

LT8253

40V USB Type-C Power Delivery 4-SW Buck-Boost Controller

DESCRIPTION

Demonstration circuit DC3004A is a 40V 4-SW Buck-Boost Controller configured for automotive USB-C PD charging applications supporting up to 60W output power capability featuring the [LT[®]8253](#). It powers devices connected through the USB-C port at voltages between 3.3V and 21V at up to 3A when VIN is between 9V and 18V. DC3004A will run down to 6VIN with reduced output power capability and can operate through up to 36V input transient conditions. DC3004A runs at 400kHz switching frequency and features spread spectrum frequency modulation (SSFM) for reduced EMI. With SSFM enabled, EMI generated by DC3004A falls below the CISPR 25 Class 5 limits.

The LT8253 has an operating input voltage range of 4V to 40V. It can regulate an output as a boost, a buck, or a 4-switch buck-boost controller. It has an adjustable switching frequency between 150kHz and 650kHz, with an option for external frequency synchronization or $\pm 15\%$ spread spectrum frequency modulation.

DC3004A utilizes Cypress Semiconductor's CCG3PA USB-C port controller (CYPD3196) to interface between connected USB-C devices and the LT8253 power circuitry in order to comply with the latest USB Type-C and PD standards. This port controller device is powered directly from the INTV_{CC} pin of the LT8253. The CCG3PA facilitates the power contract negotiation between the connected device and DC3004A and adjusts the voltage at the FB divider to set the output voltage accordingly. The

LT8253+CCG3PA system monitors input voltage, output voltage and current, and measured temperature on board to help adjust output power capabilities based off measured operation parameters, as well as provide output over-voltage, under-voltage, and over-current protection.

The demo circuit is preloaded with firmware configured to support output power delivery up to 60W using the latest USB PD 3.0 protocol, and offers the following PDO/PPS output configuration options:

PDO: 5V AT 3A, 9V AT 3A, 15V AT 3A, 20V AT 3A

PPS: 3.3-11V AT 3A, 3.3-16V AT 3A, 3.3-21V AT 3A

DC3004A firmware is also configured to support legacy charge profiles including BC 1.2, QC 4.0 & 3.0, AFC, and Apple 2.4A charging. Firmware can be updated to support different PDO voltage and power levels. Contact factory apps for support.

The LT8253 datasheet gives a complete description of the part, operation, and applications information. The datasheet must be read in conjunction with this demo manual for DC3004A. The LT8253JUFDN is assembled in a 28-lead plastic side-wettable QFN (UFDN) package with a thermally-enhanced exposed ground pad. Proper board layout is essential for maximum thermal performance. See the datasheet section "PC Board Layout Checklist".

[Design files for this circuit board are available.](#)

All registered trademarks and trademarks are the property of their respective owners.

DEMO MANUAL DC3004A

PERFORMANCE SUMMARY Specifications are at $T_A = 25^\circ\text{C}$

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
CISPR25 Conducted Emissions (Class 5 Limits) CISPR25 Radiated Emissions (Class 5 Limits)	$12V_{IN}$, $20V_{OUT}$, $3A_{OUT}$ (60W), SSFM = ON		PASS PASS		
Input Voltage V_{IN} Range	$P_{OUT, MAX} = 60W$ $P_{OUT, MAX} = 30W$	9 6		18 9	V V
Switching Frequency (f_{SW})	$R3 = 100k$, $JP1 = \text{NO SSFM/SYNC}$ $R3 = 100k$, $JP1 = \text{SSFM ON}$	340	400	460	kHz kHz
Output Voltage	$9V > V_{IN} > 18V$, $T_{NTC} < 80^\circ\text{C}^*$	3.3		21	V
Output Power	$9V > V_{IN} > 18V$, $T_{NTC} < 80^\circ\text{C}^*$			60	W
Efficiency	$V_{IN} = 12V$, $V_{OUT} = 20V$, $I_{OUT} = 3A$, $JP1 = \text{SSFM ON}$		94.3		%
V_{IN} Undervoltage Lockout (UVLO) falling	$R30 = 1M$, $R29 = 59k$		6.0		V
V_{IN} Enable Turn-On (EN) rising	$R30 = 1M$, $R29 = 59k$		6.75		V

QUICK START PROCEDURE

DC3004A is easy to set up to evaluate the performance of the LT8253. Refer to Figure 1 for proper measurement equipment setup and follow the procedure below.

NOTE: Make sure that the voltage applied to V_{IN} does not exceed 40V, which is the voltage rating for the input side MOSFETs.

1. With power off, connect a power supply to the V_{IN} and GND terminals of DC3004A. Include voltage and current meters as shown if desired.
2. Connect DC3004A to a power adapter tester tool using a USB Type-C cable. Attach a variable voltage/current load to the power adapter tester. Include voltage and current meters as shown if desired.
3. After all connections are made. Turn on the power supply and verify that the input voltage is between 9V and 18V.
4. Configure the power adapter tester to select the desired V_{BUS} voltage. Adjust variable load to consume no more than 3A.

