LT3966
I^2C Programmable Quad Monolithic Boost LED Driver

DESCRIPTION

Demonstration circuit 2630A is an I^2C programmable quad channel monolithic boost LED driver featuring the LT®3966. It drives four separate strings of LEDs (up to 50V) at 125mA when V_{IN} is between 9V and 18V. DC2630A runs at 2MHz switching frequency. Its four channels are capable of powering LED strings which can have different currents, voltages, or dimming ratios. Each channel can be independently controlled via I^2C communications or analog inputs. DC2630A can be configured to run in either mode by modifying the ADDR pin settings. It is protected against output overcurrent, overvoltage events, and reports open and short LED fault events by latching an alert pin. In I^2C mode, faults can be enabled or disabled. A DC2026C Linduino® One demonstration circuit is used to interface with the board by directly connecting it with a QuikEval™ ribbon cable and provided command line interface code.

The LT3966 has an input voltage range from 3V to 60V. Each boost channel has an integrated 60V 1.6A low-side power switch. It has adjustable switching frequency between 300kHz and 2MHz and can be synchronized to an external clock source. Additionally, LT3966 can be programmed to output its own master clock to sync other devices. The high side PWMTG MOSFET drivers assist with PWM dimming and fault protection. The LT3966 channels can be configured to operate as a ground-referenced step-up (boost) LED driver, or as a floating output LED driver to perform step-down (buck mode) or step-up/step-down (buck-boost mode) operation.

Each channel of the LT3966 can be independently dimmed by applying a PWM signal or CTRL voltage to the corresponding channel CTRL/PWM pin while operating in non-I^2C mode. In I^2C mode, each channel has a maximum of 13 bits of PWM dimming resolution and 8 bits of analog dimming resolution.

Small ceramic input and output capacitors are used to save space and cost. The open LED overvoltage protection uses the IC's constant-voltage regulation loop to regulate the output to approximately 57V if the LED string is opened.

Undervoltage lockout can be adjusted on the circuit with a few simple resistor choices. The output voltage (overvoltage protection) can be adjusted by changing the feedback resistors for different string voltages. Other components may need to be changed to accommodate the change in output voltages as well.

The LT3966 data sheet gives a complete description of the device, operation and applications information. The data sheet must be read in conjunction with this demo manual for DC2630A. The LT3966EUJ is assembled in a 40-lead plastic 6mm × 6mm QFN package with a thermally enhanced ground.

Design files for this circuit board are available.

PERFORMANCE SUMMARY Specifications are at $T_A = 25°C$

PARAMETER	CONDITION	MIN	TYP	MAX	UNIT
Input Voltage V_{IN} Range	Operating Transient	9		18 36	V V
Switching Frequency (f_{SW})	R30 = 47.5kΩ, MPHASE = OFF		2		MHz
I_{LED1}, I_{LED2}, I_{LED3}, I_{LED4}	R3 = R16 = R22 = R26 = 2Ω		125		mA
Open LED Voltage V_{OUT}	R4 = R17 = R23 = R27 = 1MΩ R5 = R18 = R24 = R28 = 21.5kΩ		57		V
Efficiency (100% PWM DC)	V_{IN} = 12.0V, f_{SW} = 2MHz, V_{LED} = 50V $I_{LED1} = I_{LED2} = I_{LED3} = I_{LED4}$ = 125mA		86.7%		
V_{LED} Range	R4 = R17 = R23 = R27 = 1MΩ R5 = R18 = R24 = R28 = 21.5kΩ	40		56	V
I^2C Minimum PWM Dimming Frequency	R30 = 47.5kΩ, SCL[2:0] = 0b111		244		Hz
V_{IN} Undervoltage Lockout (UVLO) Falling	R2 = 499kΩ, R1 = 84.5kΩ		8.5		V
V_{IN} Enable Turn-On (EN) Rising	R2 = 499kΩ, R1 = 84.5kΩ		9.7		V

QUICK START PROCEDURE

Note: Make sure that the voltage applied to V_{IN} does not exceed 50V.

