Std
1	R21	82kΩ	Resistor, chip, 1/4W, 1%	1206	Std	Std
DNP	R21A,R21B	1ΜΩ	Resistor, chip, 1/4W, 1%	1206	Std	Std
2	R22,R26	4.7kΩ	Resistor, chip, 1/4W, 1%	1206	Std	Std
1	R23	4.7E	Resistor, axial,1/4W, 1%	AXIAL0.4	Std	Std
1	R24	0.2Ω	Resistor, chip, 1/2W, 1%	1206	Std	Std
1	R25	2.7kΩ	Resistor, chip, 1/4W, 1%	1206	Std	Std
2	R27,R37	150kΩ	Resistor, chip, 1/4W, 1%	1206	Std	Std
1	R29	0.82Ω	Resistor, axial,1W, 1%	AXIAL0.4	Std	Std
DNP	R31	1Ω	Resistor, axial,1W, 1%	AXIAL0.4	Std	Std
1	R32	240kΩ	Resistor, chip, 1/4W, 1%	1206	Std	Std
3	R33, R34, R35	1kΩ	Resistor, chip, 1/4W, 1%	1206	Std	Std
1	R36	10kΩ	Resistor, chip, 1/4W, 1%	1206	Std	Std
1	R38	150Ω	Resistor, axial,1/4W, 1%	AXIAL0.4	Std	Std
1	R38A	1ΜΩ	Resistor, axial,1/4W, 1%	AXIAL0.4	Std	Std
1	R39	150Ω	Resistor, chip, 1/4W, 1%	1206	Std	Std
1	R41	100E	Resistor, chip, 1/4W, 1%	1206	Std	Std
DNP	R42	0.5Ω	Resistor, chip, 1/4W, 1%	1206	Std	Std
	T1	200µH	Transformer, Custom	PQ3230	Std	Std
DNP	T1A	200µH	Transformer, Custom	PQ2625	Std	Std
1	U1	CD74HCT14M	IC, High Speed CMOS Logic Hex Schmitt- Triggered Inverters	SOIC-14	CD74HCT14M	ТІ
1	U2	UCC28810	IC, LED Lighting Power Controller	SOIC-8	UCC28810DR	ТІ
1	U3	PC817B	IC, Optocoupler	DIP4	PC817B	Sharp
2	U4,U5	TL431	Adjustable Precision Shunt Regulator	TO-92	TL431CLPM	ТІ

5.2 Primary-Side Output Current Regulation

Table 3 lists the BOM for the primary-side output current regulation circuit.

