LT8638S
42V, 10A Synchronous Step-Down Silent Switcher 2

DESCRIPTION

Demonstration circuit 2929A is a 42V, 10A (12A peak) synchronous step-down Silent Switcher 2 with spread spectrum frequency modulation featuring the LT®8638S. The demo board is designed for 3.3V output from a 3.9V to 42V input. The wide input range allows a variety of input sources, such as automotive batteries and industrial supplies. The LT8638S is a compact, ultralow emission, high efficiency, and high speed synchronous monolithic step-down switching regulator. The integrated bypass capacitors optimize the fast current loops and make it easier to minimize EMI emissions by reducing layout sensitivity. Selectable spread spectrum mode further improves EMI performance, making it perfect solution to the noise sensitive applications.

Peak current mode control with minimum on-time of as small as 25ns allows high step-down conversion even at high frequency. The LT8638S switching frequency can be programmed either via oscillator resistor or external clock over a 200kHz to 3MHz range. The default frequency of demo circuit 2929A is 2MHz.

The SYNC/MODE pin on the demo board DC2929A is grounded (JP1 at BURST position) by default for low ripple Burst Mode® operation. It can be configured into different operation modes through JP1 and SYNC terminal (Table 1).

Figure 1 shows the efficiency of the circuit at 12V input and 24V input in BURST mode. To get accurate efficiency measurement, measure the input voltage at the VIN SENSE terminal and measure the output voltage at the VO SENSE terminal.

Figure 2 shows the LT8638S temperature rise on DC2929A demo board at 12V input and 24V input in BURST mode, with continuous load current. LT8638S can deliver 12A of peak output current for short periods of time. Figure 3 shows its case temperature rise vs the duty cycle of a 1kHz pulsed 12A load. The LT8638S is in a 5mmx4mm LQFN package with exposed pads for low thermal resistance. The rated maximum continuous load current is 10A, while derating may be necessary for certain input voltage and thermal conditions.

Table 1. Operation Mode Configuration

JP1 POSITION	SYNC (E5) INPUT	OPERATION MODE
SPREAD-SPECTRUM	N/A	Forced Continuous Mode w/ Spread-Spectrum
BURST	N/A	Low Ripple Burst Mode®
FCM/SYNC	Floating	Forced Continuous Mode w/o Spread-Spectrum
FCM/SYNC	External Clock	Forced Continuous Mode w/ Synchronization

The demo board has an EMI filter installed. The EMI performance of the board is shown in Figure 4. The red lines in EMI Performance are CISPR25 Class 5 limits. The figure shows that the circuit passes the test with a wide margin. To achieve EMI performance as shown in Figure 4, the input EMI filter is required and the input voltage should be applied to VIN_EMI terminal, and the test setup can be referred to the CISPR25 standards. If the input is applied to VIN terminal, the EMI filter is bypassed.

The LT8638S datasheet gives a complete description of the part, the operation and application information. The datasheet must be read in conjunction with this demo manual for demo circuit 2929A. The layout recommendations for low EMI operation and maximum thermal performance are available in the datasheet section Low EMI PCB Layout and Thermal Considerations and Peak Output Current. Contact ADI applications engineer for support.

Design files for this circuit board are available.

PERFORMANCE SUMMARY

Specifications are at T_A = 25°C

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	Input Supply Range		3.9		42	V
V_{OUT}	Output Voltage	V_{IN} = 12V	3.23	3.3	3.37	V
I_{OUT}	Maximum Continuous Output Current	Derating is Necessary for Certain V_{IN}	10			A
f_{SW}	Switching Frequency		1.85	2	2.15	MHz
EFF	Efficiency	V_{IN} = 12V, V_{OUT} = 3.3V, I_{OUT} = 5A		92.3		%