HOW TO OPERATE DC2630A IN NON-I^2C MODE

The DC2630A is easy to set up to evaluate the performance of the LT3966 in non-I^2C mode. Refer to Figure 1 for proper measurement equipment setup and follow the procedure below.

1. With power off, connect a string of up to 16 LEDs between each channel's LED^+ and GND turrets. Connect the EN/UVLO turret to GND to keep the circuit shut down. With the power off, connect the input power supply to the V_{IN} and GND terminals.
2. For non-I^2C mode operation, set both JP1 and JP2 (ADDR1 and ADDR2) to 0. This address is for non-I^2C mode, and all other settings are for I^2C serial communications mode.
3. Adjust the input power supply voltage between 9V and 18V and enable its output.
4. Release the EN/UVLO-to-GND connection.
5. Observe the LED string running at the programmed LED current.
6. To change the brightness with analog dimming in non-I^2C mode, attach an adjustable voltage source to the corresponding CTRL/PWM turrets and set the voltage between 0V and 1.5V. See data sheet for details.
7. To change brightness with external PWM dimming in non-I^2C mode, attach a rectangular waveform with varying duty cycle to the corresponding CTRL/PWM turrets.

HOW TO OPERATE DC2630A WITH COMMAND LINE INTERFACE – I^2C SERIAL COMMUNICATIONS MODE

The DC2630A works with a Linduino One microcontroller board (DC2026C) and can be connected to a PC via USB. This allows DC2630A to be controlled via serial port interface in Arduino IDE. Refer to the DC2026C Demo Manual for detailed instructions on installing and configuring the necessary software libraries.

1. Launch Arduino IDE.
2. Connect Linduino to computer via USB.
3. Connect a ribbon cable between the J1 serial communications connection and a Linduino One demo circuit.

QUICK START PROCEDURE

4. Download the Linduino code and library files from the DC2630A web page.
5. Upload the code to the connected Linduino demo circuit.
6. With power off, connect a string of up to 16 LEDs between each channel's LED+ and GND turrets. Connect the EN/UVLO turret to GND to keep the circuit shut down. With the power off, connect the input power supply to the V_{IN} and GND terminals.
7. For I²C serial communications, set JP1 (ADDR1) to 1 and JP2 (ADDR2) to 1. This is the chosen I²C address for the DC2630A command line interface.
8. Open up the serial monitor inside Arduino IDE.
9. Turn on 12V power to the V_{IN} and GND pins of the DC2630A.
10. Use command line interface in serial monitor to evaluate the performance of the LT3966 demo circuit.

