

LTM4658

Low  $V_{IN}$ , High Efficiency 10A Step-Down DC/DC  $\mu$ Module Regulator

**DESCRIPTION**

Demonstration circuit 2861A features the LTM®4658, a high efficiency, 10A step-down power  $\mu$ Module® regulator. The input voltage range is from 2.25V to 5.5V. The output voltage range is 0.5V to  $V_{IN}$ . Derating may be necessary for certain  $V_{IN}$ ,  $V_{OUT}$ , frequency and thermal conditions. The DC2861A offers the SSTT pin allowing the user to program output tracking, soft-start period and die temperature monitoring.

The MODE/SYNC pin either synchronizes the switching frequency to an external clock, is a clock output, or sets the PWM mode. It can be externally synchronized to a clock from 1MHz to 2.25MHz. The PWM modes of operation are forced continues mode for low noise or pulse-skipping (PS) mode for high efficiency at light load. The LTM4658 defaults to forced continues mode during synchronization. The LTM4658 operates in pulse-skipping

mode when both the FREQ and MODE/SYNC pins are connected to  $V_{IN}$ .

LTM4658 has internal compensation circuit which guarantees sufficient stability margins and good transient performance with a wide range of output capacitors, even with all ceramic output capacitors.

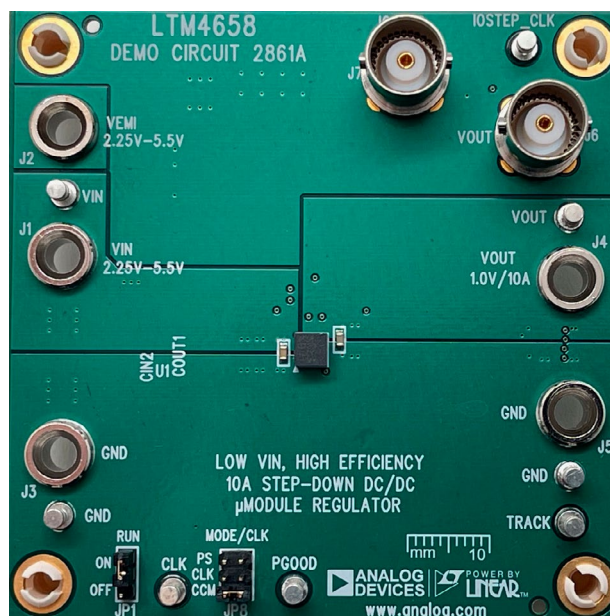
For output loads that demand more than 10A of current, multiple LTM4658s can be paralleled to run out of phase to provide more output current without increasing input and output voltage ripples.

The LTM4658 data sheet must be read in conjunction with this demo manual prior to working on or modifying demo circuit DC2861A.

**Design files for this circuit board are available.**

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**BOARD PHOTO**



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

PARAMETER	CONDITIONS/NOTES	MIN	TYP	MAX	UNITS
Input Voltage Range		2.25		5.5	V
Output Voltage		0.985	1.0	1.015	V
Maximum Continuous Output Current	Derating is Necessary for Certain Operating Conditions. See Data Sheet for Details.		10		ADC
Operating Frequency			2		MHz
Efficiency	$V_{IN} = 3.3\text{V}$ , $V_{OUT} = 1.0\text{V}$ , $I_{OUT} = 10\text{A}$		84.56 (See Figure 2)		%
Load Transient	$V_{IN} = 3.3\text{V}$ , $V_{OUT} = 1.0\text{V}$ , $I_{STEP} = 0\text{A}$ to $5\text{A}$		124 (See Figure 5)		mV

## QUICK START PROCEDURE

Demonstration circuit 2861A is an easy way to evaluate the performance of the LTM4658. Please refer to Figure 1 for proper measurement equipment setup and follow the procedure below:

- Place jumpers in the following positions for a typical application:

RUN	MODE/CLK
ON	CCM

- With power off, connect the input power supply, load and meters as shown in Figure 1. Preset the load to 0A and  $V_{IN}$  supply to 3.3V.
- Turn on the power supply at the input. The output voltage should be  $1.0\text{V} \pm 1.5\%$  (0.985V to 1.015V).
- Vary the input voltage from 2.25V to 5.5V and adjust the load current from 0A to 10A. Observe the output voltage regulation, ripple voltage, efficiency, and other parameters.
- (Optional) To set LTM4658 to pulse-skipping mode, not only the MODE pin jumper needs to be put on "PS", but also FREQ pin needs to be connected to  $V_{IN}$ . See Table 1.