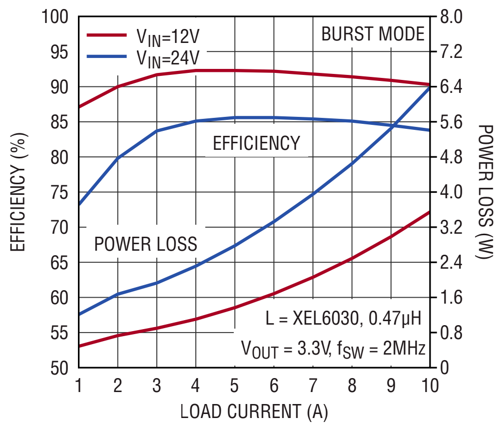


Figure 1. LT8638S Demo Circuit DC2929A Efficiency vs Load Current

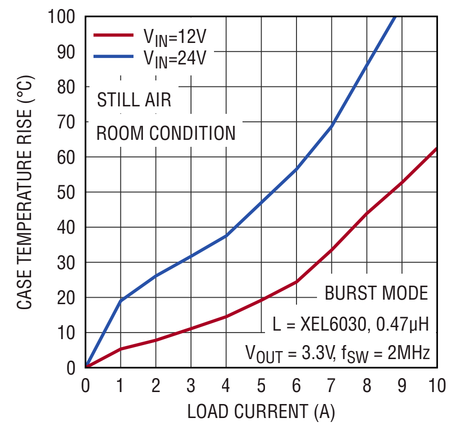


Figure 2. LT8638S Demo Circuit DC2929A Case Temperature Rise vs Load Current

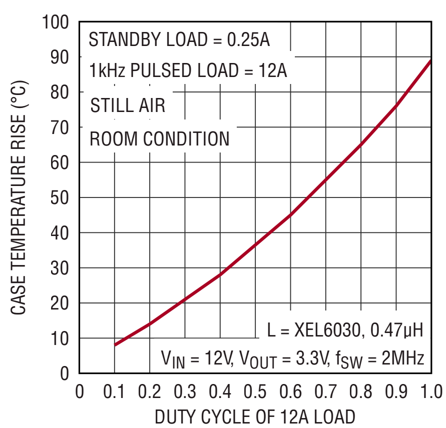
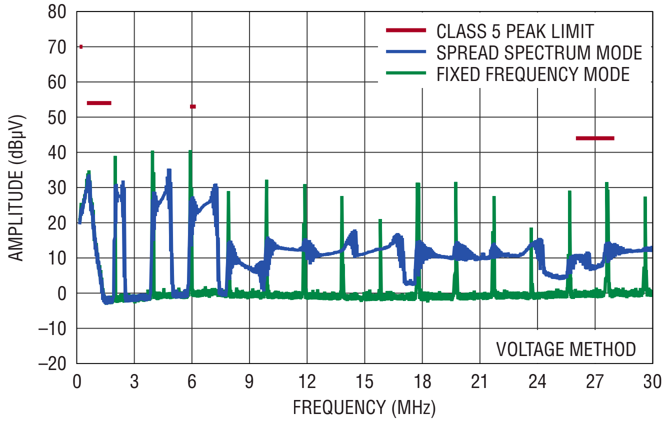


Figure 3. LT8638S Demo Circuit DC2929A Case Temperature Rise vs Duty Cycle of 12A Pulsed Load Current

