

MAXIM

MAX2003A Evaluation Kit

Evaluates: MAX2003/MAX2003A

General Description

The MAX2003A evaluation kit (EV kit) is a fast charger and conditioner for NiCd (nickel cadmium) or NiMH (nickel-metal hydride) rechargeable batteries. It is configured as a switch-mode current regulator, so power dissipation is reduced compared to linear-regulator solutions. The MAX2003A IC controls a P-channel power MOSFET switch, allowing fast-charge currents up to 2A. Fast-charge termination can be accomplished by five methods: rate-of-charge of temperature, negative delta voltage, maximum voltage, maximum time, and maximum temperature.

The MAX2003A EV kit is a fully assembled and tested surface-mount printed circuit board.

Features

- ♦ **Complete NiCd or NiMH Fast Charger**
- ♦ **New Pulsed Trickle-Charge Mode (MAX2003A only)**
- ♦ **Switch-Mode Operation**
- ♦ **Up to 2A Charge Current**
- ♦ **Charges 2 to 12 NiCd or NiMH Cells**
- ♦ **Discharge-Before-Charge Switch**
- ♦ **Automatic Switchover from Fast-Charge to Pulsed Trickle/Top-Off Charge**
- ♦ **Status LEDs**
- ♦ **Surface-Mount Components**

Ordering Information

PART	TEMP. RANGE	BOARD TYPE
MAX2003AEVKIT-SO	0°C to +70°C	Surface Mount

Component Suppliers

SUPPLIER	PHONE	FAX
Alpha Thermistor	(619) 549-4660	(619) 549-4791
AVX	(803) 946-0690	(803) 626-3123
Central Semiconductor	(516) 435-1110	(516) 435-1824
Coilcraft	(847) 639-6400	(847) 639-1469
Dale-Vishay	(402) 564-3131	(402) 563-6418
International Rectifier	(310) 322-3331	(310) 322-3332
Motorola	(602) 303-5454	(602) 994-6430
Nihon	(805) 867-2555	(805) 867-2698
Sanyo	(619) 661-6835	(619) 661-1055
Siliconix	(408) 988-8000	(408) 970-3950

Quick Start

The MAX2003A EV kit is a fully assembled and tested surface-mount board. Follow the steps below to verify board operation. **Do not turn on the power supply until all connections are completed.**

- 1) Set the number of cells in the battery pack being charged by placing the shunt across J4 pins (pins 4 and 13), as shown by the silkscreen on the board. The EV kit is shipped configured for six cells and 2A of charge current. Check that jumpers JU1, JU2, and JU3 are configured as shown in Tables 1 and 2.
- 2) Connect the input power source (6.5V to 28V) to the 2-pin power connector J1. The input supply must be 1V greater than the maximum battery charging voltage, and capable of providing the fast-charge current; otherwise, capacitor C13 will completely charge to V_{IN} and terminate the charge cycle.
- 3) Connect the battery to the 2-pin power connector J2. Observe the polarity markings.
- 4) Turn on the power supply to the board and use a voltmeter to confirm the voltage across the battery and the sense resistor.

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Component List

DESIGNATION	QTY	DESCRIPTION
C1, C4	2	22 μ F, 10V aluminum electrolytic capacitors Sanyo 10CV22GX
C2, C3	2	0.22 μ F, 50V ceramic capacitors
C5, C7, C8, C9, C11, C12	6	0.1 μ F, 50V ceramic capacitors
C6, C14	2	47 μ F, 35V aluminum electrolytic capacitors Sanyo 35CV47GX
C10	1	1000pF ceramic capacitor
C13	1	1 μ F, 25V ceramic capacitors
D1	1	100mA, 30V diode Central Semiconductor CMPSH-3
D2	1	Dual LEDs Digi-Key P507CT-ND or Panasonic LN2162C13
D4	1	1A, 30V Schottky diode Nihon EC10QS03 or Motorola MBRS130T3
D5	1	12V zener diode Central Semiconductor CMPZ5242B or Motorola MMBZ5242B
D3, D6	2	3A, 40V Schottky diodes Nihon NSQ03A04 or Motorola MBRS340T3
R1	1	63.4k Ω , 1%, 1/8W resistor
R2	1	3.48k Ω , 1%, 1/8W resistor
R3	1	33.2k Ω , 1%, 1/8W resistor
R4, R8, R9	3	1k Ω , 5%, 1/8W resistors
R5, R6, R19	3	100k Ω , 5%, 1/8W resistors
R7, R11	2	10k Ω , 5%, 1/8W resistors
R22	1	0.120 Ω , 1%, 1W resistor Dale WSL-2512-R120-F
R12, R21	2	200k Ω , 1%, 1/8W resistors
R13	1	18.2k Ω , 1%, 1/8W resistor
R14	1	24.9k Ω , 1%, 1/8W resistor
R15	1	28.7k Ω , 1%, 1/8W resistor

