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AK7903

DCDC Step-down Converter for NiH2 Battery

GENERAL DESCRIPTION

AK7903 is a DCDC step-down converter with fixed current control type for NiH2 battery. This device detects external resistor current, and controls switching regulator output voltage with fixed current. AK7903 can convert the battery voltage with a built-in general-purpose amplifier, so CPU can monitor battery easily. AK7903 also built-in output voltage detection function (external resistors fail detection), output short protection function, thermal protection circuit, so it can work safely with few radiant heat. AK7903 is the most suitable charger device for portable system which uses NiH2 battery. The AK7903 is available in QFN package (3.0mm x 3.0mm), utilizing less board space than competitive offerings.

FEATURE

- ☐ **Most Suitable Charger Device for NiH2 Battery Charging**
  - **Switching DCDC Converter with Fixed Current Control Circuit**
- ☐ **Power Supply Voltage: 4.1V～5.5V**
- ☐ **Output Voltage: 0.2V～3.6V**
- ☐ **Maximum Charger Current (pin control available):**
  - **0.4A @ ISET= "Low" (SENSE resistor= 0.353Ω)**
  - **0.3A @ ISET= "Low" (SENSE resistor= 0.470Ω)**
  - **80mA @ ISET= "High" (SENSE resistor= 0.470Ω)**
- ☐ **Charger Current Accuracy: ±5%**
- ☐ **Low Power Consumption: 2uA @ Shut-down**
- ☐ **Switching Frequency: External Resistor Adjustable (< 10%)**
- ☐ **High Efficiency: >80% @VIN=5V, Vout= 1.8V, Iout= 0.3A**
- ☐ **General-purpose Amplifier Built-in**
  - **Input Selectable (switch built-in)**
- ☐ **Protection Function (Auto Recovery)**
  - **Over Current Protection Circuit**
  - **Thermal Protection Circuit: 120℃(Recovery at 100℃)**
- ☐ **Ta: -30～70℃**
- ☐ **Few External Parts needed: Power MOSFET built-in**
- ☐ **Small Size Package: 16pins QFN (3mm×3mm, 0.5mm pitch)**
- ☐ **Application: System which used 1 or 2 series NiH2 battery**

