■ Charging circuits

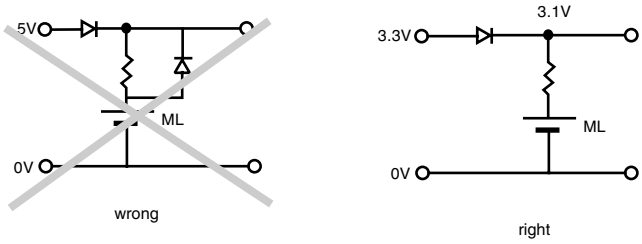
Charging/discharging cycle	Approx. 1,000 times at 10% discharge depth to nominal capacity
Charging system*	Constant-voltage charging (Please strictly adhere to the specified charge voltage)
Operating temperature	-20°C to +60°C

* Consult with Panasonic concerning constant-current charging systems.

The charging circuit is crucial in terms of ensuring that full justice will be done to the battery characteristics. Consider it carefully as the wrong charging circuit can cause trouble.

■ Precautions regarding the charge voltage setting

Under no circumstances should trickle charging, which is used for nickel-cadmium batteries, be used. Ignoring this precaution will cause the battery voltage to rise to about 5V, resulting in a deterioration of performance.



■ Charge voltage range

If a fixed-charging method is applied, please adhere to the specified charging voltage.

Guaranteed voltage is 2.8V to 3.2V at the temperature of -20°C to 60°C.

* If the charging voltage exceeds the specifications, the internal resistance of the battery will rise and may cause battery deterioration. Also, with a charge voltage around 4V, corrosion of the ⊕ terminal (case) may occur, causing leakage. ("Influence of the charge voltage on ML batteries" in chapter 3-61.)
* It is not possible for the battery capacity to recover completely when the charging voltage is below the specification.

■ Recommended charging circuits

● Basic conditions

Fixed-voltage charge

Charge voltage: 2.8 to 3.2V (Standard voltage: 3.1V)

Charge current: For a battery voltage of 2.5V

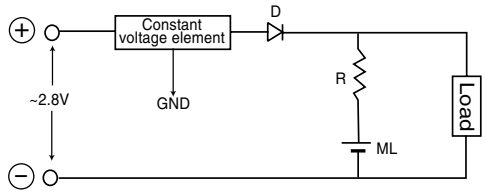
ML414	Approx. 0.1 mA or below
ML421	Approx. 0.15 mA or below
ML614	Approx. 0.3 mA or below
ML621	Approx. 0.6 mA or below
ML920, ML1220	Approx. 1.2 mA or below
ML2020	Approx. 3.0 mA or below

■ Mixed usage of batteries

Do not use these batteries and lithium primary batteries or other rechargeable batteries together, and do not use new batteries and old batteries together even if they are of the same type.

● Reference: Examples of charging circuits

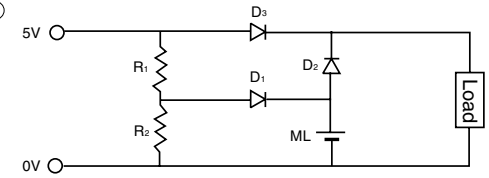
①



When Charging using another battery

ML414		
REG	D	R
3.2V	MA2J728	4.7kΩ
3.1V	MA2J728	3.9kΩ
ML421		
REG	D	R
3.2V	MA2J728	6.2kΩ
3.1V	MA2J728	5.1kΩ
ML614		
REG	D	R
3.2V	MA2J728	1.8kΩ
3.1V	MA2J728	1.5kΩ
ML621		
REG	D	R
3.2V	MA2J728	910Ω
3.1V	MA2J728	750Ω
ML920		
REG	D	R
3.2V	MA2J728	470Ω
3.1V	MA2J728	390Ω
ML1220		
REG	D	R
3.2V	MA2J728	470Ω
3.1V	MA2J728	390Ω
ML2020		
REG	D	R
3.2V	MA2J728	180Ω
3.1V	MA2J728	150Ω

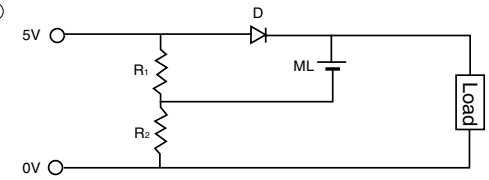
②



Standard circuits
For D_2, select a diode of small inverse current
D_1, D_2 : MA3X716 (Diode type code)
D_3 : MA3X704, MA2J728 (Ir=1μA/5V)

	R_1	R_2
ML414	5.1k Ω	9.1k Ω
ML421	5.1k Ω	9.1k Ω
ML614	2.7k Ω	5.1k Ω
ML621	1.1k Ω	2.0k Ω
ML920	680 Ω	1.3k Ω
ML1220	680 Ω	1.3k Ω
ML2020	180 Ω	330 Ω

③



Simple economical circuits

Load	100μA below	
D,Vf	0~0.2V	
	R_1	R_2
ML414	9.1kΩ	5.6kΩ
ML421	10kΩ	5.1kΩ
ML614	5.1kΩ	2.7kΩ
ML621	2.4kΩ	1.3kΩ
ML920	1kΩ	510Ω
ML1220	1kΩ	510Ω
ML2020	330Ω	180Ω

* VF of D will be different from the value given above if a current in excess of 10μA flows to the load during operation. Compensation must be provided by the resistors in such cases.

● Influence of the charge voltage on ML batteries

If the charge voltage goes beyond its adequate range, battery performance may deteriorate early. Be sure to observe the guaranteed charge voltage.