Table 3. Bill of Materials for Circuit with Primary Side Regulation

1 C1 0000F Capacitor, Film, 1000F, 300/VAC Radial B20203A104M Epods 1 C2 22 C2,3C28 1nF Capacitor, corranic, 1nF, 2kV Radial DEBE33D1022282 Murata 1 C4 100pF Capacitor, corranic, 1nF, 2kV Radial DEBE33D1022282 Murata 2 C5,C22 1nF Capacitor, corranic, 1nF, 10V 805 Std Std 2 C6,C7 220pF Capacitor, corranic, 1nF, 10V 805 Std Std Std 1 C11 47,pF Capacitor, electralytic, 220pF, 180V Radial UVRE1221MHA Nethicon 2 C13,C217 47,pF Capacitor, electralytic, 47,pF, 29V 805 Std Std Std 2 C13,C24 100pF Capacitor, electralytic, 47,pF, 29V 805 Std Std Std 2 C13,C23 100rF Capacitor, electralytic, 71,F, 29V 805 Std Std Std 1 C14 10pF Capa	Count	RefDes	Value	Description	Size	Part Number	MFR
1 C2 200nF Comparation, ceramic, 1220nF, 10V 805 Std Std 2 C3.C22 1nF Capacitor, ceramic, 172, 24V Radial DEBE330102282 Muraia 1 C4 100pF Capacitor, ceramic, 107, 10V 805 Std Std Std 2 C6,C2 1nF Capacitor, ceramic, 107, 10V 805 Std Std Std 1 C6A 220nF Capacitor, infertory, 200F, 100V Radial UVRC221MHA Nethorion 1 C6A 220nF Capacitor, electrolytic, 47, F, 53V 805 Std Std Std 1 C11 4.7µF Capacitor, ceramic, 100nF, 63V 805 Std Std Std 2 C13.C24 100nF Capacitor, ceramic, 100nF, 63V 805 Std Std Std 1 C16 2.0nF Capacitor, eeramic, 100nF, 13V 805 Std Std 2 C13.C24 100nF Capacitor, eeramic, 10nF, 13V 805 Std <td>1</td> <td>C1</td> <td>100nF</td> <td>Capacitor, Film, 100nF, 300VAC</td> <td>Radial</td> <td>B32023A3104M</td> <td>Epcos</td>	1	C1	100nF	Capacitor, Film, 100nF, 300VAC	Radial	B32023A3104M	Epcos
2 C3.C28 1 FF Capacitor, ceramic, 107, 24V Radial DEEE31012282B Murata 1 C4 100pF Capacitor, ceramic, 107, 10V 805 Std Std Std 2 C5.C22 1nF Capacitor, ceramic, 1nF, 10V 805 Std Std Std 2 C6.C7 220µF Capacitor, electrolytic, 220µF, 160V Radial UVR20221MHA Nichcon 1 C10 47pF Capacitor, electrolytic, 220µF, 160V Radial UVR20221MHA Nichcon 2 C11.2 4.7µF Capacitor, electrolytic, 4.7µF, 25V Radial UVR1247MDA Nichcon 2 C12.2 100nF Capacitor, ceramic, 100r, 6.3V 805 Std Std 1 C14 10µF Capacitor, ceramic, 10µF, 13V 805 Std Std 1 C16 2.2nF Capacitor, ceramic, 10µF, 13V 805 Std Std 1 C18 2.3µF Capacitor, ceramic, 10µF, 13V Radial UVR1200MAA Nichcon	1	C2	220nF	Capacitor, ceramic, 220nF, 10V	805	Std	Std
1 C4 100pF Capacitor, ceramic, 100pF, 10V 805 Sid Sid 2 C6,C7 220µF Capacitor, ceramic, 10F, 10V 805 Sid Sid 1 C6A 220nF Capacitor, Film, 220µF, 100V Radial UVR2C221MHA Nichicon 1 C6A 220nF Capacitor, ceramic, 470F, 5.3V Radial UVR2C221MHA Nichicon 1 C11 4.7µF Capacitor, ceramic, 470F, 5.3V 805 Sid Sid 2 C12.C17 4.7µF Capacitor, ceramic, 10nF, 6.3V 805 Sid Sid 2 C13.C24 100nF Capacitor, ceramic, 10nF, 10V 805 Sid Sid 1 C16 2.2nF Capacitor, ceramic, 10nF, 10V 805 Sid Sid 2 C13.C23 10onF Capacitor, ceramic, 10nF, 32V 805 Sid Sid 2 C14A,C20A 10µF Capacitor, ceramic, 10nF, 32V 805 Sid Sid 2 C14A,C20A 10µF<	2	C3,C28	1nF	Capacitor, ceramic, 1nF, 2kV	Radial	DEBE33D102ZB2B	Murata
2 CS.C2 1 nF Capacitor, eterrupher, 220,F 100/ 8tol Std Std 2 CS.C2 220,F Capacitor, eterrupher, 220,F 100/ Radial UVR20221H4/A Nechcon 1 CEA 220,F Capacitor, eterrupher, 250,F 100/V Radial UVR20221H4/A Nechcon 0 10 010 47,pF Capacitor, ceramic, 47,pF, 25V Radial UVR15427D4A Nechcon 2 C12,C21 100,F Capacitor, ceramic, 47,P, 25V Radial UVR15427D4A Nechcon 2 C13,C24 100,F Capacitor, ceramic, 100,F, 6.3V 805 Std Std 1 C14 10,F Capacitor, ceramic, 10,F, 6.3V 805 Std Std 1 C16 2.onF Capacitor, ceramic, 10,F, 6.3V 805 Std Std 1 C16 2.onF Capacitor, eeterrupher, 10V 805 Std Std 2 C19,C23 100,F Capacitor, eeterrupher, 50Y 805 Std Std	1	C4	100pF	Capacitor, ceramic, 100pF, 10V	805	Std	Std
2 CBC C7 220µF Capacitor, electrolytic, 220µF, 160V Radial UKRC2211MHA Nichcon 1 C6A 220µF Capacitor, Film, 220µF, 305VAC Radial B32822C3224MH3 Excos 1 C10 47pF Capacitor, ceramic, 47pF, 6.3V 805 Sid Sid Sid 2 C12.017 4.7µF Capacitor, ceramic, 47µF, 6.3V 805 Sid Sid Sid 2 C12.017 4.7µF Capacitor, ceramic, 10µF, 6.3V 805 Sid Sid Sid 2 C13.024 100nF Capacitor, ceramic, 10µF, 6.3V 805 Sid Sid Sid 1 C16 2.2µF Capacitor, ceramic, 10µF, 6.3V 805 Sid Sid Sid 2 C16A.C2AD 10µF Capacitor, ceramic, 10µF, 30V 805 Sid Sid Sid 2 C16A.C2AD 10µF Capacitor, cercarvic, 10µF, 31V Radial UVR12F100MA Nichicon 1 C23 47µF Capacitor, cerarvic,	2	C5,C22	1nF	Capacitor, ceramic, 1nF, 10V	805	Std	Std
1 C6A 220+F Capacitor, Finz, 20+F, 305VAC Radial B3222C3224W188 Epons DNP C8 220+F Capacitor, electrolytic, 220,F 180V Radial UVR2C21MHA Nichicon 1 C10 470F Capacitor, electrolytic, 47,F, 53V Rodial UVR1EqR7MDA Nichicon 2 C12,C14 47,F Capacitor, ceramic, 100-F, 63V 805 Std Std Std 2 C13,C24 100-F Capacitor, ceramic, 100-F, 63V 805 Std Std Std 1 C15 100-F Capacitor, ceramic, 100-F, 10V 805 Std Std Std 1 C16 220-F Capacitor, electrolytic, 74,F, 25V Rodial UVR1E330MDA Nichicon 2 C16,C23 100-F Capacitor, electrolytic, 74,F, 25V Rodial UVR1E330MDA Nichicon 2 C16,C23 100-F Capacitor, electrolytic, 74,F, 25V Rodial UVR1E470MDA Nichicon 1 C13 10-F Capacitor, electrolytic, 74,F,	2	C6,C7	220µF	Capacitor, electrolytic, 220µF, 160V	Radial	UVR2C221MHA	Nichicon
