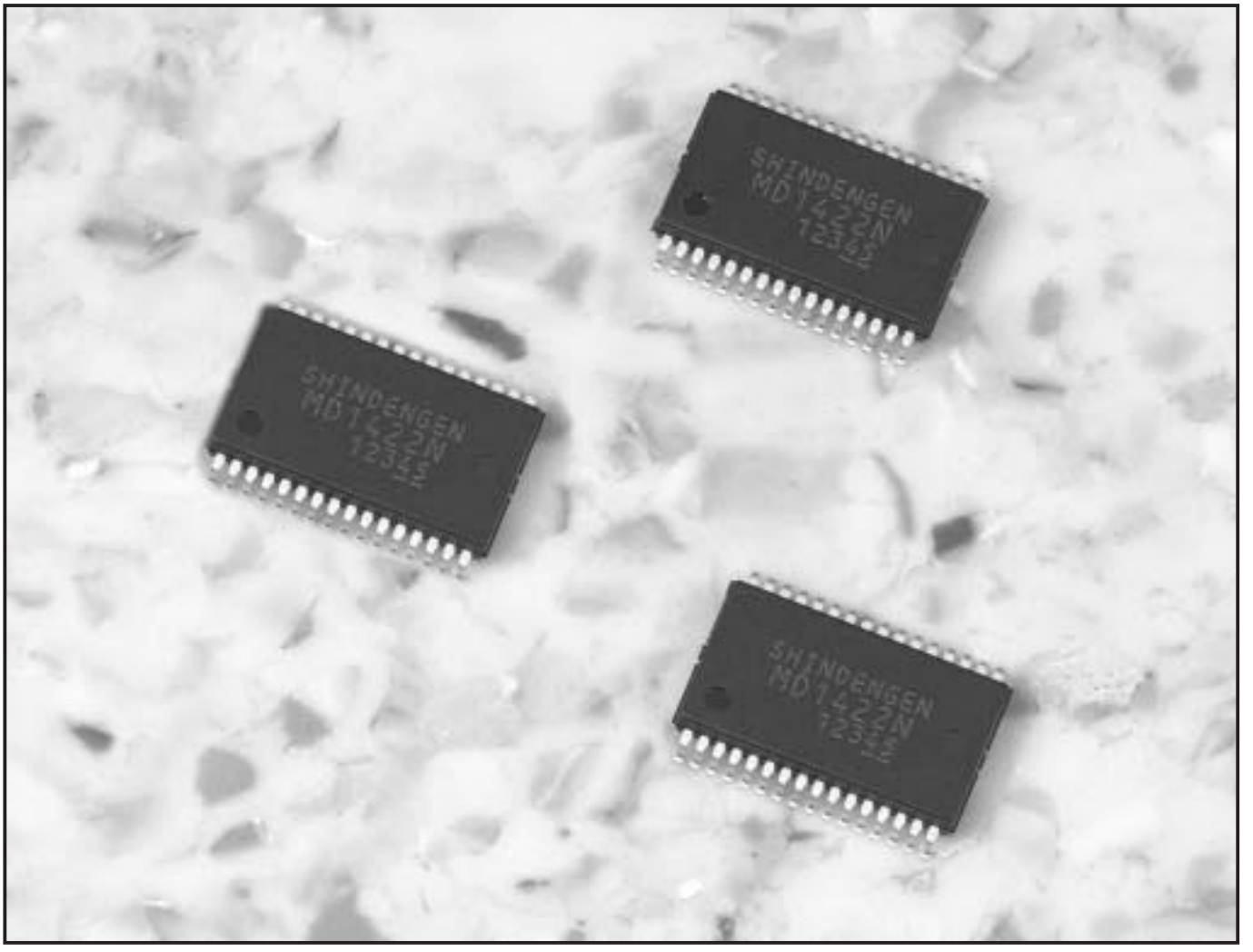
CAT. No. U092

Synchronous Rectification System
Variable Output Voltage Stepdown

DC to DC Converter Power IC
MD1422N

Application Manual



SHINDENGEN ELECTRIC MFG. CO., LTD.

1 Using the MD1422N DC to DC Converter Power IC

Thank you for purchasing the MD1422N DC to DC Converter Power IC. This manual contains important information on the safe use of the MD1422N. Your safety is most important to our company. Please read these instructions carefully before using this device.

CAUTION ⚠	The improper use of this device can result in serious injury or death. Expensive damage to this and other equipment can result. Failure to observe the cautions in this Manual can also result in minor injuries and annoying equipment damage.

CAUTION	⚠	The MD1422N is intended for use with general electronic equipment (office automation, communication, measurement, household, etc.) It is not intended for use with equipment whose failure might result in the death or injury of those depending upon it (medical treatment, air navigation, railroad, cargo handling, nuclear power, etc.) If you intend to use the MD1422N with other than the general equipment listed above, please consult with our company.
	⚠	Under no conditions attempt to repair or modify this device by yourself. Doing so can result in electric shock, equipment breakage, fire, and unreliable (and dangerous) equipment operation.
	⚠	Abnormal operating conditions may result in excessive voltage at the output terminal or excessive voltage drops elsewhere in the device. Take steps to prevent load mishandling and breakage (overvoltage and overcurrent prevention) at the final point in the equipment chain.
	⚠	Overvoltage protection The MD1422N is not equipped with an overvoltage protection function. In the event excessive voltage appears within a module, the high input voltage may remain together with a high output voltage even when the equipment is turned off. Smoke and flame may appear. To prevent this, be sure to install some sort of overvoltage protection circuitry before using the equipment.
	⚠	Before providing electrical power to the device, check that the polarity of the input and output terminals is correct (check for misconnections). If circuit protection circuitry is cut off from the rest of the equipment, smoke and flames may appear.
	⚠	Be sure that input voltage level is maintained at the specified level. This may require the installation of a voltage regulator to the input line. Voltage fluctuations may result in the appearance of smoke and flames.
	⚠	If a breakdown or other abnormal condition occurs during equipment use, immediately stop power to the equipment. Contact our company at your earliest possible convenience.

■ This device fully meets the reliability and quality control standards described in our company's catalog. If this device is to be used in a situation where its misuse or failure might cause serious injury or death, consult with our company.
■ Reliability and quality control standards for this device are considered adequate when it is used with the following types of end equipment.
Computer - Office automation - Communication terminal - Measurement ·Machine tools - Audio-visual - Games and other amusements - Household appliance - Personal items - Industrial robot.
Special applications where the device may or may not be suitable include the following.
Transportation and conveyance (cargo loading) equipment- Primary communications equipment- Traffic signal control equipment - Fire and burglary alarms - Various safety devices - Medical equipment
Other special applications where the device reliability is not considered high enough include the following.
Atomic energy control systems - Aviation equipment- Aeronautics and space equipment - Ocean depth sounding equipment - Life supportequipment
■ Our company makes a constant effort to improve the quality and reliability of our products. However, it is the customer's responsibility to provide safety. Take the appropriate steps to prevent personal injury, fire, and damage by providing redundancy equipment, fire containment equipment, and devices to protect personnel and equipment from operational mistakes.

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2 General description of the DC to DC Converter Power IC MD1422N

The MD1422N is a non-isolated step-down DC to DC converter power IC. Main components are the MOSFET switch and the built-in synchronous rectification MOSFET. Maximum output is 3A. The equipment is highly efficient and may be used for a wide range of applications.
Output voltage is further adjustable using external resistances (2.5V - 12V).
HSOP-type surface mount packaging is used. Minimal external control circuitry is required. This permits a small footprint and low profile of power supply.

◆ 2 – 1 Features

- Input voltage range: 8∼40V
- Output voltage : Output voltage Adjustable using external resistances (2.5V - 12V)
- Maximum output current: 3A (Derating is required for output higher than 8V)
- Main switch MOSFET and built-in synchronous rectification MOSFET
- Oscillation frequency: 250 kHz (Built-in oscillator does not require external capacitors or resistors)
- Overcurrent protection function
- Heat protection function
- Built-in low-voltage protection (UVLO) function
- Built-in remote control functions

◆ 2 – 2 Applications

- Information distribution equipment
- Office automation equipment
- Electronic measuring instruments
- Home appliances
- Telecommunications equipment
- Factory automation equipment (Process control)
- Audio-video devices

◆ 2 – 3 Nomenclature

Device name and packaging specification codes are provided. Shipping conditions are determined according to these specifications.
Entry example: MD1422N 4072
Specification code: Shows package configuration and product name

◆ 2 – 4 Peripheral functions

1) Internal reference voltage (Vref)

IC internal circuitry reference voltage is provided by the temperature compensation reference voltage (5.0V). This reference voltage (Vref) provides a maximum external output current measured at the terminal of 1 mA.

2) Oscillation circuit (OSC)

The oscillation circuit is built into the device. No external oscillation capacitor nor resistor is required. The oscillation frequency (250 kHz) is set internally and has a sawtooth wave pattern. The sawtooth wave pattern cannot be outputted externally.

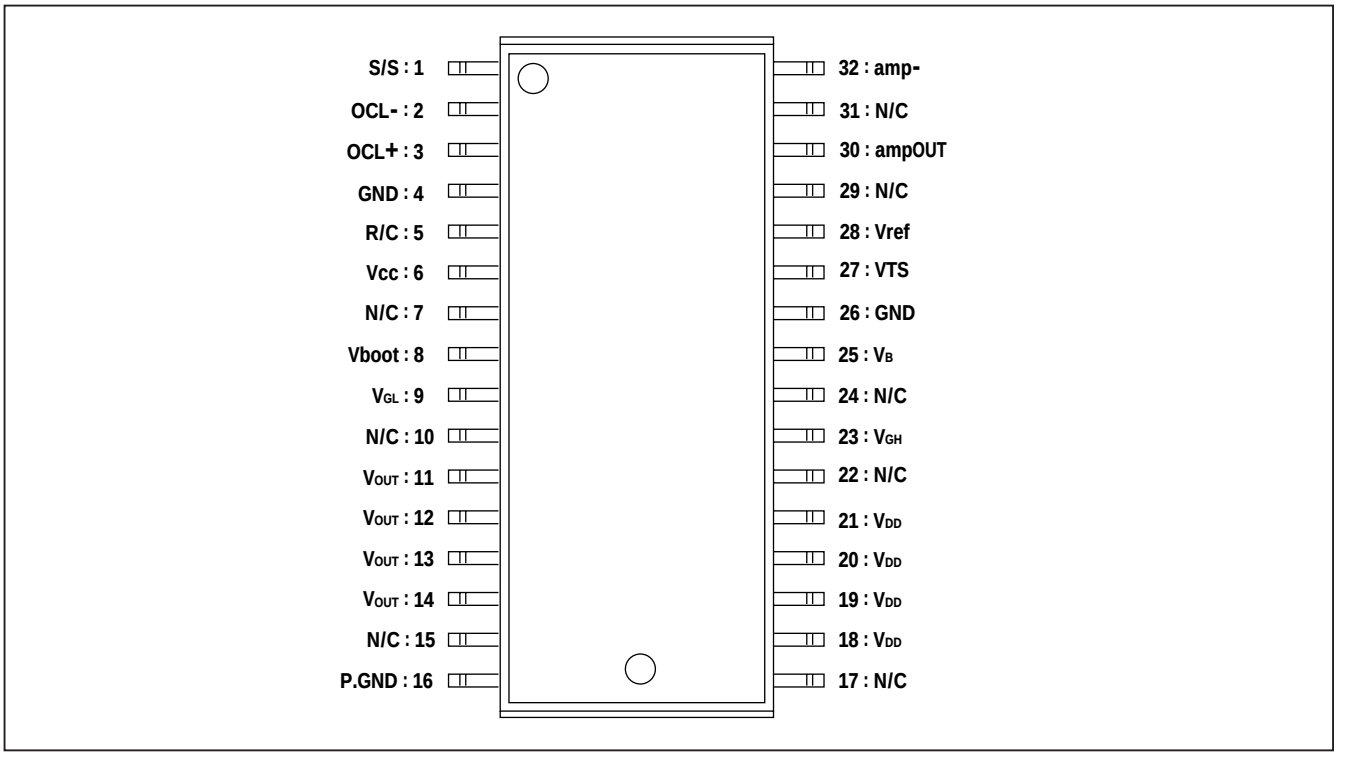
3) Error amplifier (Error Amp.)

The error amplifier senses the DC to DC converter voltage and provides a PWM control signal output. Loop gain between the error amplifier ampOUT terminal and the negative amp terminal is determined by the connections between the feedback resistor and the capacitor. This provides stable loop compensation throughout the system.

4) Overcurrent sensor (OCL)

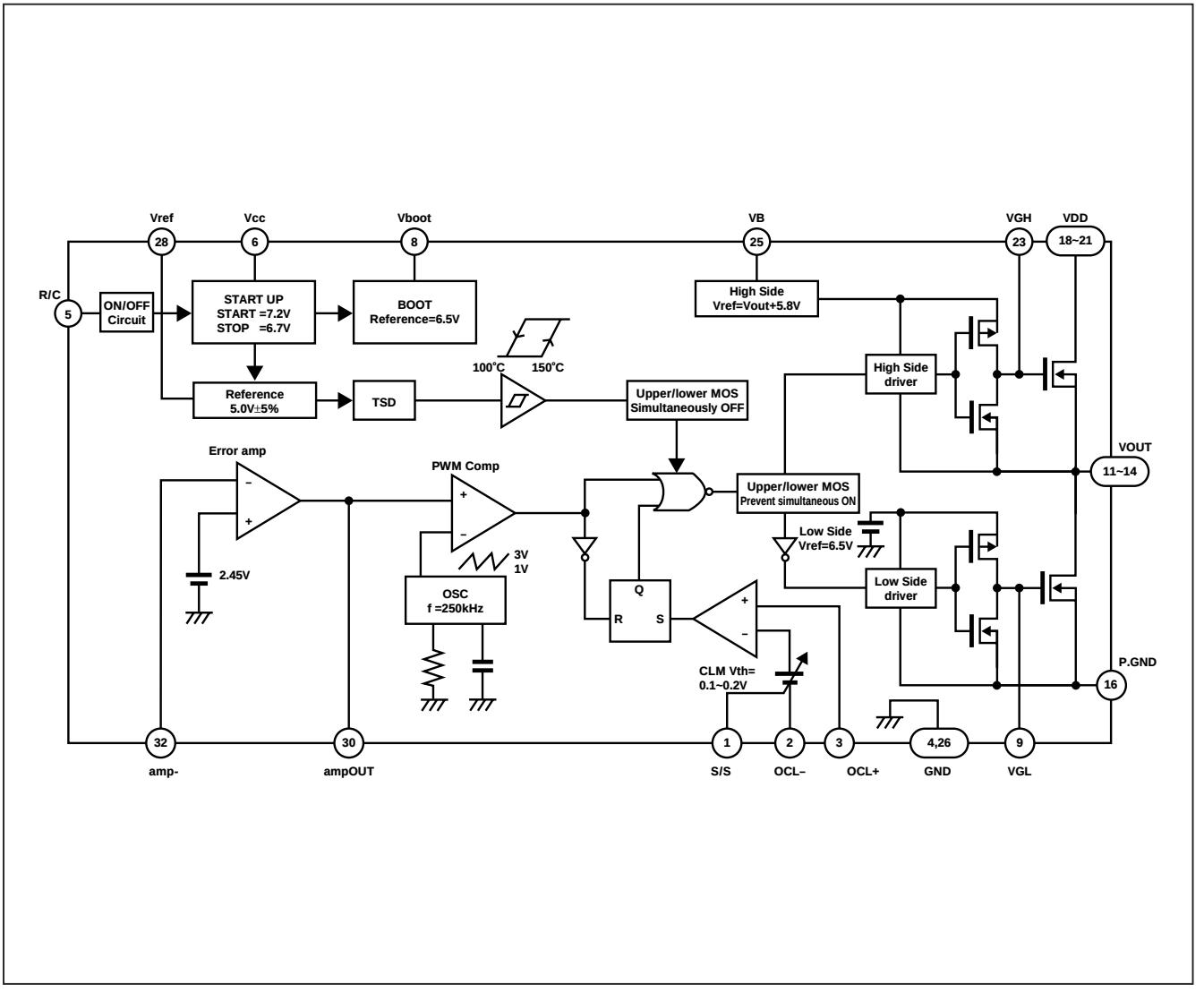
The OCL is a pulse-by-pulse overcurrent sensor. The voltage drop across the external current sensing resistor is measured between the negative and positive terminals of the OCL. If the voltage drop exceeds ≒0.19V, the main switch (MOSFET) opens.