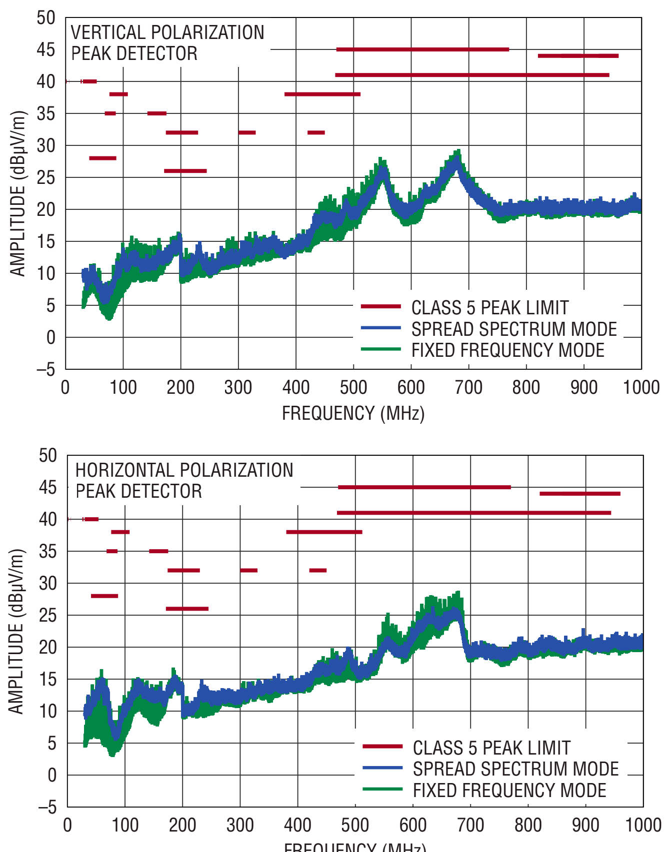
PERFORMANCE SUMMARY

Specifications are at T_A = 25°C

Conducted EMI Performance
(CISPR25 Conducted Emission Test with Class 5 Peak Limits)



Radiated EMI Performance
(CISPR25 Radiated Emission Test with Class 5 Peak Limits)



DC2929A DEMO BOARD
(WITH EMI FILTER INSTALLED)
14V INPUT TO 3.3V OUTPUT AT 10A, f_{SW} = 2MHz

Figure 4. LT8638S Demo Circuit DC2929A EMI Performance

QUICK START PROCEDURE

Demonstration circuit 2929A is easy to set up to evaluate the performance of the LT8638S. Refer to Figure 5 for proper measurement equipment setup and follow the procedure below:

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 output voltage ripple by touching the probe tip directly across the output capacitor. See Figure 6 for the proper scope technique.

1. Make sure the Jump JP1 is on the BURST position. Refer to the schematic.
2. With power off, connect the input power supply to VIN_EMI and GND. If the input EMI filter is not desired, connect the input power supply to VIN and GND.
3. With power off, connect the load from VOUT to GND.
4. Connect the voltage meter across the VIN SENSE and GND for VIN measurement, and VOUT SENSE and GND for VOUT measurement.
5. Turn on the power at the input.

NOTE. Make sure that the input voltage does not exceed 42V.

6. Check for the proper output voltage (VOUT = 3.3V).

NOTE. If there is no output, temporarily disconnect the load to make sure that the load is not set too high or is shorted.

7. Once the proper output voltage is established, adjust the load within the operating ranges and observe the output voltage regulation, ripple voltage, efficiency, and other parameters. For accurate efficiency measurement, use the VIN SENSE and VOUT SENSE accordingly.
8. An external clock can be added to the SYNC terminal when SYNC function is used (JP1 on the FCM/SYNC position). Please make sure that R2 should be chose to set the LT8638S switching frequency equal to or below the lowest SYNC frequency. When JP1 is in FCM/SYNC position and no external clock is connected to the SYNC terminal of the board, the SYNC/MODE pin is floating and the LT8638S runs in forced continuous mode. JP1 can also set LT8638S in spread spectrum mode (JP1 on the SPREAD-SPECTRUM position).
9. To test the transient response, connect a signal generator to PULSE GEN terminal, and add a desired base load between VOUT and GND (LOAD shown on Figure 5). Adjust the signal generator with a 2ms period, 5% duty cycle and an amplitude from 1V to 2V to start. Measure the LOAD STEP voltage to observe the current ($I_{LOADSTEP} = V_{LOADSTEP}/100m\Omega$). Adjust the amplitude of the pulse to provide the desired transient. Adjust the rising and falling edge of the pulse to provide the desired ramp rate. Figure 7 shows a load step from 2.5A to 7.5A. The 2.5A base load is added between VOUT and GND, while the 5A step load is controlled by the signal generator at PULSE GEN and measured at LOAD STEP with 0.1V/A ratio.

