

LTM4651 EN55022B Compliant 58V, 24W Inverting-Output DC/DC μ Module Regulator

DESCRIPTION

Demonstration circuit 2328A is an inverting buck-boost converter with 12V to 34V input voltage, -24V output voltage and max 2A output current capability, which features the LTM[®]4651Y. The [LTM4651](#) is an ultralow noise, 58V, 24W inverting-topology DC/DC μ Module regulator. It is designed to meet the radiated emissions requirement of EN55022B. A switching frequency range of 250kHz to

3MHz is supported and the module can synchronize to an external clock. The LTM4651 data sheet must be read in conjunction with this demo manual prior to working on or modifying demo circuit DC2328A.

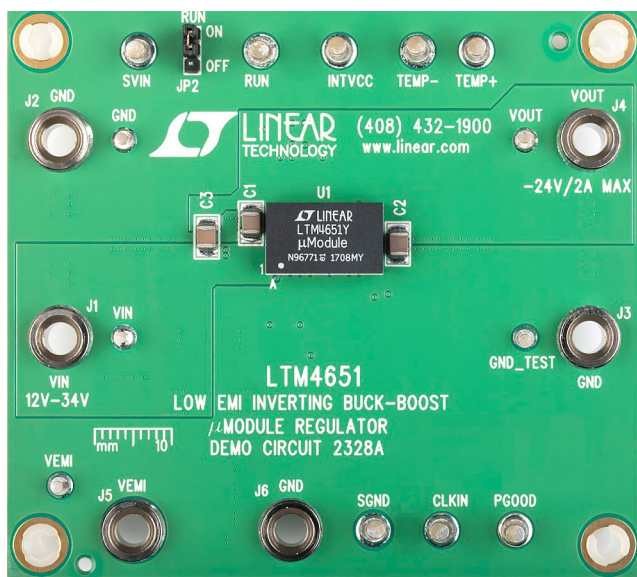
Design files for this circuit board are available at <http://www.linear.com/demo/DC2328A>

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

PARAMETER	CONDITIONS	VALUE
Input Voltage Range		12V to 34V
Output Voltage, V_{OUT}	12V _{IN} , 0A to 1A; 24V _{IN} , 0A to 2A; 34V _{IN} , 0A to 2A	-24V $\pm 2\%$
Maximum Output Current, I_{OUT}	Derating for Certain V_{IN} and Thermal Conditions	2A
Default Operating Frequency		1.2MHz
Efficiency	24V _{IN} , -24V _{OUT} , 2A	87.5%

BOARD PHOTO



DC2328A Top View

QUICK START PROCEDURE

Demonstration circuit 2328A is easy to set up to evaluate the performance of the LTM4651Y. Refer to Figure 1 for the proper measurement equipment setup and follow the procedure below:

1. With power off, connect the input power supply to V_{IN} (12V to 34V) and GND (input return).
2. Connect the -24V output load between V_{OUT} (-) and GND (+) (Initial load: no load).
3. Connect the DVMs to the input and output. Set the default jumper position, JP2: ON.
4. Turn on the input power supply and check for the proper output voltages. V_{OUT} should be $-24V \pm 2\%$.

5. Once the proper output voltages are established, adjust the loads within the operating range and observe the output voltage regulation, ripple voltage and other parameters.

Note: When measuring the output or input voltage ripple, do not use the long ground lead on the oscilloscope probe. See Figure 2 for the proper scope probe technique. Short, stiff leads need to be soldered to the (+) and (-) terminals of an output capacitor. The probe's ground ring needs to touch the (-) lead and the probe tip needs to touch the (+) lead.