**Table 1. LTM4658 Single Phase Configuration**

FREQ PIN CONNECTION	MODE/SYNC PIN CONNECTION	MODE OF OPERATION	SWITCHING FREQUENCY
$V_{IN}$	Clock Input	Forced Continuous	External Clock
$V_{IN}$	AGND	Forced Continuous	2MHz Default
$V_{IN}$	$V_{IN}$	Pulse-Skip	2MHz Default
Resistor to AGND	Clock Output	Forced Continuous	$f_{FREQ}$ Programmed

- (Optional) For optional load transient test, apply an adjustable pulse signal between IOSTEP\_CLK and GND test points. The pulse amplitude sets the load step current amplitude. Keep the pulse width short (<1ms) and pulse duty cycle low (<5%) to limit the thermal stress on the load transient circuit.
- (Optional) LTM4658 can be synchronized to an external clock signal. Place the JP8 jumper on CLK and apply a clock signal on the CLK test point.
- (Optional) The output of LTM4658 can track another voltage. This external voltage can be connected to the test point TRACK on this board.

**QUICK START PROCEDURE**

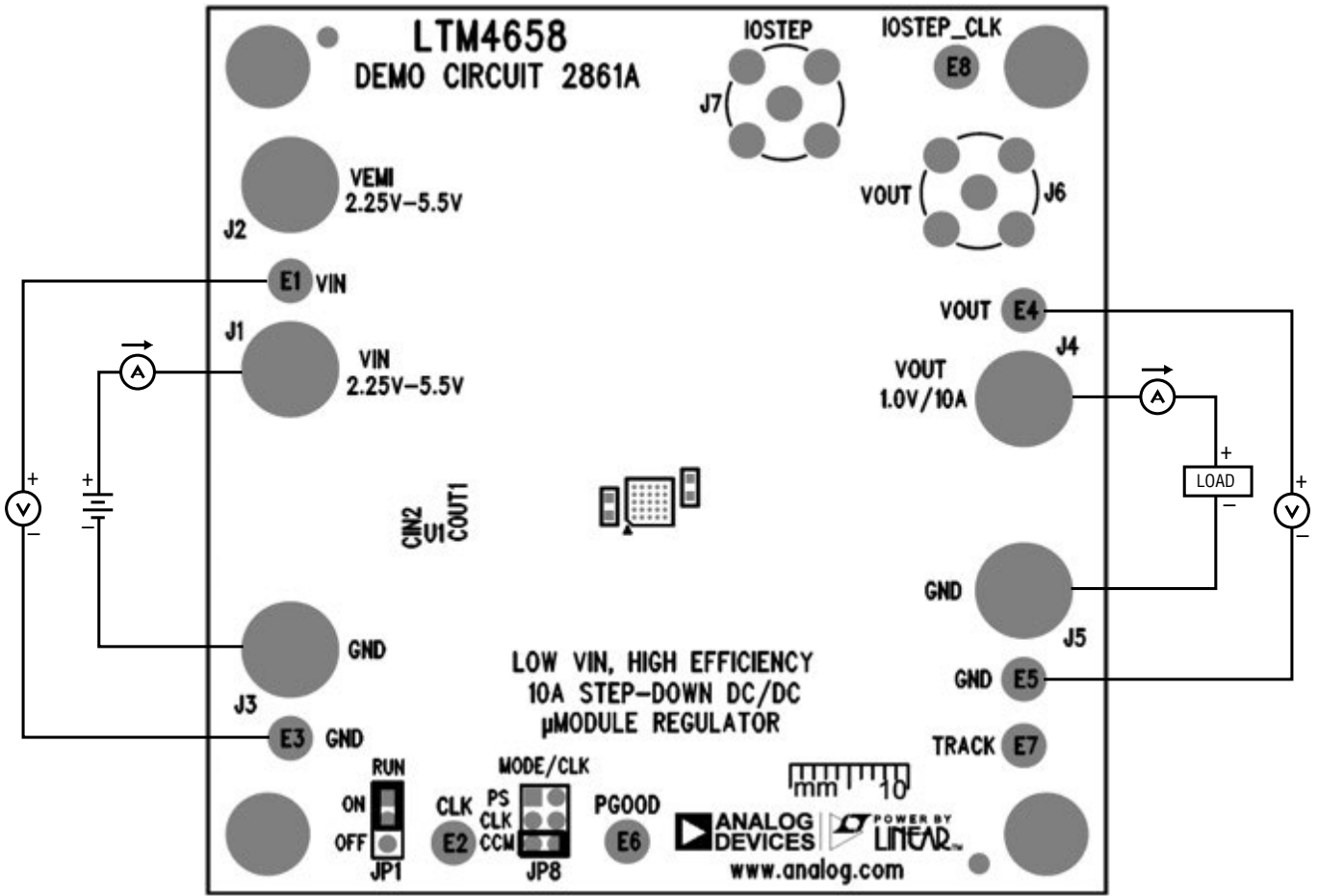


Figure 1. Measurement Setup of DC2861A

## QUICK START PROCEDURE

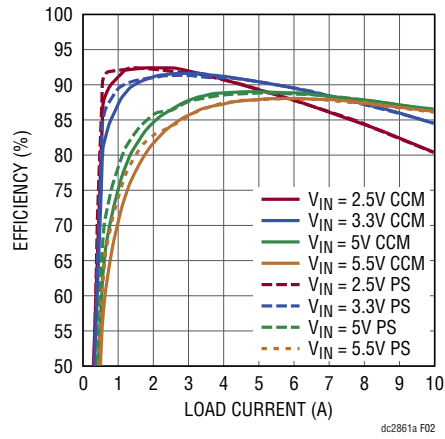


Figure 2. Measured Efficiency at  $f_{SW} = 2\text{MHz}$

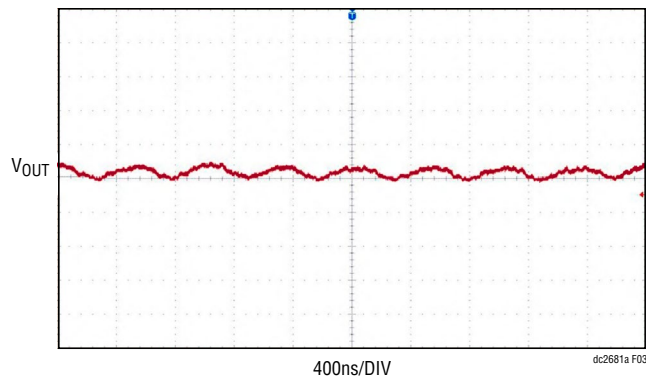


Figure 3. Output Voltage Ripple at  $V_{IN} = 3.3\text{V}$ ,  $V_{OUT} = 1.0\text{V}$ ,  $I_{OUT} = 0\text{A}$

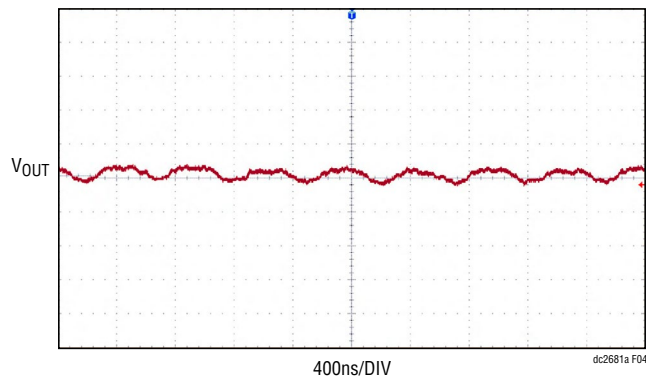


Figure 4. Output Voltage Ripple at  $V_{IN} = 3.3\text{V}$ ,  $V_{OUT} = 1.0\text{V}$ ,  $I_{OUT} = 10\text{A}$

## QUICK START PROCEDURE

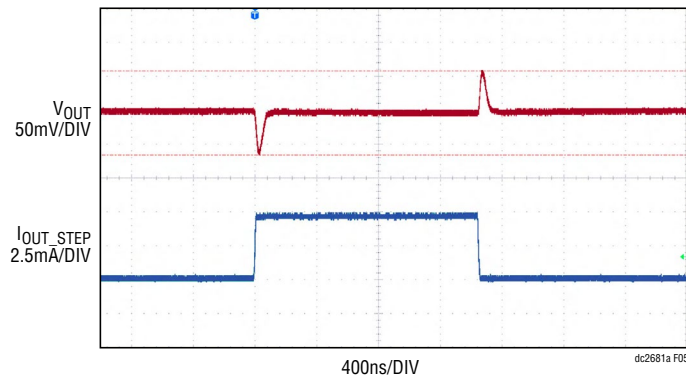


Figure 5. Load Transient at  $V_{IN} = 3.3V$ ,  $V_{OUT} = 1.0V$ ,  $I_{OUT\_STEP} = 0A$  to  $5A$