DNP C8 220µF Capacitor, electrolytic, 220µF, 63V Redial UVR1E2211M1A Nehoon 1 C11 4.7µF Capacitor, cearmic, 4.7µF, 63V Redial UVR1E4R7MDA Nichicon 2 C12.017 4.7µF Capacitor, cerami, 00nF, 6.3V 805 Std Std 2 C13.224 100nF Capacitor, cerami, 00nF, 6.3V 805 Std Std 1 C16 2.0nF Capacitor, cerami, 2.0nF, 10V 805 Std Std 1 C16 2.0nF Capacitor, cerami, 2.0nF, 10V 805 Std Std 2 C19.223 100nF Capacitor, electrolytic, 3.9rF, 25V Radial UVR21103MDA Nichicon 1 C28 10µF Capacitor, electrolytic, 10µF, 315V Radial UVR1E120MDA Nichicon 1 C28 10µF Capacitor, electrolytic, 10µF, 315V Radial UVR1E120MDA Nichicon 1 C24 10µF Capacitor, electrolytic, 10µF, 315V Radial UVR1E120MDA Nichicon <td>1</td> <td>C6A</td> <td>220nF</td> <td>Capacitor, Film, 220nF, 305VAC</td> <td>Radial</td> <td>B32922C3224M189</td> <td>Epcos</td>	1	C6A	220nF	Capacitor, Film, 220nF, 305VAC	Radial	B32922C3224M189	Epcos
1 C10 47pF Capacitor, ceramic, 47p, F, 3.W 905 Std Std 1 C11 4.7pF Capacitor, oreamic, 4.7p, 25V Radial UVR1E4R7MDA Nichicon 2 C12.C17 4.7pF Capacitor, oreamic, 4.7pF, 25V 805 Std Std 1 C14 10pF Capacitor, ceramic, 10pF, 6.3V 805 Std Std 1 C15 10nF Capacitor, ceramic, 10pF, 6.3V 805 Std Std 1 C16 2.2nF Capacitor, ceramic, 10pF, 6.3V 805 Std Std 1 C18 33pF Capacitor, ceramic, 10pF, 315V Radial UVR1530MDA Nichicon 2 C19A,C20A 10pF Capacitor, electrolytic, 47pF, 25V Radial UVR1510MDA Nichicon 1 C26 47µF Capacitor, electrolytic, 47pF, 50V Radial UVR1510MDA Nichicon 1 C27 100nF Capacitor, electrolytic, 47pF, 50V Radial UVR1510MDA Nichicon 1	DNP	C8	220µF	Capacitor, electrolytic, 220µF, 160V	Radial	UVR2C221MHA	Nichicon
1 C11 4,7µF Capacitor, destrolytic, 4,7µF, 25V Radial UVRTE4R7MDA Nichicon 2 C13,C24 100nF Capacitor, ceramic, 4,7µF, 25V 805 Std Std Std 1 C14 10µF Capacitor, ceramic, 10µF, 6,3V 805 Std Std Std 1 C16 2,onF Capacitor, ceramic, 2µF, 10V 805 Std Std Std 1 C16 2,onF Capacitor, ceramic, 2µF, 10V 805 Std Std Std 2 C18,C23 100nF Capacitor, electrolytic, 3µF, 25V Radial UVRE30MDA Nichicon DNP C25 d7µF Capacitor, electrolytic, 4µF, 25V Radial UVRE120MDA Nichicon DNP C25 d7µF 100rF Capacitor, electrolytic, 4µF, 2V Radial UVRE1470MDA Nichicon DNP C26 10µF Capacitor, electrolytic, 4µF, 10V Radial UVRE1470MDA Nichicon 1 C26 10µF Capacitor, electrol	1	C10	47pF	Capacitor, ceramic, 47pF, 6.3V	805	Std	Std
2 C12.C17 4,7µF Capacitor, coramic, 4,7µF, 28V 805 Stid Stid 2 C13,C24 100nF Capacitor, coramic, 10µF, 6.3V 805 Stid Stid 1 C14 10µF Capacitor, coramic, 10µF, 6.3V 805 Stid Stid 1 C16 2.2nF Capacitor, coramic, 32µF, 25V Radial UVR1E30MDA Nichicon 2 C19,C23 100nF Capacitor, coramic, 10µF, 35V Radial UVR2F100MDA Nichicon 1 C28 10µF Capacitor, electrolytic, 10µF, 35V Radial UVR2F100MDA Nichicon 1 C26 10µF Capacitor, electrolytic, 47µF, 25V Radial UVR2F100MDA Nichicon 1 C27 47µF 10V Capacitor, electrolytic, 47µF, 10V Radial UVR1470MDA Nichicon 1 C29 1nF Capacitor, electrolytic, 47µF, 10V Radial UVR1470MDA Nichicon 1 C30 1µF Capacitor, electrolytic, 47µF, 63V Rod Stid Stid </td <td>1</td> <td>C11</td> <td>4.7µF</td> <td>Capacitor, electrolytic, 4.7µF, 25V</td> <td>Radial</td> <td>UVR1E4R7MDA</td> <td>Nichicon</td>	1	C11	4.7µF	Capacitor, electrolytic, 4.7µF, 25V	Radial	UVR1E4R7MDA	Nichicon
2 C13.C24 100rF Capacitor, ceramic, 10µF, 6.3V 805 Sid Sid 1 C15 10µF Capacitor, ceramic, 10µF, 6.3V 805 Sid Sid 1 C15 10nF Capacitor, ceramic, 2.2nF, 10V 805 Sid Sid 1 C16 2.2nF Capacitor, ceramic, 2.2nF, 10V 805 Sid Sid Sid 2 C19,C23 100nF Capacitor, ceramic, 100rF, 35V Radial UVRE130MDA Nichicon DNP C25 47µF Capacitor, ceramic, 104°, 53V Radial UVRE1470MDA Nichicon 1 C26 10µF Capacitor, electrolytic, 47µF, 13V Radial UVRE1470MDA Nichicon 1 C27 47µF Capacitor, ceramic, 164°, 52V Radial UVRE1470MDA Nichicon 1 C29 1nF Capacitor, ceramic, 148°, 24V Radial UVRE1470MDA Nichicon 1 C30 168°F Capacitor, ceramic, 147°, 24V Radial UVRE1470MDA Nichico </td <td>2</td> <td>C12,C17</td> <td>4.7µF</td> <td>Capacitor, ceramic, 4.7µF, 25V</td> <td>805</td> <td>Std</td> <td>Std</td>	2	C12,C17	4.7µF	Capacitor, ceramic, 4.7µF, 25V	805	Std	Std
1 C14 10µF Capacitor, ceramic, 10µF, 3.3/ 805 Std Std 1 C15 10nF Capacitor, ceramic, 10nF, 10V 805 Std Std 1 C16 2.2nF Capacitor, ceramic, 22nF, 10V 805 Std Std 2 C19,C23 100hF Capacitor, ceramic, 100hF, 35V Radial UVR1E330MDA Nichicon DNP C25 47µF Capacitor, electrolytic, 47µF, 25V Radial UVR2F10MDA Nichicon 1 C26 10µF Capacitor, electrolytic, 47µF, 25V Radial UVR1F470MDA Nichicon DNP C2A 10µF Capacitor, electrolytic, 47µF, 72V Radial UVR1F470MDA Nichicon DNP C2A 100hF Capacitor, ceramic, 168P, 28V 805 Std S	2	C13,C24	100nF	Capacitor, ceramic, 100nF, 6.3V	805	Std	Std
1 C15 10nF Capacitor, ceramic, 10nF, 10V 805 Std Std 1 C16 32µF Capacitor, ceramic, 22nF, 10V 805 Std Nichicon 2 C18,C23 100nF Capacitor, ceramic, 100nF, 35V 805 Std Std 2 C19,C23 100nF Capacitor, ceramic, 100nF, 35V 805 Std Std 1 C28 10µF Capacitor, electrolytic, 10µF, 25V Radial UVR1E100MDA Nichicon 1 C28 10µF Capacitor, electrolytic, 10µF, 25V Radial UVR1E100MDA Nichicon DNP C24 10nF Capacitor, electrolytic, 10µF, 25V Radial UVR1E100MDA Nichicon DNP C24 10nF Capacitor, ceramic, 16P, 28V Radial UVR1E100MDA Nichicon 1 C30 168pF Capacitor, ceramic, 22P, 52V 805 Std Std 1 C31 1µF Capacitor, ceramic, 22P, 52V 805 Std Std 1 <	1	C14	10µF	Capacitor, ceramic, 10µF, 6.3V	805	Std	Std
1 C16 2.2nF Capacitor, electrolytic, 33µF, 25V Radial UVR 1E330MDA Nichicon 2 C19,C23 100nF Capacitor, electrolytic, 13µF, 25V Radial UVR 1E330MDA Nichicon DNP C25 47µF Capacitor, electrolytic, 10µF, 315V Radial UVR 1E100MDA Nichicon DNP C25 47µF Capacitor, electrolytic, 17µF, 25V Radial UVR 1E100MDA Nichicon 1 C26 10µF Capacitor, electrolytic, 47µF, 25V Radial UVR 1E100MDA Nichicon DNP C2A 100nF Capacitor, electrolytic, 47µF, 10V Radial B32023A3104M Epcos 1 C23 1nF Capacitor, electrolytic, 11µF, 25V Radial B32023A3104M Epcos 1 C30 168pF Capacitor, electrolytic, 11µF, 25V Radial Std Std 1 C31 1µF Capacitor, electrolytic, 1µF, 25V Radial Std Std 1 C33 4.7µF Capacitor, electrolytic, 1µF, 25V Radial	1	C15	10nF	Capacitor, ceramic, 10nF, 10V	805	Std	Std
