Dedicated ICs of CT04120 in Energy harvesting Applications

RoHS REACH Hand Soldering Only

1. Overview

Murata's CT04120 is new type of Lithium ion secondary battery in which Lithium titanate is used as negative active material. CT04120 has the following four outstanding characteristics which are quite suitable to energy harvesting (EH) applications as shown in Fig. 1.

① **Long life for maintenance-free**
② **Low loss (low self-leakage)**
③ **High rate discharge to drive RF function directly**
④ **Quick-ready from initial installation (charging start)**

Because of using the new material, charge voltage and discharge cutoff voltage are different from those of conventional Li-ion batteries. In this paper, we introduce the dedicated charge-discharge control ICs which can control charge-discharge condition of CT04120 within recommended range and which have suitable functions; MPPT and low quiescent current for EH.

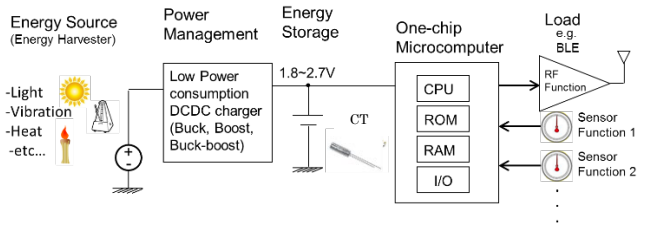


Fig. 1: Block diagram of EH application

2. Charge-discharge voltage and characteristics of CT04120

・Table 1 shows differences of charge-discharge control between conventional Li-ion battery and CT04120. Over Voltage Protection (OVP) needs to be set to less than 2.7V, and Under Voltage Protection (UVP) needs to be set to more than 1.8V. Since there is no limitation on charge current, CT04120 can be charged full only by Constant-voltage (CV).

<Table1. Differences of charge-discharge control between conventional lithium-ion secondary battery and Murata's CT04120>

Characteristics	Conventional Li-ion secondary battery*	CT04120
Maximum charge voltage	4.2V	**2.7V**
Charge current	1C	**N/A**
Discharge cutoff voltage	2.5V	**1.8V**

* Values of lithium-ion secondary battery is Murata's estimated value.

・ Figure 2 shows relation between charge voltage and State of Charge (SOC). Since nominal voltage of CT04120 is 2.3V, OVP needs to be set to more than 2.3V, less than 2.7V. SOC depends on charge voltage, and CT04120 can get nominal capacity when beeing charge at 2.7V and discharged until 1.8V. When being charged at 2.4V and discharge until 1.8V, capacity is approx. 70% against nominal. When being charged at 2.5V and discharge until 1.8V, capacity is approximately 90%.

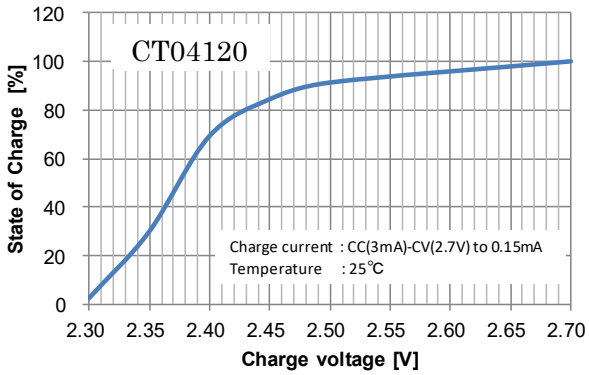


Fig.2: Relation between charge voltage and SOC

・ Figure 3 shows the discharge characteristics of CT04120. CT04120 has flat discharge characteristics around at 2.3V. We recommend to set UVP to less than 2.2V, more than 1.8V. Nominal capacity can be provided at OVP=2.7V, UVP=1.8V. About 90% of capacity can be provided at OVP=2.7V, UVP=2.2V.

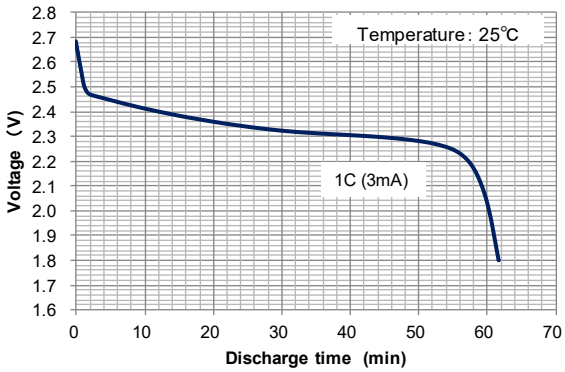


Fig.3 : 1C discharge characteristics

3. Power management IC for energy harvesting

Generally, below two functions are equipped in power management ICs for EH application to maximize the harvested energy efficiently.