◆ 2 – 5 Terminal functions

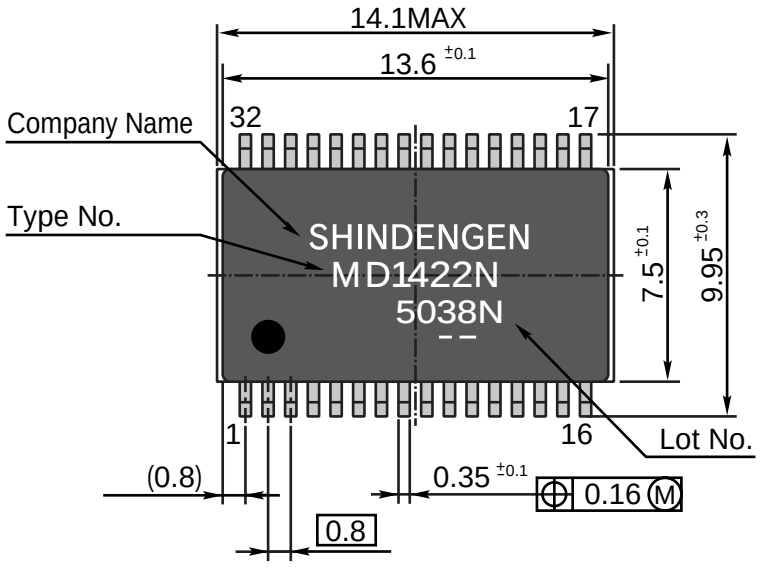


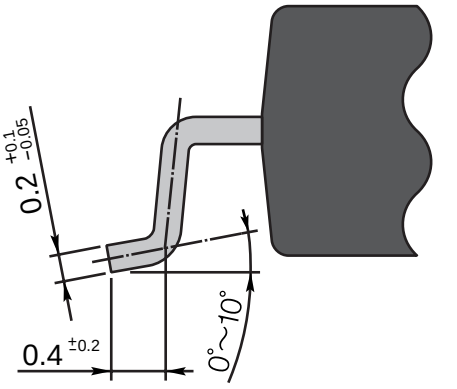
Terminal No.	Terminal symbol	Function
1	S／S	Soft-start capacitor terminal
2	OCL−	Overcurrent detection terminal (−)
3	OCL+	Overcurrent detection terminal (+)
4,26	GND	Ground terminal
5	R／C	Remote ON/OFF control terminal
6	Vcc	Control circuit power supply terminal
8	Vboot	Main switch MOSFET control circuit power supply terminal
9	V_{GL}	Low side MOSFET gate terminal for synchronous rectification
11～14	V_{OUT}	Power supply output terminal
16	P.GND	Output circuit ground terminal
18～21	V_{DD}	Main switch MOSFET power supply terminal
23	V_{GH}	Main switch high side MOSFET gate terminal
25	V_B	Output boot strap terminal. Used for connecting condenser across VB and VOUT terminals to boot strap IC internal main switch MOSFET control circuit.
27	VTS	Test terminal. Do not connect it to anything.
28	Vref	Internal reference voltage output terminal
30	ampOUT	Internal error amplifier output terminal
32	amp−	Internal error amplifier reversing input terminal
7,10,15,17,22, 24,29,31	N／C	No connection terminal (N/C terminal)

◆ 2 – 6 Block diagrams



3 External dimensions (Diagram)(SSOP-32)





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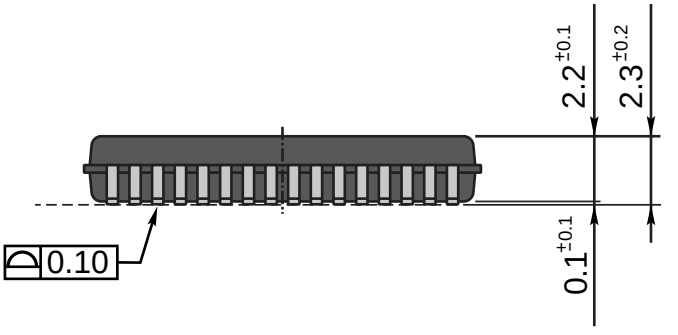
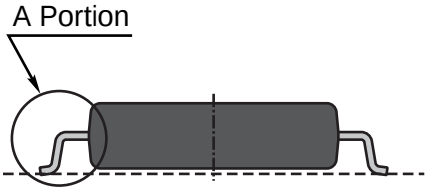




Unit : mm

4 Characteristics

1）Absolute maximum rating（Ta=25 C）

Item	Symbol	Rating	Unit
Line voltage	V_{IN}	42	V
Output MOS input voltage	V_{DD}	42	V
Output current (AVE)	I_{OUT}ave	3	A
Output current (PEAK)	I_{OUT}peak	4	A
OCL-, OCL+ terminal voltage	V_{OCL}	5.5	V
Remote control voltage	V_{RC}	5.5	V
Storage temperature	Tstg	– 40~150	°C
Junction temperature	Tj	150	°C

2）Recommended operating conditions

Item	Recommended value	Unit
Input voltage	8~40	V
Output voltage setting range	2.5~12	V
Operating temperature	-10~80	°C

4）Output current deleting for output higher than 8V

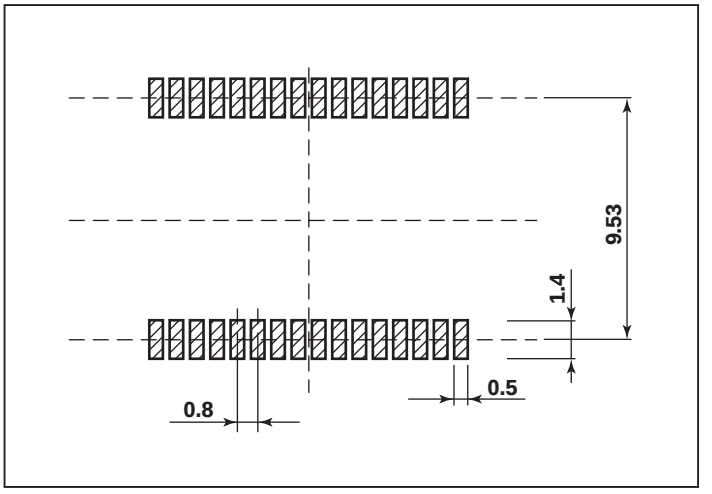
Set output voltage	Output current
2.5V~8V	3A
≦12V	2.5A

3）Electrical characteristics（Ta=25 C）

Item	Symbol	Conditions	MIN	TYP	MAX	Unit
HighsideMOS Drain-source breakdown voltage	Vdss	I_D = 1mA,V_{GS} = 0V	42	–	–	V
HighsideMOS Drain interruption current	Idss	V_{DS} = 40V,V_{GS} = 0V	–	–	10	μA
HighsideMOS Drain-source ON resistance	Ron	I_D = 1.2A,V_{GS} = 4.5V	–	33	70	mΩ
HighsideMOS Source-drain Di forward voltage	V_{SD}	I_S = 1.2A,V_{GS} = 0V	–	–	1.5	V
LowSideMOS Drain-source breakdown voltage	Vdss	I_D = 1mA,V_{GS} = 0V	42	–	–	V
LowSideMOS Drain interruption current	Idss	V_{DS} = 40V,V_{GS} = 0V	–	–	10	μA
LowSideMOS Drain-source ON resistance	Ron	I_D = 1.2A,V_{GS} = 4.5V	–	33	70	mΩ
LowSideMOS Source-drain breakdown voltage	V_{SD}	I_S = 1.2A,V_{GS} = 0V	–	–	1.5	V
Start voltage	Vcc_start	–	6.5	7.2	7.9	V
Stop voltage	Vcc_stop	–	6.0	6.7	7.4	V
Start-stop voltage hysteresis	Vcc_hys	–	–	0.5	–	V
Current consumption	Icc	Vcc = 8V~40V	–	10	13	mA
Current consumption with remote control OFF	Icc_off	Vcc = 8V~40V	–	1.2	1.5	mA
Voltage with remote control terminal ON	V_{RC}_on	Vcc = 8V~40V	–0.2	–	0.5	V
Voltage with remote control terminal OFF	V_{RC}_off	Vcc = 8V~40V	2.5	–	5.3	V
Current with remote control terminals shorted	I_{RC}	Vcc = 8V~40V	–	–	250	μA
BOOT terminal voltage	Vboot	Vcc = 24V	5.4	6.5	7.6	V
Internal reference voltage	Vref	Vcc = 8V~40V	4.75	5	5.25	V
Internal oscillation frequency	fosc	Vcc = 24V	212.5	250	287.5	kHz
Overcurrent threshold voltage	Vth_OCL	Vcc = 24V	0.162	0.19	0.218	V
SoftStart terminal current	Is/s	Vcc = 24V	–20	–12.5	–5	μA
ErrorAmp reference voltage	Vamp	Vcc = 8V~40V	2.4	2.45	2.5	V
Overcurrent protection operating temperature	T_TSD	–	–	150	–	°C

5 Mounting

◆5 – 1 Soldering pattern reference (Reflow-type)



◆5 – 2 Mounting cautions

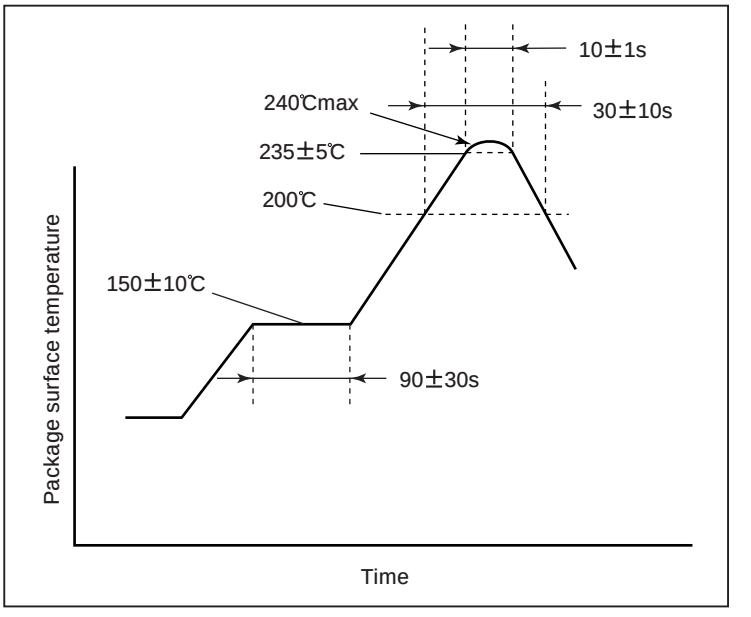
1) Mounting

Vibration and other mechanical disturbances can exert stress on the internal parts of the device. Carefully examine your equipment and place the device where vibration and other shock is minimal.

2) Soldering cautions

● Infrared reflow method

This method provides very high temperature soldering. The chart at the right shows the recommended temperature profiles for the Infrared reflow soldering method.



(Figure 5-A)

● Soldering iron

When using a soldering iron, observe the following.

Soldering iron temperature: Not to exceed 300℃

Soldering iron contact time: Not to exceed 5 seconds

3) Cleaning cautions

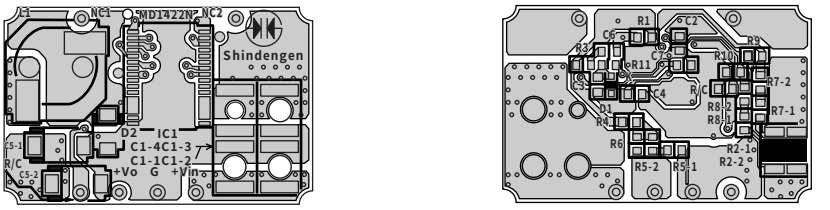
Carefully remove all flux. Allow time for the soldered areas to completely dry before using the device.

4) Secondary mold cautions

After installation of the device to a board, remolding using plastic may be required. During this process, stress on the device will depend on the type of plastic used. The best plastic (that which causes the least stress on the device) has a minimum contraction ratio and high flexibility. Hardening temperatures should not exceed the storage temperature. Carefully check the plastic characteristics before use.

※ Static electricity can damage the device. The person and clothing of personnel working with the device should be grounded to prevent the build-up of static electricity. It is recommended that personnel stand on rubber mats (electrical safety mats) having a resistance greater than 1MΩ when working with the device. This will prevent damage to the device from static electricity discharge and protect the personnel form electrical shock.

◆5 – 3 Printed circuit board patterns and design considerations(Reference)



3A Product model sample

※ The device does not have a voltage surge protection circuit or an input fuse. The user should install an input fuse to protect the device and equipment before using the device.

- For optimum thermal efficiency, maintain the copper foil pattern as much as possible.
- Connect the input capacitor (C1), output capacitor (C5), choke (L1), and drooping resistor (R2) as close as possible to the power IC device.
- Separate the ground terminals (Pin 4 and Pin 26) and the P and ground terminals (Pins 16). Connect each of them as close as possible to output capacitor (C5).
- OCL + (3rd pin) and OCL - (2nd pin) should be connected as close to the drooping resistance (R2) as possible.
- Output detect resistances (R5, R6) should be connected as close to the load as possible.

6 Operating instructions

The MD1422N power IC device uses chopper circuitry and can be referred to as a chopper type DC to DC converter. The device requires an external choke and capacitor to be connected to it. The characteristics of these external parts and the way they are packaged and connected will greatly affect the performance of the device and its circuits. Carefully select these external parts to provide optimum device performance.
Neither the device input side nor output side is isolated.