1 C18 33yF Capacitor, electrolytic, 33yF, 25V Radial UVR1E330MDA Nichicon 2 C19A,C23 100nF Capacitor, electrolytic, 100nF, 35V 805 Std Std 2 C19A,C20A 100pF Capacitor, electrolytic, 10pF, 75V Radial UVR1E470MDA Nichicon 1 C25 47µF Capacitor, electrolytic, 10µF, 25V Radial UVR1E470MDA Nichicon 1 C27 47µF 10V Capacitor, electrolytic, 10µF, 10V Radial UVR1470MDA Nichicon DNP C2A 100nF Capacitor, electrolytic, 17µF, 10V Radial DEE33D1022B2B Murata 1 C29 1nF Capacitor, electrolytic, 17µF, 52V Radial Std Std 1 C31 1µF Capacitor, electrolytic, 17µF, 52V Radial Std Std 1 C33 14PF Capacitor, electrolytic, 17µF, 52V Radial Std Std 1 C34 1µF Capacitor, electrolytic, 17µF, 52V Radial Std	1	C16	2.2nF	Capacitor, ceramic, 2.2nF, 10V	805	Std	Std
2 C19,C23 100nF Capacitor, ceramic, 100nF, 35V 805 Std Std 2 C19A,C20A 10µF Capacitor, electrolytic, 10µF, 315V Radial UVR2F100MPA Nichicon 1 C26 17µF Capacitor, electrolytic, 10µF, 25V Radial UVR1E470MDA Nichicon 1 C27 47µF Capacitor, electrolytic, 47µF, 10V Radial UVR14470MDA Nichicon DNP C2A 100nF Capacitor, electrolytic, 47µF, 10V Radial B202333104M Epocs 1 C29 1nF Capacitor, ceramic, 168pF, 25V 805 Std Std 1 C30 168pF Capacitor, ceramic, 22nF, 25V 805 Std Std 1 C33 4.7µF Capacitor, ceramic, 17P, 25V Radial Std Std 2 C35,C36 1nF Capacitor, ceramic, 17P, 35V 805 Std Std 2 C37,C38 100pF Capacitor, ceramic, 100P, 35V 805 Std Std 1 <td>1</td> <td>C18</td> <td>33µF</td> <td>Capacitor, electrolytic, 33µF, 25V</td> <td>Radial</td> <td>UVR1E330MDA</td> <td>Nichicon</td>	1	C18	33µF	Capacitor, electrolytic, 33µF, 25V	Radial	UVR1E330MDA	Nichicon
2 C19A,C20A 10µF Capacitor, electrolytic, 10µF, 315V Radial UVR2F100MPA Nichicon DNP C25 47µF Capacitor, electrolytic, 47µF, 25V Radial UVR1E470MDA Nichicon 1 C27 47µF 10V Capacitor, electrolytic, 47µF, 10V Radial UVR1E470MDA Nichicon DNP C2A 100nF Capacitor, electrolytic, 47µF, 10V Radial B3202A3104M Epocs 1 C29 1nF Capacitor, electrolytic, 1µF, 25V Radial DEBE33D102ZB2B Murata 1 C30 188pF Capacitor, ceramic, 18F, 25V 805 Std Std 1 C31 1µF Capacitor, electrolytic, 1µF, 25V Radial Std Std Std 1 C33 4.7µF Capacitor, electrolytic, 1µF, 25V Radial Std Std Std 1 C34 1µF Capacitor, electrolytic, 1µF, 25V Radial Std Std Std 2 C35,C38 100pF Capacitor, electrolytic, 1µF, 25V <td>2</td> <td>C19,C23</td> <td>100nF</td> <td>Capacitor, ceramic, 100nF, 35V</td> <td>805</td> <td>Std</td> <td>Std</td>	2	C19,C23	100nF	Capacitor, ceramic, 100nF, 35V	805	Std	Std
DNP C25 47µF Capacitor, electrolytic, 47µF, 25V Radial UVR1E470MDA Nichicon 1 C26 10µF Capacitor, electrolytic, 10µF, 25V Radial UVR1470MDA Nichicon DNP C2A 100nF Capacitor, electrolytic, 47µF, 10V Radial UVR1470MDA Nichicon DNP C2A 100nF Capacitor, electrolytic, 47µF, 10V Radial B32023A3104M Epcos 1 C29 1nF Capacitor, electrolytic, 17µF, 25V Radial DEBE33D1022B2B Murata 1 C30 168pF Capacitor, ceramic, 167, 25V Radial Std Std 1 C31 1µF Capacitor, ceramic, 22nF, 25V Ro5 Std Std 2 C35,C36 1nF Capacitor, ceramic, 17µF, 25V Radial Std Std 2 C35,C36 1nF Capacitor, ceramic, 167,35V 805 Std Std 2 C35,C36 1nF Capacitor, ceramic, 167,35V 805 Std Std	2	C19A,C20A	10µF	Capacitor, electrolytic, 10µF, 315V	Radial	UVR2F100MPA	Nichicon
1 C26 10µF Capacitor, electrolytic, 10µF, 25V Radial UVR1E100MDA Nichicon 1 C27 47µF 10V Capacitor, electrolytic, 47µF, 10V Radial UVR1A470MDA Nichicon DNP C2A 100nF Capacitor, ceramic, 1nF, 2kV Radial DEBE33D102ZB2B Murata 1 C30 168pF Capacitor, ceramic, 1nF, 2kV Radial DEBE33D102ZB2B Murata 1 C31 1µF Capacitor, ceramic, 1nF, 2kV Radial Std Std 1 C32 22nF Capacitor, ceramic, 2nF, 25V 805 Std Std 1 C33 4.7µF Capacitor, ceramic, 1nF, 35V 805 Std Std 2 C35,C36 1nF Capacitor, ceramic, 100F, 35V 805 Std Std 3 D1, D2, D3 US1M Diode, rectifier, 1000V, 1A DIODE0.4 US1M Diodes Inc. 4 D3A, D4A INS399 Diode, rectifier, 100V, 1.5A DIODE0.4 1N4742A-TP MCC	DNP	C25	47µF	Capacitor, electrolytic, 47µF, 25V	Radial	UVR1E470MDA	Nichicon
1 C27 47μF 10V Capacitor, electrolytic, 47μF, 10V Radial UVR14470MDA Nichicon DNP C2A 100nF Capacitor, Ceramic, 1nF, 2kV Radial B52023A3104M Epose 1 C29 1nF Capacitor, ceramic, 1nF, 2kV Radial DEBE33D102ZB2B Murata 1 C30 168pF Capacitor, ceramic, 22nF, 25V 805 Std Std 1 C33 4.7μF Capacitor, ceramic, 22nF, 25V 805 Std Std 1 C34 1µF Capacitor, ceramic, 47µF, 6.3V 805 Std Std 2 C35,C36 1nF Capacitor, ceramic, 100F, 35V 805 Std Std 3 D1,D2,D3 US1M Diode, rectifier, 100V, 1.5A DIODE.0 US1M Diodes Inc. 4 D1A, D2A, D3A, D4A INS399 Diode, rectifier, 75V, 150mA TO22AC STTH1008DTI STMicro 1 D4 STTH1008DTI Diode, schottky, 30V, 200mA DO-34 BAT65.T13 NXP	1	C26	10µF	Capacitor, electrolytic, 10µF, 25V Radial UVR		UVR1E100MDA	Nichicon
DNP C2A 100nF Capacitor, Film, 100nF, 300VAC Radial B32023A3104M Epcos 1 C29 1nF Capacitor, ceramic, 1nF, 2kV Radial DEBE33D102ZB2B Murata 1 C30 168pF Capacitor, ceramic, 188pF, 25V 805 Std Std 1 C31 1µF Capacitor, ceramic, 187p, 25V 805 Std Std 1 C32 22nF Capacitor, ceramic, 4.7µF, 6.3V 805 Std Std 2 C35,C36 1nF Capacitor, ceramic, 1nF, 35V 805 Std Std 3 D1,D2,D3 US1M Diode, rectifier, 1000V, 1A DIODE0.4 US1M Diodes Inc. 4 D1A, D2A, 1N5399 Diode, rectifier, 1000V, 1.5A DIODE0.6 1N5399-E3/54 Vishay 1 D4 STTH1008DTI Diode, schotty, 30V, 200mA DO-34 BAT85, 113 NXP 2 D7,D8 IN4148 Diode, schotty, 30V, 200mA SOD523 IN4148X-TP MCC 1	1	C27	47µF 10V	Capacitor, electrolytic, 47µF, 10V	Radial	UVR1A470MDA	Nichicon