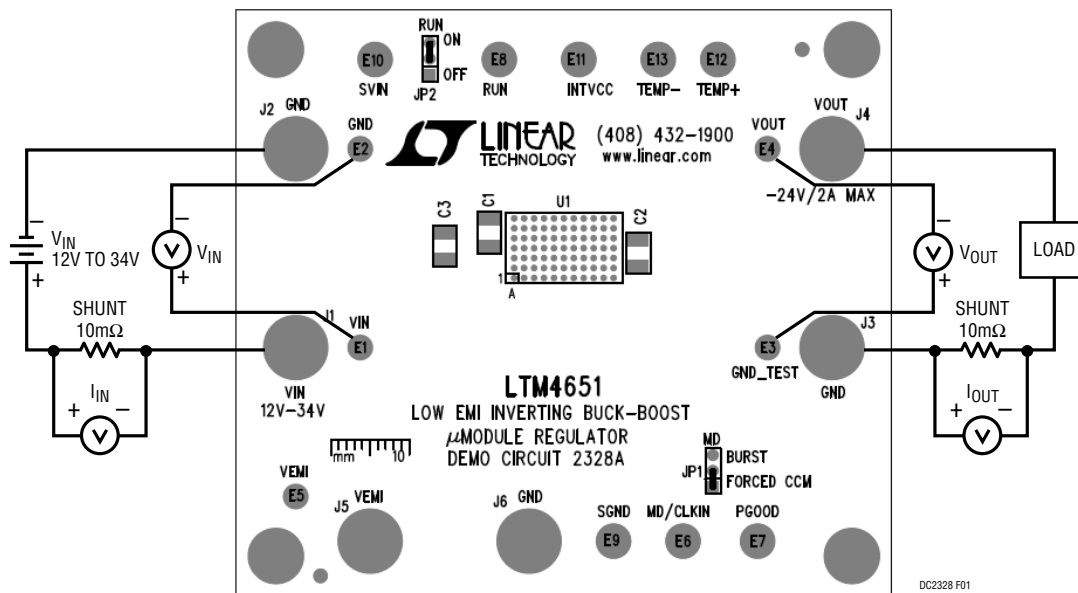


Figure 1. Proper Measurement Equipment Setup

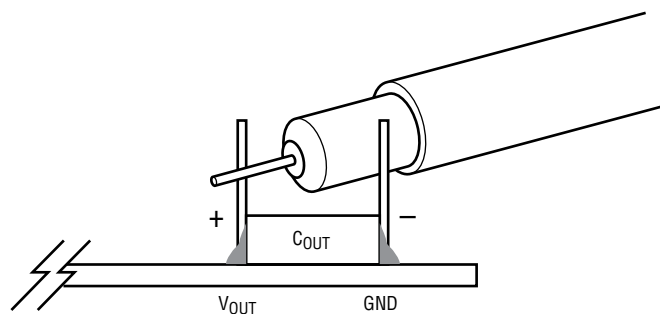


Figure 2. Measuring Output Voltage Ripple

QUICK START PROCEDURE

Optional $-12V_{OUT}$

Besides the default $-24V$ output voltage which shows the full capacity of LTM4651, it is very easy to customize the DC2328A demo board to make other negative output voltages available. As an example, to implement $-12V_{OUT}$ with $5V - 36V V_{IN}$,

1. Change R4 from 14k to 39k. This sets the minimum operation input voltage, 5V for this case.
2. Change R1 and R8 from 240k to 121k. This sets the output voltage, $-12V$ for this case.

Check the input and output capacitor voltage rating. And then it is done.

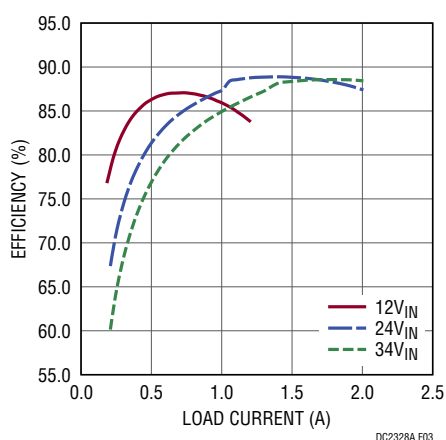


Figure 3. Efficiency vs Load Current ($V_{OUT} = -24V$)

However, to maximize the efficiency of the regulator for different input voltage, the switching frequency can be adjusted by changing R13. For the recommended switching frequency for given input voltage and given output voltage, please refer to the LTM4651 data sheet.

The results for the $-12V_{OUT}$ are listed below.

For $5V_{IN}$, change R13 from 124k to $1.3M\Omega$. The switching frequency will be 475kHz. For $12V_{IN}$, change R13 from 124k to 237k. The switching frequency will be 825kHz. For $24V_{IN}$, change R13 from 124k to 143k. The switching frequency will be 1.1MHz. For $36V_{IN}$, keep the default R13. The switching frequency will be 1.2MHz.

The optimized efficiency for $-12V_{OUT}$ is as shown in Figure 4.