QUICK START PROCEDURE

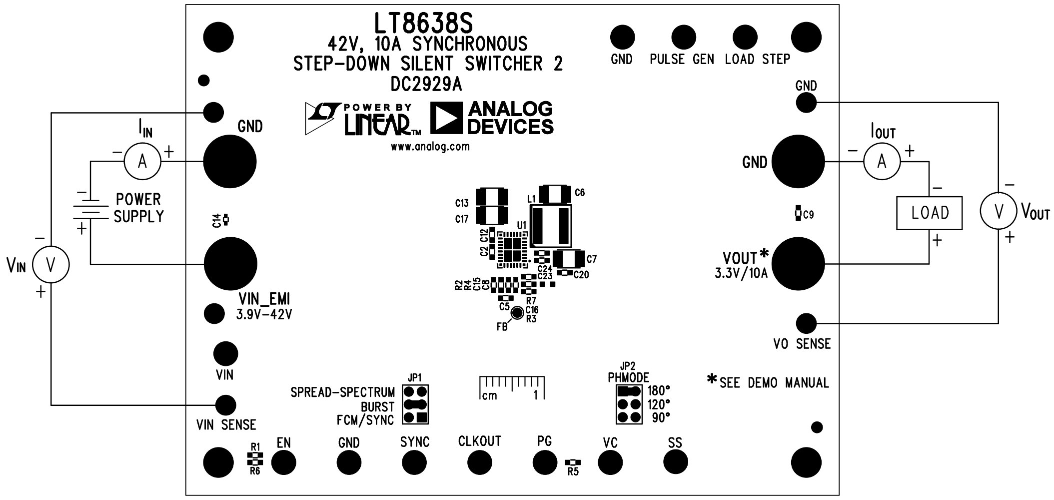


Figure 5. Proper Measurement Equipment Setup

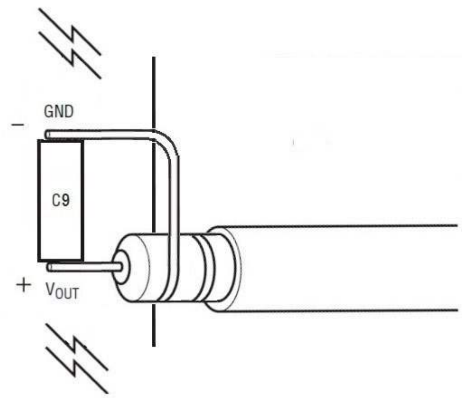


Figure 6. Measuring Output Ripple at Output Capacitor C9