1 C29 1nF Capacitor, ceramic, 1nF, 2kV Radial DEBE33D102ZB2B Murata 1 C30 188pF Capacitor, ceramic, 168pF, 25V 805 Std Std 1 C31 1µF Capacitor, ceramic, 25V 805 Std Std 1 C32 22nF Capacitor, ceramic, 27P, 25V 805 Std Std 1 C33 4.7µF Capacitor, ceramic, 17, 25V 805 Std Std 2 C35,C36 1nF Capacitor, ceramic, 17, 35V 805 Std Std 2 C37,C38 100pF Capacitor, ceramic, 100pF, 35V 805 Std Std 3 D1A, D2A, D3A, D4A 1N5399 Diode, rectifier, 1000V, 1.5A DIODE0.4 US1M Diodes Inc. 1 D4 STTH1008DTI Diode, rectifier, 75V, 150mA TO220AC STTH1008DTI STMicro 1 D4 STTH1008DTI Diode, schottky, 30V, 200mA DO-34 BAT54S, 113 NXP 2 D7,D8	DNP	C2A	100nF	Capacitor, Film, 100nF, 300VAC Radial B32023		B32023A3104M	Epcos
1 C30 168pF Capacitor, ceramic, 168pF, 25V 805 Std Std 1 C31 1µF Capacitor, electrolytic, 1µF, 25V Radial Std Std 1 C32 22nF Capacitor, ceramic, 22nF, 25V 805 Std Std 1 C33 4.7µF Capacitor, ceramic, 2.7µF, 6.3V 805 Std Std 2 C35,C36 1nF Capacitor, ceramic, 1.7µF, 25V Radial Std Std 2 C37,C38 100pF Capacitor, ceramic, 100pF, 35V 805 Std Std 3 D1, D2,D3 US1M Diode, rectifier, 1000V, 1.5A DIODE0.6 1N5399-E3/54 Vishay 1 D4 STTH1008DTI Diode, rectifier, 1000V, 1.5A DIODE0.6 1N5399-E3/54 Vishay 1 D4 STTH1008DTI Diode, rectifier, 1000V, 1.5A DIODE0.4 1N4742A-TP MCC 1 D5 12V Diode, rectifier, 75V, 150mA SOD523 1N474A-TP MCC 1	1	C29	1nF	Capacitor, ceramic, 1nF, 2kV Radial DEBE33D102Z		DEBE33D102ZB2B	Murata
1 C31 1µF Capacitor, electrolytic, 1µF, 25V Radial Std Std 1 C32 22PF Capacitor, ceramic, 22nF, 25V 805 Std Std 1 C33 4.7µF Capacitor, ceramic, 22nF, 25V 805 Std Std 1 C34 1µF Capacitor, electrolytic, 1µF, 25V Radial Std Std 2 C35,C36 1nF Capacitor, ceramic, 100PF, 35V 805 Std Std 3 D1, D2, D3 US1M Diode, rectifier, 1000V, 1A DIODE0.4 US1M Diodes Inc. 4 D1A, D2A, D3A, D4A 1N5399 Diode, rectifier, 1000V, 1.5A DIODE0.6 1N5399-53/54 Vishay 1 D4 STTH1008DTI Diode, pertast, 800V, 10A TO220AC STTH1008DTI STMicro 1 D5 12V Diode, zenetrifier, 75V, 150mA SOD53 BAT85 NXP 2 D7,D8 IN4148 Diode, schottky 30V, 200mA SOT-23 BAT54S-TP MCC 1	1	C30	168pF	Capacitor, ceramic, 168pF, 25V 805 Std		Std	Std
1 C32 22nF Capacitor, ceramic, 22nF, 25V 805 Std Std 1 C33 4.7µF Capacitor, ceramic, 4.7µF, 6.3V 805 Std Std 1 C34 1µF Capacitor, ceramic, 4.7µF, 6.3V 805 Std Std 2 C35,C36 1nF Capacitor, ceramic, 100pF, 35V 805 Std Std 2 C37,C38 100pF Capacitor, ceramic, 100pF, 35V 805 Std Std 3 D1,D2,D3 US1M Diode, rectifier, 1000V, 1.5A DIODE0.4 US1M Diodes Inc. 4 D1A,D2A, D3A, D4A STTH1008DTI Diode, predifier, 1000V, 1.5A DIODE0.4 1N4742A-TP MCC 1 D4 STTH1008DTI Diode, forentifier, 1000V, 1.5A DIODE0.4 1N4742A-TP MCC 1 D4 STTH1008DTI Diode, forentifier, 1000V, 1.5A DIODE0.4 1N4742A-TP MCC 1 D5 12V Diode, Schottky, 30V, 200mA DO-34 BAT65,113 NXP 2 </td <td>1</td> <td>C31</td> <td>1µF</td> <td colspan="2">Capacitor, electrolytic, 1µF, 25V Radial Std</td> <td>Std</td> <td>Std</td>	1	C31	1µF	Capacitor, electrolytic, 1µF, 25V Radial Std		Std	Std
1 C33 4.7μF Capacitor, ceramic, 4.7μF, 6.3V 805 Std Std 1 C34 1μF Capacitor, electrolytic, 1μF, 25V Radial Std Std 2 C35,C36 1nF Capacitor, ceramic, 1nF, 35V 805 Std Std 2 C37,C38 100pF Capacitor, ceramic, 100P, 35V 805 Std Std 3 D1,D2,D3 US1M Diode, rectifier, 1000V, 1A DIODE0.4 US1M Diodes Inc. 4 D1A,D2A, D3A,D4A 1N5399 Diode, rectifier, 1000V, 1.5A DIODE0.6 1N5399-E3/54 Vishay 1 D4 STTH1008DTI Diode, petfast, 800V, 10A TO220AC STTH1008DTI STMicro 1 D5 12V Diode, schottky, 30V, 200mA DO-34 BAT85,113 NXP 2 D7,D8 IN4148 Diode, schottky 30V, 200mA SOT-23 BAT64-ST-P MCC 1 D9A IN4007 Diode, certifier, 1000V, 1A DIODE0.4 1N4148X-TP MCC 1<	1	C32	22nF	Capacitor, ceramic, 22nF, 25V	805	Std	Std
1 C34 1µF Capacitor, electrolytic, 1µF, 25V Radial Std Std 2 C35,C36 1nF Capacitor, ceramic, 1nF, 35V 805 Std Std 3 D1,D2,D3 US1M Diode, rectifier, 1000V, 1A DIODE0.4 US1M Diodes Inc. 4 D1A,D2A, D3A,D4A 1N5399 Diode, rectifier, 1000V, 1.5A DIODE0.6 1N5399-E3/54 Vishay 1 D4 STTH1008DTI Diode, zener, 12V, 1W DIODE0.4 1N4742A-TP MCC 1 D5 12V Diode, Zener, 12V, 1W DIODE0.4 1N4742A-TP MCC 1 D6 BAT85 Diode, Schottky, 30V, 200mA DO-34 BAT85,113 NXP 2 D7.D8 IN4148 Diode, schottky, 30V, 200mA SOD523 1N4148X-TP MCC 1 D9A IN4007 Diode, Schottky, 30V, 200mA SOD423 IN4007-TP MCC 1 D9A IN4007 Diode, Zener, 18V, 1W SMA SMAZ18-13-F Diodes Inc. 1	1	C33	4.7µF	Capacitor, ceramic, 4.7µF, 6.3V	805	Std	Std
2 C35,C36 1nF Capacitor, ceramic, 1nF, 35V 805 Std Std 2 C37,C38 100pF Capacitor, ceramic, 100pF, 35V 805 Std Std 3 D1, D2, D3 US1M Diode, rectifier, 1000V, 1A DIODE0.4 US1M Diodes Inc. 4 D1A, D2A, D3A, D4A 1N5399 Diode, rectifier, 1000V, 1.5A DIODE0.6 1N5399-E3/54 Vishay 1 D4 STTH1008DTI Diode, hyperfast, 800V, 10A TO220AC STTH1008DTI STMicro 1 D5 12V Diode, schottky, 30V, 200mA DO-34 BAT85,113 NXP 2 D7,D8 IN4148 Diode, rectifier, 75V, 150mA SOD523 1N4148X-TP MCC 1 D9 BAT54 Diode, cener, 18V, 1W SMA SMA218-13-F Diodes Inc. 1 D14 18V Diode, Zener, 18V, 1W SMA SMA218-13-F Diodes Inc. 1 D14 18V Diode, Zener, 18V, 1W DIODE0.4 1N476A-TP MCC <t< td=""><td>1</td><td>C34</td><td>1µF</td><td>Capacitor, electrolytic, 1µF, 25V</td><td>Radial</td><td>Std</td><td>Std</td></t<>	1	C34	1µF	Capacitor, electrolytic, 1µF, 25V	Radial	Std	Std