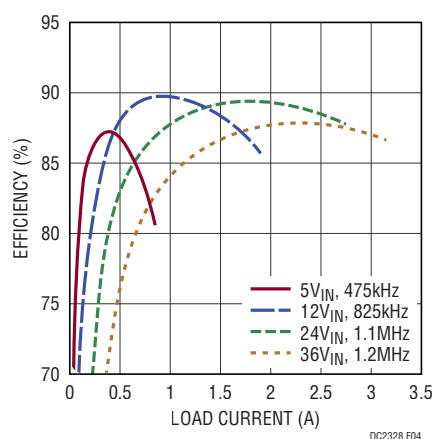


Figure 4. Efficiency vs Load Current ($V_{OUT} = -12V$)

QUICK START PROCEDURE

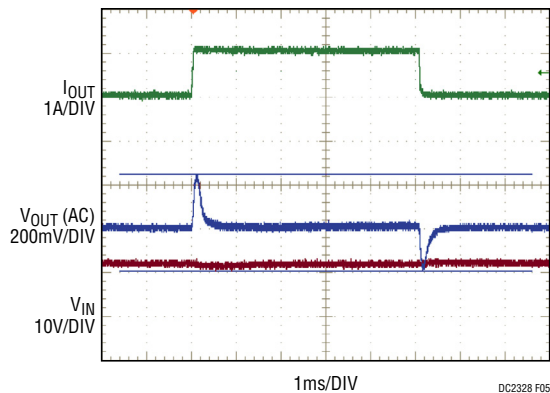


Figure 5. 0A $\leftrightarrow$ 1A Load Transients
($V_{IN} = 12V$, $V_{OUT} = -24V$)

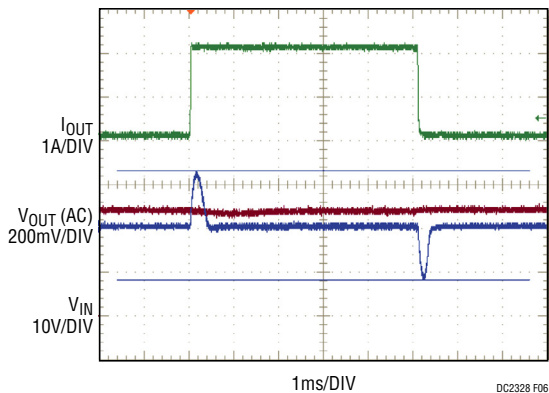


Figure 6. 0A $\leftrightarrow$ 2A Load Transients
($V_{IN} = 24V$, $V_{OUT} = -24V$)

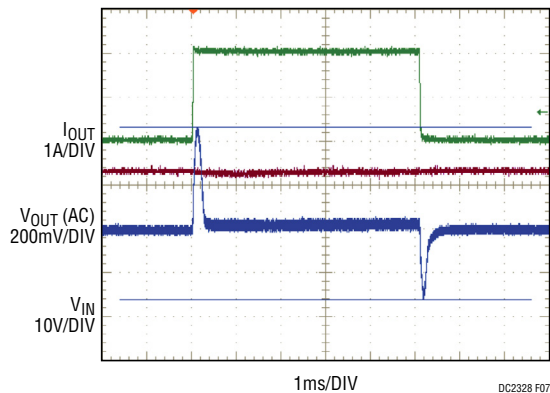


Figure 7. 0A $\leftrightarrow$ 2A Load Transients
($V_{IN} = 34V$, $V_{OUT} = -24V$)

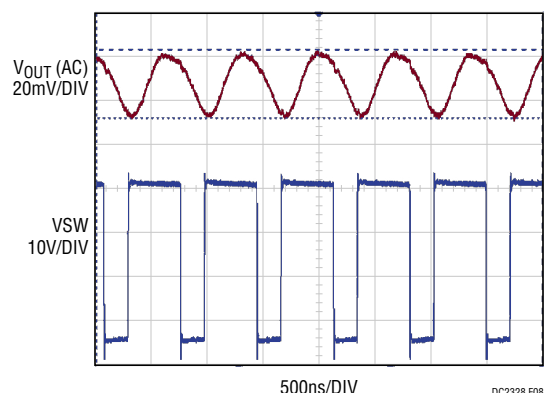


Figure 8. Output Voltage Ripple
($V_{IN} = 12V$, $V_{OUT} = -24V$, 1A Load)