■ BLOCK DIAGRAM

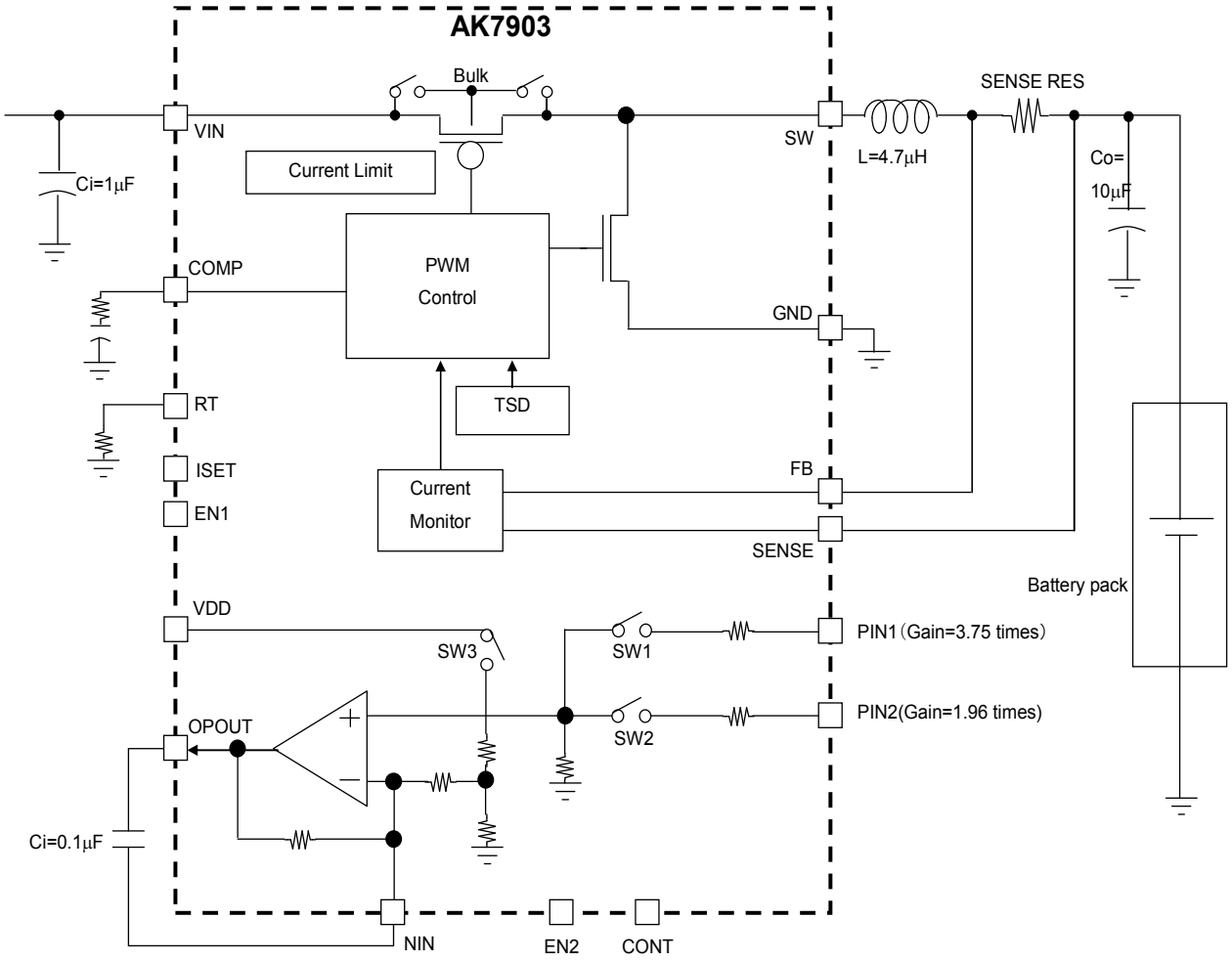
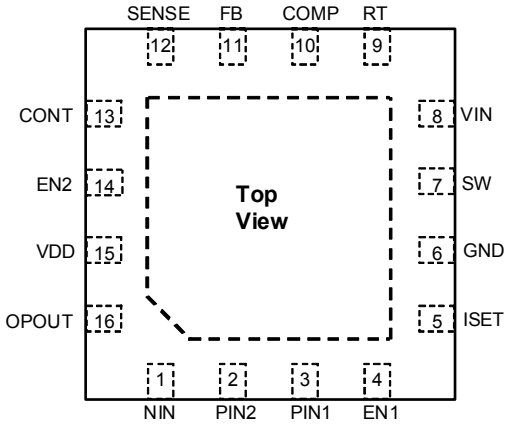


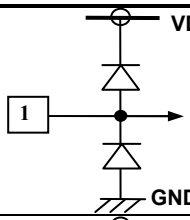
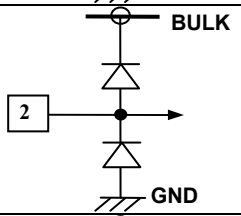
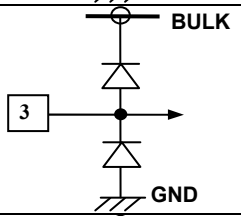
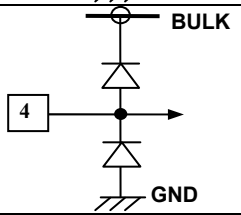
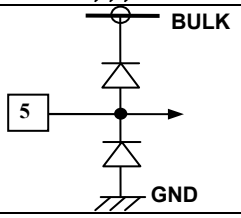
Figure 1. AK7903 Block Diagram