2 C37,C38 100pF Capacitor, ceramic, 100pF, 35V 805 Std Std 3 D1, D2, D3 US1M Diode, rectifier, 1000V, 1A DIODE0.4 US1M Diodes Inc. 4 D1A, D2A, D3A, D4A 1N5399 Diode, rectifier, 1000V, 1.5A DIODE0.6 1N5399-E3/54 Vishay 1 D4 STTH1008DTI Diode, hyperfast, 800V, 10A TO220AC STTH1008DTI STMicro 1 D5 12V Diode, zener, 12V, 1W DIODE0.4 1N4742A-TP MCC 1 D6 BAT85 Diode, schottky, 30V, 200mA DO-34 BAT85,113 NXP 2 D7,D8 IN4148 Diode, schottky 30V, 200mA SOT-23 BAT54S-TP MCC 1 D9 BAT54 Diode, schottky 30V, 200mA SOT-23 BAT54S-TP MCC 1 D9A 1N4007 Diode, cener, 18V, 1W SMA SMA218-13-F Diodes Inc. 1 D14 18V Diode, zener, 18V, 1W DIODE0.4 1N4746A-TP MCC <	2	C35,C36	1nF	Capacitor, ceramic, 1nF, 35V	805	Std	Std
3 D1, D2, D3 US1M Diode, rectifier, 1000V, 1A DIODE0.4 US1M Diodes Inc. 4 D1A, D2A, D3A, D4A 1N5399 Diode, rectifier, 1000V, 1.5A DIODE0.6 1N5399-E3/54 Vishay 1 D4 STTH1008DTI Diode, hyperfast, 800V, 10A TO220AC STTH1008DTI STMicro 1 D5 12V Diode, zener, 12V, 1W DIODE0.4 1N4742A-TP MCC 1 D6 BAT85 Diode, schottky, 30V, 200mA DO-34 BAT85,113 NXP 2 D7,D8 IN4148 Diode, rectifier, 75V, 150mA SOD523 1N4148X-TP MCC 1 D9 BAT54 Diode, Zener, 18V, 1W DIODE0.4 1N4007-TP MCC 1 D10 18V Diode, Zener, 18V, 1W DIODE0.4 1N407-TP MCC 1 D14 18V Diode, Zener, 18V, 1W DIODE0.4 1N4746A-TP MCC 2 D15,D17 BAT85 Diode, zener, 12V, 1W DIODE0.4 1N4748A-TP MCC 1 </td <td>2</td> <td>C37,C38</td> <td>100pF</td> <td>Capacitor, ceramic, 100pF, 35V</td> <td>805</td> <td>Std</td> <td>Std</td>	2	C37,C38	100pF	Capacitor, ceramic, 100pF, 35V	805	Std	Std
4D1A, D2A, D3A, D4A1N5399Diode, rectifier, 1000V, 1.5ADIODE0.61N5399-E3/54Vishay1D4STTH1008DTIDiode, hyperfast, 800V, 10ATO220ACSTTH1008DTISTMicro1D512VDiode, Zener, 12V, 1WDIODE0.41N4742A-TPMCC1D6BAT85Diode, schottky, 30V, 200mADO-34BAT85,113NXP2D7,D8IN4148Diode, rectifier, 75V, 150mASOD5231N4148X-TPMCC1D9BAT54Diode, Schottky 30V, 200mASOT-23BAT54S-TPMCC1D9A1N4007Diode, Zener, 18V, 1WDIODE0.41N474A-TPMCC1D1018VDiode, Zener, 18V, 1WSMASMAZ18-13-FDiodes Inc.1D1418VDiode, Zener, 18V, 1WDIODE0.41N4746A-TPMCC2D15,D17BAT85Diode, Schottky, 30V, 200mADO-34BAT85,113NXP1D1612VDiode, Zener, 18V, 1WDIODE0.41N4746A-TPMCC2D15,D17BAT85Diode, Schottky, 30V, 200mADO-34BAT85,113NXP1D1612VDiode, rectifier, 75V, 150mASOD5231N4148X-TPMCC2D18,D19IN4148Diode, rectifier, 75V, 150mASOD5231N4148X-TPMCC1J1TC03236200J0GFerninal Block, 15A, 5.1mm200-3TC03236200J0GFCI1J35010Test point, red, thru hole0.125 x 0.125 in5	3	D1, D2, D3	US1M	Diode, rectifier, 1000V, 1A	DIODE0.4	US1M	Diodes Inc.
1 D4 STTH1008DTI Diode, hyperfast, 800V, 10A TO220AC STTH1008DTI STMicro 1 D5 12V Diode, Zener, 12V, 1W DIODE0.4 1N4742A-TP MCC 1 D6 BAT85 Diode, schottky, 30V, 200mA DO-34 BAT85,113 NXP 2 D7,D8 IN4148 Diode, rectifier, 75V, 150mA SOD523 1N4148X-TP MCC 1 D9 BAT54 Diode, Schottky 30V, 200mA SOT-23 BAT54S-TP MCC 1 D9A 1N4007 Diode, rectifier, 1000V, 1A DIODE0.4 1N4007-TP MCC 1 D10 18V Diode, Zener, 18V, 1W SMA SMAZ18-13-F Diodes Inc. 1 D14 18V Diode, Zener, 18V, 1W DIODE0.4 1N4746A-TP MCC 2 D15,D17 BAT85 Diode, Zener, 12V, 1W DIODE0.4 1N4746A-TP MCC 2 D18,D19 IN4148 Diode, rectifier, 75V, 150mA SOD523 1N4148X-TP MCC 1 D1	4	D1A, D2A, D3A, D4A	1N5399	Diode, rectifier, 1000V, 1.5A	DIODE0.6	1N5399-E3/54	Vishay
1 D5 12V Diode, Zener, 12V, 1W DIODE0.4 1N4742A-TP MCC 1 D6 BAT85 Diode, schottky, 30V, 200mA DO-34 BAT85,113 NXP 2 D7,D8 IN4148 Diode, schottky, 30V, 200mA SOD523 1N4148X-TP MCC 1 D9 BAT54 Diode, schottky 30V, 200mA SOT-23 BAT54S-TP MCC 1 D9A 1N4007 Diode, Schottky 30V, 200mA SOT-23 BAT54S-TP MCC 1 D9A 1N4007 Diode, Schottky 30V, 200mA SOT-23 BAT54S-TP MCC 1 D9A 1N4007 Diode, Schottky 30V, 200mA DIODE0.4 1N4007-TP MCC 1 D14 18V Diode, Zener, 18V, 1W SMA SMAZ18-13-F Diodes Inc. 2 D15,D17 BAT85 Diode, Zener, 18V, 1W DIODE0.4 1N4746A-TP MCC 2 D18,D19 IN4148 Diode, Zener, 12V, 1W DIODE0.4 1N4742A-TP MCC 1 F1	1	D4	STTH1008DTI	Diode, hyperfast, 800V, 10A	TO220AC	STTH1008DTI	STMicro
1 D6 BAT85 Diode, schottky, 30V, 200mA DO-34 BAT85,113 NXP 2 D7,D8 IN4148 Diode, rectifier, 75V, 150mA SOD523 1N4148X-TP MCC 1 D9 BAT54 Diode, Schottky 30V, 200mA SOT-23 BAT54S-TP MCC 1 D9A 1N4007 Diode, rectifier, 1000V, 1A DIODE0.4 1N4007-TP MCC 1 D10 18V Diode, Zener, 18V, 1W SMA SMAZ18-13-F Diodes Inc. 1 D14 18V Diode, Zener, 18V, 1W DIODE0.4 1N4746A-TP MCC 2 D15,D17 BAT85 Diode, schottky, 30V, 200mA DO-34 BAT85,113 NXP 1 D16 12V Diode, Zener, 18V, 1W DIODE0.4 1N4746A-TP MCC 2 D15,D17 BAT85 Diode, schottky, 30V, 200mA DO-34 BAT85,113 NXP 1 D16 12V Diode, cener, 12V, 1W DIODE0.4 1N4742A-TP MCC 2 D18,D19	1	D5	12V	Diode, Zener, 12V, 1W	DIODE0.4	1N4742A-TP	MCC
2 D7,D8 IN4148 Diode, rectifier, 75V, 150mA SOD523 1N4148X-TP MCC 1 D9 BAT54 Diode, Schottky 30V, 200mA SOT-23 BAT54S-TP MCC 1 D9A 1N4007 Diode, schottky 30V, 200mA DIODE0.4 1N4007-TP MCC 1 D9A 1N4007 Diode, rectifier, 1000V, 1A DIODE0.4 1N4007-TP MCC 1 D10 18V Diode, Zener, 18V, 1W SMA SMAZ18-13-F Diodes Inc. 1 D14 18V Diode, Zener, 18V, 1W DIODE0.4 1N4746A-TP MCC 2 D15,D17 BAT85 Diode, Zener, 12V, 1W DIODE0.4 1N4742A-TP MCC 1 D16 12V Diode, zener, 12V, 1W DIODE0.4 1N4742A-TP MCC 2 D18,D19 IN4148 Diode, rectifier, 75V, 150mA SOD523 1N4148X-TP MCC 1 F1 39213150000 Fuse, 3.15A, 250V Radial, Box 39213150000 Littelfuse 1	1	D6	BAT85	Diode, schottky, 30V, 200mA	DO-34	BAT85,113	NXP
1 D9 BAT54 Diode, Schottky 30V, 200mA SOT-23 BAT54S-TP MCC 1 D9A 1N4007 Diode, rectifier, 1000V, 1A DIODE0.4 1N4007-TP MCC 1 D10 18V Diode, Zener, 18V, 1W SMA SMAZ18-13-F Diodes Inc. 1 D14 18V Diode, Zener, 18V, 1W DIODE0.4 1N4746A-TP MCC 2 D15,D17 BAT85 Diode, schottky, 30V, 200mA DO-34 BAT85,113 NXP 1 D16 12V Diode, Zener, 12V, 1W DIODE0.4 1N4742A-TP MCC 2 D18,D19 IN4148 Diode, rectifier, 75V, 150mA SOD523 1N4148X-TP MCC 1 F1 39213150000 Fuse, 3.15A, 250V Radial, Box 39213150000 Littelfuse 1 J1 TC03236200J0G Terminal Block, 15A, 5.1mm 200-3 TC03236200J0G FCI 1 J3 5010 Test point, red, thru hole 0.125 × 0.125 in 5010 Keystone 1	2	D7,D8	IN4148	Diode, rectifier, 75V, 150mA	SOD523	1N4148X-TP	MCC