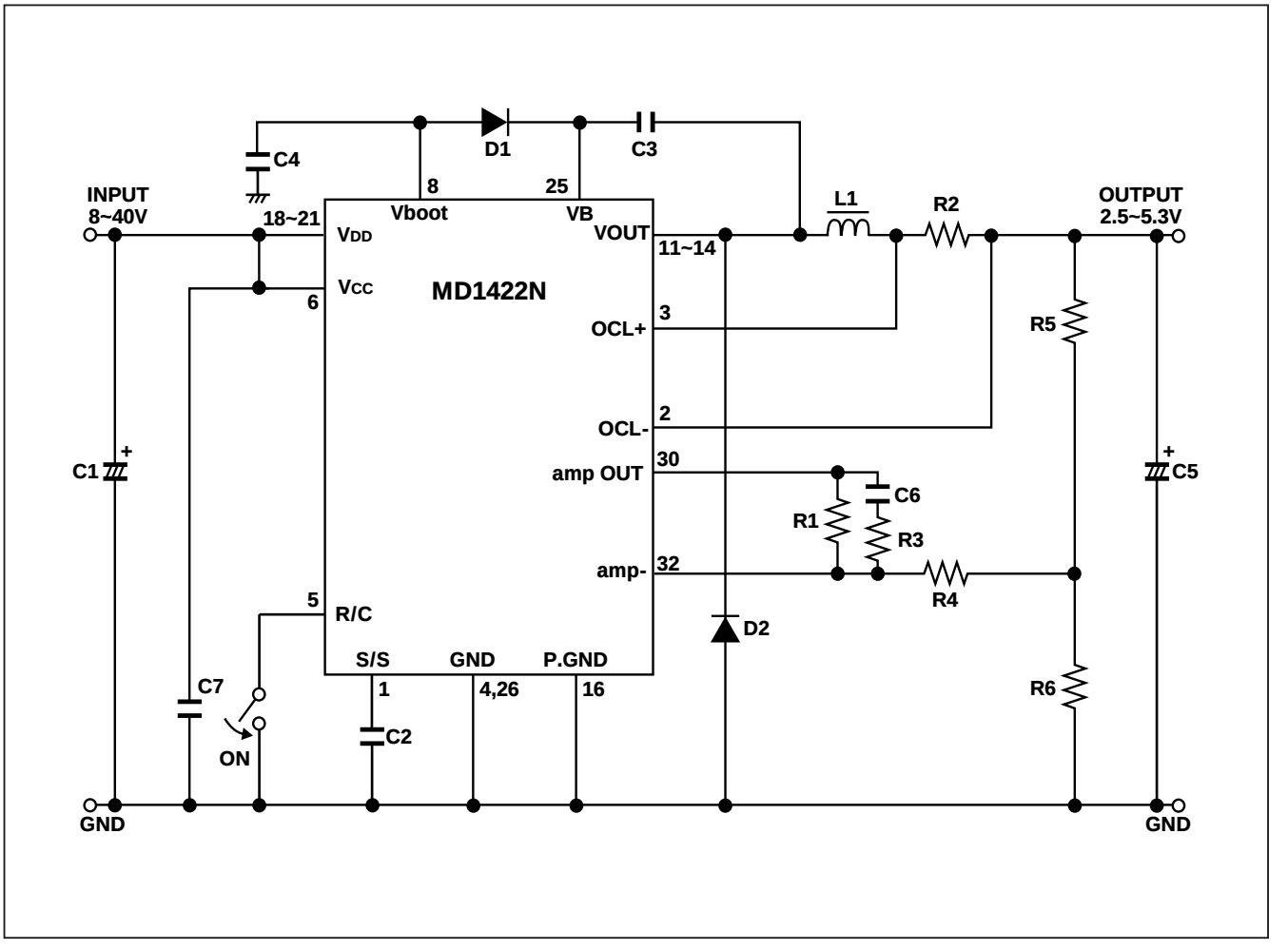
◆6 − 1 For use with output voltage lower than 5.3V

1) Basic input and output terminal connections

Power IC device connection and use involves the rated output voltage and the maximum current output range.

- Pins 9, 23 and 27 are the test terminals and must be left open.
- Pins 7, 10, 15, 17, 22, 24, 29 and 31 are internal non-connecting pins (N/C terminals).
- Figure 6-A shows the external parts and their connections. Be sure to prepare and connect these items before using the device.
- Output capacitor (C5) minimizes switching frequency ripple and provides a smooth and stable output voltage. The use of a low-impedance capacitor is recommended (low impedance provides minimum ripple).

●Standard connections (Figure 6-A)



2) Resistors for setting output voltage

Output voltage is adjusted using R5 and R6.

R6 = 2.2kΩ

$$R5 = \frac{R6 \times (Vout - 2.45)}{2.45} \ [\Omega]$$

3) Setting the output voltage for lower than 3V

The maximum input voltage within the usable input voltage range is determined as follows.

$$Vin\ (max) \leqq \frac{Vout}{0.075} \ [V]$$

4) Reference parts

Reference parts for the standard circuit

Part No.	Nomenclature	Output voltage 2.5V~5.3V		
		Output current example		
		1 A	2 A	3 A
L1	Choke	68μH 1A	33μH 2A	22μH 3A
D1	Diode	HSU119 (80V 0.3A)	HSU119 (80V 0.3A)	HSU119 (80V 0.3A)
D2	Shottky barrier diode	D1FS4A (40V 1.5A)	D1FS4A (40V 1.5A)	D1FS4A (40V 1.5A)
C1	Electrolyte capacitor (parallel)	50V 100μF 724mA	50V 180μF 1190mA	50V 270μF 1580mA
C2	Ceramic capacitor	25V 0.047μF	25V 0.047μF	25V 0.047μF
C3	Ceramic capacitor	25V 0.01μF	25V 0.01μF	25V 0.01μF
C4	Ceramic capacitor	25V 1000pF	25V 1000pF	25V 1000pF
C5	Electrolyte capacitor (parallel)	10V 470μF 72mΩ	10V 1000μF 38mΩ	10V 1200μF 23mΩ
C6	Ceramic capacitor	25V 1000pF	25V 1000pF	25V 1000pF
C7	Ceramic capacitor	50V 0.01μF	50V 0.01μF	50V 0.01μF
R1	Resistance	0.1W 1MΩ	0.1W 1MΩ	0.1W 1MΩ
R2	Resistance (parallel)	0.5W 0.15Ω ±5%	0.5W 0.15Ω ±5%×2	0.75W 0.1Ω ±5%×2
R3	Resistance	0.1W 100kΩ	0.1W 100kΩ	0.1W 100kΩ
R4	Resistance	0.1W 10kΩ	0.1W 10kΩ	0.1W 10kΩ
R5	Resistance	It is determined using the expression in Item 6-1 (2).		
R6	Resistance	0.1W 2.2kΩ ±0.5%	0.1W 2.2kΩ ±0.5%	0.1W 2.2kΩ ±0.5%

5) Electrical characteristics (Ta=25°C)

Efficiency and ripple are measured according to external reference parts circuit configuration that is based on standard circuit configuration (Figure 6-A).

Item	Output current example								
	1A			2A			3A		
Output voltage (V)	2.5	3.3	5	2.5	3.3	5	2.5	3.3	5
Input voltage (V)	8~33	8~40		8~33	8~40		8~33	8~40	
Output current (A)	0~1			0~2			0~3		
Voltage regulation accuracy (%)	±5								
Efficiency Typ. (%)	86	89	92	86	89	92	84	87	91
Oscillation frequency Typ. (kHz)	250								
Ripple voltage p-p Typ. (mV)	25								
Overcurrent protection	Operation / auto-recovery at a current lower than the rated current								
Thermal protection Typ. (°C)	150								
Operating (ambient) temperature (°C)	–10~80								

Efficiency and ripple voltage conditions: Vin = 12V and Io = rated output current

R5: Example R5 = 47 +/- 0.5% for 2.5V, R5 = 300Ω + 470Ω (series) +/- 0.5% for 3.3V
R5 = 1kΩ + 1.3Ω (series) +/- 0.5% for 5V

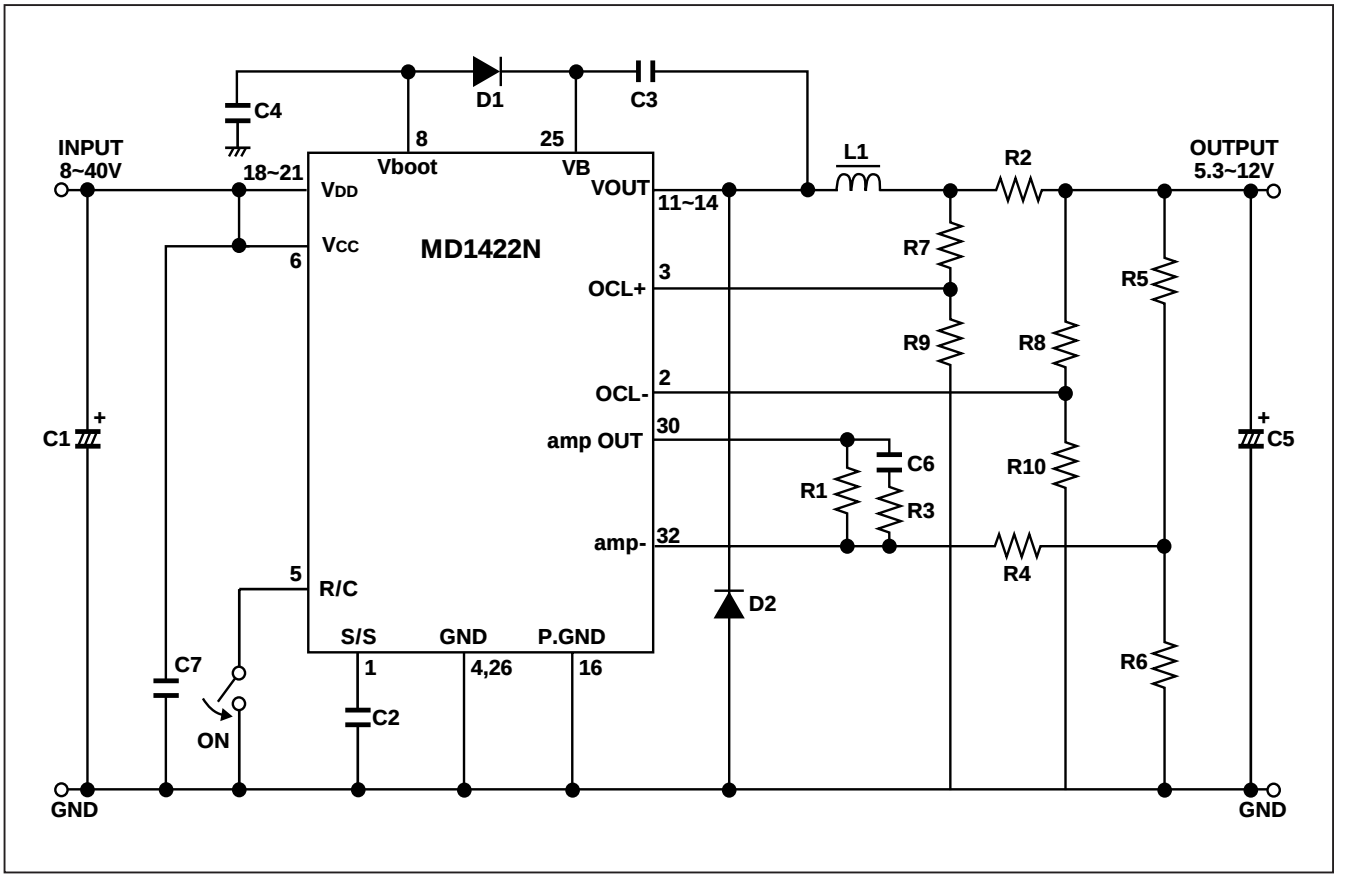
◆6 – 2 For use with output voltage higher than 5.3V

1) Basic connection of input/output terminals

- Pins 9, 23 and 27 are the test terminals and must be left open.
- Pins 7, 10, 15, 17, 22, 24, 29 and 31 are internal non-connecting pins (N/C terminals).
- Figure 6-B shows the external parts and their connections. Be sure to prepare and connect these items before using the device.
- Output capacitors (C5) minimizes switching frequency ripple and provide a smooth and stable output voltage. The use of a low-impedance capacitor is recommended (low impedance provides minimum ripple).

Note: Please ask for our advice when setting the output voltage for higher than 5.3V.

●Standard connections (Figure 6-B)



2) Usable input voltage range

For setting the output voltage higher than 5.6V, the minimum input voltage should be determined as follows.

$$\text{Vin (min)} \geqq \frac{\text{Vout}}{0.7} \text{ [V]}$$

3) For output voltage higher than 5.3V, the drooping resistances R2, R7, R8, R9 and R10 should be used as follows, provided that the voltage at the 2nd and 3rd pins is less than 5.3V.

$R9 = R10 = 1k\Omega$

$R7 = R8 = 193 \times (\text{Vout} - 4.99\text{V}) \text{ [}\Omega\text{]}$

$$R2 = \frac{(\text{Vout} - 1.53)}{105} \text{ [}\Omega\text{]}$$

Note 1: R7, R8, R9 and R10 are added for setting the output voltage to be higher than 5.3V, and the dropping point is significantly moved. Therefore, parts having a precision of less than +/-0.5% should be used for R7, R8, R9 and R10 and less than 5% for R2.

4) Reference parts

Part No.	Nomenclature	Output voltage 5.3V~8V		Output voltage 8V~12V	
		Output current example			
		2 A	3 A	2 A	2.5 A
L1	Choke	47μH 2A	33μH 3A	120μH 1A	47μH 2.5A
D1	Diode	HSU119 (80V 0.3A)	HSU119 (80V 0.3A)	HSU119 (80V 0.3A)	HSU119 (80V 0.3A)
D2	Shottky barrier diode	D1FS4A (40V 1.5A)	D1FS4A (40V 1.5A)	D1FS4A (40V 1.5A)	D1FS4A (40V 1.5A)
C1	Electrolyte capacitor	50V 180μF 1190mA	50V 270μF 1580mA	50V 100μF 724mA	50V 220μF 1370mA
C2	Ceramic capacitor	25V 0.047μF	25V 0.047μF	25V 0.047μF	25V 0.047μF
C3	Ceramic capacitor	25V 0.01μF	25V 0.01μF	25V 0.01μF	25V 0.01μF
C4	Ceramic capacitor	25V 1000pF	25V 1000pF	25V 1000pF	25V 1000pF
C5	Electrolyte capacitor	16V 680μF 38mΩ	16V 1000μF 23mΩ	16V 330μF 72mΩ	16V 680μF 38mΩ
C6	Ceramic capacitor	25V 1000pF	25V 1000pF	25V 1000pF	25V 1000pF
C7	Ceramic capacitor	50V 0.01μF	50V 0.01μF	50V 0.01μF	50V 0.01μF
R1	Resistance	0.1W 1MΩ	0.1W 1MΩ	0.1W 1MΩ	0.1W 1MΩ
R2	Resistance	It is determined using the expression in Item 6-2 (3).			
R3	Resistance	0.1W 100kΩ	0.1W 100kΩ	0.1W 100kΩ	0.1W 100kΩ
R4	Resistance	0.1W 10kΩ	0.1W 10kΩ	0.1W 10kΩ	0.1W 10kΩ
R5	Resistance	It is determined using the expression in Item 6-1 (2).			
R6	Resistance	0.1W 2.2kΩ ±0.5%	0.1W 2.2kΩ ±0.5%	0.1W 2.2kΩ ±0.5%	0.1W 2.2kΩ ±0.5%
R7	Resistance	It is determined using the expression in Item 6-2 (3).			
R8	Resistance				
R9	Resistance	0.1W 1kΩ ±0.5%	0.1W 1kΩ ±0.5%	0.1W 1kΩ ±0.5%	0.1W 1kΩ ±0.5%
R10	Resistance	0.1W 1kΩ ±0.5%	0.1W 1kΩ ±0.5%	0.1W 1kΩ ±0.5%	0.1W 1kΩ ±0.5%

5) Electrical characteristics (Ta=25°C)

Efficiency and ripple voltage are measured according to external reference parts circuit configuration that is based on standard circuit configuration (Figure 6-B).