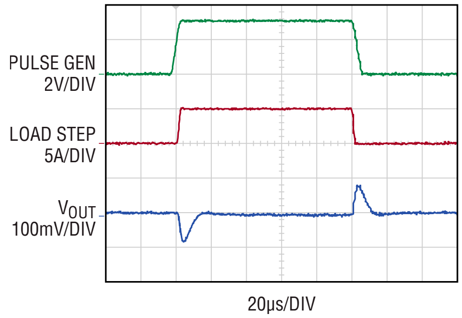
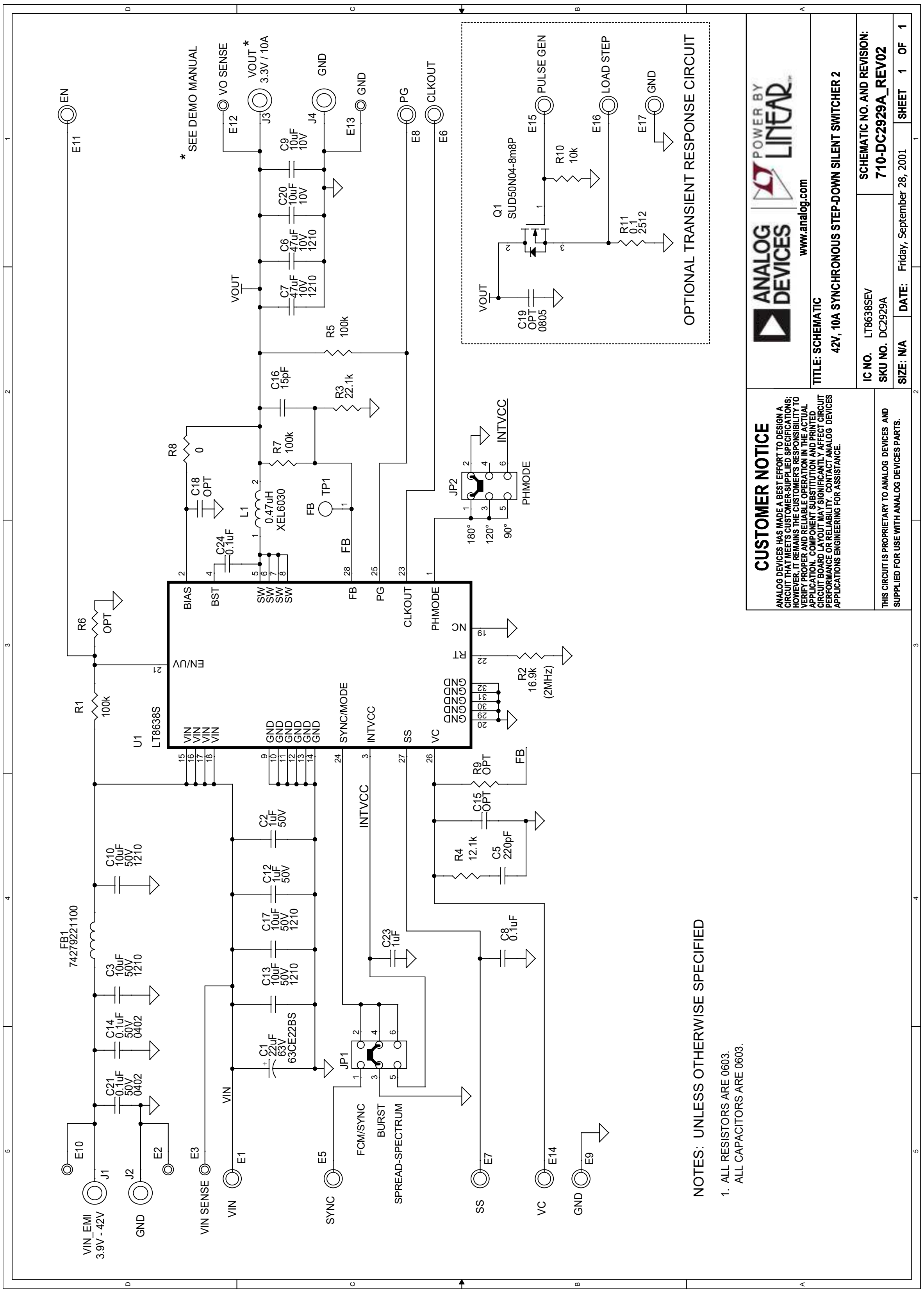


Figure 7. LT8638S Demo Circuit DC2929A Transient Response (V_{IN} = 12V, 2.5A to 7.5A Load Step)