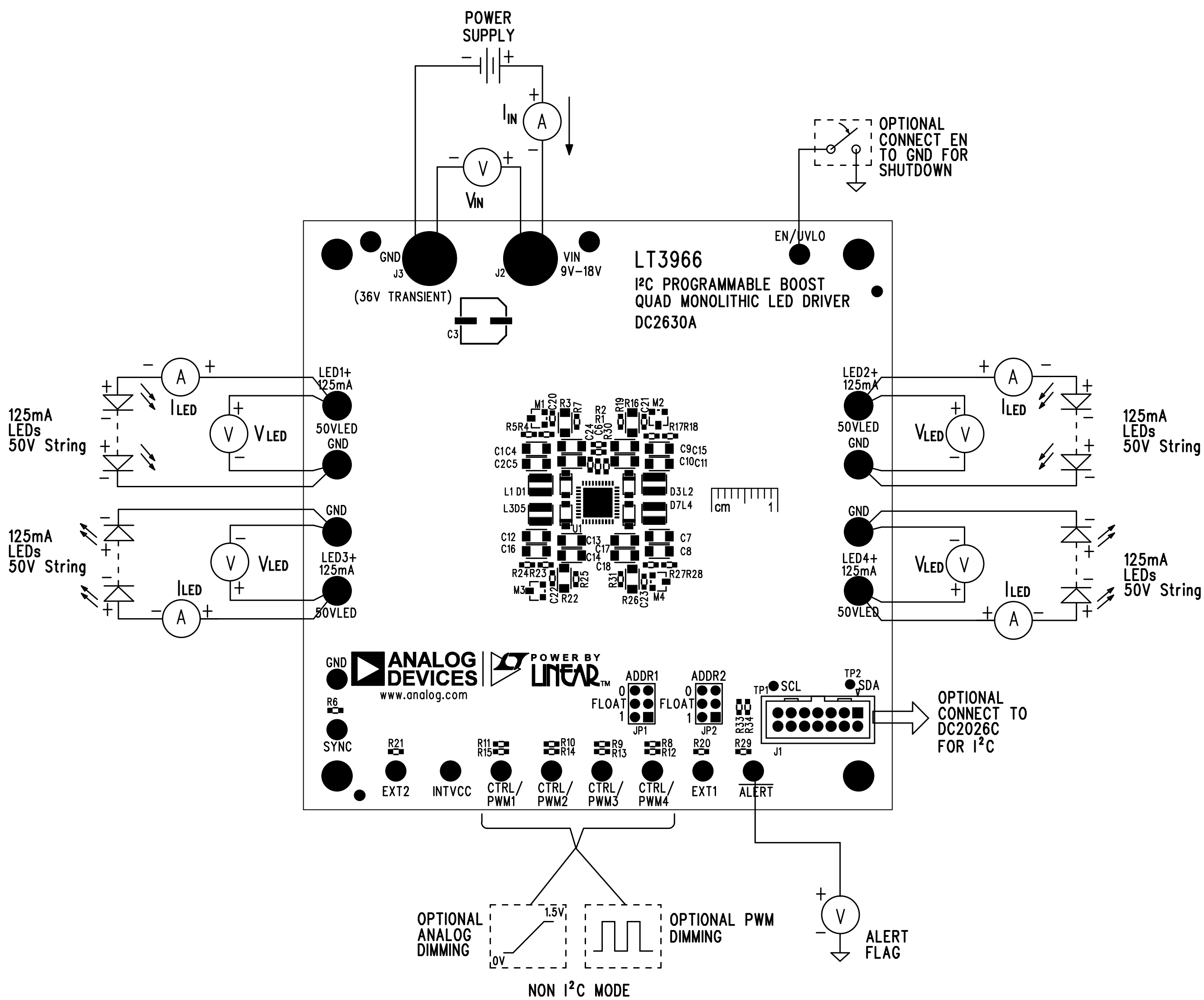


Figure 1. Test Setup Drawing for DC2630A

TEST RESULTS

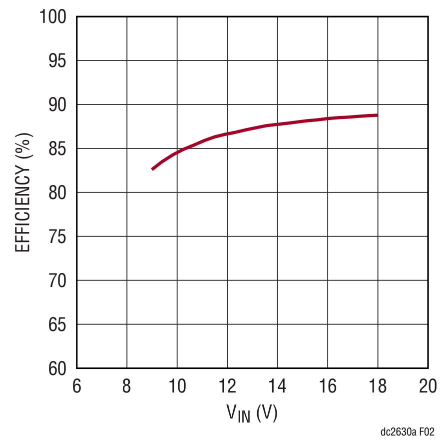


Figure 2. DC2630A Input Voltage vs Efficiency – 4× Channels Powering 16 White LEDs Per Channel at 125mA

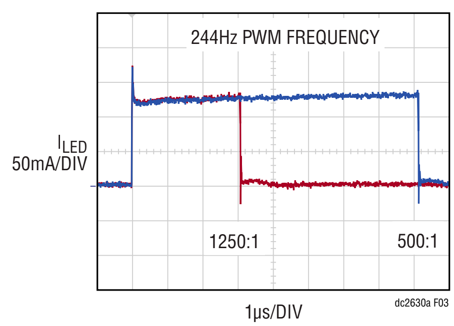
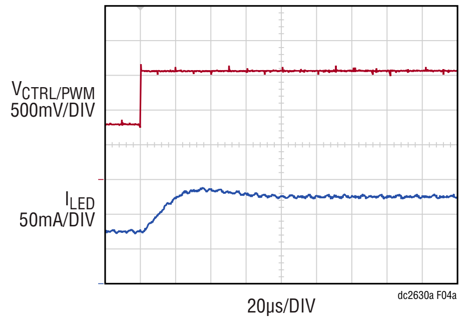
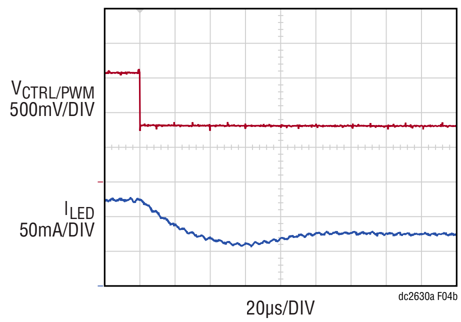