QUICK START PROCEDURE

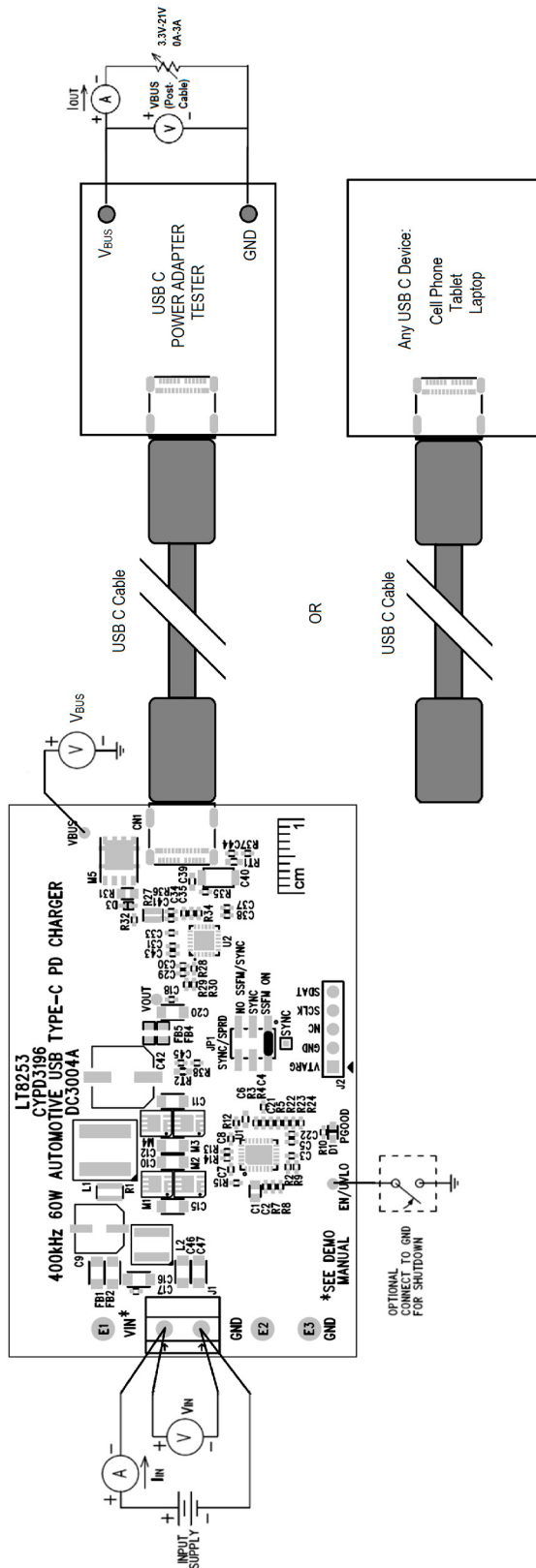


Figure 1. Test Procedure Setup Drawing for DC3004A

DEMO MANUAL DC3004A