Item	Output current example			
	1A		2.5A	
Output voltage (V)	9	12	9	12
Input voltage (V)	13~40	17.5~40	13~40	17.5~40
Output current (A)	0~1		0~2.5	
Voltage regulation accuracy (%)	±5			
Efficiency Typ. (%)	93	94	94	95
Oscillation frequency Typ. (kHz)	250			
Ripple voltage p-p Typ. (mV)	25			
Overcurrent protection	Operation / auto-recovery at a current lower than the rated current			
Thermal protection Typ. (°C)	150			
Operating (ambient) temperature (°C)	–10~80			

The requirement for efficiency and ripple voltage is: Vin = 24V and Io = the dating current.

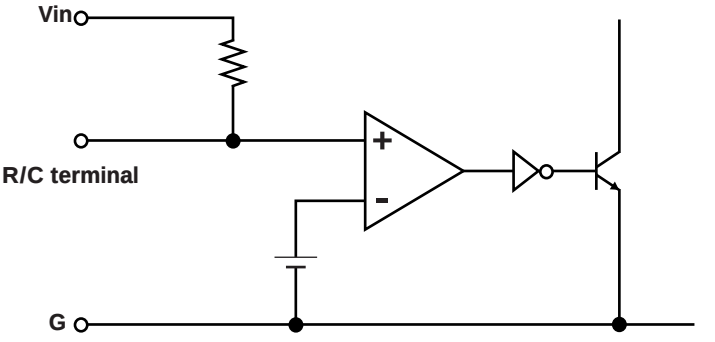
Example R5= 2kΩ + 3.9kΩ (series) +/- 0.5% for 9V, R2 = 0.068Ω +/- 5%, R7 = 750Ω + 20Ω (series)+/- 0.5%
R5= 5.6kΩ + 3kΩ (series) +/- 0.5% for 12V, R2 = 0.1Ω +/- 5%, R7 = 1.2kΩ + 150Ω (series)+/- 0.5%

◆6 – 3 Remote ON/OFF Control Function

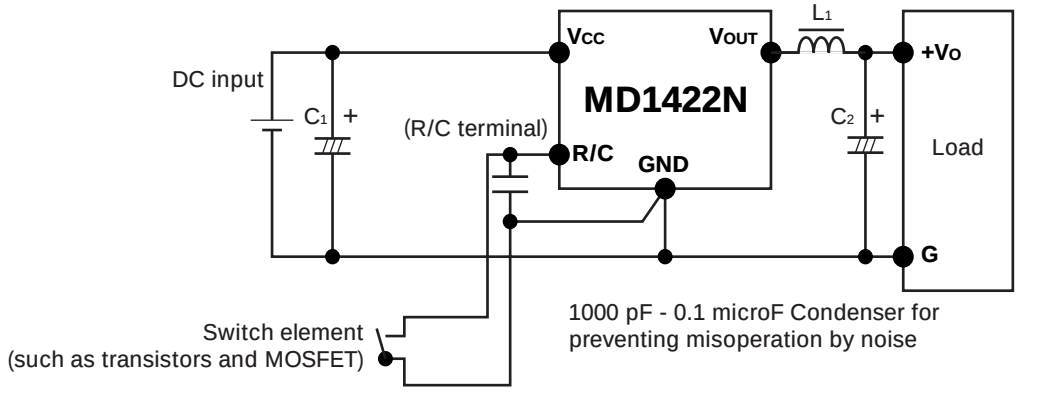
The remote ON/OFF control function can be used for turning output ON and OFF without making or breaking the input. The function can also be employed in systems such as sequence control for a power supply system.

* When the R/C function is not used, be sure to connect R/C terminal (Pin 5) and ground (Pins 4 and 26).
* The R/C terminal can be turned ON and OFF by a switch element such as a transistor or MOSFET. However, be sure to add a condenser (1000 pF - 0.1 micro F) across the R/C terminal (Pin 5) and ground (Pins 4 and 26) to prevent misoperation by noise.
  Refer to Fig. 6 - C and D shown below.
* Since pull-up has been carried out in the module, there is no need of impressing the voltage from the outside.

●R/C Functional Terminal Internal Equivalent Circuit (Figure 6-C)



●Method of Connecting R/C Functional Terminals (Figure 6-D)



◆6 – 4 Input protection element connection

⚠ Caution

The MD1422N device has an output current drop function. In the event of power IC device malfunction resulting in excessive input current flow, smoke and flame may be emitted from the equipment. To prevent this, install a fuse or protective circuitry to the power IC device input line.

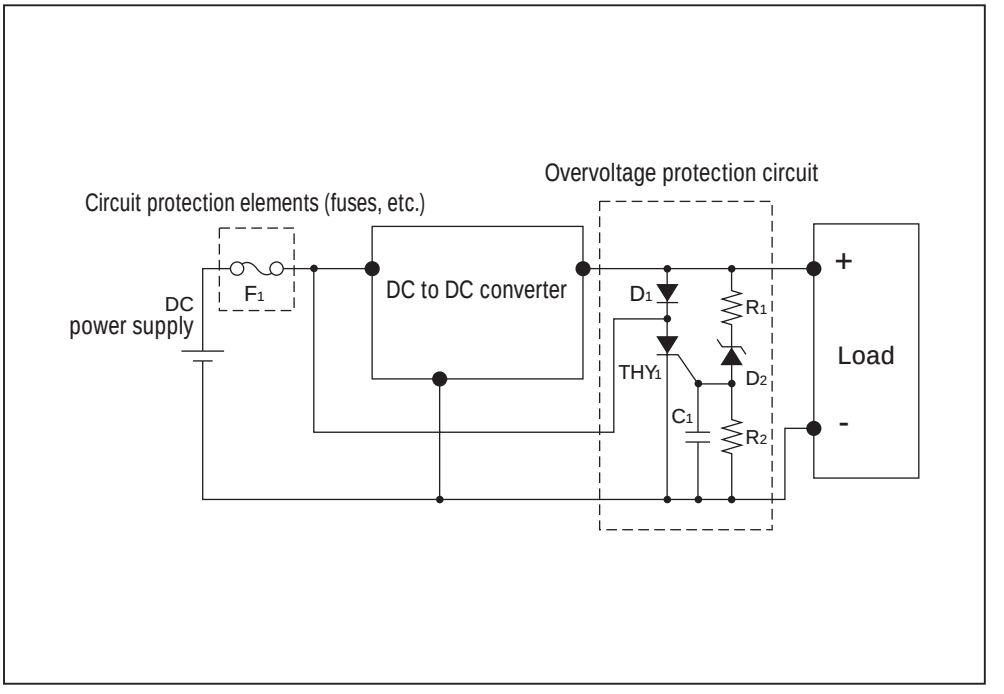
Install the fuse or protective circuitry to the positive side of the input line (Figure 6-2, DC input). Be sure that the fuse or protective circuitry is not too large to effectively protect the circuitry (the input line must be capable of carrying enough current to blow the fuse).

◆6 – 5 Overvoltage protection

The MD1422N power IC device does not have an overvoltage (voltage surge) protection function. If a malfunction occurs in the device internal circuitry, there may be a voltage surge. Output will reflect this surge and damage to equipment may result. Smoke and flame may be emitted from the equipment. To prevent this, be sure to install voltage surge sensing and protection circuitry.

There are a number of ways to protect against voltage surge. Figure 6-E shows a typical voltage surge protection set-up. The voltage surge sensing and protection circuit should be installed as close as possible to the load (away from the output smoothing capacitor).

●Reference part example (Figure 6-E)



Part No.	Nomenclature	Output voltage example				
		2.5V	3.3V	5V	9V	12V
F1	Circuit protection elements (fuses, etc.)	3A				
R1	Resistance	0.1W 22Ω				
R2	Resistance	0.1W 1kΩ				
C1	Ceramic capacitor	CM316334K10AT 10V 0.33μF				
D1	Diode	M1FL20U 200V 1.1A				
D2	Zener diode	HZM2.5N B1	HZM3.6N B1	HZM5.6N B1	HZM11N B1	HZM15N B1
		3.1~3.35V (5mA)	3.4~3.65V (5mA)	5.31~5.55V (5mA)	10.44~10.88V (5mA)	13.84~14.46V (5mA)
THY1	Thyrister	3P4J – Z 400V 3A				

Conditions: At rated output current

7 Basic device set-up standards

Set-up sequence below
Areas that must be carefully considered in the set-up of the device include the overcurrent detecting resistor, circuit inductance, output capacitor, input capacitor, and thermal characteristics. (Standard connections (Figures 6-A, 6-B))

◆7 − 1 Overcurrent detecting resistor (R2) selection (Output voltage lower than 5.3V)

Detects a peak voltage across the resistor of 0.19V ±15%

$$R2 = \frac{V_R}{I_R} [\Omega]$$

※ Switching noise and other factors may cause some variation in the calculated drop point value. Check your own equipment and calculate the value accordingly.

V_R : 0.19V (voltage produced at R2)
I_R : Droop point

◆7 − 2 Inductance (L1) selection

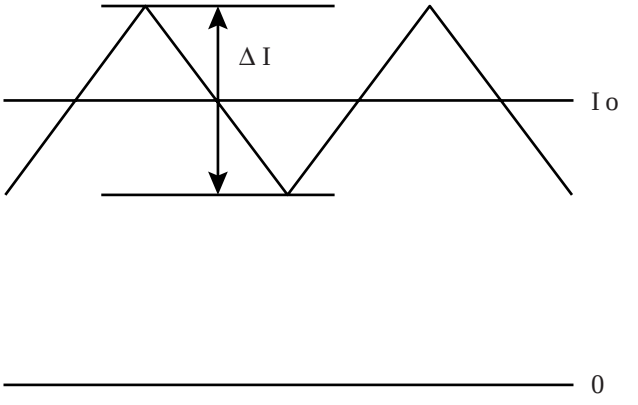
Inductance is determined so that ΔI is 30% of the rating output current at the maximum input voltage.

$$L1 = \frac{(Vi\ (max) - Vo) \times Vo}{\Delta I \times Vi\ (max) \times f} [H]$$

Vi (max) = Maximum input voltage
Vo : Output voltage
ΔI : 30% of output current (Io × 0.3)
f : Oscillation frequency (250 kHz)
Io : Output current

Calculated inductance values (L1) shown here represent those used in previously manufactured devices and may not be applicable to your device. The use of an actual value somewhat higher than the measured value is standard procedure. However, actual values lower than the measured value may be used where the rated current is low. Use the formula to back-calculate the Δ I using the selected L1 value. The recommended value is 0 . 2 × Io ≦ Δ I ≦ 0 .4 × Io (10 - 20% of output current × 2).

●Choke (L1) current



◆7 − 3 Output capacitor (C5) selection

If an electrolytic capacitor is used, output ripple is determined by ΔI and capacitor impedance. Use the formula below to calculate the value. Select a device providing an impedance (Zc) lower than the calculated value.

$$Zc \leqq \frac{Vrip}{\Delta I} [\Omega]$$

Vrip : Output ripple voltage (Ex : 25mV$_{P\text{-}P}$)
Δ I : 30% of output current
Zc : Electrolyte capacitor impedance

◆7 − 4 Input capacitor (C1) selection

A large ripple current flows through the input capacitor. Use the formula below to calculate the value. Select a device providing a higher ripple current capacity (Irip) than the calculated value.

$$D = \frac{Vo}{Vi\ (min)}$$

$$Irip \geqq \sqrt{D\ (1-D)} \times Io\ [A]$$

D : Duty
Vo : Output voltage
Vi (min) : Minimum input voltage
Io : Output current

◆7 − 5 Thermal management

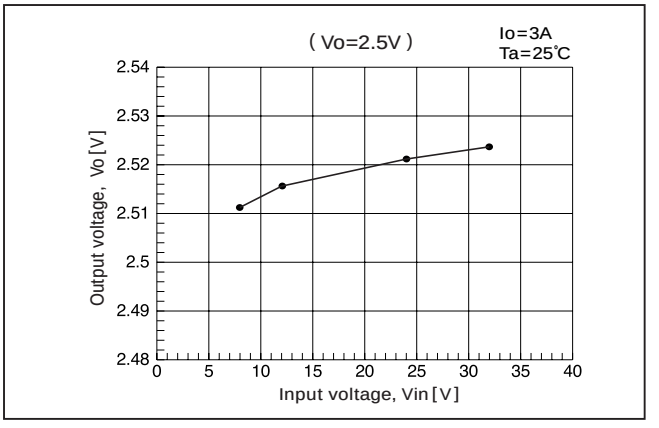
Temperature increase varies with input voltage, output voltage, and output current. Case surface temperatures should not exceed 105℃. Set-up your equipment accordingly.

8 Electrical data measurement

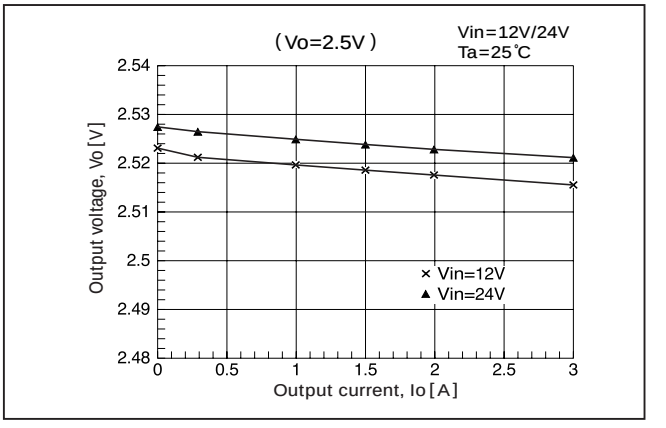
The data given below is based on standard connection diagrams (Figures 6-A, 6-B), and makeup of reference parts and surface mounted parts modules of reference circuitry patterns.