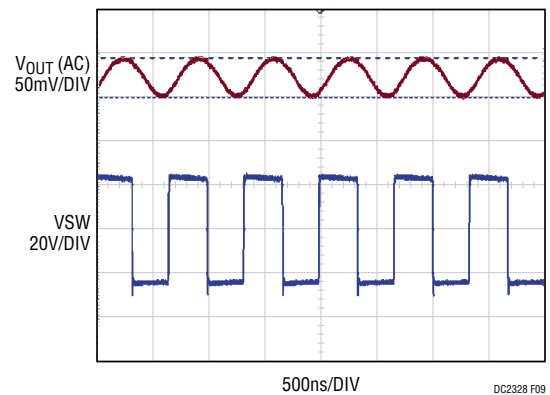


Figure 9. Output Voltage Ripple
($V_{IN} = 24V$, $V_{OUT} = -24V$, 2A Load)

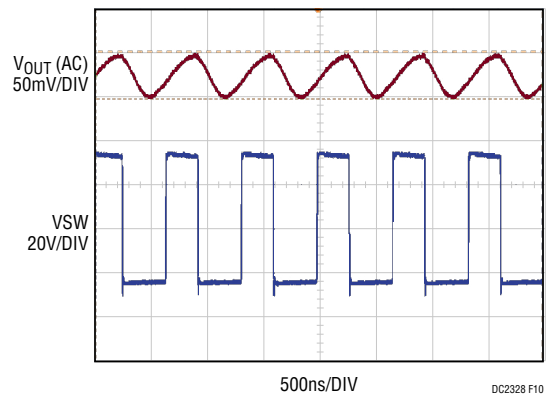


Figure 10. Output Voltage Ripple
($V_{IN} = 34V$, $V_{OUT} = -24V$, 2A Load)

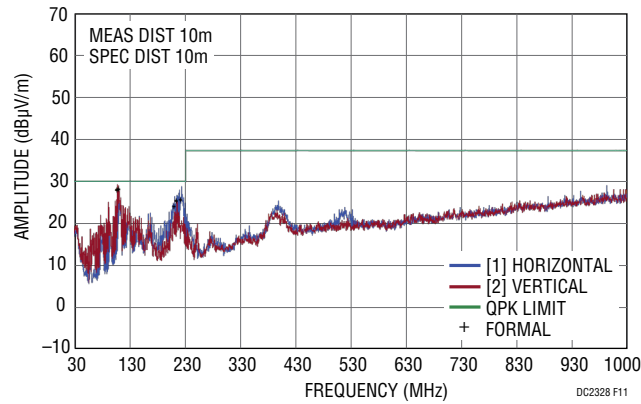


Figure 11. Radiated Emissions Scan of the LTM4651. Producing $-24V_{OUT}$ at 1A, from $12V_{IN}$. DC2328A Hardware. $f_{SW} = 1.2\text{MHz}$. Measured in a 10m Chamber. Peak Detect Method

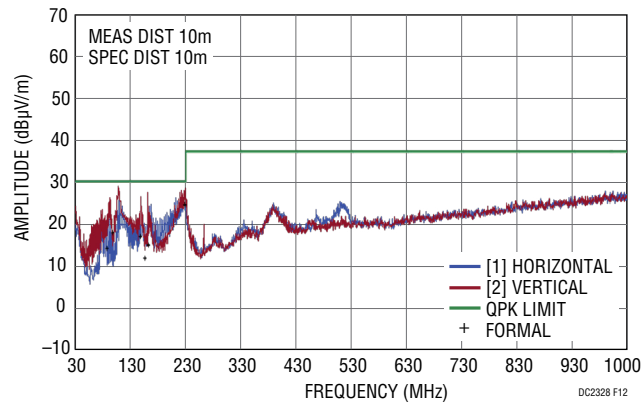


Figure 12. Radiated Emissions Scan of the LTM4651 Producing $-24V_{OUT}$ at 2A, from $25V_{IN}$. DC2328 Hardware. $f_{SW} = 1.2\text{MHz}$. Measured in a 10m Chamber. Peak Detect Method