QUICK START PROCEDURE

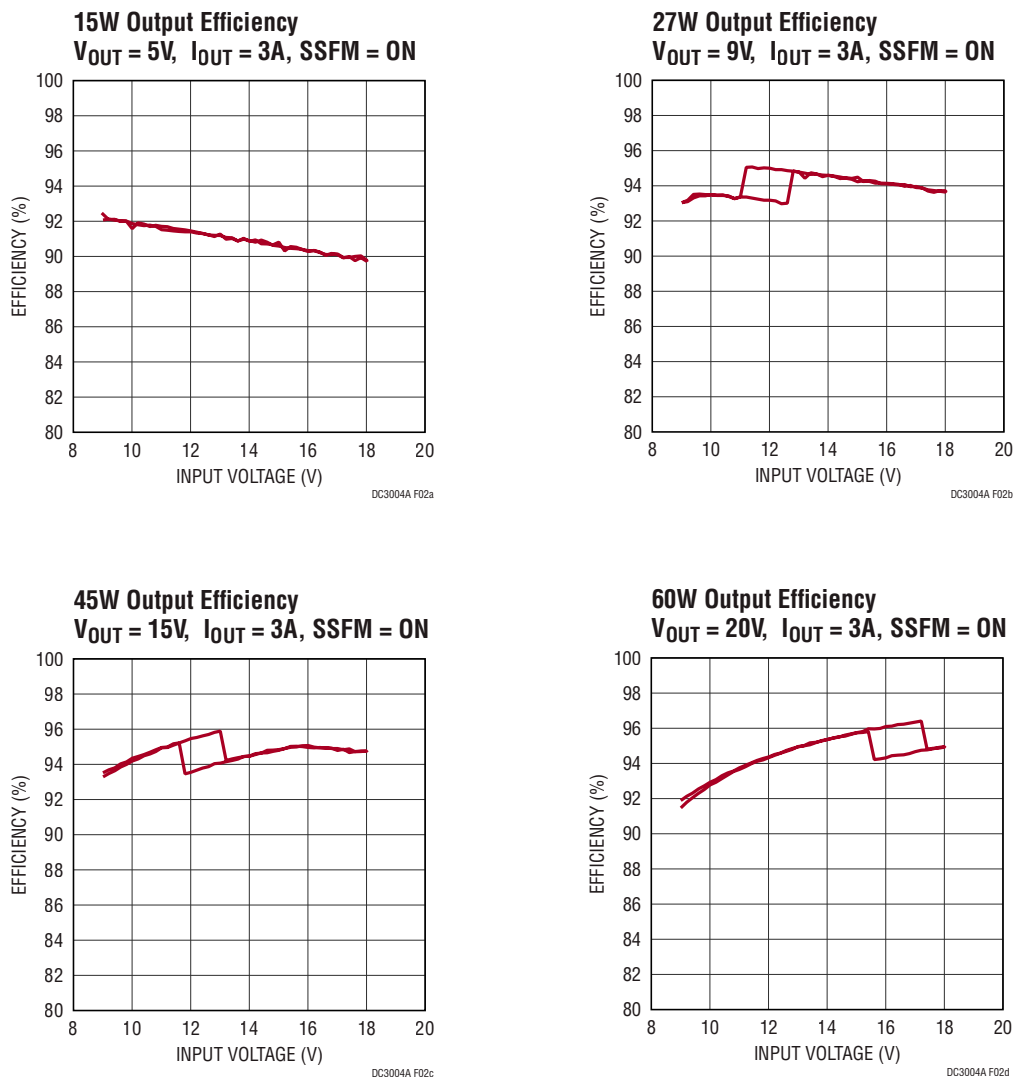
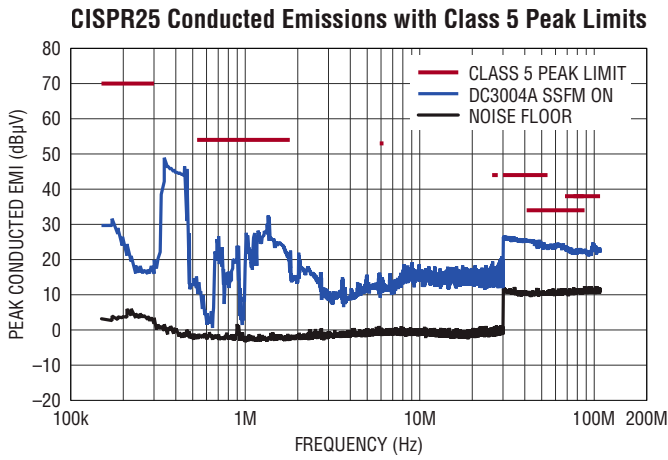
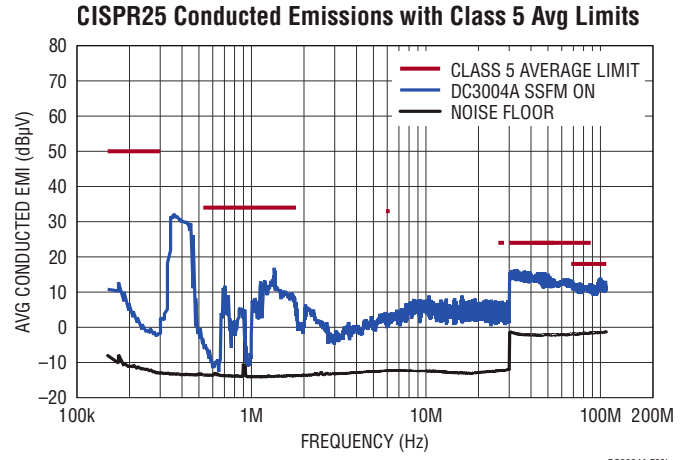