DESIGNATION	QTY	DESCRIPTION
R16	1	40.2k Ω , 1%, 1/8W resistor
R17	1	49.9k Ω , 1%, 1/8W resistor
R18	1	66.5k Ω , 1%, 1/8W resistor
R20	1	100k Ω , 1%, 1/8W resistor
R23	1	243 Ω , 1%, 1/8W resistor
R24	1	732 Ω , 1%, 1/8W resistor
RT1	1	2.21k Ω , 1%, 1/8W resistor
RT2	1	1.62k Ω , 1%, 1/8W resistor
P1	1	2A, 30V dual P-FET Motorola MMDF2P03HD or Siliconix Si4953DY or International Rectifier IRF7306
N1	1	5A, 30V N-FET Motorola MMSF5N03HD or Siliconix Si9410DY
L1	1	100 μ H, 2.5A inductor Coilcraft DO3340-104
U1	1	MAX2003A IC Maxim MAX2003ACSE
U2	1	Hex inverter 74HC04 National Semiconductor MM74HC04M14A or Texas Instruments SN74HC04D
U3	1	Voltage regulator National Semiconductor LM317LM
Therm	1	Thermistor Alpha Thermistor P1624
J1, J2	2	2-pin term connectors Mouser 506-2MV02
J3	1	3-pin term connector Mouser 506-2MV03
J4	1	16-pin header
JU1, JU2, JU3	3	3-pin headers
SW1	1	Momentary switch Digi-Key P8006/7S
None	4	Shunts
None	1	MAX2003A PC board
None	1	MAX2003A data sheet

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Detailed Description

The MAX2003A EV kit is configured as a switch-mode regulator controlling a P-channel power MOSFET, P1, as shown in Figure 1. When power is applied, the MAX2003A goes into reset mode for approximately 1.5sec, and then samples the CCMD and DCMD pins. Charge status is determined by CCMD and DCMD; refer to the MAX2003A data sheet for detailed information on the operation of these pins. For this EV kit, CCMD and DCMD are grounded so that fast-charge is initiated on power-up after the reset cycle.

When the MAX2003A MOD pin (pin 14) goes high, the power switch (P1) turns on via C13 and U2. Current starts to ramp up linearly through L1, producing a voltage across the sense resistor (R22). This voltage is delivered to the SNS pin (pin 9) via filter network R4 and C10. When the sense voltage reaches $0.050V_{CC}$ (250mV for $V_{CC} = 5V$), MOD goes low and P1 turns off. The voltage across the inductor reverses polarity because of the collapsing magnetic field, causing catch diode D3 to be forward biased and to deliver current from L1 into the battery. The inductor current ramps down linearly until the sense voltage across R22 reaches $0.044V_{CC}$ (220mV for $V_{CC} = 5V$), causing MOD to go high and the cycle to repeat itself.

Selecting the Number of Cells

The number of battery-pack cells is selected by a voltage divider. Refer to the MAX2003A data sheet for information on how to select resistive divider values. Selection of the number of cells in this EV kit is made via J4 (pins 4 and 13). Place the shunt across J4 pins to select the desired number of cells as indicated on the board. This EV kit is shipped configured for six cells.

Negative Delta Voltage Termination

The Negative Delta Voltage Termination ($-\Delta V$) method measures a negative voltage change to determine termination of fast-charge. $-\Delta V$ detection is enabled (DVEN) by placing the shunt across JU1 pins 1 & 2 (DVEN to V_{CC}). This EV kit is shipped with DVEN enabled.