◆8 – 1 Output voltage - 2.5V

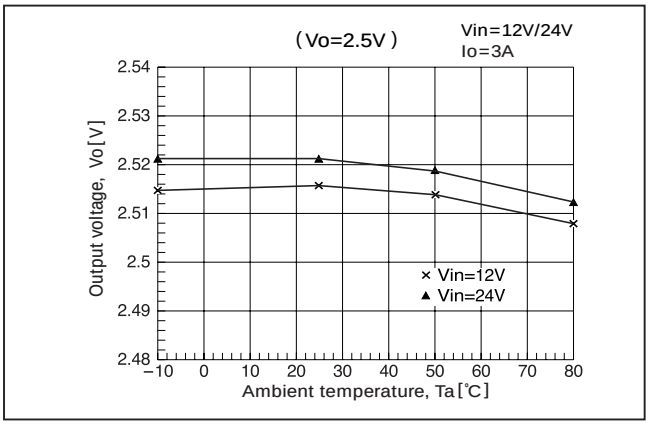
● Line regulation



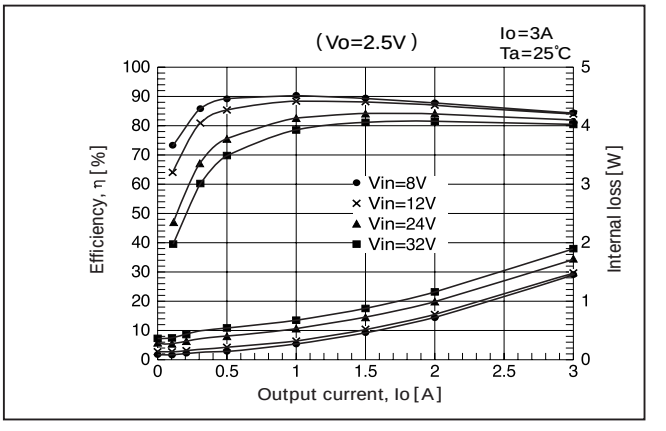
● Load regulation



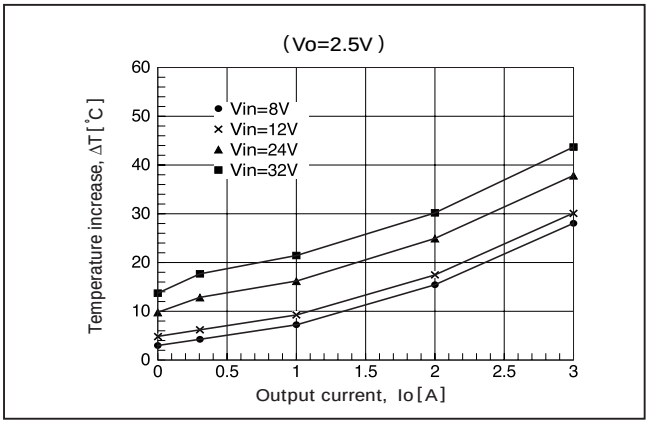
● Temperature drift



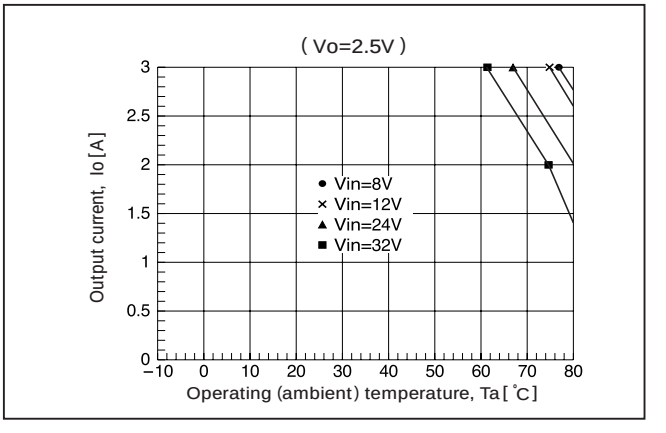
● Efficiency and loss characteristics



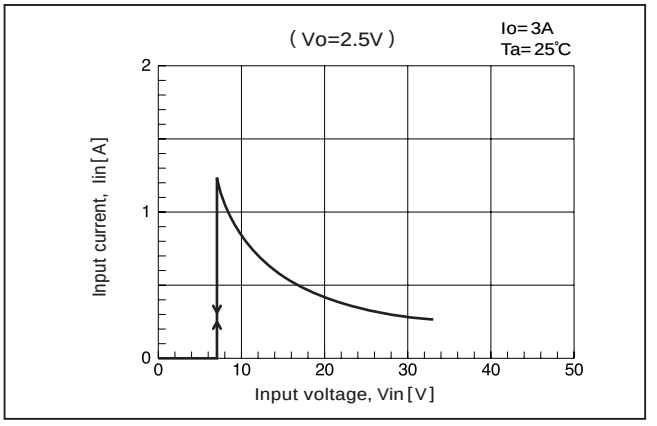
● IC temperature increase



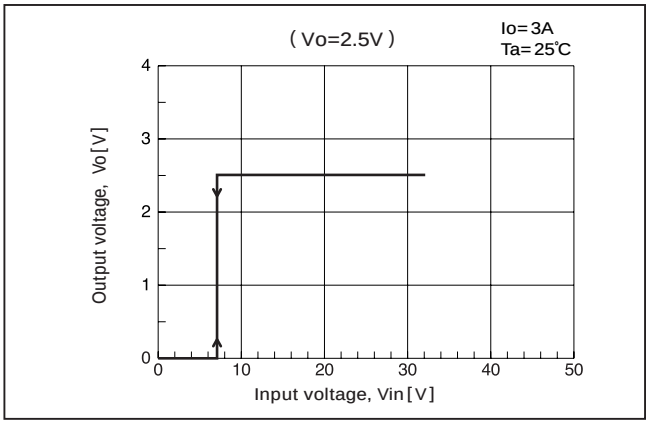
● Derating curve



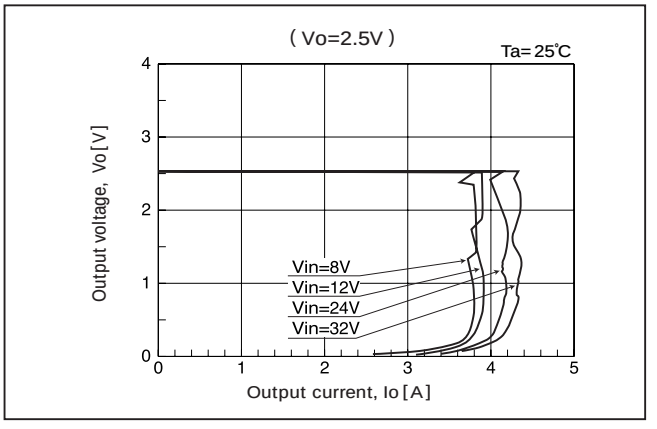
● Input voltage / input current characteristics



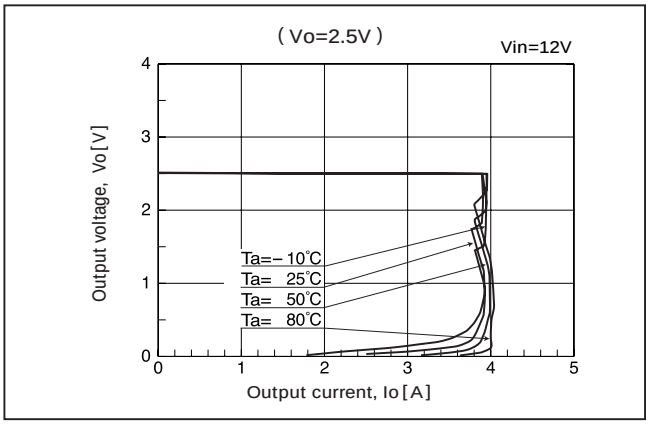
● Input voltage/output voltage characteristics



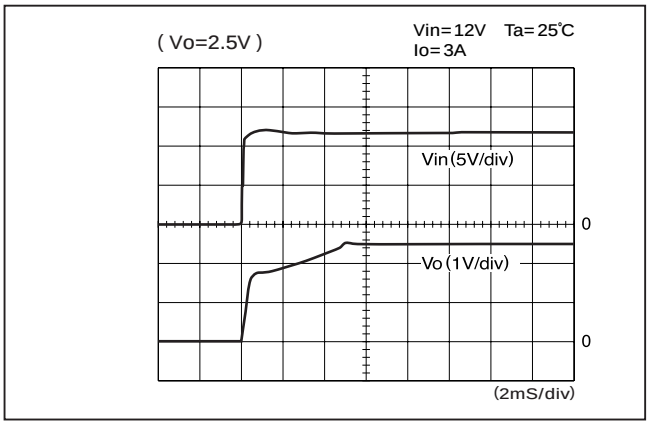
● Current limit characteristic (Input fluctuation)



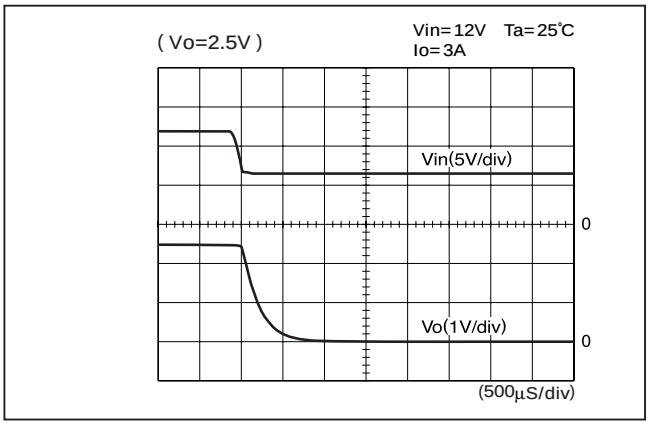
● Current limit characteristic (Temperature fluctuation)