Figure 2. DC3004A Efficiency Versus Input Voltage

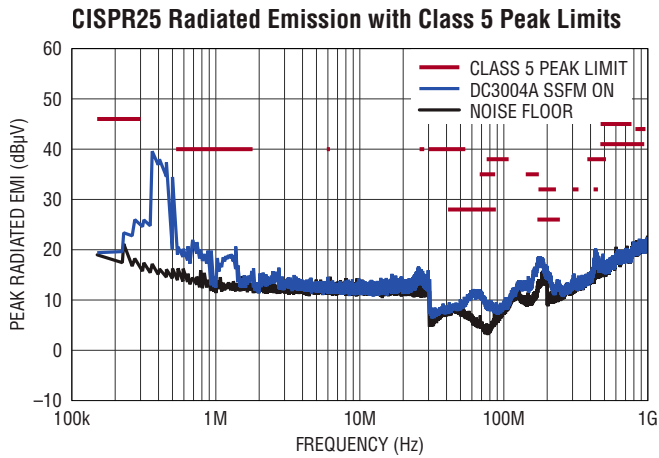
QUICK START PROCEDURE



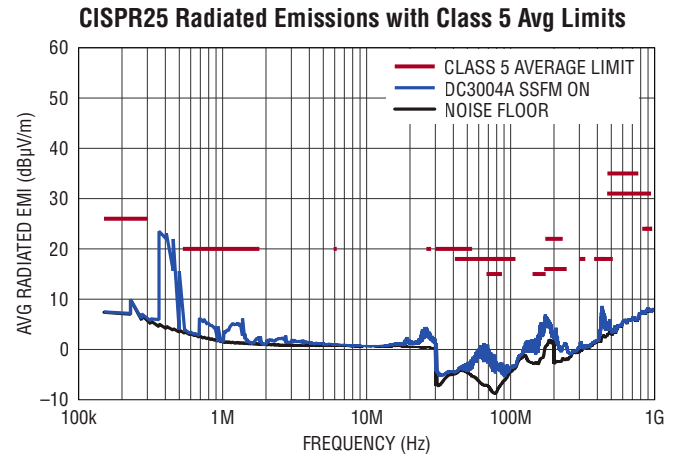
DC3004A F03a



DC3004A F03b



DC3004A F03c



DC3004A F03d

Figure 3. . DC3004A 60W Output Conducted and Radiated EMI Results with CISPR25 Class 5 Limit Lines.

DEMO MANUAL DC3004A

THERMAL IMAGE

An example thermal image shows the temperature distribution on DC3004A. The test is done in still air at room temperature (23°C) with spread spectrum frequency modulation (SSFM) enabled. Figure 4 shows a result when the input voltage is 12V and the output is configured for a 60W load; the highest temperature is

under 68°C. No heatsink or forced airflow is used for these measurements.

*Local temperature is measured by CCG3PA using NTC circuitry. Output power is programmed to fold back at ~80°C measured. This can be reprogrammed for higher temperature operation.

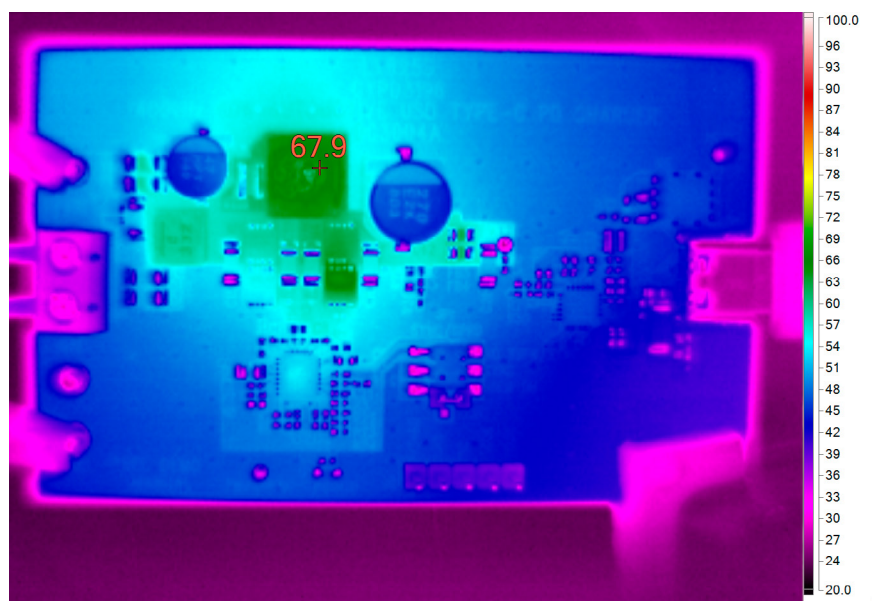


Figure 4. Board Temperature with 60W Output ($V_{IN} = 12V$, $V_{OUT} = 20V$, $I_{OUT} = 3A$, SSFM = ON, $T_{AMB} = 23^{\circ}C$, No Heatsink / Forced Air)

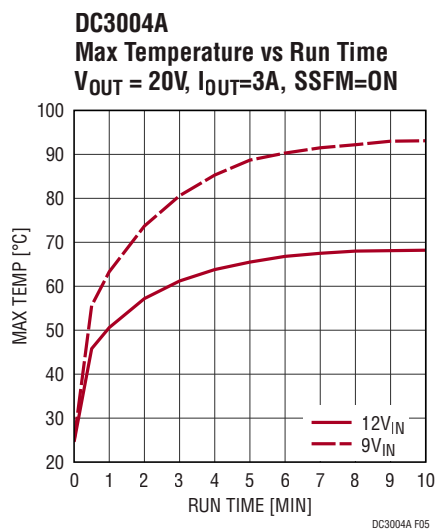


Figure 5. Max Temperature on DC3004A Over Time for both 12V_{IN} and 9V_{IN} Conditions

