

LTM4655

Low EMI Dual 13V to 40V_{IN}, 12V/4A_{OUT} µModule Regulator

DESCRIPTION

Demonstration circuit 2898A is a dual DC/DC converter with a 13V to 40V input voltage range, two 12V outputs at 4A each featuring the [LTM®4655](#). The LTM4655 is a EN55022B compliant 40V, dual 4A or single 8A step-down or 50W inverting DC/DC µModule® Regulator.

The switching frequencies of both channels are set at 1.2MHz on DC2898A. If the output voltage collapses sufficiently due to an overload or short-circuit condition, the internal oscillator will fold-back to one-fifth of the LTM4655's programmed switching frequency, protecting the power switch from damage.

Key features of this board include:

- SSFM Jumper for Spread Spectrum Options
- CLKIN Inputs for External Sync
- PGOOD Signals for Each Output

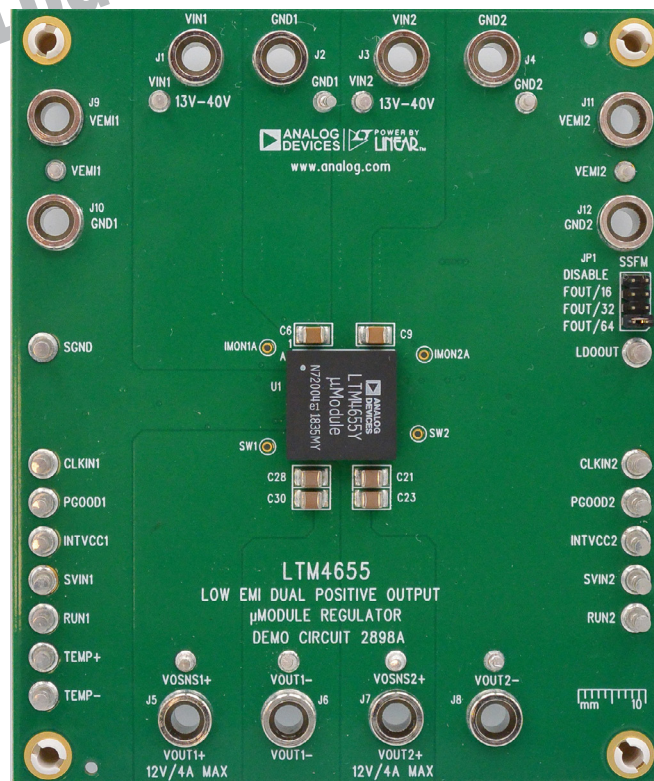
The two channels can be paralleled for higher output current. See the data sheet for more information on setting up the board for paralleling the two outputs.

The LTM4655 data sheet gives a complete description of the device, its operation and application information. The data sheet must be read in conjunction with this demo manual prior to working on or modifying DC2898A.

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

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

BOARD PHOTO



DEMO MANUAL DC2898A

PERFORMANCE SUMMARY

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

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	Input Supply Range		13		40	V
f_{SW}	Switching Frequency			1.2		MHz
V_{OUT}	Output Voltage	$V_{IN} = 14\text{V} - 40\text{V}$, $I_{OUT} = 0\text{A} - 4\text{A}$	11.9	12	12.1	V
I_{OUT}	Output Current per Output	$V_{IN} = 13.5\text{V}$	0		4	A
$V_{OUT(AC)}$	Output Ripple (Across C23/C30)	$V_{IN} = 28\text{V}$, $I_{OUT} = 4\text{A}$, 20MHz		10		mV _{P-P}
η	Efficiency	$V_{IN} = 28\text{V}$, $I_{OUT} = 4\text{A}$		89.5		

QUICK START PROCEDURE

Demo circuit 2898A is an easy way to evaluate the performance of the LTM4655. Refer to Figure 1 for proper measurement equipment setup, and follow the procedure below.

1. With power off, connect the input power supply “+” to V_{IN1} and V_{IN2} and “-” to GND1 and GND2. Connect the loads from V_{OUT1}^+ to V_{OUT1}^- , and V_{OUT2}^+ to V_{OUT2}^- .
2. Set voltage of the DC power supply at 14V. Turn on the power at the input.

NOTE: Make sure that the input voltage does not exceed 40V.
3. Check for the proper output voltage between V_{OUT1}^+ and V_{OUT1}^- ($V_{OUT1} = 12\text{V}$). Check for the proper output voltage between V_{OUT2}^+ and V_{OUT2}^- ($V_{OUT2} = 12\text{V}$).