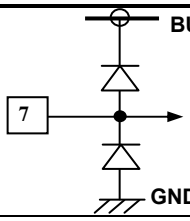
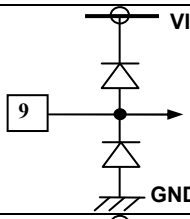
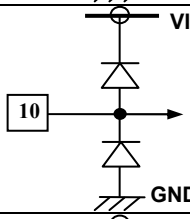
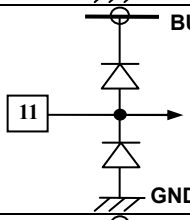
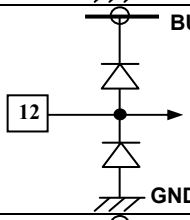
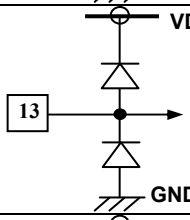
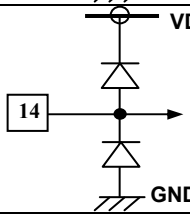
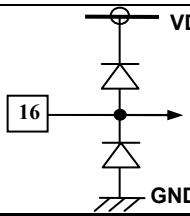
*) The BULK of PMOS connects to the high voltage of VIN or SW.

■ PIN LAYOUT



PIN / FUNCTION

No.	Pin Name	I/O	Protection Diode	Function
1	NIN	I		OP-AMP Negative Input Pin 1
2	PIN2	I		OP-AMP Positive Input Pin 2
3	PIN1	I		OP-AMP Positive Input Pin 1
4	EN1	I		Enable Pin 1
5	ISET	I		Charge Current Setting Pin
6	GND	—		Ground Pin

Pin Name	I/O	Protection Diode	Function
SW	O		Choke Coil Connection Pin
VIN	–		DCDC Power Supply Pin
RT	O		Frequency Setting Pin (Adjusted by external resistor)
COMP	O		Boost Compensation Pin
FB	I		Output Voltage Detection Pin
SENSE	I		Connect to Current Detection SENSE Resistor
CONT	I		PIN1 or PIN2 Select Pin (PIN1@CONT= “L”, PIN2 @CONT= “H”)
EN2	I		OP-AMP Enable Pin
VDD	–		OP-AMP Power Supply Pin
OPOUT	O		OP-AMP Output Pin

ABSOLUTE MAXIMUM RATING

(GND=0V; (Note 1))

Parameter	Symbol	min	max	Units
VIN Pin Voltage	Vin	–0.3	6.5	V
Input Current (FB, SENSE, CONT, EN1, EN2, ISET, RT, COMP)	Iin	-	±10	mA
SW MOS. Peak Current	Ici	-	1.0	A
Junction Temperature	Tj		125	℃
Storage Temperature	Tstg	–40	125	℃
Power Dissipation (Note 2)	Pd		1700	W

Note 1. All voltage is respect to ground.

Note 2. In case that PCB(size: 76×114mm,1.6mm, 4 layer) , material is FR4, base on JDEC51-7, and temperature is 25℃, windless.

Note: Operation at or beyond these limits may result in permanent damage to the device.
Normal operation is not guaranteed at these extremes.

RECOMMENDED OPERATING CONDITIONS

(GND=0V; (Note 1))

Parameter	Symbol	min	typ	max	Units
Power Supply for DCDC	VIN	4.1	-	5.5	V
Power Supply for OP-AMP	VDD	2.8	-	3.2	V
Ambient Temperature	Top	–30	25	70	℃

* AKM assumes no responsibility for the usage beyond the conditions in this datasheet.

ANALOG CHARACTERISTICS

(Ta=25℃, VIN=5.0V, VDD=3.0V, GND=0V(Note 3))