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	1	C1	CAP, 1uF, X7R, 50V, 10%, 0805, AEC-Q200	MURATA, GCM21BR71H105KA03L
2	1	C2	CAP, 4.7uF, X5R, 6.3V, 20%, 0402, AEC-Q200	TAIYO YUDEN, JMK105BBJ475MVHF
3	1	C3	CAP, 0.47uF, X5R, 25V, 10%, 0402, AEC-Q200	MURATA, GRT155R61E474KE01D
4	1	C4	CAP, 2200pF, X7R, 50V, 10%, 0402, AECQ200	MURATA, GCM155R71H222KA37D
5	3	C5, C7, C8	CAP, 0.1uF, X7R, 16V, 10%, 0402, AEC-Q200	MURATA, GCM155R71C104KA55D
6	1	C6	CAP, 1uF, X7R, 25V, 10%, 0603, AEC-Q200	MURATA, GCM188R71E105KA64D
7	2	C10, C15	CAP, 10uF, X5R, 50V, 10%, 1206, AEC-Q200	MURATA, GRT31CR61H106KE01L
8	2	C11, C12	CAP, 10uF, X7R, 25V, 10%, 1206, AEC-Q200	TAIYO YUDEN, TMK316AB7106KLHT
9	1	C21	CAP, 180pF, C0G/NP0, 50V, 5%, 0402	MURATA, GRM1555C1H181JA01D
10	1	C22	CAP, 1000pF, X7R, 50V, 10%, 0402, AEC-Q200	MURATA, GCM155R71H102KA37D
11	4	C30, C31, C33, C35	CAP, 0.1uF, X7R, 25V, 10%, 0402, AEC-Q200	MURATA, GCM155R71E104KE02D
12	3	C29, C34, C43	CAP, 1uF, X5R, 25V, 10%, 0402, AEC-Q200	MURATA, GRT155R61E105KE01D
13	2	C37, C38	CAP, 390pF, X7R, 50V, 10%, 0402, AEC-Q200	MURATA, GCM155R71H391KA37D
14	1	C39	CAP, 4.7uF, X5R, 25V, 10%, 0603, AEC-Q200	MURATA, GRT188R61E475KE13D
15	1	C40	CAP, 2200pF, X7R, 2000V, 10%, 1808	AVX, 1808GC222KAT1A
16	1	C41	CAP, 0.01uF, X7R, 25V, 10%, 0402, AEC-Q200	MURATA, GCM155R71E103KA37D
17	1	C42	CAP, 270uF, ALUM. POLY. HYB., 25V, 20%, 8x10.2mm SMD, RADIAL, AEC-Q200, EEHZK	PANASONIC, EEHZK1E271P
18	1	L1	IND., 6.8uH, PWR, SHIELDED, 20%, 11.3A, 14.5mOhms, 8.8mmX8.3mm, XAL8080, AEC-Q200	COILCRAFT, XAL8080-682MEB
19	4	M1, M2, M3, M4	XSTR., MOSFET, N-CH, 40V, 40A, PG-TSDSON-8, AEC-Q101	INFINEON, IPZ40N04S5L-4R8
20	1	M5	XSTR., MOSFET, P-CH, 30V, 36A, PowerDI5060-8, AEC-Q101	DIODES INC., DMP3010LPSQ-13
21	1	R1	RES., 0.005, OHM, 1%, 1.5W, 1206, LONG-SIDE TERM, KRL3216, METAL, SENSE, AEC-Q200	SUSUMU, KRL3216E-C-R005-F-T1
22	2	R2, R35	RES., 100k OHMS, 5%, 1/16W, 0402, AEC-Q200	VISHAY, CRCW0402100KJNED
23	1	R3	RES., 100k OHMS, 1%, 1/16W, 0402, AEC-Q200	VISHAY, CRCW0402100KFED
24	1	R4	RES., 30k OHMS, 1%, 1/16W, 0402, AECQ200	VISHAY, CRCW040230K0FKED
25	1	R5	RES., 200k OHMS, 1%, 1/10W, 0402, AEC-Q200	PANASONIC, ERJ2RKF2003X
26	1	R23	RES., 49.9k OHMS, 1%, 1/10W, 0402, AEC-Q200	PANASONIC, ERJ2RKF4992X
27	1	R24	RES., 100 OHMS, 1%, 1/16W, 0402, AEC-Q200	VISHAY, CRCW0402100RFKED
28	1	R27	RES., 0.005 OHM, 1%, 1W, 0805, LONG-SIDE TERM., METAL, SENSE, AEC-Q200	SUSUMU, KRL2012E-M-R005-F-T1
29	1	R29	RES., 59k OHMS, 1%, 1/16W, 0402, AEC-Q200	VISHAY, CRCW040259K0FKED
30	1	R30	RES., 1M OHM, 5%, 1/16W, 0402, AEC-Q200	VISHAY, CRCW04021M00JNED
31	1	R31	RES., 40.2k OHMS, 1%, 1/8W, 0805, AEC-Q200	VISHAY, CRCW080540K2FKEA
32	1	R32	RES., 698 OHMS, 1%, 1/16W, 0402, AEC-Q200	PANASONIC, CRCW0402698RFKED
33	1	R34	RES., 6.04k OHMS, 1%, 1/16W, 0402, AEC-Q200	VISHAY, CRCW04026K04FKED
34	1	R36	RES., 470 OHMS, 5%, 1/10W, 0402, AEC-Q200	PANASONIC, ERJ2GEJ471X
35	1	U1	IC, SYN. 4-SWITCH BUCK-BOOST CTRLR, QFN-28, AEC-Q200	ANALOG DEVICES, LT8253JUFDM#WPPBF