1 D9A 1N4007 Diode, rectifier, 1000V, 1A DIODE0.4 1N4007-TP MCC 1 D10 18V Diode, Zener, 18V, 1W SMA SMAZ18-13-F Diodes Inc. 1 D14 18V Diode, Zener, 18V, 1W DIODE0.4 1N4746A-TP MCC 2 D15,D17 BAT85 Diode, schottky, 30V, 200mA DO-34 BAT85,113 NXP 1 D16 12V Diode, Zener, 12V, 1W DIODE0.4 1N4742A-TP MCC 2 D18,D19 IN4148 Diode, rectifier, 75V, 150mA SOD523 1N4148X-TP MCC 1 F1 39213150000 Fuse, 3.15A, 250V Radial, Box 39213150000 Littelfuse 1 J1 TC03236200J0G Terminal Block, 15A, 5.1mm 200-3 TC03236200J0G FCI 1 J3 5010 Test point, red, thru hole 0.125 × 0.125 in 5010 Keystone 1 J4 5011 Test point, black, thru hole 0.125 × 0.125 in 5011 Keystone <	1	D9	BAT54	Diode, Schottky 30V, 200mA	SOT-23	BAT54S-TP	MCC
1 D10 18V Diode, Zener, 18V, 1W SMA SMAZ18-13-F Diodes Inc. 1 D14 18V Diode, Zener, 18V, 1W DIODE0.4 1N4746A-TP MCC 2 D15,D17 BAT85 Diode, schottky, 30V, 200mA DO-34 BAT85,113 NXP 1 D16 12V Diode, Zener, 12V, 1W DIODE0.4 1N4742A-TP MCC 2 D18,D19 IN4148 Diode, rectifier, 75V, 150mA SOD523 1N4148X-TP MCC 1 F1 39213150000 Fuse, 3.15A, 250V Radial, Box 39213150000 Littelfuse 1 J1 TC03236200J0G Terminal Block, 15A, 5.1mm 200-3 TC03236200J0G FCI 1 J3 5010 Test point, red, thru hole 0.125 × 0.125 in 5010 Keystone 1 J4 5011 Test point, black, thru hole 0.125 × 0.125 in 5011 Keystone 1 L1 10mH Inductor, Common-Mode, 10mH, 3A, TH UU10.5 Custom Custom	1	D9A	1N4007	Diode, rectifier, 1000V, 1A	DIODE0.4	1N4007-TP	MCC
1 D14 18V Diode, Zener, 18V, 1W DIODE0.4 1N4746A-TP MCC 2 D15,D17 BAT85 Diode, schottky, 30V, 200mA DO-34 BAT85,113 NXP 1 D16 12V Diode, Zener, 12V, 1W DIODE0.4 1N4742A-TP MCC 2 D18,D19 IN4148 Diode, zener, 12V, 1W DIODE0.4 1N4742A-TP MCC 1 F1 39213150000 Fuse, 3.15A, 250V Radial, Box 39213150000 Littelfuse 1 J1 TC03236200J0G Terminal Block, 15A, 5.1mm 200-3 TC03236200J0G FCI 1 J3 5010 Test point, red, thru hole 0.125 x 0.125 in 5010 Keystone 1 J4 5011 Test point, black, thru hole 0.125 x 0.125 in 5011 Keystone 1 L1 10mH Inductor, Common-Mode, 10mH, 3A, TH UU10.5 Custom Custom	1	D10	18V	Diode, Zener, 18V, 1W	SMA	SMAZ18-13-F	Diodes Inc.
2 D15,D17 BAT85 Diode, schottky, 30V, 200mA DO-34 BAT85,113 NXP 1 D16 12V Diode, Zener, 12V, 1W DIODE0.4 1N4742A-TP MCC 2 D18,D19 IN4148 Diode, rectifier, 75V, 150mA SOD523 1N4148X-TP MCC 1 F1 39213150000 Fuse, 3.15A, 250V Radial, Box 39213150000 Littelfuse 1 J1 TC03236200J0G Terminal Block, 15A, 5.1mm 200-3 TC03236200J0G FCI 1 J3 5010 Test point, red, thru hole 0.125 x 0.125 in 5010 Keystone 1 J4 5011 Test point, black, thru hole 0.125 x 0.125 in 5011 Keystone 1 L1 10mH Inductor, Common-Mode, 10mH, 3A, TH UU10.5 Custom Custom	1	D14	18V	Diode, Zener, 18V, 1W	DIODE0.4	1N4746A-TP	MCC
1 D16 12V Diode, Zener, 12V, 1W DIODE0.4 1N4742A-TP MCC 2 D18,D19 IN4148 Diode, rectifier, 75V, 150mA SOD523 1N4148X-TP MCC 1 F1 39213150000 Fuse, 3.15A, 250V Radial, Box 39213150000 Littelfuse 1 J1 TC03236200J0G Terminal Block, 15A, 5.1mm 200-3 TC03236200J0G FCI 1 J3 5010 Test point, red, thru hole 0.125 x 0.125 in 5010 Keystone 1 J4 5011 Test point, black, thru hole 0.125 x 0.125 in 5011 Keystone 1 L1 10mH Inductor, Common-Mode, 10mH, 3A, TH UU10.5 Custom Custom	2	D15,D17	BAT85	Diode, schottky, 30V, 200mA	DO-34	BAT85,113	NXP
2 D18,D19 IN4148 Diode, rectifier, 75V, 150mA SOD523 1N4148X-TP MCC 1 F1 39213150000 Fuse, 3.15A, 250V Radial, Box 39213150000 Littelfuse 1 J1 TC03236200J0G Terminal Block, 15A, 5.1mm 200-3 TC03236200J0G FCI 1 J3 5010 Test point, red, thru hole 0.125 x 0.125 in 5010 Keystone 1 J4 5011 Test point, black, thru hole 0.125 x 0.125 in 5011 Keystone 1 L1 10mH Inductor, Common-Mode, 10mH, 3A, TH UU10.5 Custom Custom	1	D16	12V	Diode, Zener, 12V, 1W	DIODE0.4	1N4742A-TP	MCC
1 F1 39213150000 Fuse, 3.15A, 250V Radial, Box 39213150000 Littelfuse 1 J1 TC03236200J0G Terminal Block, 15A, 5.1mm 200-3 TC03236200J0G FCI 1 J3 5010 Test point, red, thru hole 0.125 x 0.125 in 5010 Keystone 1 J4 5011 Test point, black, thru hole 0.125 x 0.125 in 5011 Keystone 1 L1 10mH Inductor, Common-Mode, 10mH, 3A, TH UU10.5 Custom Custom	2	D18,D19	IN4148	Diode, rectifier, 75V, 150mA	SOD523	1N4148X-TP	MCC
1 J1 TC03236200J0G Terminal Block, 15A, 5.1mm 200-3 TC03236200J0G FCI 1 J3 5010 Test point, red, thru hole 0.125 × 0.125 in 5010 Keystone 1 J4 5011 Test point, black, thru hole 0.125 × 0.125 in 5011 Keystone 1 L1 10mH Inductor, Common-Mode, 10mH, 3A, TH UU10.5 Custom Custom	1	F1	39213150000	Fuse, 3.15A, 250V	Radial, Box	39213150000	Littelfuse
1 J3 5010 Test point, red, thru hole 0.125 x 0.125 in 5010 Keystone 1 J4 5011 Test point, black, thru hole 0.125 x 0.125 in 5011 Keystone 1 L1 10mH Inductor, Common-Mode, 10mH, 3A, TH UU10.5 Custom Custom	1	J1	TC03236200J0G	Terminal Block, 15A, 5.1mm	200-3	TC03236200J0G	FCI
1 J4 5011 Test point, black, thru hole 0.125 x 0.125 in 5011 Keystone 1 L1 10mH Inductor, Common-Mode, 10mH, 3A, TH UU10.5 Custom Custom	1	J3	5010	Test point, red, thru hole	0.125 × 0.125 in	5010	Keystone
1 L1 10mH Inductor, Common-Mode, 10mH, 3A, TH UU10.5 Custom Custom	1	J4	5011	Test point, black, thru hole	0.125 × 0.125 in	5011	Keystone
	1	L1	10mH	Inductor, Common-Mode, 10mH, 3A, TH	UU10.5	Custom	Custom