MPPT/MPPC(Maximum power point tracking/control)

Photovoltaic (PV) cell has I-V characteristics on its output as shown in Fig. 4. When connecting PV with low impedance load such as regulator/ storage, charge is performed in a not efficient condition because PV output current and voltage are close to short circuit current/voltage. This is not the maximum power which PV can generate. IC with MPPT or MPPC function can improve generated energy dramatically by controlling the output voltage from PV

aroundV_{Pmax}.

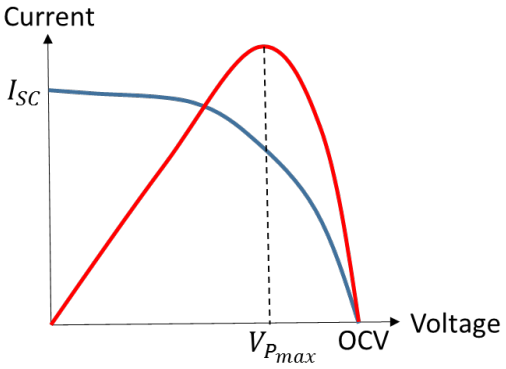


Fig.4 : I-V characteristics of PV cell

Low Quiescent current (Iq)

In EH applications, it is necessary to charge precious harvested energy efficiently and store them for a long time. Low Iq is preferred in terms of storing energy for a long time. Each IC manufactures released regulators whose Iq is several 100nA orders.

In here, Murata introduces ICs with MPPT functions and low Iq characteristics as CT04120 dedicated ICs for EH applications. It actually depends on system design on harvested energy and system consumption whether MPPT and low Iq characteristics are necessary or not.

4. Dedicated IC model number and changes on peripheral circuits.

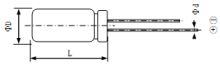
Table 2 shows examples of IC model numbers which are able to control charge-discharge of CT04120 with MPPT and low Iq. Described ICs below are the ones Murata has already performed an operation check; however, we do not guarantee on the IC operation. Please confirm the operation by yourself when you consider these ICs. Please also confirm the details of IC specification with IC manufactures.

<Table2. Dedicated IC and changes of peripheral circuits>

Supplier	Part#	Quiescent Current	Charge	Discharge	Memo
Analog Devices	ADP5091 ADP5092	390nA@idle	2.7V	2.0V	RTerm1=3.9MΩ Rterm2=5.1MΩ RSD1=3.3MΩ RSD2=4.7MΩ
E-peas	AEM10941	400nA@idle	2.7V	2.2V	Configuration pin setting: (CFG2,CFG1<CFG0) =(H,L,L)
Nisshinbo Micro Devices	R1800K 021A, 022A, 023A	144nA@idle	2.7V	2.0V	MPPC power ratio is different in each IC p/n ※Buck type
	R1801K 001A, 002A, 004A, 006A, 007A	200nA@idle	2.6V 2.7V	2.0V	
	R1810Z, R1810L 003A, 004A, 013A, 022A～034A	600nA@idle	2.6V 2.7V	2.0V	MPPC power ratio is different in each IC p/n ※Boost type
STMicro Electronics	SPV1050	800nA@idle	2.7V	2.2V	R4=6.2MΩ R5=1.4MΩ R6=6.4MΩ
TI	BQ25505 BQ25570	325nA@idle 445nA@idle	2.7V	1.95V	ROV1=4.7MΩ ROV2=2.2MΩ

5. Products Lineup

Product name	CT04120	Dimensions	
		ΦD	4mm
Nominal Voltage	2.3V	L	12mm
Charge Voltage	2.7V	Φd	0.45mm
End of discharge Voltage	1.8V	F	1.5mm
Capacity	3mAh	Operating temp	-20～70℃



6. Support

Please access below Website form or contact form,

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7. Link to dedicated ICs

Analog Devices : ADP5091/ADP5092

e-peas: AEM10941

Nisshinbo Micro Devices:

R1800K021A,022A,023A

R1801K001A,002A,004A,006A,007A

R1810Z,R1810L 003A,004A,013A,022A～034A

STMicro Electronics: SPV1050

TI: BQ25505/BQ25570