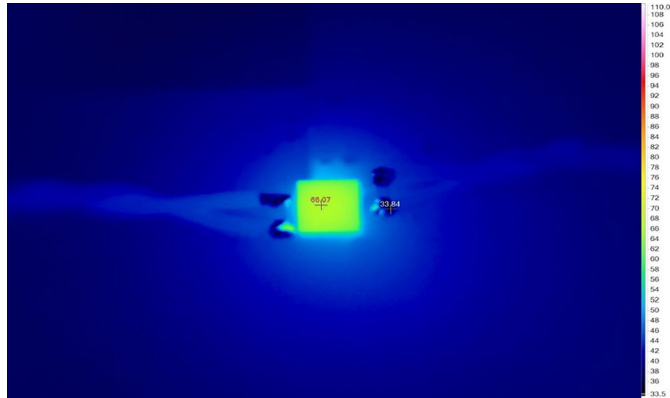


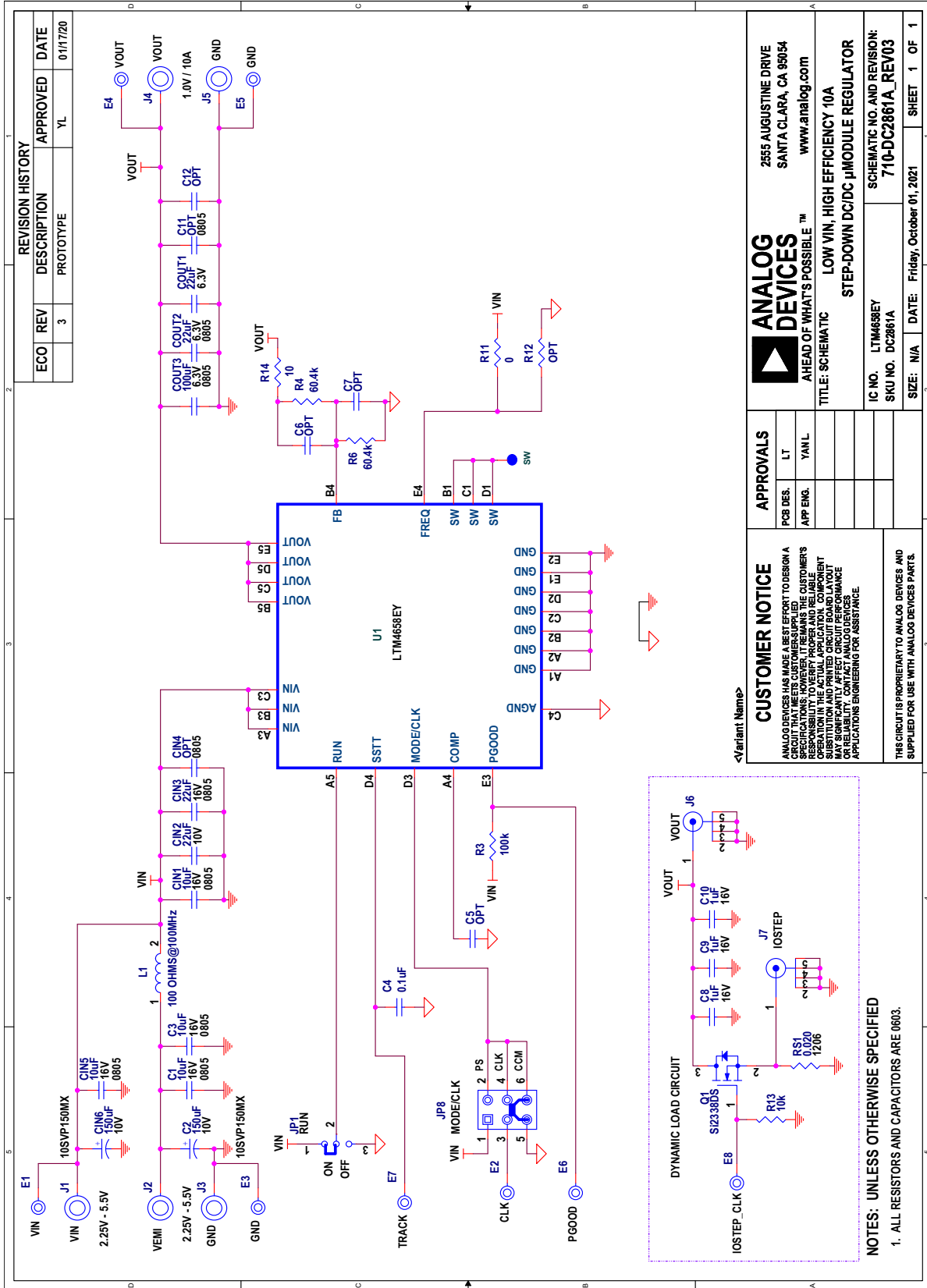
Figure 6. Thermal Image of LTM4658 at  $V_{IN} = 3.3V$ ,  $V_{OUT} = 1.0V$ ,  $I_{OUT} = 10A$  ( $T_A = 25^{\circ}C$ , No Forced Airflow)