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	3	C2, C12, C23	CAP., 1µF, X5R, 50V, 10%, 0603	AVX, 06035D105KAT2A
2	1	C5	CAP., 220pF, C0G, 50V, 5%, 0603	AVX, 06035A221JAT2A
3	2	C6, C7	CAP., 47µF, X7R, 10V, 10%, 1210	MURATA, GRM32ER71A476KE15L
4	2	C8, C24	CAP., 0.1µF, X7R, 16V, 10%, 0603	AVX, 0603YC104KAT2A
5	2	C9, C20	CAP., 10µF, X5R, 10V, 10%, 0603	MURATA, GRM188R61A106KAALD
6	2	C13, C17	CAP., 10µF, X7R, 50V, 10%, 1210	MURATA, GRM32ER71H106KA12L
7	1	C16	CAP., 15pF, C0G, 25V, 5%, 0603	AVX, 06033A150JAT2A
8	1	L1	IND., 0.47µH, PWR, 20%, 22.3A, 3.31mOHMS, 6.56mm x 6.36mm	COILCRAFT, XEL6030-471MEB
9	3	R1, R5, R7	RES., 100k OHMS, 1%, 1/10W, 0603	VISHAY, CRCW0603100KFKEA
10	1	R2	RES., 16.9k OHMS, 1%, 1/10W, 0603	VISHAY, CRCW060316K9FKEA
11	1	R3	RES., 22.1k OHMS, 1%, 1/10W, 0603	VISHAY, CRCW060322K1FKEA
12	1	R4	RES., 12.1k OHMS, 1%, 1/10W, 0603	VISHAY, CRCW060312K1FKEA
13	1	U1	IC, STEP-DOWN REG., LQFN-28	ANALOG DEVICES., LT8638SEV#PBF
Additional Demo Board Circuit Components				
1	1	C1	CAP., 22uF, ALUM. ELECT., 63V, 20%, 6.3x7.7mm, CE-BS	SUN ELECTRONIC INDUSTRIES CORP, 63CE22BS
2	2	C3, C10	CAP., 10uF, X7R, 50V, 10%, 1210	MURATA, GRM32ER71H106KA12L
3	2	C14, C21	CAP., 0.1uF, X7R, 50V, 10%, 0402	MURATA, GRM155R71H104KE14D
4	0	C15, C18 (OPT)	CAP., OPTION, 0603	
5	0	C19 (OPT)	CAP., OPTION, 0805	
6	1	FB1	IND., 10 Ohms@100MHz, FERRITE BEAD, 25%, 10.5A, 3mOHM, 1206	WURTH ELEKTRONIK, 74279221100
7	1	Q1	XSTR., MOSFET, N-CH, 40V, 14A, DPAK (TO-252)	VISHAY, SUD50N04-8M8P-4GE3
8	0	R6, R9 (OPT)	RES., OPTION, 0603	
9	1	R8	RES., 0 OHM, 1/10W, 0603	VISHAY, CRCW06030000Z0EA
10	1	R10	RES., 10k OHMS, 1%, 1/10W, 0603	VISHAY, CRCW060310K0FKEA
11	1	R11	RES., 0.1 OHMS, +/-1%, 1W, 2512, SHORT-SIDE TEMINAL	SUSUMU, KRL3264-C-R100-F-T1
Hardware: For Demo Board Only				
1	11	E1, E5-E9, E11, E14-E17	TEST POINT, TURRET, 0.094" MTG. HOLE, PCB 0.062" THICK	MILL-MAX, 2501-2-00-80-00-00-07-0
2	5	E2, E3, E10, E12, E13	TEST POINT, TURRET, 0.064" MTG. HOLE, PCB 0.062" THICK	MILL-MAX, 2308-2-00-80-00-00-07-0
3	2	JP1, JP2	CONN., HDR, MALE, 2x3, 2mm, VERT, STR, THT	WURTH ELEKTRONIK, 62000621121
4	4	J1-J4	CONN., BANANA JACK, FEMALE, THT, NON-INSULATED, SWAGE, 0.218"	KEYSTONE, 575-4
5	4	MH1-MH4	STANDOFF, NYLON, SNAP-ON, 0.50"	WURTH ELEKTRONIK, 702935000
6	2	XJP1, XJP2	CONN., SHUNT, FEMALE, 2 POS, 2mm	WURTH ELEKTRONIK, 60800213421

SCHEMATIC DIAGRAM



Rev. 0

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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