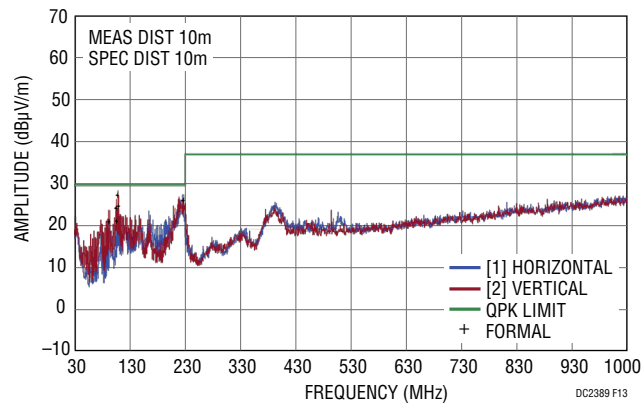


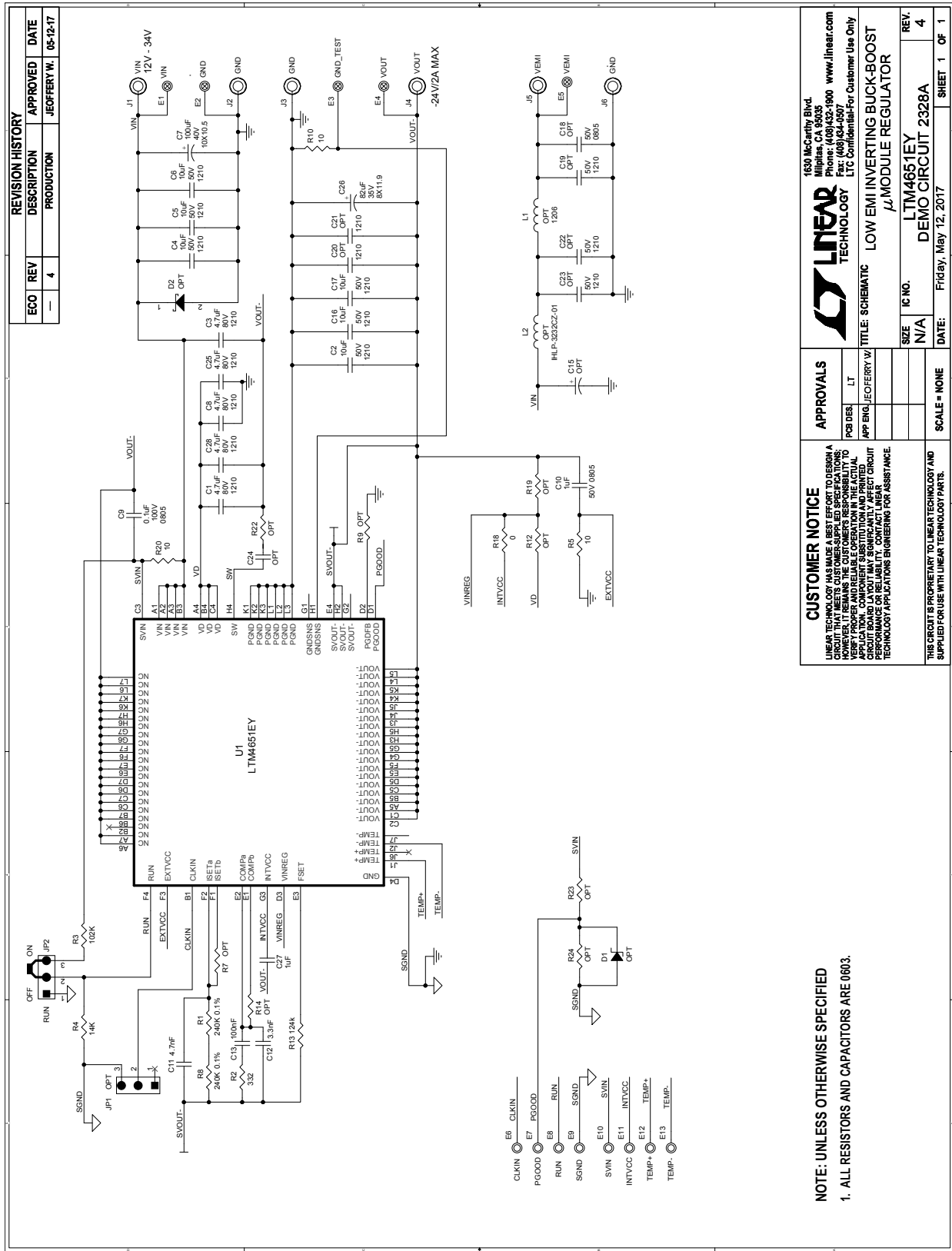
Figure 13. Radiated Emissions Scan of the LTM4651. Producing $-24V$ at 2A, from $34V$. DC2328A Hardware. $f_{SW} = 1.2\text{MHz}$. Measured in a 10m Chamber. Peak Detect Method