Texas Instruments

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Count	RefDes	Value	Description	Size	Part Number	MFR
2	L2,L3	100uH	Inductor, Differential, 100uH, 3A, TH	ТН	Custom	Custom
1	MOV1	B72207S271K321	MOV, 387V, 1.2kA	Disc 7mm	B72207S271K321	Epcos
1	Q1	BC857	Transistor, PNP, 45V, 100mA	SOT-23	BC857BLT3G	On Semi
3	Q2,Q4,Q5	BC847	Transistor, NPN, 45V, 100mA	SOT-23	BC847CLT3G	On Semi
1	Q3	STP8N80K5	Transistor, N-ch FET, 800V, 6A	TO-220-3	STP8N80K5	STMicro
2	Q6,Q9	BC547	Transistor, NPN, 45V, 100mA	TO-92	BC547CZL1G	On Semi
1	Q7	BSS123	Transistor, N-ch FET, 100V, 170mA	SOT-23	BSS123LT1G	On Semi
1	Q8	FJP5027OTU	Transistor, NPN, 800V, 3A	TO-220-3	FJP5027OTU	Fairchild
4	Q10, Q11, Q12, Q13	BC847	Transistor, NPN, 45V, 100mA	SOT-23	BC847CLT3G	On Semi
2	R1,R30	33K	Resistor, chip, 1/4W, 1%	1206	Std	Std
1	R2	330K	Resistor, chip, 1/4W, 1%	1206	Std	Std
1	R3	47kΩ	Resistor, chip, 1/4W, 1%	1206	Std	Std
1	R4	220kΩ	Resistor, axial,1/4W, 1%	AXIAL0.4	Std	Std
DNP	R4A	220kΩ	Resistor, axial,1/4W, 1%	AXIAL0.4	Std	Std
1	R5	100K	Resistor, axial,1/4W, 1%	AXIAL0.4	Std	Std
1	R5A	100K	Resistor, chip, 1/4W, 1%	1206	Std	Std
1	R7	22kΩ	Resistor, chip, 1/4W, 1%	1206	Std	Std
1	R8	82kΩ	Resistor, chip, 1/4W, 1%	1206	Std	Std
1	R9	12kΩ	Resistor, axial,1/4W, 1%	AXIAL0.4	Std	Std
1	R10	2.2ΜΩ	Resistor, chip, 1/4W, 1%	1206	Std	Std
DNP	R10A,R20A	2.2ΜΩ	Resistor, chip, 1/4W, 1%	1206	Std	Std
1	R11	12kΩ	Resistor, chip, 1/4W, 1%	1206	Std	Std
2	R12,R13	5.6kΩ	Resistor, chip, 1/4W, 1%	1206	Std	Std
1	R14	120kΩ	Resistor, chip, 1/4W, 1%	1206	Std	Std
1	R15	8.2kΩ	Resistor, axial.1/4W. 1%	AXIAL0.4	Std	Std
1	R16	8.2kΩ	Resistor, chip. 1/4W. 1%	1206	Std	Std
1	R17	0E	Resistor, axial.1/4W, 1%	AXIAL0.4	Std	Std
2	R18.R19	1MΩ	Resistor, chip. 1/4W. 1%	1206	Std	Std
1	R20	56kΩ	Resistor, chip, 1/4W, 1%	1206	Std	Std
1	R21	68kΩ	Resistor, chip, 1/4W, 1%	1206	Std	Std
DNP	R21A R21B	1MQ	Resistor chip 1/4W 1%	1206	Std	Std
1	R22	4 7kO	Resistor chip 1/4W 1%	1206	Std	Std
1	R23	4 7F	Resistor axial 1/4W 1%		Std	Std
1	R24	0.20	Resistor chip 1/2W 1%	1206	Std	Std
1	R27	150k0	Resistor chip 1/4W/ 1%	1200	Std	Std
1	R32	240k0	Resistor chip 1/4W/ 1%	1200	Std	Std
2	R33 R34	1k0	Resistor chip 1/4W 1%	1206	Std	Std
1	R36	10k0	Resistor chip 1/4W/ 1%	1200	Std	Std
1	R38	1500	Resistor avial 1/4W/ 1%		Std	Std
1	D39A	1002	Posistor, axial 1/4W, 1%		Std	Std
1	R30	1500	Resistor chip 1/4W/ 1%	1206	Std	Std
1	R03	10052	Resistor chip 1/4W/ 1%	1200	Std	Std
	R41	0.50	Posistor, chip, 1/4W, 1%	1200	Std	Std
1	R43	165k0	Resistor chip 1/4/W/ 1%	1206	Std	Std
1	R43	33040	Resistor chip 1/4/1/ 19/	1200	Std	Std
1	D46 D54	1000	Resistor, chip, 1/4W, 1%	1200	Std	Std
3	R40, R51, R52	10022		1200	Siu	
2	R46 ,R49	22kΩ	Resistor, chip, 1/4W, 1%	1206	Std	Std
3	R47, R53, R54	4.7kΩ	Resistor, chip, 1/4W, 1%	1206	Std	Std
3	R48, R57, R58	10kΩ	Resistor, chip, 1/4W, 1%	1206	Std	Std

Table 3. Bill of Materials for Circuit with Primary Side Regulation (continued)



Test Results

				-		
Count	RefDes	Value	Description	Size	Part Number	MFR
1	R50	47kΩ	Resistor, chip, 1/4W, 1%	1206	Std	Std
2	R55, R56	100kΩ	Resistor, chip, 1/4W, 1%	1206	Std	Std
2	R57, R58	10kΩ	Resistor, chip, 1/4W, 1%	1206	Std	Std
1	T1	200µH	Transformer, Custom	PQ3230	Std	Std
DNP	T1A	200µH	Transformer, Custom	PQ2625	Std	Std
1	U1	CD74HCT14M	IC, High Speed CMOS Logic Hex Schmitt- Triggered Inverters	SOIC-14	CD74HCT14M	ТІ
1	U2	UCC28810	IC, LED Lighting Power Controller	SOIC-8	UCC28810DR	ТІ

Table 3. Bill of Materials for Circuit with Primary Side Regulation (continued)

6 Test Results

6.1 Secondary-Side Output Current Regulation

Table 4 lists the performance characteristics of a 70-W LED driver design with secondary-side output current regulation.

Table 4. Performance Characteristics of 70-W LED Driver Design With Secondary-Side Output Current Regulation

Input RMS Voltage (V)	Input Power (W)	Output Voltage (V)	Output Current (mA)	Output Power (W)	Efficiency (%)	Power Factor	Current THD (%)
90	71.35	105.8	586	61.99	86.89	0.996	4.67
120	69.55	106	587	62.22	89.46	0.997	3.25
150	68.85	106.1	586	62.17	90.30	0.998	2.67
180	68.68	106.1	586	62.17	90.52	0.998	2.56
220	67.91	106.1	586	62.17	91.55	0.998	2.54
250	68.12	106.2	586	62.23	91.35	0.999	2.55
265	68.17	106.2	586	62.23	91.29	0.998	2.97

6.2 Primary-Side Output Current Regulation

Table 5 lists the performance characteristics of a 70-W LED driver design with primary-side output current regulation.

Table 5.	Performance	Characteri	stics of 70	-W LED	Driver I	Design	with
	Primar	y-Side Outp	out Current	t Regula	tion	•	

Input RMS Voltage (V)	Input Power (W)	Output Voltage (V)	Output Current (mA)	Output Power (W)	Efficiency (%)	Power Factor	Current THD (%)
90	79.41	112.6	621	69.92	88.05	0.999	3.88
120	78.25	112.3	622	69.85	89.26	0.999	3.58
150	75.3	111.0	611	67.82	90.06	0.999	2.12
180	73.57	109.9	605	66.48	90.37	0.999	1.92
220	69.37	107.5	595	63.96	92.20	0.998	2.80
250	70.69	108.3	599	64.87	91.77	0.998	2.26
265	70.93	108.4	598	64.82	91.39	0.997	2.25



7 Conclusion

This application report describes design details and test results for a fixed-frequency, single-stage 70-W AC/DC flyback LED driver for streetlight applications, both with primary-side and secondary-side output current regulation circuits. Due to constant on-time and fixed switching-frequency operation, power factor greater than 0.9, and current THD less than 10 percent, is easily achieved. This design meets all the necessary performance specifications, including output open-circuit and short-circuit protections.

Conclusion

8 References

- 1. UCC28810 LED lighting power controller: <u>http://www.ti.com/product/ucc28810</u>.
- 2. CD74HCT14M High Speed CMOS Logic Hex Schmitt-Triggered Inverter: http://www.ti.com/product/cd74hct14.
- 3. TL431 Adjustable Precision Shunt Regulator: http://www.ti.com/product/tl431.
- 4. TPS92314 Off-Line Primary Side Sensing Controller with PFC: http://www.ti.com/product/tps92314

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