Symbol	Parameter	Condition	Min	Typ	Max	Unit
DCDC CONVERTER、FIXED CURRENT CIRCUIT						
Vin	Input Voltage	In the case of VIN=3.8V, VOUT= 1.8V is guaranteed	4.1 (3.8V)		5.5	V
Iddsdn	Shut-down Current	EN=L		2	10	uA
Treg	Stop Temperature			120		℃
Ilimt	Current Limit	Vin=5.0V		1000		mA
Vsense	Current Detection Accuracy	R=0.47Ω,Iout=300mA	-5		5	%
Ipre1	Output Current1	R=0.353Ω, ISET= “Low” Vin=4.1 ～ 5.5V,Vout=0.2 ～ 3.5V		400		mA
Ipre2	Output Current 2	R=0.470Ω, ISET= “Low” Vin=4.1 ～ 5.5V,Vout=0.2 ～ 3.5V		300		mA
Ipre3	Output Current 3	R=0.470Ω, ISET= “High” Vin=4.1 ～ 5.5V,Vout=0.2 ～ 3.5V		80		mA
fosc	Switching Frequency	Freq= 1220kHz	-2		+2	%
Tstart	Start-up Time	The time which from EN＝ “L→H” to the time which charge current is 90% of the setting current.		20		ms
Effi	Efficiency (Note 4)	Vout=1.8V、Iout=300mA		80		%
OP-AMP						
VDD	Input Voltage		2.8		3.2	V
	Maximum Output	Load≧10kΩ（@1/2*VDD）	0.05		VDD-0.05	V
Gain1	Gain 1	PIN1→OPOUT		3.75		倍
Gain2	Gain 2	PIN2→OPOUT		1.96		倍
Opout1	Output Level 1	PIN1= 1.75V		1.95		V
Opout2	Output Level 2	PIN2= 3.5V		2.26		V
IDD1	Power consumption 1	EN2= “H”, 無負荷		1.7	4	mA
IDD2	Power consumption 2	EN2= “L”, 無負荷		0.1	2	μA
$Load_{Cap}$	Maximum Load CAP				50	pF
DIGITAL INPUT/OUTPUT						
Vil	Low Level Input	Input Pins			0.4	V
Vih	High Level Input	Input Pins	1.2			V
Vimax	Maximum Input	EN2, CONT pins			VDD+0.3	V
Ibias1	Input Bias Current 1	EN1 pin =VIN			5	μA
Ibias	Input Bias Current 2	Input Pins			1	uA

Note 3. All the characteristic is supposed that recommend external parts is used.
Note 4. Exclude SENSE resistor consumption.

OPERATION OVERVIEW

■Input and Output

AK7903 is a DCDC converter which power MOSFET is built-in, and input voltage support 4.1V～5.5V; the device is the most suitable charger for NiH2 battery system which used 1 or 2 series NiH2 battery. In the case of charging to 1 cell, the characteristic can be guaranteed even input voltage below 3.8V. AK7903 detects external resister current through FB and SENSE pins, and it regulates switching regulator output voltage in order to maintain DCDC output current fixed. When the SENSE resistor current decreased, DCDC output voltage will be increased, so output current increase with coil current limitation (1.0A @typ). SENSE resistor is recommended less than 0.353Ω. Use small size SENSE resistor, the charge current is possible not reach set current.

■Protection Functions

AK7903 is built-in over current protection circuit and thermal protection circuit for preventing device be damaged. Protection condition and recovery method is showed at Table 1.

Protection Function	Working Condition	Device Condition	Recovery Condition
Current Limit (Including Output Short to Ground)	Coil current 1.0A	PMOS= OFF in the case that coil current > 1.0A. It will be judged at every cycle.	Auto recovery when left condition is cancelled.
Thermal Shut-Down	Chip temperature exceed 120℃(typ)	Switching Stop	Auto recovery when chip temperature below 100℃(typ).

Table 1. Protection Function

■Output PMOS Bulk Control

AK7903 controls output PMOS bulk, so is the most suitable construction for system environment.