DEMO MANUAL DC3004A

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
36	1	U2	IC, USB TYPE-C PORT CONTROLER, QFN-24, AEC-Q100	CYPRESS, CYPD3196-24LDXS

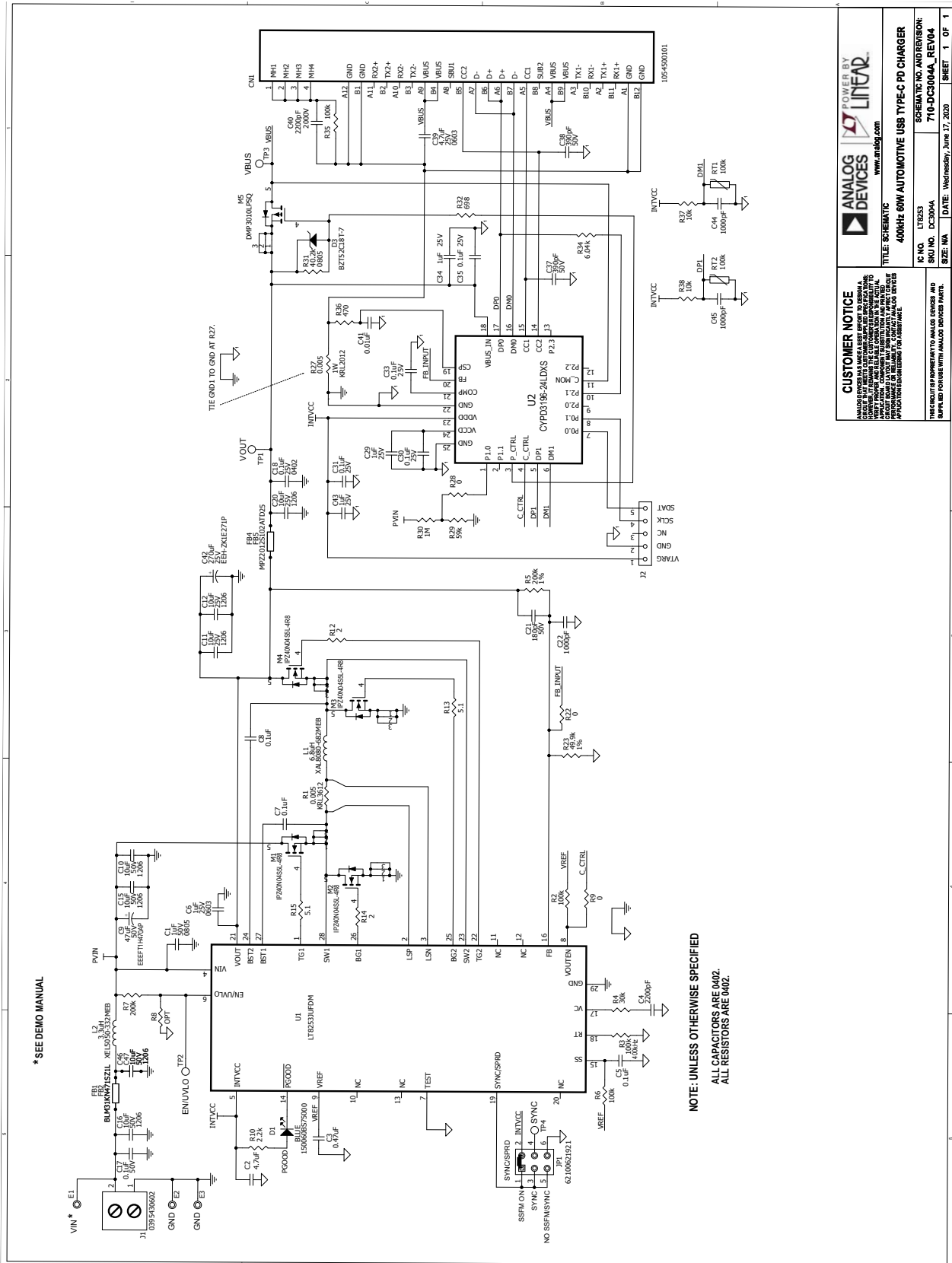
Additional Demo Board Circuit Components