NOTE: If there is no output, or output voltage value is out of the spec, temporarily disconnect the load to make sure that the load is not set too high.

NOTE: The circuit features frequency foldback to protect the power switches during a fault or output current overload.

4. Once the proper output voltage at each channel is established, adjust the load within the operating range and measure the output voltage regulation, ripple voltage, efficiency and other parameters.

NOTE: When measuring the input or output voltage ripple, care must be taken to avoid a long ground lead on the oscilloscope probe. Measure the input or output voltage ripple by touching the probe tip directly across the V_{IN1} or V_{IN2} and GND terminals, V_{OUT1}^+ and V_{OUT1}^- terminals, or V_{OUT2}^+ and V_{OUT2}^- terminals. See Figure 2 for proper scope probe technique.

QUICK START PROCEDURE

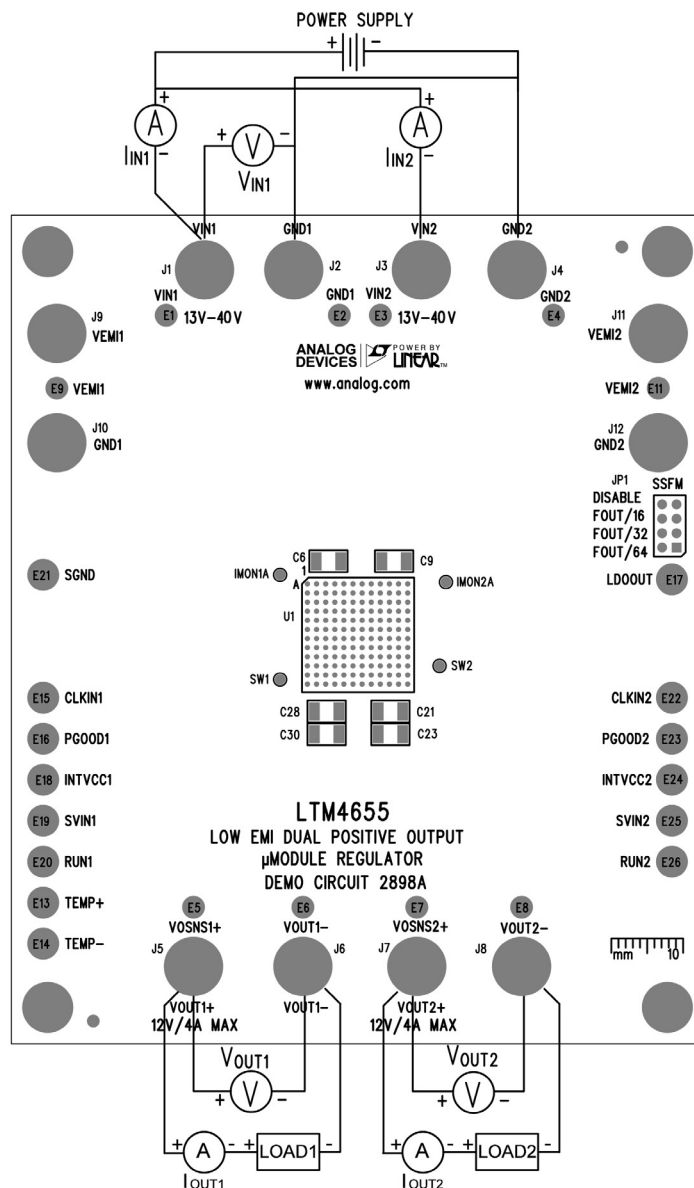


Figure 1. DC2898A Proper Equipment Setup

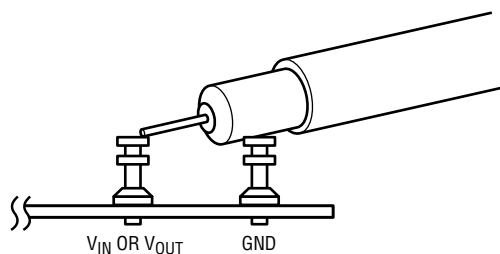


Figure 2. Measuring Input or Output Ripple

QUICK START PROCEDURE

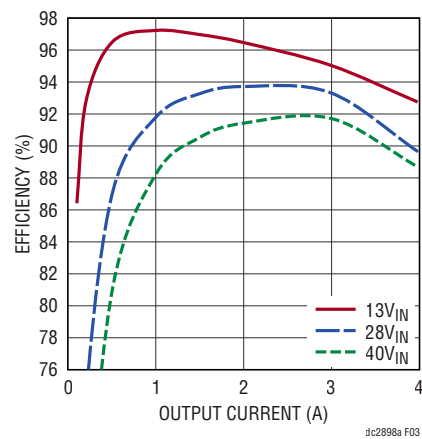


Figure 3. DC2898A Output Efficiency vs Load Current ($T_A = 25^{\circ}\text{C}$)