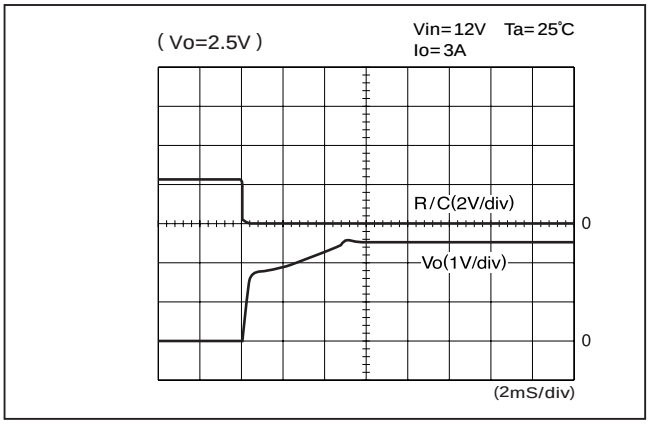
● Start-up rising characteristics



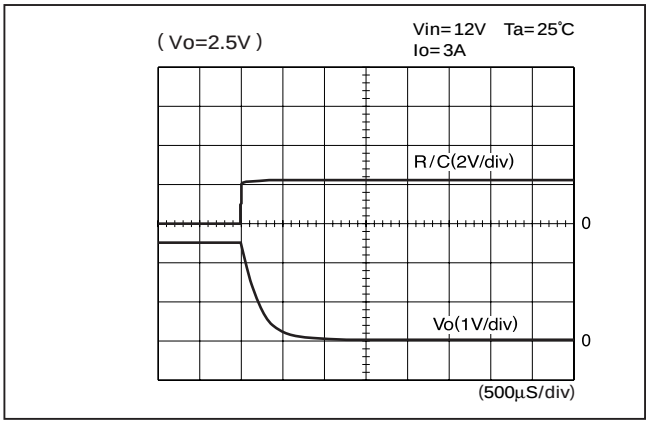
● Shut-down falling characteristics



● Rise characteristics with remote control turned ON

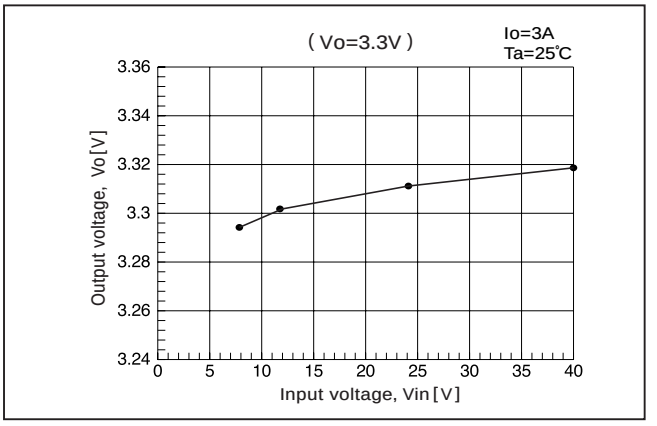


● Down characteristics with remote control turned OFF

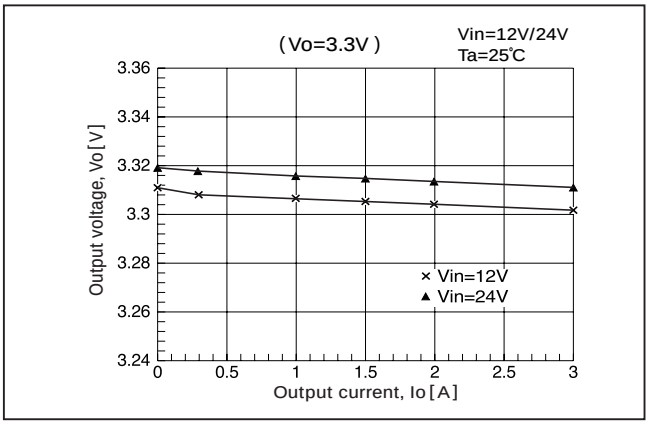


◆8 – 2 Output voltage - 3.3V

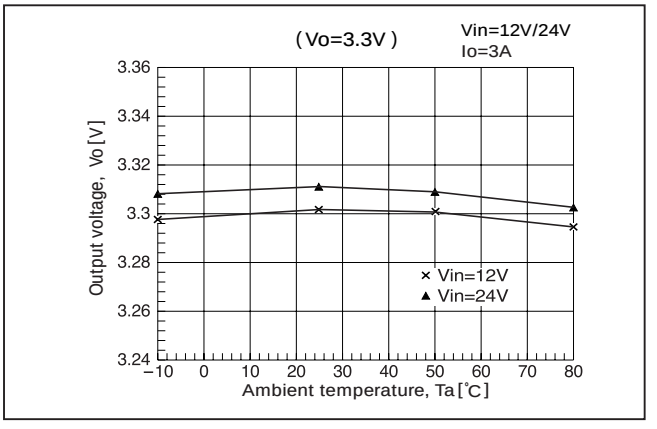
● Line regulation



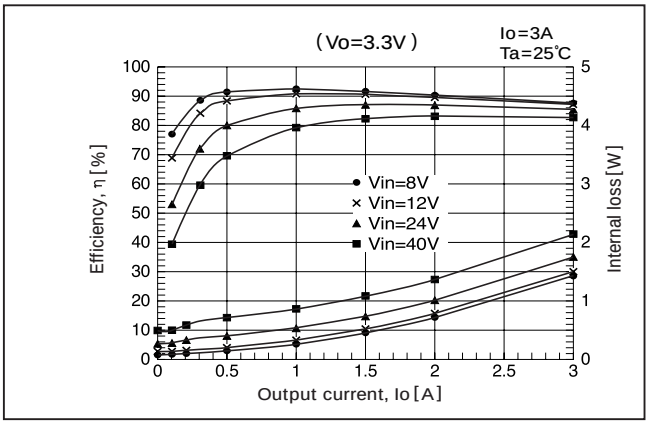
● Load regulation



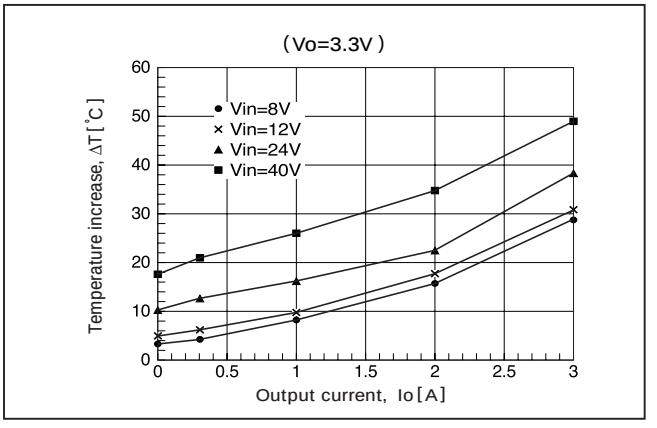
● Temperature drift



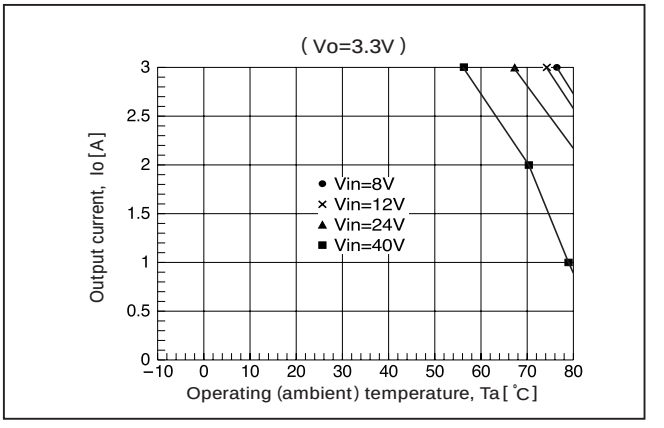
● Efficiency and loss characteristics



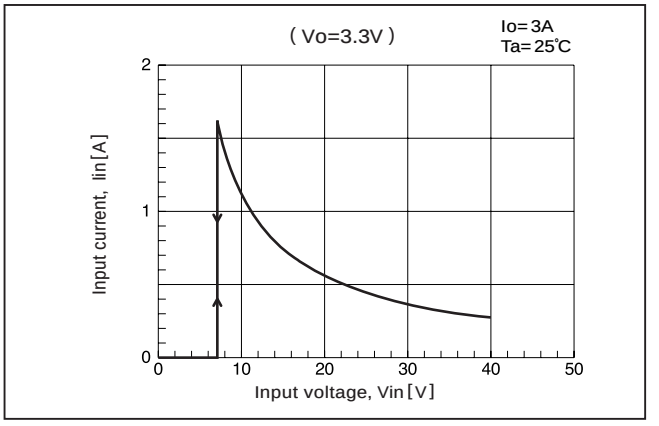
● IC temperature increase



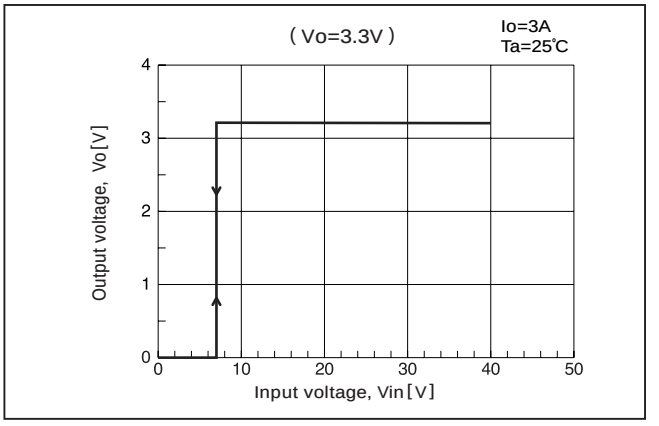
● Derating curve



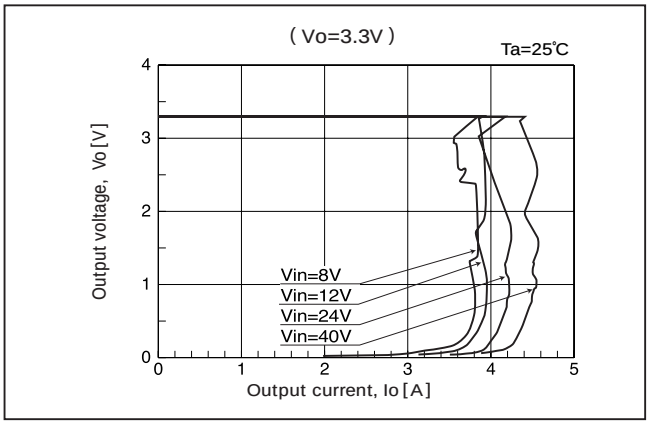
● Input voltage / input current characteristics



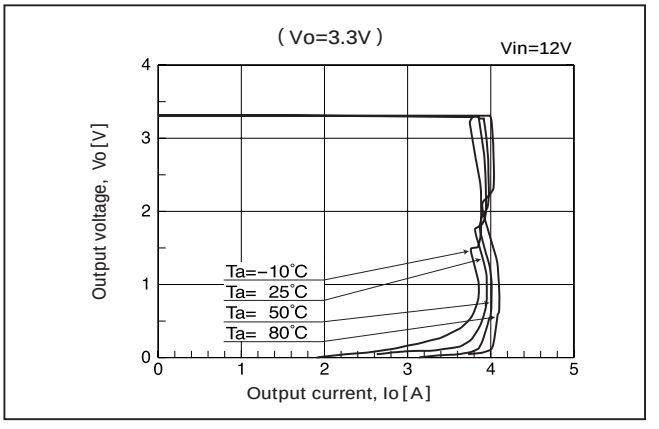
● Input voltage/output voltage characteristics



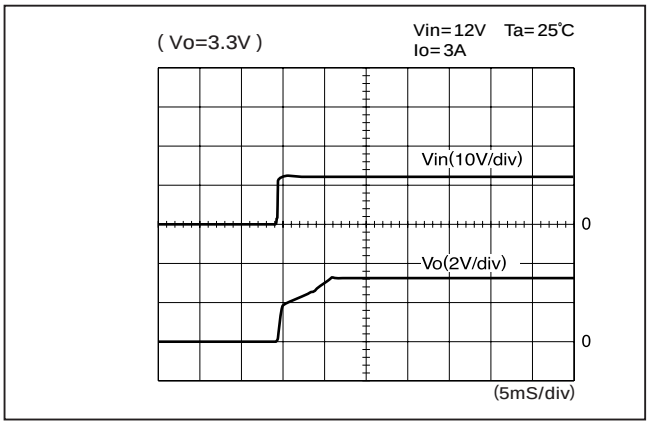
● Current limit characteristic (Input fluctuation)



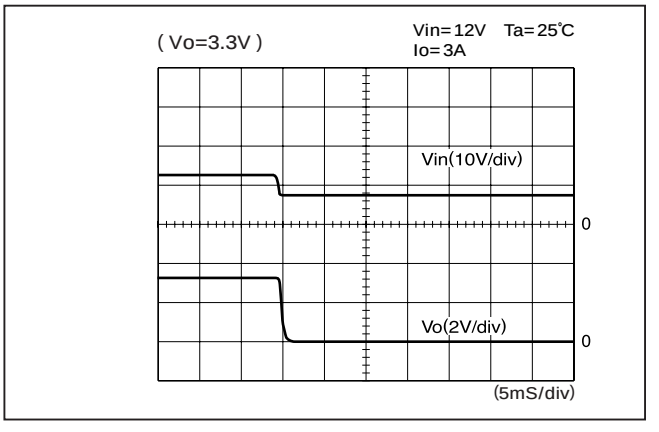
● Current limit characteristic (Temperature fluctuation)



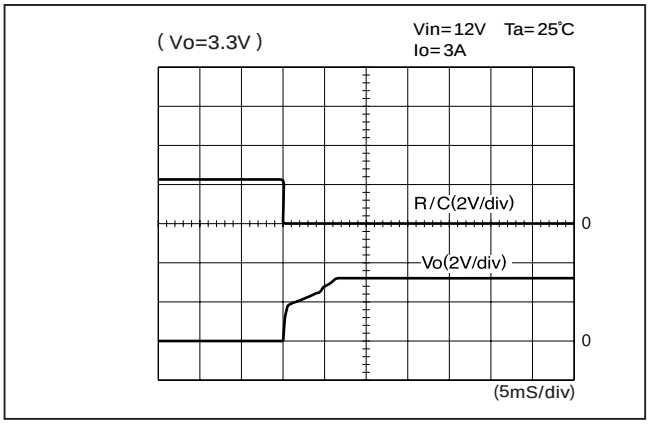
● Start-up rising characteristics



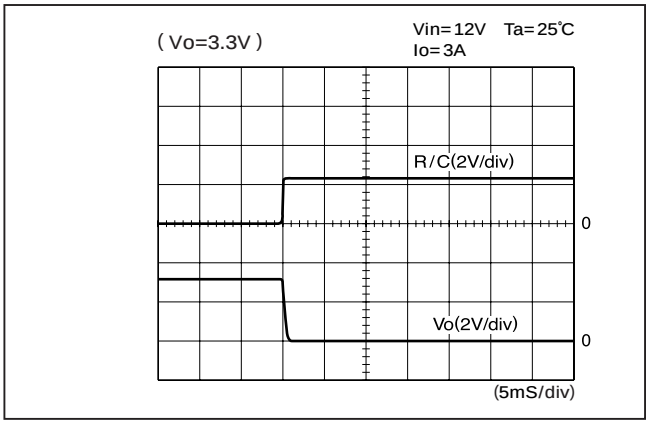
● Shut-down falling characteristics



● Rise characteristics with remote control turned ON

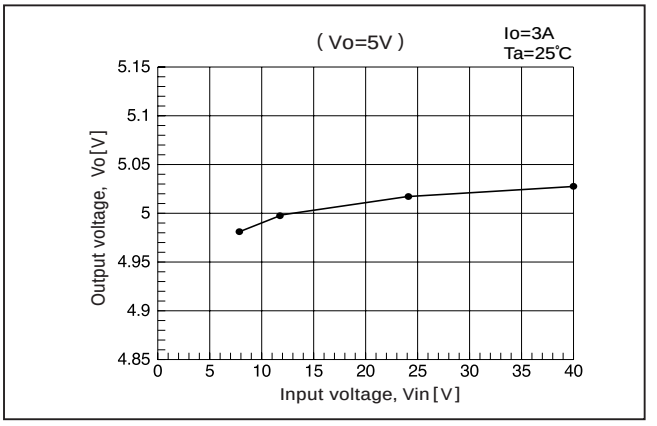


● Down characteristics with remote control turned OFF

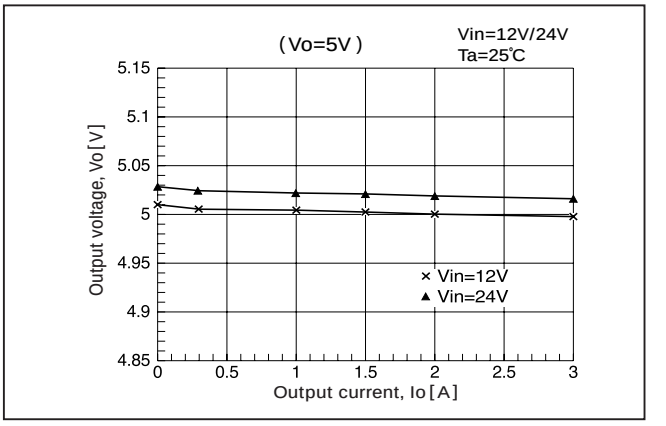


◆8 – 3 Output voltage - 5V

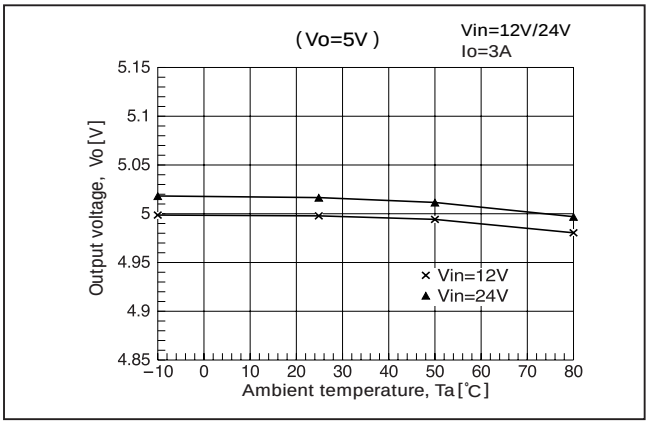
● Line regulation



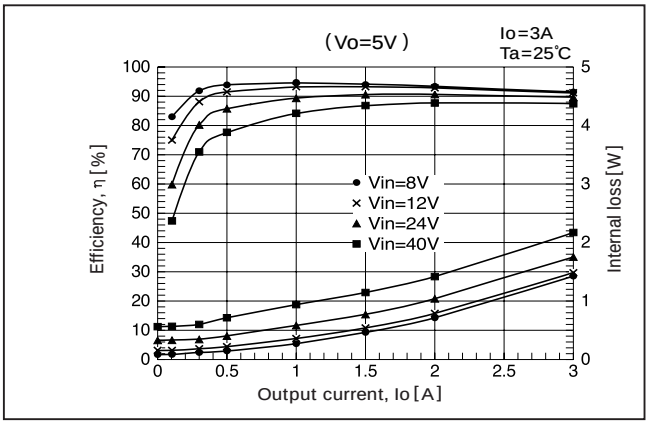
● Load regulation



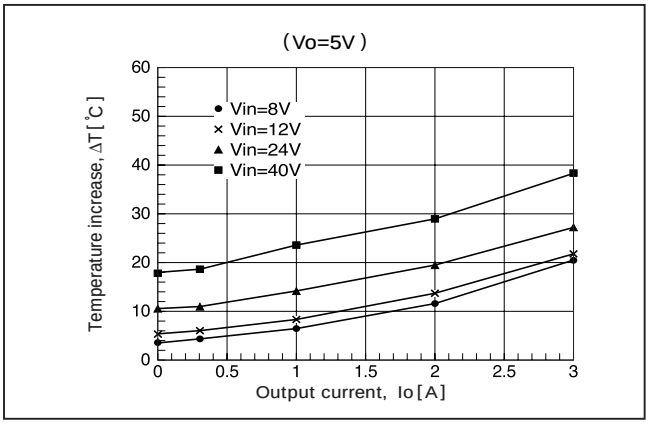
● Temperature drift



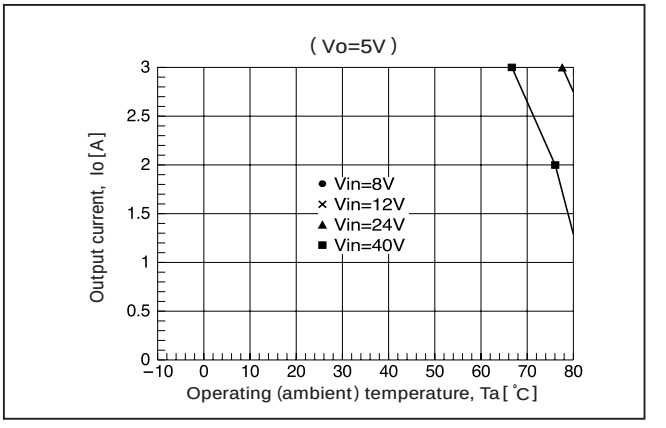
● Efficiency and loss characteristics



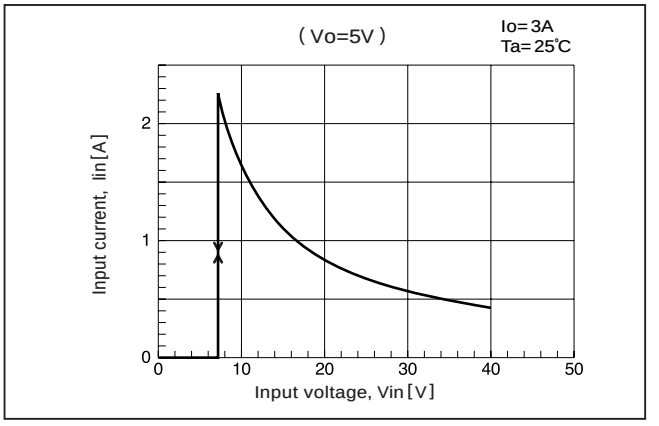
● IC temperature increase



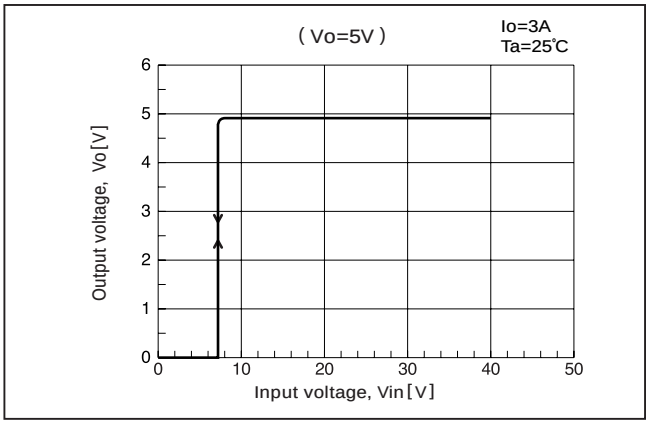
● Derating curve



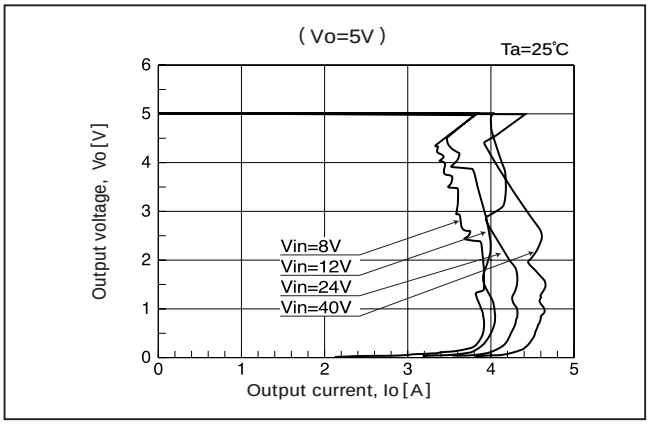
● Input voltage / input current characteristics