37	1	C9	CAP, 47uF ALUM. ELECT., 50V, 20%, 6.3x5.8mm SMD, RADIAL, AEC-Q200	PANASONIC, EEEFT1H470AP
38	3	C16, C46, C47	CAP, 10uF X5R, 50V, 10%, 1206, AEC-Q200	MURATA, GRT31CR61H106KE01L
39	1	C20	CAP, 10uF X7R, 25V, 10%, 1206, AEC-Q200	TAIYO YUDEN, TMK316AB7106KLHT
40	1	C18	CAP, 0.1uF X7R, 25V, 10%, 0402, AEC-Q200	MURATA, GCM155R71E104KE02D
41	2	C44, C45	CAP, 1000pF, X7R, 50V, 10%, 0402, AEC-Q200	MURATA, GCM155R71H102KA37D
42	1	D1	LED, BLUE, WATERCLEAR, 0603	WURTH ELEKTRONIK, 150060BS75000
43	1	D3	DIODE, ZENER, 18V, 300mW, SOD-523, AEC-Q101	DIODES INC., BZT52C18T-7
44	2	FB1, FB2	IND., 470 OHMS@100MHz, FERRITE BEAD, 25%, 4A, 20mOHMS, 1206, AEC-Q200	MURATA, BLM31KN471S21L
45	2	FB4, FB5	IND., 1k OHM@100MHz, FERRITE BEAD, 25%, 1.5A, 150mOHMS, 0805, AEC-Q200	TDK, MPZ2012S102ATD25
46	1	L2	IND., 3.3uH, PWR, SHIELDED, 30%, 10.6A, 14.6mOHMS, 5.5mmX5.5mm, XEL5050, AEC-Q200	COILCRAFT, XEL5050-332MEB
47	1	R10	RES., 2.2k OHMS, 1%, 1/16W, 0402, AEC-Q200	PANASONIC, ERJ2RKF2201X
48	1	R7	RES., 200k OHMS, 1%, 1/10W, 0402, AEC-Q200	PANASONIC, ERJ2RKF2003X
49	0	R8 (OPT)	RES., OPTION, 0402	
50	4	R9, R22, R28	RES., 0 OHM, 1/10W, 0402, AEC-Q200	PANASONIC, ERJ2GE0R00X
51	2	R12, R14	RES., 2 OHMS, 1%, 1/16W, 0402, AEC-Q200	VISHAY, CRCW04022R00FKED
52	2	R13, R15	RES., 5.1 OHMS, 5%, 1/10W, 0402, AEC-Q200	PANASONIC, ERJ2GEJ5R1X
53	2	R37, R38	RES., 10k OHMS, 1%, 1/10W, 0402, AEC-Q200	PANASONIC, ERJ2RKF1002X
54	2	RT1, RT2	RES., 100k OHMS, 1%, 1/10W, 0603, 4419K, NTC THERMISTOR, AEC-Q200	TDK, NTCG164KF104FTDS

Hardware: For Demo Board Only

55	1	CN1	CONN., USB3.1, RCPT, 24POS, 1PORT, 0.5mm, R/A, HORZ, SMT, TYPE C	MOLEX, 1054500101
56	3	E1, E2, E3	TEST POINT, TURRET, 0.064" MTG. HOLE, PCB 0.062" THK	MILL-MAX, 2308-2-00-80-00-00-07-0
57	1	J1	CONN., TERM. BLOCK, 1x2, 5mm, SIDE ENTRY, VERT, THT	MOLEX, 0395430602
58	1	J2	CONN., HDR, MALE, 1x5, 2.54mm, VERT, ST, THT	SAMTEC, TSW-105-07-L-S
59	1	JP1	CONN., HDR, MALE, 2x3, 2mm, VERT, STR, SMD	WURTH ELEKTRONIK, 62100621921
60	1	XJP1	CONN., SHUNT, FEMALE, 2 POS, 2mm	WURTH ELEKTRONIK, 60800213421

SCHEMATIC DIAGRAM



CUSTOMER NOTICE
THIS DOCUMENT CONTAINS ANALOG DEVICES AND LINEAR INFORMATION THAT IS UNCLASSIFIED AND UNCONTROLLED. IT IS THE PROPERTY OF ANALOG DEVICES AND LINEAR. IT IS LOANED TO YOU BY ANALOG DEVICES AND LINEAR. IT IS NOT TO BE REPRODUCED, COPIED, OR DISTRIBUTED IN ANY MANNER WITHOUT THE WRITTEN PERMISSION OF ANALOG DEVICES AND LINEAR. ANALOG DEVICES AND LINEAR ARE NOT RESPONSIBLE FOR ANY DAMAGE TO PROPERTY OR PERSONS ARISING FROM THE USE OF THIS INFORMATION.