DEMO MANUAL DC2328A

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	5	C1, C3, C8, C25, C28	CAP, X7R, 4.7µF, 80V, 10%, 1210	MURATA, GRM32ER71K475KE14L
2	6	C2, C4, C5, C6, C16, C17	CAP, X7R, 10µF, 50V, 10%, 1210	MURATA, GRM32ER71H106KA12L
3	0	C19, C20, C21, C22, C23	CAP, OPT, 1210	OPT
4	1	C7	CAP, ALUM., 100µF, 40V, 10x10.5	SUN ELECTRONIC, 40HVP100M
5	1	C9	CAP, X7R, 0.1µF, 100V, 10%, 0805	MURATA, GRM21BR72A104KAC4K
6	1	C10	CAP, X7R, 1µF, 50V, 10%, 0805	MURATA, GRM21BR71H105KA12L
7	1	C11	CAP, X7R, 4.7nF, 50V, 10%, 0603	MURATA, GRM188R71H472KA01D
8	1	C12	CAP, X7R, 3.3nF, 50V, 10%, 0603	MURATA, GRM188R71H332KA01D
9	1	C13	CAP, X7R, 100nF, 50V, 10%, 0603	MURATA, GRM188R71H104KA93D
10	0	C15	CAP, OPT, 10X10.2	OPT
11	0	C18	CAP, OPT, 0805	OPT
12	0	C24	CAP, OPT, 0603	OPT
13	1	C26	CAP, OS-CON., 82µF, 35V, 8x11.9	PANASONIC, 35SVPF82M
14	1	C27	CAP, X5R, 1µF, 25V, 10%, 0603	MURATA, GRM188R61E105KA12D
15	0	D1	DIODE, OPT, SOT23	OPT
16	0	D2	DIODE, OPT, SMA	OPT
17	5	E1-E5	TESTPOINT, TURRET, .061"	MILL-MAX, 2308-2-00-80-00-00-07-0
18	8	E6-E13	TESTPOINT, TURRET, .094"	MILL-MAX, 2501-2-00-80-00-00-07-0
19	0	JP1	HEADER, OPT	OPT
20	1	JP2	HEADER, 1X3, 0.079	WURTH ELEKTRONIK, 62000311121
21	6	J1, J2, J3, J4, J5, J6	JACK, BANANA	KEYSTONE, 575-4
22	0	L1	IND, OPT, 1206	OPT
23	0	L2	IND, OPT, IHLP3232CZ-01	OPT
24	2	R1, R8	RES., 240k, 0.1%, 0603	PANASONIC, ERA3AEB244V
25	1	R2	RES., 332Ω, 1%, 0603	VISHAY, CRCW0603332RFKEA
26	1	R3	RES., 102k, 1%, 0603	VISHAY, CRCW0603102KFKEA
27	1	R4	RES., 14k, 1%, 0603	VISHAY, CRCW060314K0FKEA
28	3	R5, R10, R20	Res., 10Ω, 1%, 0603	VISHAY, CRCW060310R0FKEA
29	0	R7, R9, R12, R14, R19, R22, R23, R24	RES., OPT, 0603	OPT
30	1	R13	RES., 124k, 1%, 0603	VISHAY, CRCW0603124KFKEA
31	1	R18	RES., 0Ω, 1%, 0603	VISHAY, CRCW06030000Z0EA
32	1	U1	I.C., LTM4651EY, BGA77-15X9X5.01	LINEAR TECH., LTM4651EY#PBF
33	1	XJP2	SHUNT, 0.079" CENTER	WURTH ELEKTRONIK, 60800213421
34	4	(STAND-OFF)	STAND-OFF, NYLON 0.50"	WURTH ELEKTRONIK, 702935000
35	1		FAB, PRINTED CIRCUIT BOARD	DEMO CIRCUIT, 2328A
36	2		STENCILS TOP AND BOTTOM	STENCIL DC2328A

SCHEMATIC DIAGRAM



DEMO MANUAL DC2328A

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