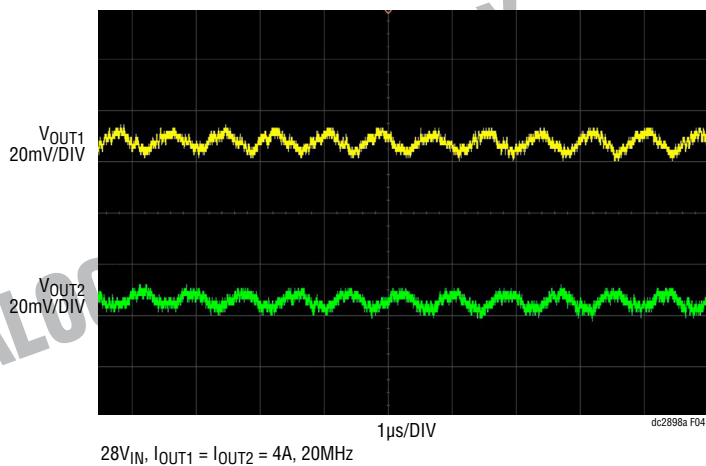


Figure 4. DC2898A Output Ripple

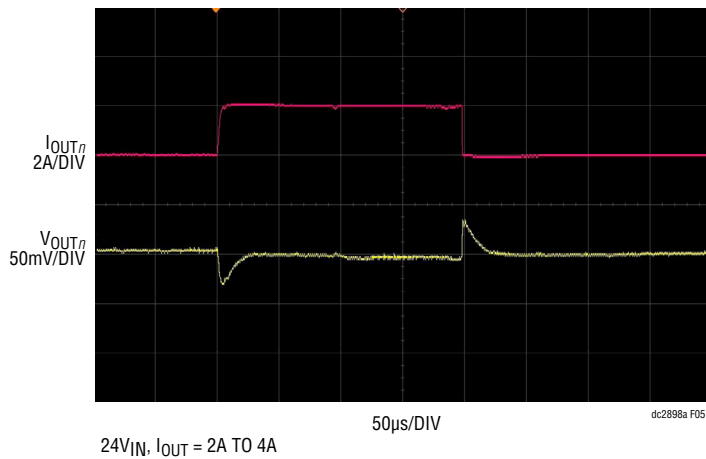


Figure 5. DC2898A Transient Response

QUICK START PROCEDURE

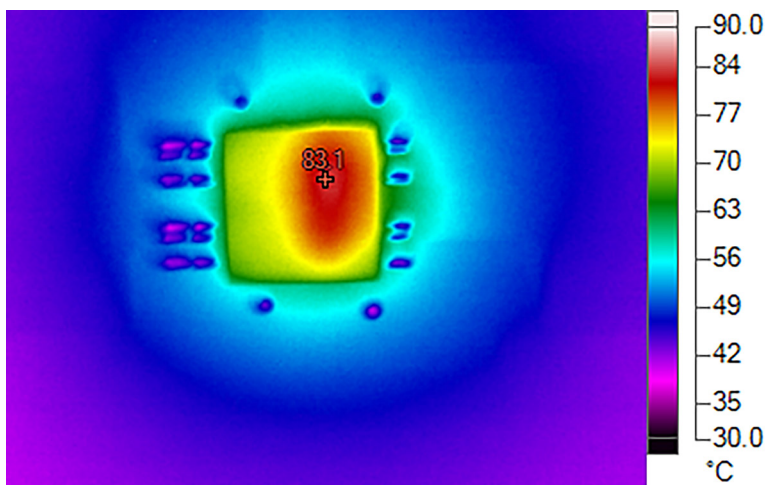


Figure 6. DC2898A Thermal Performance ($14V_{IN}$, $I_{OUT1} = I_{OUT2} = 3.5A$, $T_A = 25^\circ C$, Free Air)