# DEMO MANUAL DC2861A

## PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
<b>Required Circuit Components</b>				
1	4	C1, C3, CIN1, CIN5	CAP., 10 $\mu$ F, X7R, 16V, 10%, 0805	TAIYO YUDEN, EMK212BB7106MG
2	2	C2, CIN6	CAP., 150 $\mu$ F, ALUM POLY, OS-CON, 10V, 20%, 8mm x 6.9mm	PANASONIC, 10SVP150MX
3	1	C4	CAP., 0.1 $\mu$ F, X7R, 6.3V, 10%, 0603	AVX, 06036C104KAT2A
4	1	CIN2	CAP., 22 $\mu$ F, X5R, 10V, 20%, 0603	AVX, 0603ZD226MAT2A
5	1	CIN3	CAP., 22 $\mu$ F, X5R, 16V, 10%, 0805	TDK, C2012X5R1C226K125AC
6	1	COUT1	CAP., 22 $\mu$ F, X5R, 6.3V, 20%, 0603	MURATA, GRM188R60J226MEA0D
7	1	COUT2	CAP., 22 $\mu$ F, X5R, 6.3V, 20%, 0805	KEMET, C0805C226M9PACTU
8	1	COUT3	CAP., 100 $\mu$ F, X5R, 6.3V, 20%, 0805	MURATA, GRM21BR60J107ME15K
9	1	R3	RES., 100k, 1%, 1/10W, 0603	STACKPOLE ELECTRONICS, INC., RMCF0603FG100K
10	2	R4, R6	RES., 60.4k, 1%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW060360K4FKEA
11	1	R11	RES., 0 $\Omega$ , 1/10W, 0603, AEC-Q200	VISHAY, CRCW06030000Z0EAHP
12	1	U1	IC, 5.5V <sub>IN</sub> , 10A $\mu$ Module in 4mm x 4mm PACKAGE, BGA	ANALOG DEVICES, LTM4658EY#PBF
<b>Additional Demo Board Circuit Components</b>				
1	0	C5, C6, C7, C12	CAP., OPTION, 0603	
2	0	C11, CIN4	CAP., OPTION, 0805	
3	1	L1	IND., 100 $\Omega$ AT 100MHz, FERRITE BEAD, 25%, 8A, 6m $\Omega$ , 1812	WURTH ELEKTRONIK, 74279226101
4	1	Q1	XSTR., MOSFET, N-CH, 30V, 5.5A, SOT-23-3	VISHAY, Si2338DS-T1-GE3
5	0	R12	RES., OPTION, 0603	
6	3	C8, C9, C10	CAP., 1 $\mu$ F, X7R, 16V, 10%, 0603	KEMET, C0603C105K4RAC7867
7	1	R13	RES., 10k, 1%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW060310K0FKEA
8	1	R14	RES., 10 $\Omega$ , 1%, 1/10W, 0603	VISHAY, CRCW060310R0FKEA
9	1	RS1	RES., 0.02 $\Omega$ , 1%, 1W, 1206, PWR, METAL, SENSE, AEC-Q200	VISHAY, WSLP1206R0200FEA
<b>Hardware: For Demo Board Only</b>				
1	8	E1, E2, E3, E4, E5, E6, E7, E8	TEST POINT, TURRET, 0.094" MTG. HOLE, PCB 0.062" THK	MILL-MAX, 2501-2-00-80-00-00-07-0
2	5	J1, J2, J3, J4, J5	CONN., BANANA JACK, FEMALE, THT, NON-INSULATED, SWAGE, 0.218"	KEYSTONE, 575-4
3	2	J6, J7	CONN., RF, BNC, RCPT, JACK, 5-PIN, ST, THT, 50 $\Omega$	AMPHENOL RF, 112404
4	1	JP1	CONN., HDR, MALE, 1x3, 2mm, VERT, ST, THT, NO SUBS. ALLOWED	WURTH ELEKTRONIK, 62000311121
5	1	JP8	CONN., HDR, MALE, 2x3, 2mm, VERT, ST, THT	WURTH ELEKTRONIK, 62000621121
6	4	MP1, MP2, MP3, MP4	STANDOFF, NYLON, SNAP-ON, 0.50"	KEYSTONE, 8833
7	2	XJP1, XJP8	CONN., SHUNT, FEMALE, 2-POS, 2mm	WURTH ELEKTRONIK, 60800213421

**SCHEMATIC DIAGRAM**



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## 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.

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