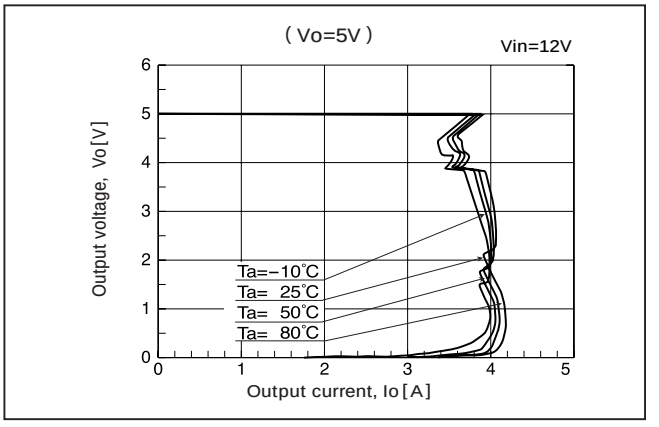
● Input voltage/output voltage characteristics



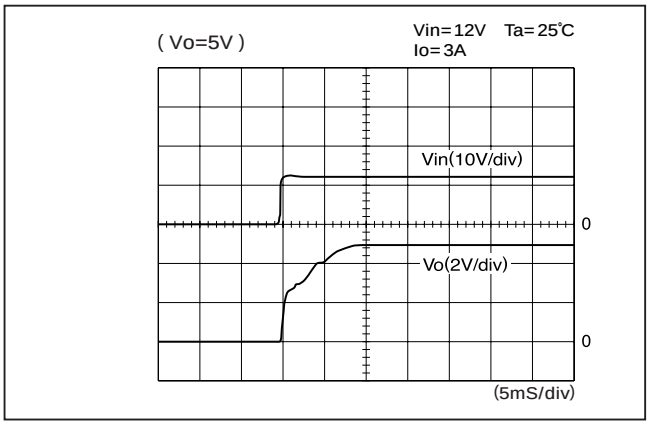
● Current limit characteristic (Input fluctuation)



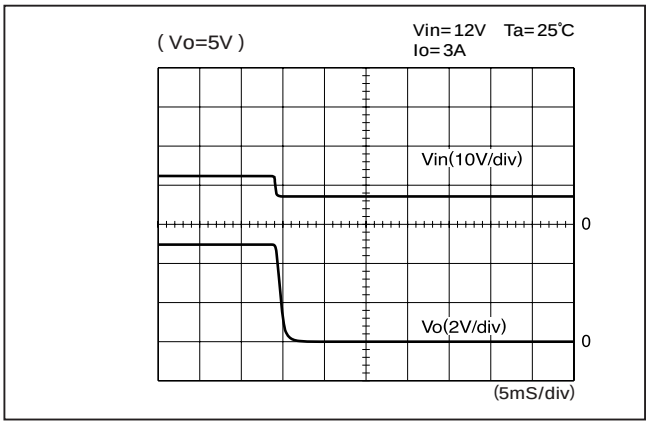
● Current limit characteristic (Temperature fluctuation)



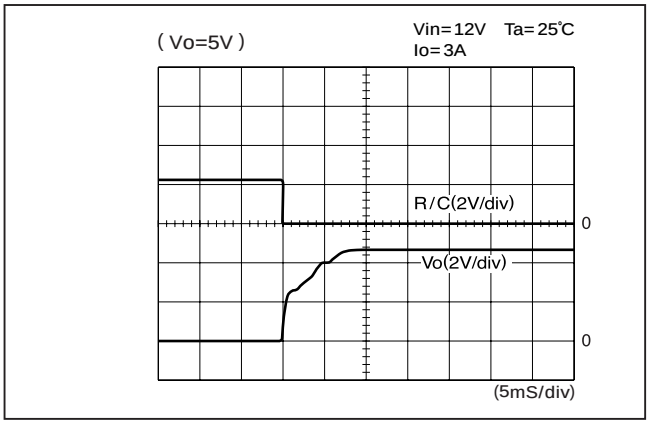
● Start-up rising characteristics



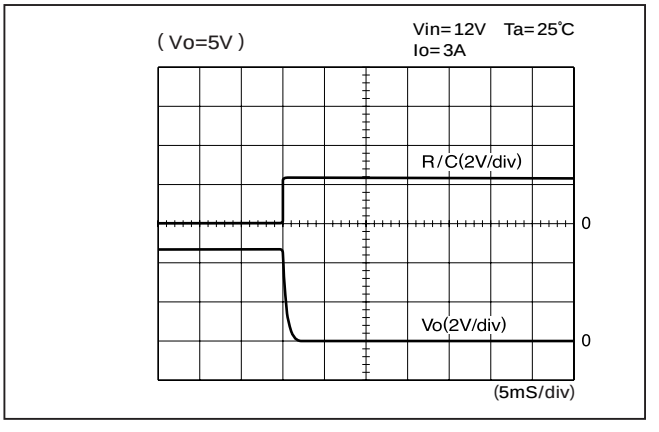
● Shut-down falling characteristics



● Rise characteristics with remote control turned ON

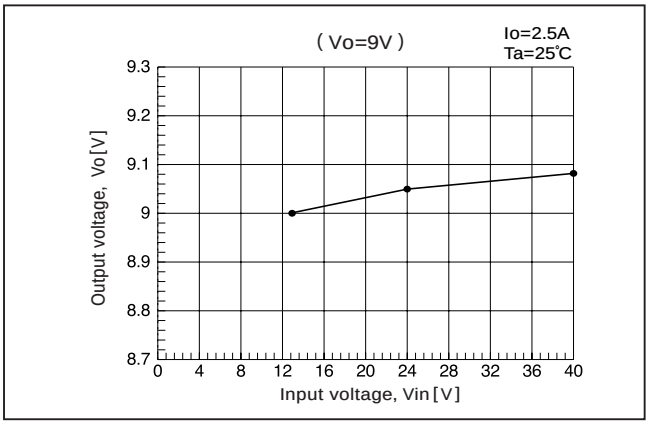


● Down characteristics with remote control turned OFF

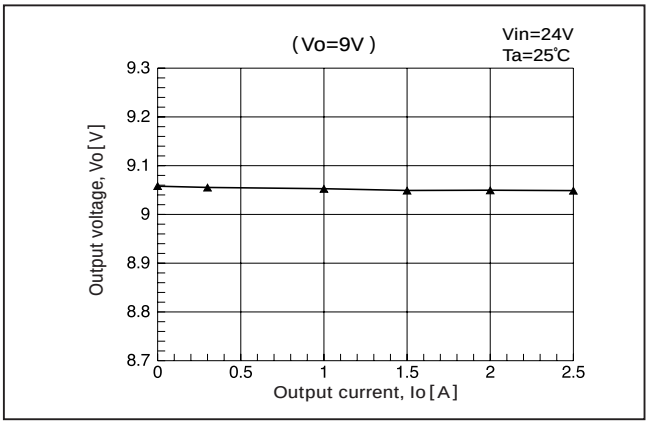


◆8 – 4 Output voltage - 9V

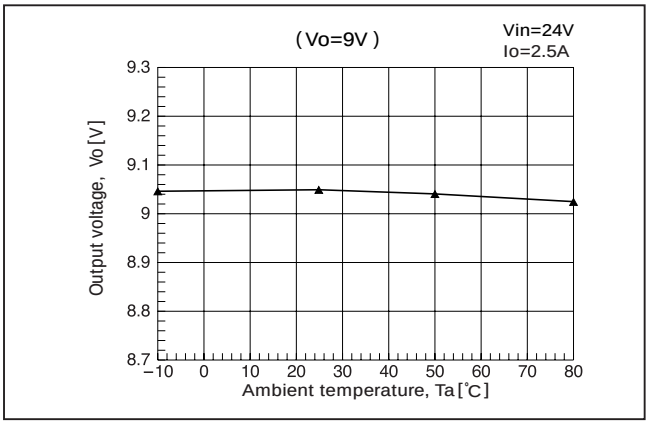
● Line regulation



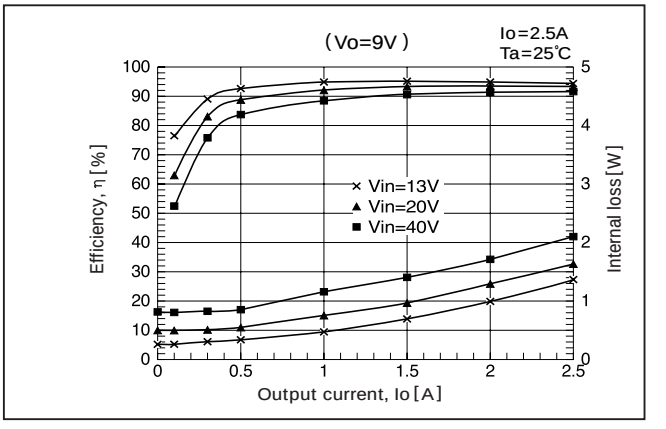
● Load regulation



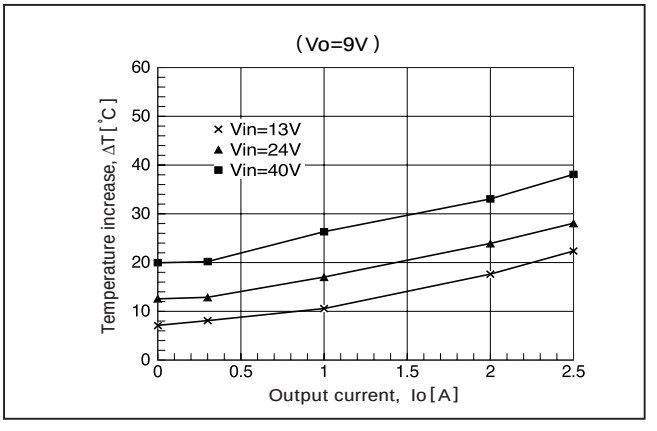
● Temperature drift



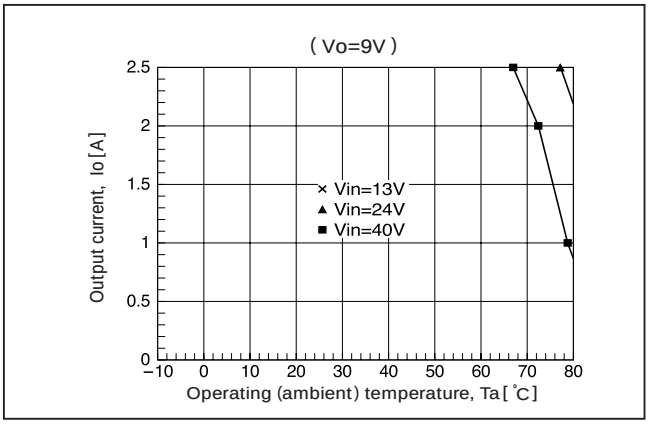
● Efficiency and loss characteristics



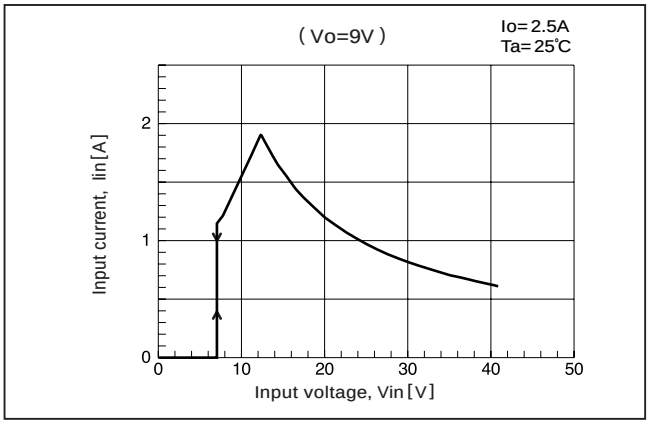
● IC temperature increase



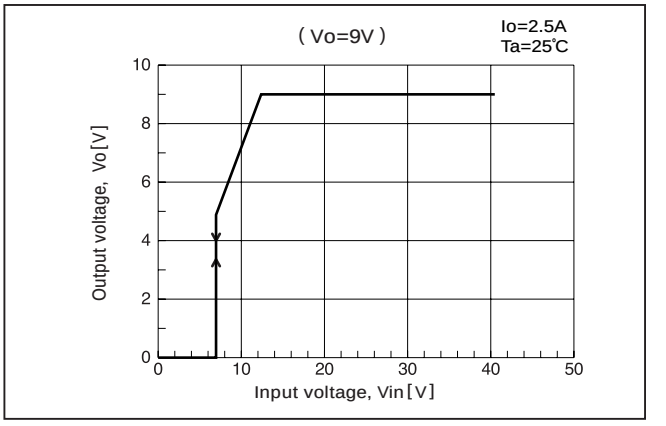
● Derating curve



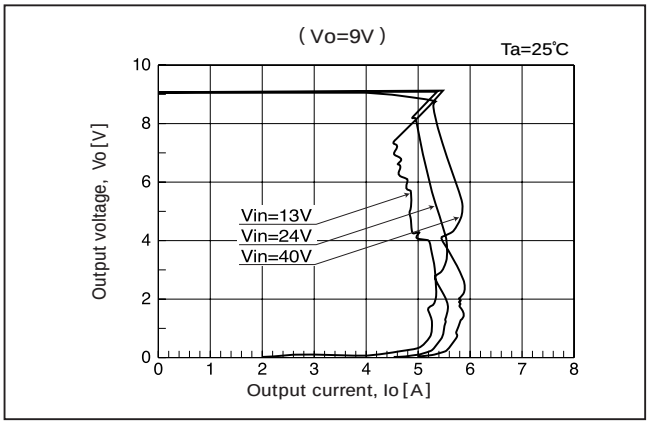
● Input voltage / input current characteristics