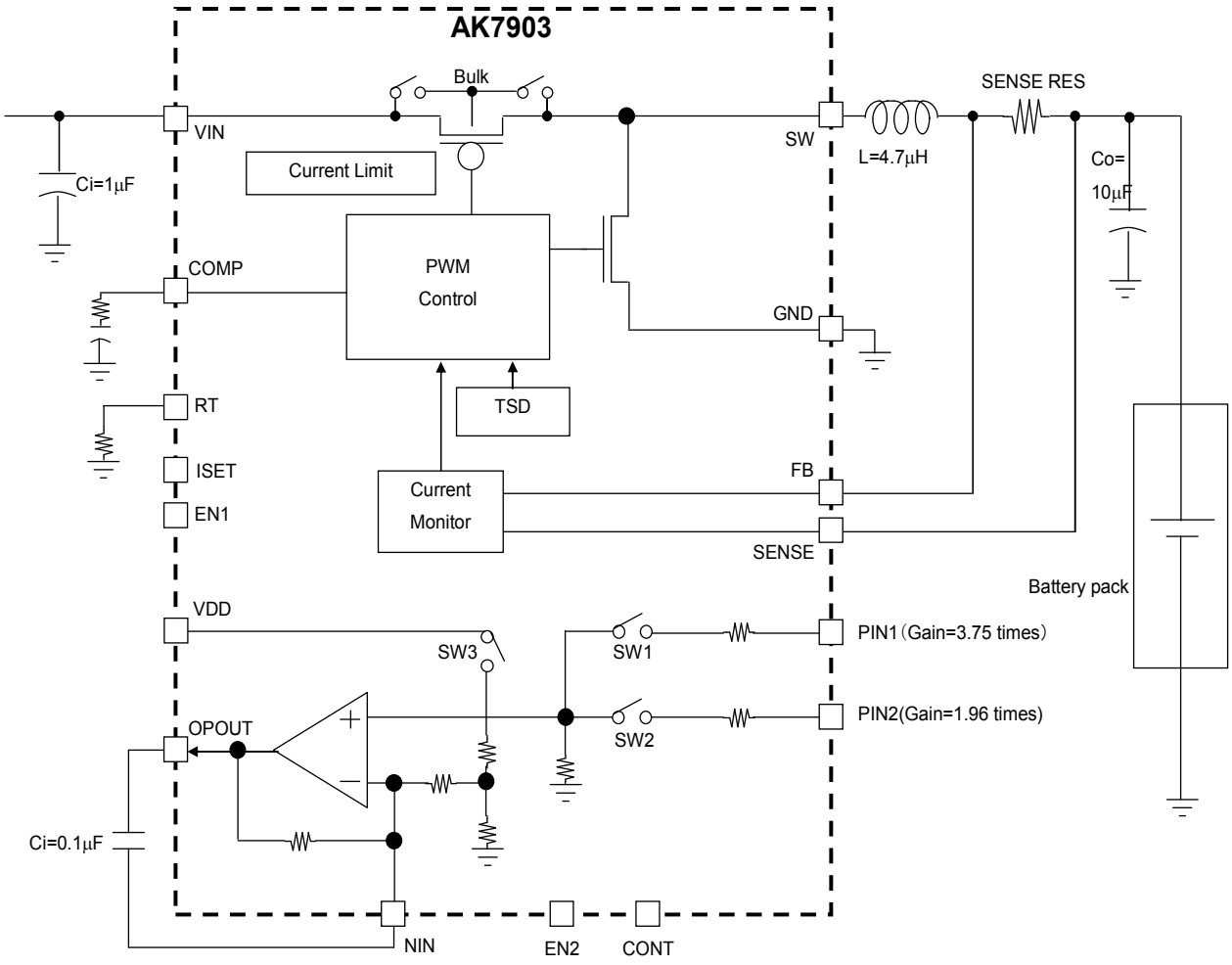
■ Gain Switching for OP-AMP

Table 2 shows OP-AMP gain setting.

EN2	CONT	SW1	SW2	SW3	オペアンプ
0	0 or 1	OFF	OFF	OFF	Power-down
1	0	ON	OFF	ON	Gain=3.75 times
1	1	OFF	ON	ON	Gain=1.96 times

Table 2. OP-AMP gain setting

SYSTEM DESIGN AND RECOMMENDED PARTS



Recommend Parts :

Component	Symbol	Value	Type	Dimensions	Supplier
Capacitance	Ci	4.7uF	C1608JB1E105K	1608 type (25v)	TDK
Inductance	L	4.7uH	LTF5022	5.0×5.2×2.2	TDK
Capacitance	Co	10uF	C2012JB1C106K	2012 type	TDK

*) Excellent DC bias characteristic of Ci is recommended.
Low value of Ci is possible to effect stability of AK7903.