Temperature Rate Termination

The Temperature Rate Termination ($\Delta T/\Delta t$) method terminates fast-charge when a particular rate-of-change of temperature is exceeded. An external Alpha Thermistor

PT1624 (10k Ω at +25°C, negative temperature coefficient) connected between J2 pin 2 (BAT-) and J3 pin 3 (THERM) is provided with this EV kit to monitor temperature. If this method is used for charge termination, make sure the thermistor is in contact with the cells. Refer to the MAX2003/MAX2003A data sheet for information on how to select values for the thermistor resistive divider (RT1, RT2) and temperature-control components. RT1 and RT2 have been selected for the Alpha Thermistor to provide a 1°C/minute termination rate.

Maximum Temperature Termination

The Maximum Temperature Termination method is used as a safety feature and should not be needed under normal operation of the charger. When the thermistor exceeds the maximum temperature limit of the externally set TCO pin ($V_{TCO} = 1.72V$ for $V_{CC} = 5V$ in this EV kit (+50°C)) or the minimum temperature limit of the internally set low-temperature fault ($V_{LTF} = 2.0V$ for $V_{CC} = 5V$ in this EV kit (+10°C)), fast-charge is terminated. In this case, the TEMP pin is driven low and the TEMP fault red LED turns on. Refer to the MAX2003A data sheet for information on how to set the temperature fault limits.

Maximum Voltage Termination

The Maximum Voltage Termination method is another safety feature of the charger. If the cell voltage measured at the BAT pin exceeds that at the MCV pin, fast-charge is terminated. This EV kit has the external resistor divider set to 1.9V ($V_{CC} = 5V$). Refer to the MAX2003A data sheet for information on how to set the maximum cell voltage (MCV).

Maximum Timeout Termination

The Maximum Timeout Termination is another safety feature. The timeout time depends on the charge rate and is set by control signals TM1 and TM2. If the timeout is reached before any other termination method is seen, fast-charge is terminated to protect the battery. Refer to Table 4 in the MAX2003/MAX2003A data sheet for timeout programming information. Control signals TM1 and TM2 are programmed via jumpers JU2 and JU3. This EV kit is shipped configured for a 1C fast-charge rate with a 90 minute timeout and top-off charge enabled.

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Discharge-Before-Charge

Initiate the discharge-before-charge function by activating switch SW1. Once the momentary switch SW1 is activated, a low on-resistance, N-channel power MOSFET turns on, providing a discharge path to the battery. Simply connect an external discharge resistor (R_{DIS}) between J3 pins 1 & 2. The discharge process continues until the per-cell voltage drops below 1V. During the discharge phase, the CHG pin goes low (LED on) for 1.375sec and high (LED off) for 0.125sec. Fast-charging begins as soon as conditions allow. Take extra care not to overheat the battery during discharge. Observe the power rating of R_{DIS} .

Charge Status

Two LED indicators show the MAX2003A's charge status. Table 3 summarizes the different charge-status conditions.

Inductor Selection

The inductor value is not critical to circuit operation. However, the greater its value the lower the output ripple current. The 100 μ H Coilcraft DO3340-104 inductor used on the evaluation board provides low output ripple current (approximately 30% of fast-charge current) and has a 2.5A current rating. Refer to the data sheet for information on how to select inductor value. For lower current (up to 1A) and lower profile applications, use Coilcraft's DO3316-104 inductor (0.215" max height).

Using the MAX2003

The MAX2003A EV kit can also be used to evaluate the MAX2003. Besides replacing the IC, the only other modification is to change the trickle-charge resistor, (R11) to 130 Ω , 2W.

Table 1. Jumper JU1 Settings

SHUNT LOCATION	DVEN PIN STATUS	CHARGER STATUS
JU1 across pins 1 & 2	VCC	DVEN = enabled
JU1 across pins 2 & 3	GND	DVEN = disabled