ANALOG DEVICES
POWERED BY
LINEAR
www.analog.com

TITLE: SCHEMATIC
400kHz 60W AUTOMOTIVE USB TYPE-C PD CHARGER

IC HQ: LT8253
SKU NO.: DC3004A
SCHEMATIC NO. AND REVISION: 710-DC3004A_REV04

DATE: Wednesday, June 17, 2020
SIZE: NA
SHEET: 1 OF 1

Information furnished by Analog Devices is believed to be accurate and reliable. However, no responsibility is assumed by Analog Devices for its use, nor for any infringements of patents or other rights of third parties that may result from its use. Specifications subject to change without notice. No license is granted by implication or otherwise under any patent or patent rights of Analog Devices.

DEMO MANUAL DC3004A



ESD Caution

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

Legal Terms and Conditions

By using the evaluation board discussed herein (together with any tools, components documentation or support materials, the "Evaluation Board"), you are agreeing to be bound by the terms and conditions set forth below ("Agreement") unless you have purchased the Evaluation Board, in which case the Analog Devices Standard Terms and Conditions of Sale shall govern. Do not use the Evaluation Board until you have read and agreed to the Agreement. Your use of the Evaluation Board shall signify your acceptance of the Agreement. This Agreement is made by and between you ("Customer") and Analog Devices, Inc. ("ADI"), with its principal place of business at One Technology Way, Norwood, MA 02062, USA. Subject to the terms and conditions of the Agreement, ADI hereby grants to Customer a free, limited, personal, temporary, non-exclusive, non-sublicensable, non-transferable license to use the Evaluation Board FOR EVALUATION PURPOSES ONLY. Customer understands and agrees that the Evaluation Board is provided for the sole and exclusive purpose referenced above, and agrees not to use the Evaluation Board for any other purpose. Furthermore, the license granted is expressly made subject to the following additional limitations: Customer shall not (i) rent, lease, display, sell, transfer, assign, sublicense, or distribute the Evaluation Board; and (ii) permit any Third Party to access the Evaluation Board. As used herein, the term "Third Party" includes any entity other than ADI, Customer, their employees, affiliates and in-house consultants. The Evaluation Board is NOT sold to Customer; all rights not expressly granted herein, including ownership of the Evaluation Board, are reserved by ADI. CONFIDENTIALITY. This Agreement and the Evaluation Board shall all be considered the confidential and proprietary information of ADI. Customer may not disclose or transfer any portion of the Evaluation Board to any other party for any reason. Upon discontinuation of use of the Evaluation Board or termination of this Agreement, Customer agrees to promptly return the Evaluation Board to ADI. ADDITIONAL RESTRICTIONS. Customer may not disassemble, decompile or reverse engineer chips on the Evaluation Board. Customer shall inform ADI of any occurred damages or any modifications or alterations it makes to the Evaluation Board, including but not limited to soldering or any other activity that affects the material content of the Evaluation Board. Modifications to the Evaluation Board must comply with applicable law, including but not limited to the RoHS Directive. TERMINATION. ADI may terminate this Agreement at any time upon giving written notice to Customer. Customer agrees to return to ADI the Evaluation Board at that time. LIMITATION OF LIABILITY. THE EVALUATION BOARD PROVIDED HEREUNDER IS PROVIDED "AS IS" AND ADI MAKES NO WARRANTIES OR REPRESENTATIONS OF ANY KIND WITH RESPECT TO IT. ADI SPECIFICALLY DISCLAIMS ANY REPRESENTATIONS, ENDORSEMENTS, GUARANTEES, OR WARRANTIES, EXPRESS OR IMPLIED, RELATED TO THE EVALUATION BOARD INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTY OF MERCHANTABILITY, TITLE, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS. IN NO EVENT WILL ADI AND ITS LICENSORS BE LIABLE FOR ANY INCIDENTAL, SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES RESULTING FROM CUSTOMER'S POSSESSION OR USE OF THE EVALUATION BOARD, INCLUDING BUT NOT LIMITED TO LOST PROFITS, DELAY COSTS, LABOR COSTS OR LOSS OF GOODWILL. ADI'S TOTAL LIABILITY FROM ANY AND ALL CAUSES SHALL BE LIMITED TO THE AMOUNT OF ONE HUNDRED US DOLLARS (\$100.00). EXPORT. Customer agrees that it will not directly or indirectly export the Evaluation Board to another country, and that it will comply with all applicable United States federal laws and regulations relating to exports. GOVERNING LAW. This Agreement shall be governed by and construed in accordance with the substantive laws of the Commonwealth of Massachusetts (excluding conflict of law rules). Any legal action regarding this Agreement will be heard in the state or federal courts having jurisdiction in Suffolk County, Massachusetts, and Customer hereby submits to the personal jurisdiction and venue of such courts. The United Nations Convention on Contracts for the International Sale of Goods shall not apply to this Agreement and is expressly disclaimed.

Rev. 0