Figure 3. DC2630A PWM Dimming Using I^2C Settings for 1250:1 and 500:1 Dimming Ratios

TEST RESULTS



(a) 50% to 100%



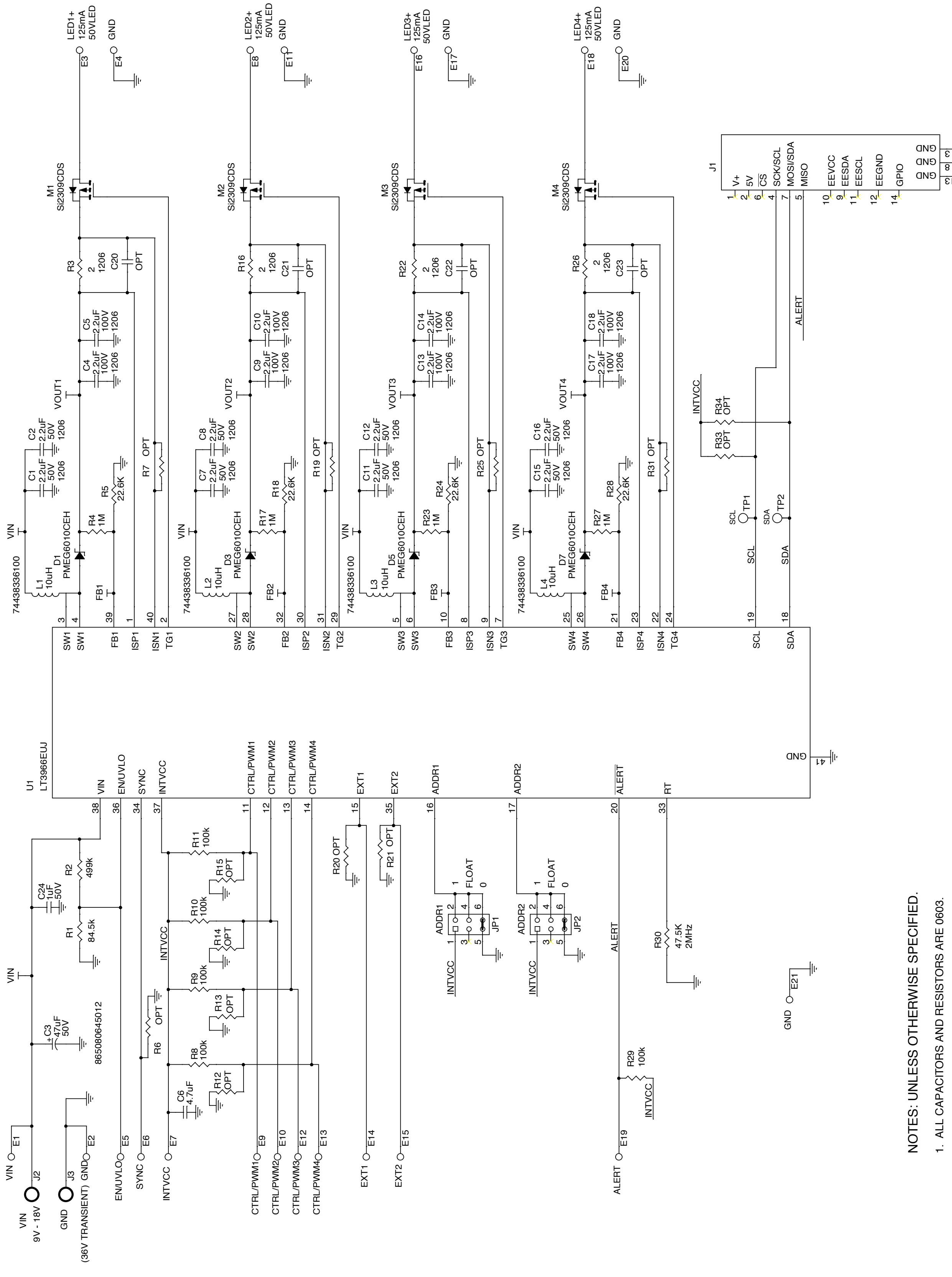
(b) 100% to 50%

Figure 4. DC2630A Load Transient Response

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	8	C1, C2, C7, C8, C11, C12, C15, C16	CAP., X7R, 2.2µF, 50V, 10% 1206	AVX, 12065C225KAT2A
2	8	C4, C5, C9, C10, C13, C14, C17, C18	CAP., X7R, 2.2µF, 100V, 10% 1206	AVX, 12061C225KAT4A
3	1	C6	CAP., X5R, 4.7µF, 16V, 10% 0603	MURATA, GRM188R61C475KAAJD
4	1	C24	CAP., X7R, 1.0µF, 50V, 10% 0603	TAIYO YUDEN, UMK107AB7105KA-T
5	4	D1, D3, D5, D7	SCHOTTKY DIODES, PMEG6010CEH, SOD-123	NXP, PMEG6010CEH
6	4	L1, L2, L3, L4	IND., 10µH	WURTH ELEKTRONIK, 74438336100
7	4	R3, R16, R22, R26	RES., 2Ω, 1/2W, 1% 1206	SUSUMU, RL1632R-2R00-F
8	4	R4, R17, R23, R27	RES., 1M, 1/10W, 1% 0603	VISHAY, CRCW06031M00FKEA
9	4	R5, R18, R24, R28	RES., 22.6k, 1/10W, 1% 0603	VISHAY, CRCW060322K6FKEA
10	1	R30	RES., 47.5k, 1/10W, 1% 0603	VISHAY, CRCW060347K5FKEA
11	1	U1	IC., LT3966, QFN-40, 6mm × 6mm	ANALOG DEVICES., LT3966EUJ#PBF
Additional Demo Board Components				