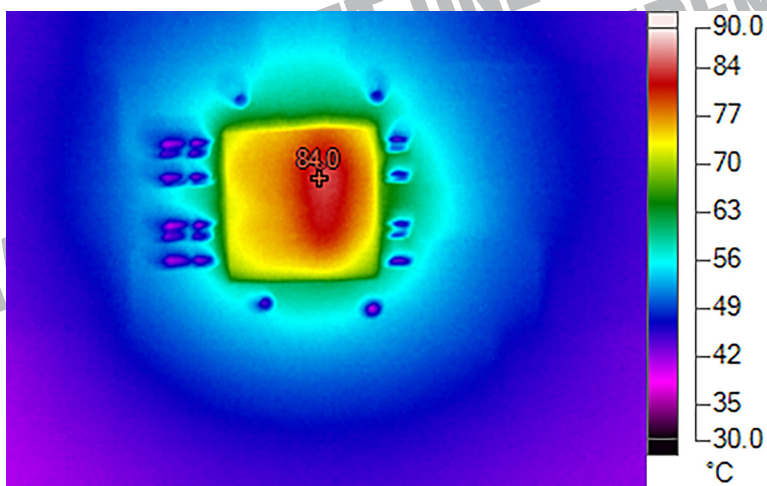


Figure 7. DC2898A Thermal Performance ($24V_{IN}$, $I_{OUT1} = I_{OUT2} = 3.5A$, $T_A = 25^\circ C$, Free Air)

QUICK START PROCEDURE

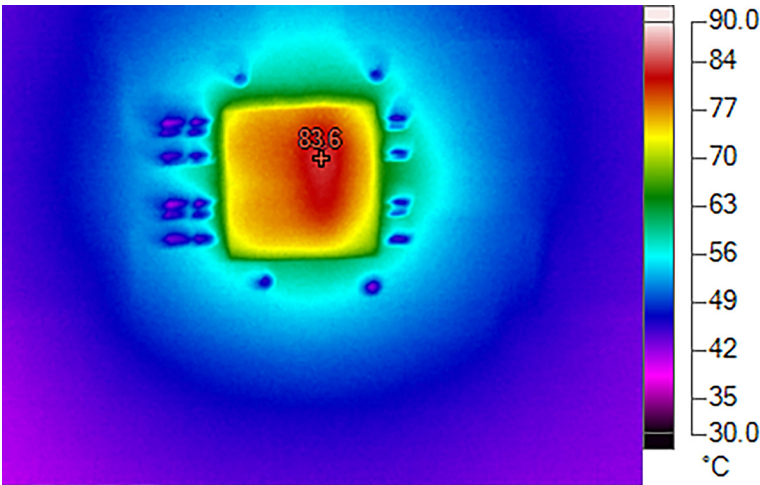


Figure 8. DC2898A Thermal Performance ($40V_{IN}$, $I_{OUT1} = I_{OUT2} = 3A$, $T_A = 25^{\circ}C$, Free Air)