PACKAGE

(a) Package Information　UQFN 16pin（unit：mm）

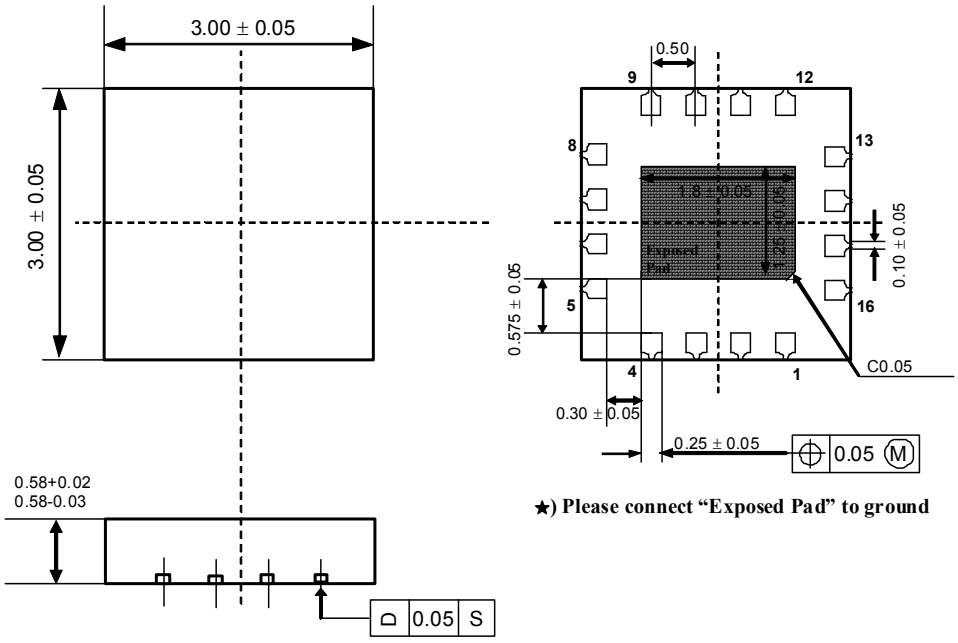


Figure 3　Package Information

(b)Recommend Food Pattern

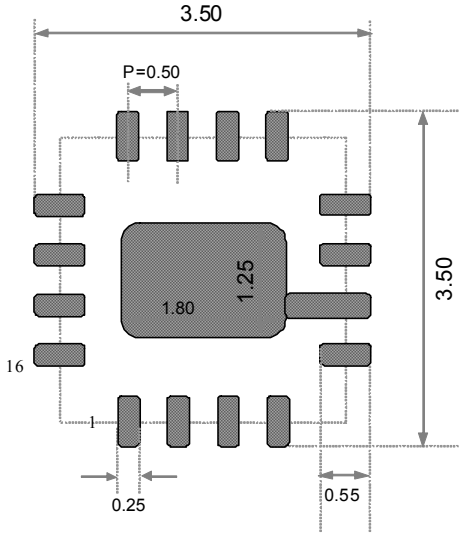
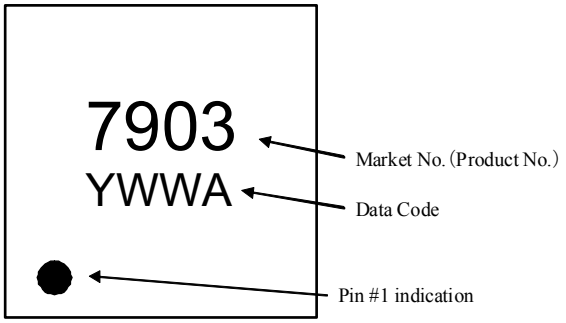


Figure 4. Recommend food pattern

MARKING



YWWA: Date code (4 digit)
Y: Product Year (A.D.) last No(Ex. "2009" → "9")
WW: Product Week
A: Product Manage Code

REVISION HISTORY

Date (YY/MM/DD)	Revision	Reason	Page	Contents
10/06/03	00	First Edition		

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