1	1	C3	CAP., ALUM., 47µF, 50V, 6.3×7.7 SIZE	WURTH ELEKTRONIK, 865080645012
2	0	C20–C23(OPT)	CAP., OPTION, 0603	
3	4	M1, M2, M3, M4	P-MOSFET, 60V, SOT-23	VISHAY, Si2309CDS-T1-GE3
4	1	R1	RES., 84.5k, 1/10W, 1% 0603	VISHAY, CRCW060384K5FKEA
5	1	R2	RES., 499k, 1/10W, 1% 0603	VISHAY, CRCW0603499KFKEA
6	0	R6, R7, R12, R13, R14, R15, R19, R20, R21, R25, R31, R33, R34	RES., OPTION, 0603	
7	5	R8, R9, R10, R11, R29	RES., 100k, 1/10W, 1% 0603	VISHAY, CRCW0603100KFKEA
Hardware: For Demo Board Only				
1	8	E3, E4, E8, E11, E16, E17, E18, E20	TESTPOINT, TURRET, .094" PBF	MILL-MAX, 2501-2-00-80-00-00-07-0
2	13	E1, E2, E5, E6, E7, E9, E10, E12, E13, E14, E15, E19, E21	TESTPOINT, TURRET, .061" PBF	MILL-MAX, 2308-2-00-80-00-00-07-0
3	2	JP1, JP2	HEADER 3-PIN 0.079 DOUBLE ROW	WURTH ELEKTRONIK, 62000621121
4	2	XJP1 ,XJP2	SHUNT, .079" CENTER	WURTH ELEKTRONIK, 60800213421
5	1	J1	HEADER, 2×7 DUAL ROW	MOLEX, 87831-1420
6	2	J2, J3	JACK BANANA	KEYSTONE, 575-4
7	4	MH1–MH4	STAND-OFF, NYLON 6.4mm	WURTH ELEKTRONIK, 702931000

SCHEMATIC DIAGRAM



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.