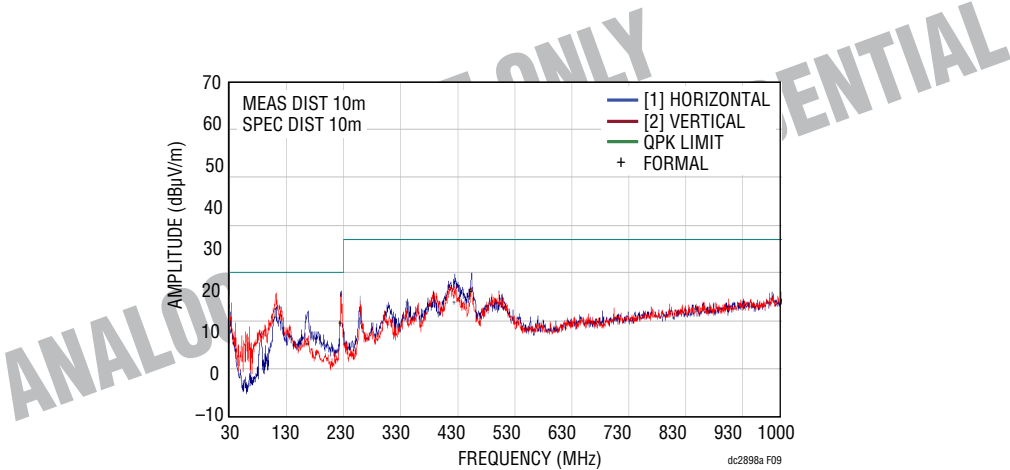


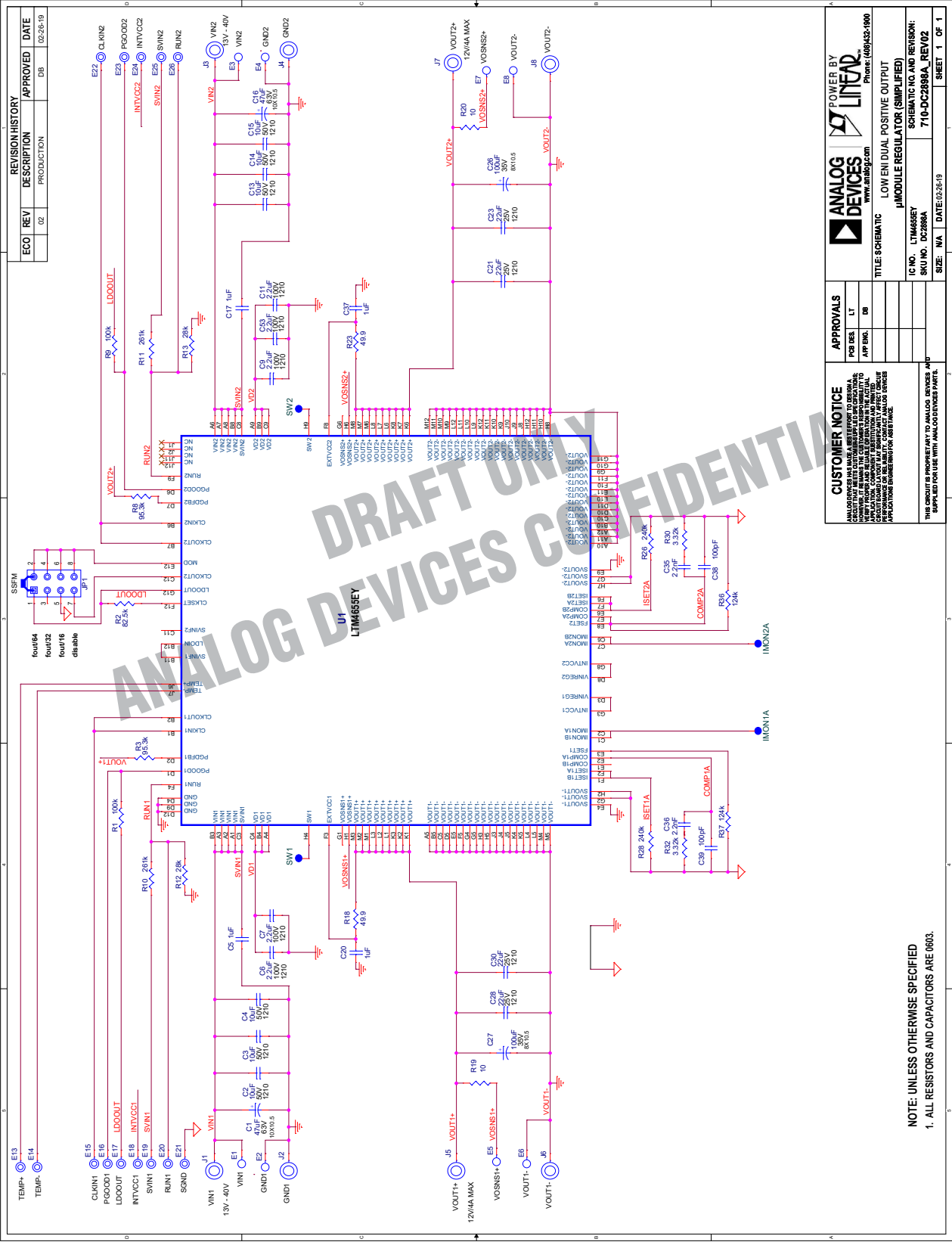
Figure 9. Radiated Emissions Scan of the LTM4655. Producing $24V_{OUT}$ at $7A$, from $36V_{IN}$. DC2898A Hardware. $f_{SW} = 1.2MHz$. Measured in a 10m Chamber. Peak Detect Method