Table 2. Jumper JU2 & JU3 Settings

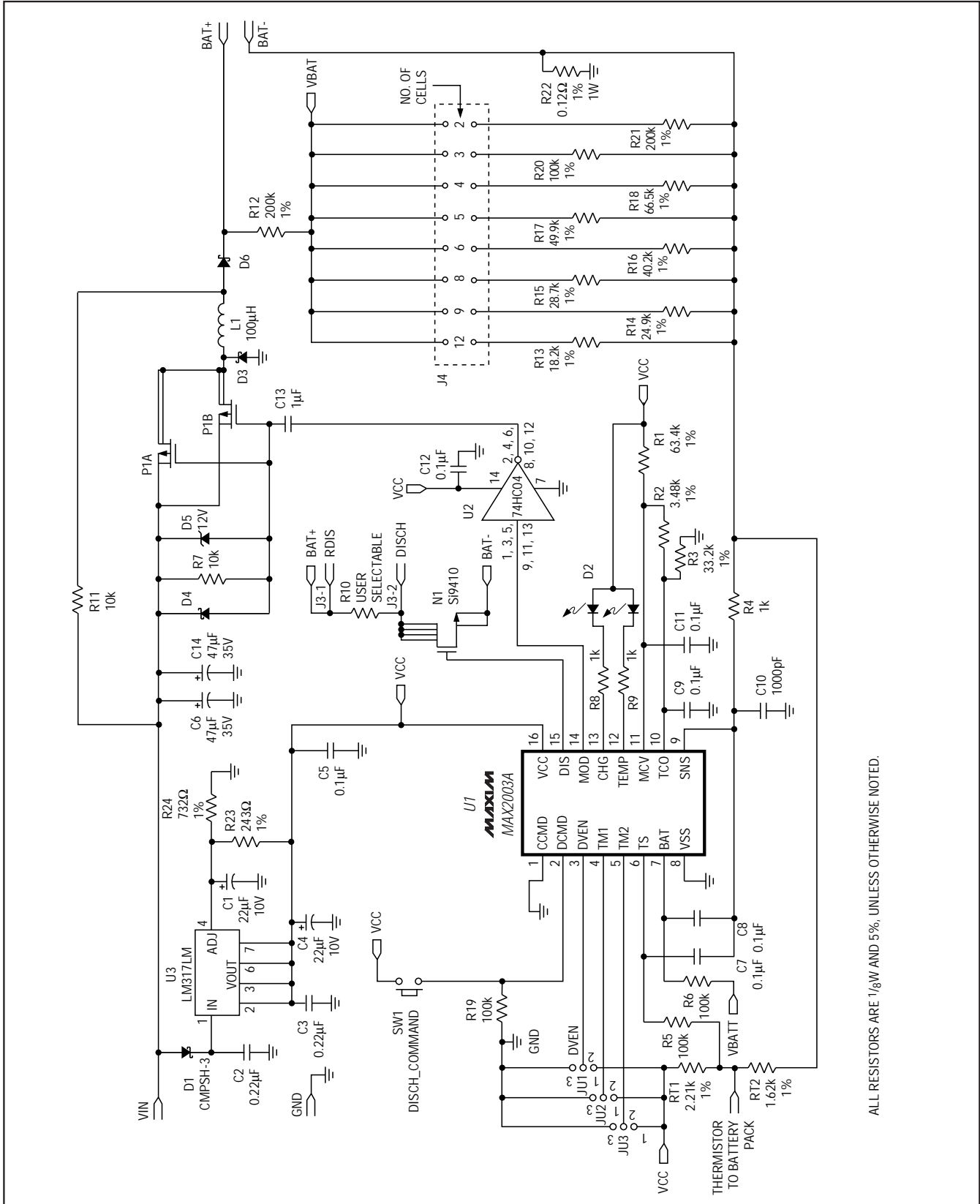
SHUNT LOCATION	TM1 AND TM2 PIN STATUS	CHARGER STATUS
JU2 across pins 2 & 3	TM1* = GND	Fast-charge rate = C, Timeout = 90 min, Top-off charge = enabled
JU3 across pins 1 & 2	TM2* = VCC	

* Refer to the MAX2003A data sheet for more detailed information on TM1 and TM2 control signals.

Table 3. Charge Status

CHARGE STATE	LED STATUS
Fast-Charge	Green LED on
Charge Pending	Green LED on for 0.125sec, off for 1.375sec
Discharge-Before-Charge	Green LED on for 1.375sec, off for 0.125sec
Charge Complete and Top-Off	Green LED on for 0.125sec, off for 0.125sec
Temperature Fault	Red LED on

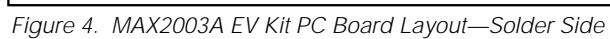
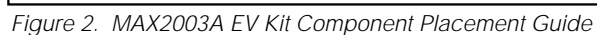
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ALL RESISTORS ARE 1/8W AND 5%, UNLESS OTHERWISE NOTED.

Figure 1. MAX2003A EV Kit Schematic

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NOTES

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NOTES

Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time.

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