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	2	C1, C16	CAP., 47µF, ALUM POLY HYB, 63V, 20%, SMD 10mm × 10.5mm, AEC-Q200, HVP Series	SUN ELECTRONIC INDUSTRIES CORP., 63HVP47M
2	6	C2–C4, C13–C15	CAP., 10µF, X7R, 50V, 10%, 1210, NO SUBS. ALLOWED	MURATA, GRM32ER71H106KA12L
3	4	C5, C17, C20, C37	CAP., 1µF, X5R, 50V, 10%, 0603	AVX, 06035D105KAT2A
4	5	C6, C7, C9, C11, C53	CAP., 2.2µF, X7R, 100V, 10%, 1210	AVX, 12101C225KAT2A
5	4	C21, C23, C28, C30	CAP., 22µF, X7R, 25V, 10%, 1210	SAMSUNG, CL32B226KAJNNNE
6	2	C26, C27	CAP., 100µF, ALUM POLY HYB, 35V, 20%, SMD 8mm × 10.5mm, AEC-Q200, HVP Series	SUN ELECTRONIC INDUSTRIES CORP., 35HVP100M
7	2	C35, C36	CAP., 2200pF, X7R, 50V, 10%, 0603	AVX, 06035C222KAT2A
8	2	C38, C39	CAP., 100pF, X7R, 50V, 10%, 0603	AVX, 06035C101KAT2A
9	2	R1, R9	RES., 100k, 1%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW0603100KFKEA
10	1	R2	RES., 82.5k, 1%, 1/10W, 0603, AEC-Q200	PANASONIC, ERJ3EKF8252V
11	2	R3, R8	RES., 95.3k, 1%, 1/10W, 0603, AEC-Q200	PANASONIC, ERJ3EKF9532V
12	2	R10, R11	RES., 261k, 1%, 1/10W, 0603, AEC-Q200	NIC, NRC06F2613TRF
13	2	R12, R13	RES., 28k, 1%, 1/10W, 0603, AEC-Q200	PANASONIC, ERJ3EKF2802V
14	2	R18, R23	RES., 49.9Ω, 1%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW060349R9FKEA
15	2	R19, R20	RES., 10Ω, 1%, 1/10W, 0603	VISHAY, CRCW060310R0FKEA
16	2	R26, R28	RES., 240k, 1%, 1/10W, 0603	VISHAY, CRCW0603240KFKEA
17	2	R30, R32	RES., 3.32k, 1%, 1/10W, 0603, AEC-Q200	PANASONIC, ERJ3EKF3321V
18	2	R36, R37	RES., 124k, 1%, 1/10W, 0603, AEC-Q200	PANASONIC, ERJ3EKF1243V
19	1	U1	IC, DC/DC REGULATOR, BGA-144 (16mm × 16mm × 5.01mm)	ANALOG DEVICES, LTM4655EY#PBF
Additional Demo Board Circuit Components				
1	0	C8, C22, C24, C25, C29, C31, C32, C44–C46, C49–C51	CAP., OPTION, 1210	
2	0	C18, C19, C33, C34, C40–C42, C54	CAP., OPTION, 0603	
3	0	C43, C52	CAP., OPTION, 0805	
4	0	D1, D2	DIODE, OPTION, SMA	
5	0	L1, L4	IND., OPTION, 1206	
6	0	L2, L3	IND., OPTION	
7	11	R4, R5, R7, R14, R15, R21, R24, R25, R34, R39, R42	RES., 0Ω, 1/10W, 0603, AEC-Q200	VISHAY, CRCW06030000Z0EA
8	0	R6, R16, R17, R22, R27, R29, R31, R33, R35, R38, R43–R46	RES., OPTION, 0603	
9	1	R40	RES., 0Ω, 1W, 2512, 7A, AEC-Q200	VISHAY, CRCW25120000Z0EG
10	0	R41	RES., OPTION, 2512	
Hardware				
1	10	E1–E9, E11	TEST POINT, TURRET, 0.064" MTG. HOLE, PCB 0.062" THK	MILL-MAX, 2308-2-00-80-00-00-07-0
2	14	E13–E26	TEST POINT, TURRET, 0.094" MTG. HOLE, PCB 0.062" THK	MILL-MAX, 2501-2-00-80-00-00-07-0
3	12	J1–J12	CONN., BANANA JACK, FEMALE, THT, NON-INSULATED, SWAGE, 0.218"	KEYSTONE, 575-4
4	1	JP1	CONN., HDR, MALE, 2×4, 2mm, VERT, ST, THT	WURTH ELEKTRONIK, 62000821121
5	4	MP1–MP4	STANDOFF, NYLON, SNAP-ON, 0.50"	KEYSTONE, 8833
6	1	XJP2	CONN., SHUNT, FEMALE, 2 POS, 2mm	WURTH ELEKTRONIK, 60800213421

DEMO MANUAL DC2898A

SIMPLIFIED SCHEMATIC DIAGRAM





DRAFT ONLY
ANALOG DEVICES CONFIDENTIAL



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.