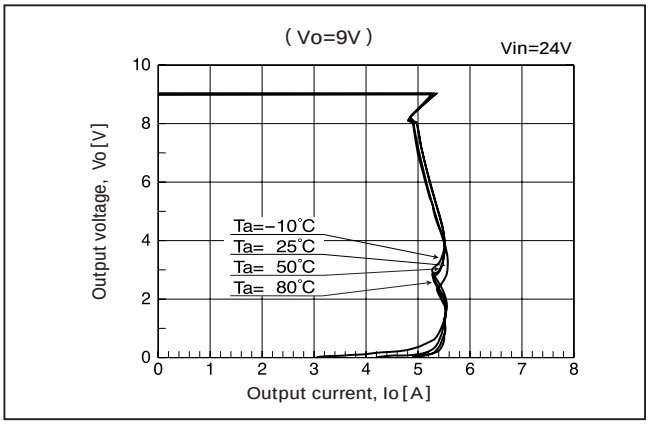
● Input voltage/output voltage characteristics



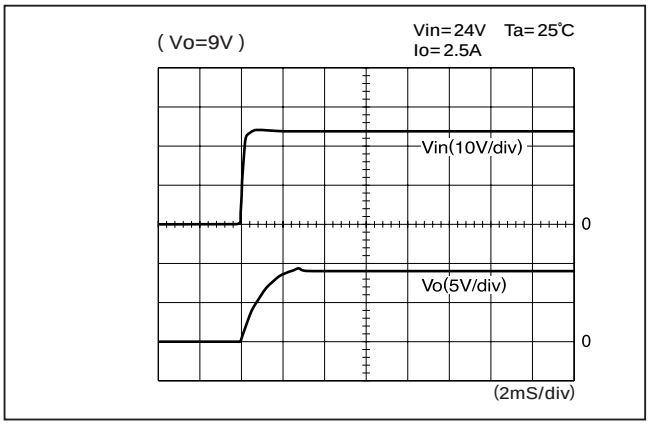
● Current limit characteristic (Input fluctuation)



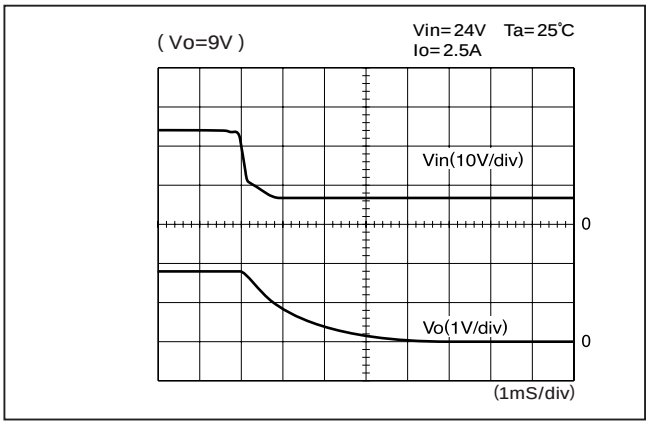
● Current limit characteristic (Temperature fluctuation)



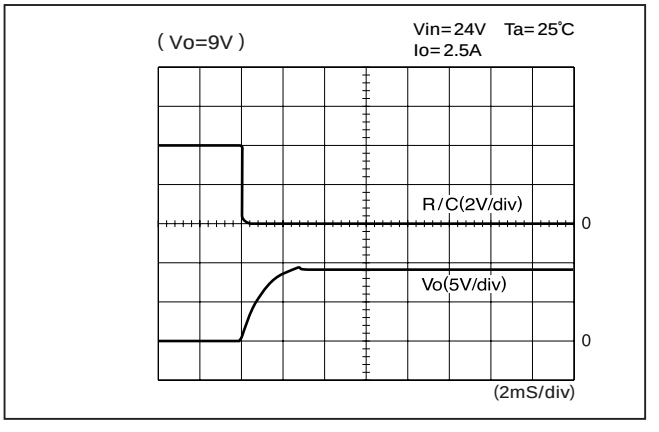
● Start-up rising characteristics



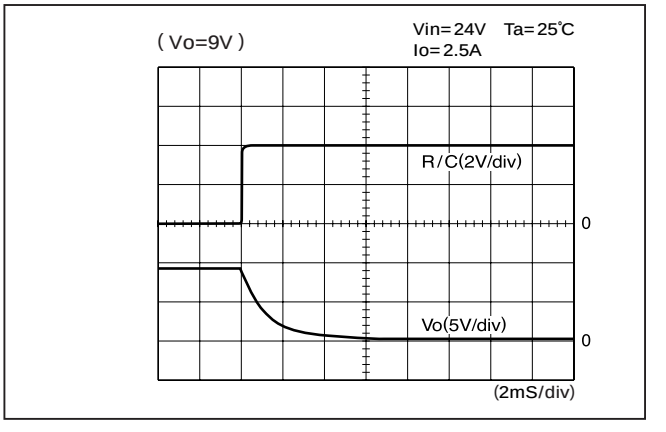
● Shut-down falling characteristics



● Rise characteristics with remote control turned ON

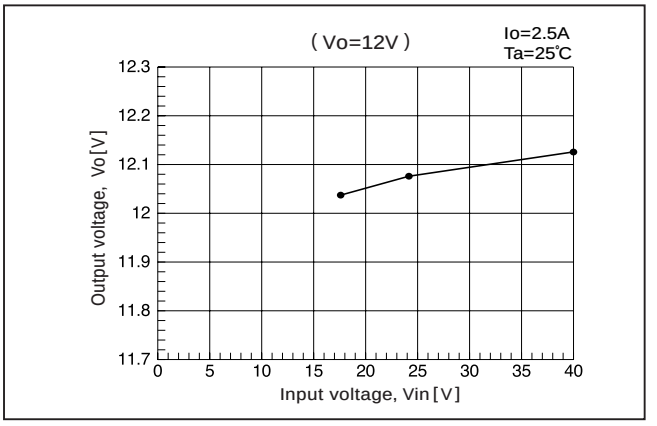


● Down characteristics with remote control turned OFF

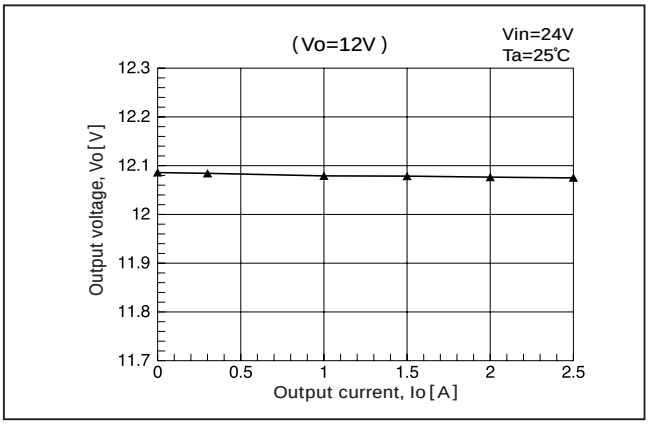


◆8 – 5 Output voltage - 12V

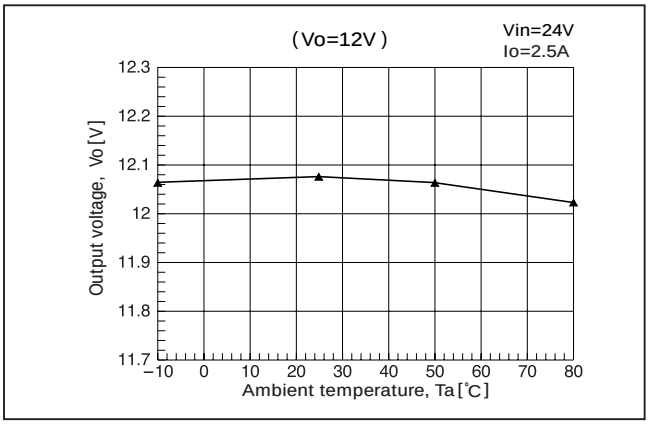
● Line regulation



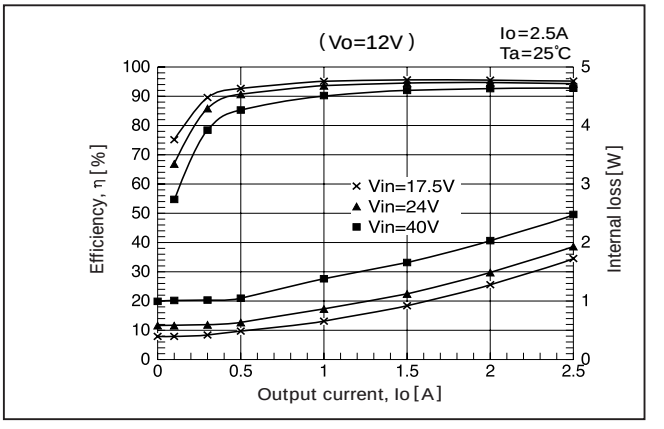
● Load regulation



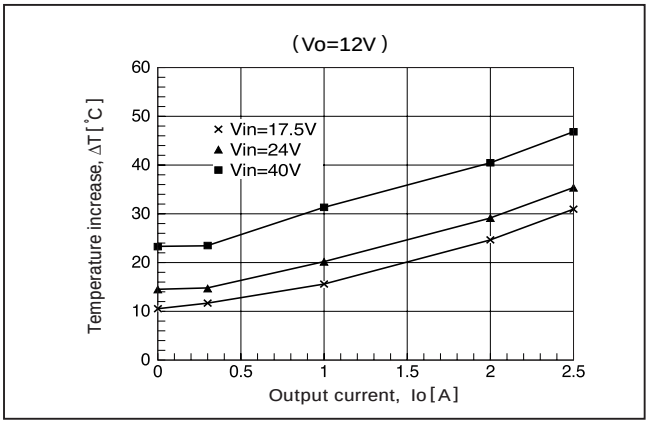
● Temperature drift



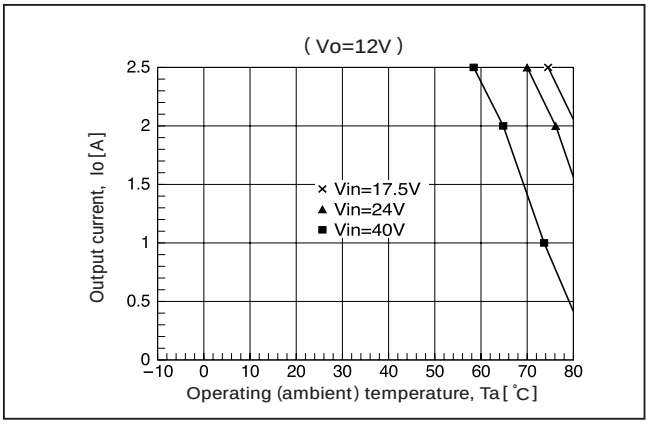
● Efficiency and loss characteristics



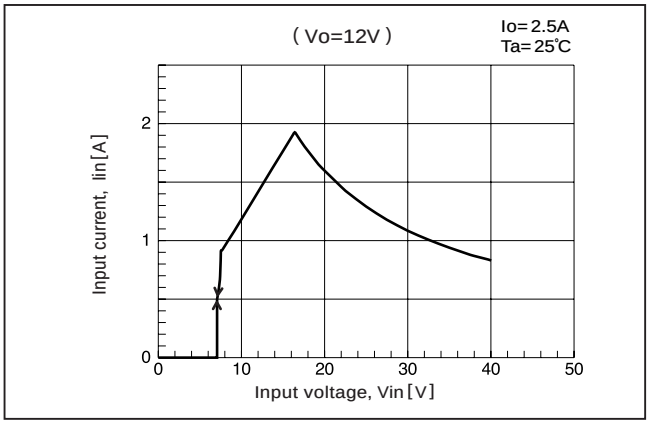
● IC temperature increase



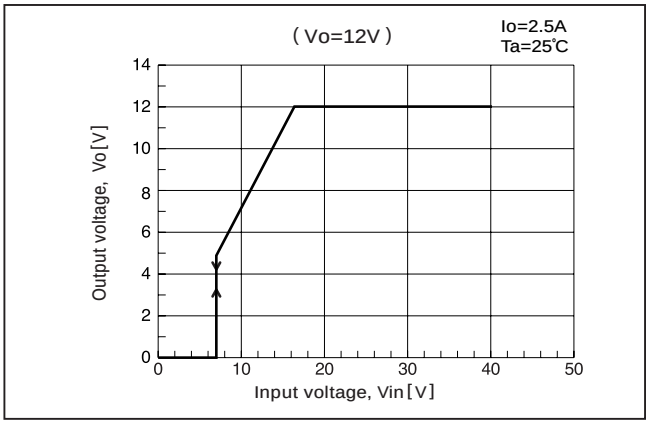
● Derating curve



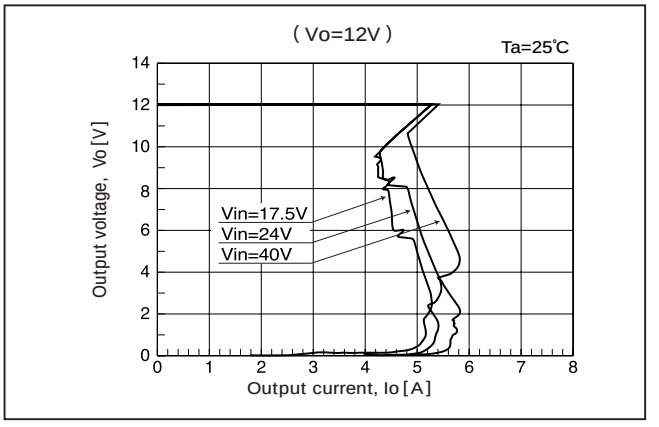
● Input voltage / input current characteristics



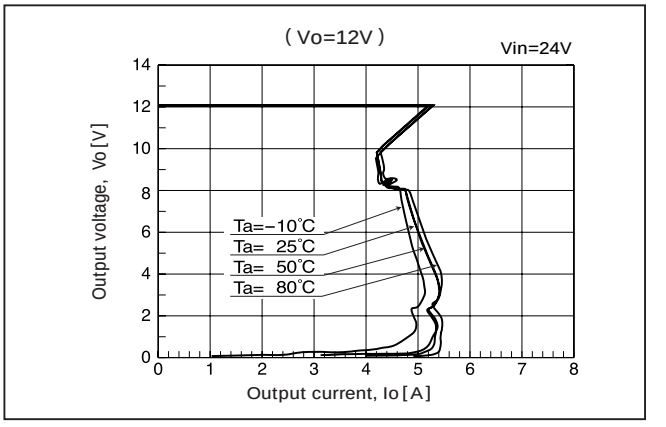
● Input voltage/output voltage characteristics



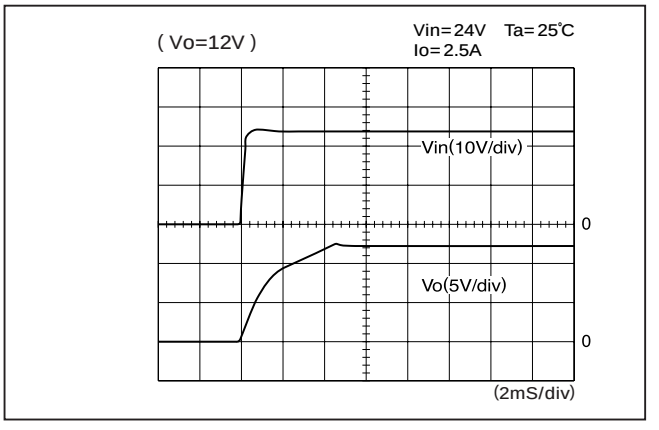
● Current limit characteristic (Input fluctuation)



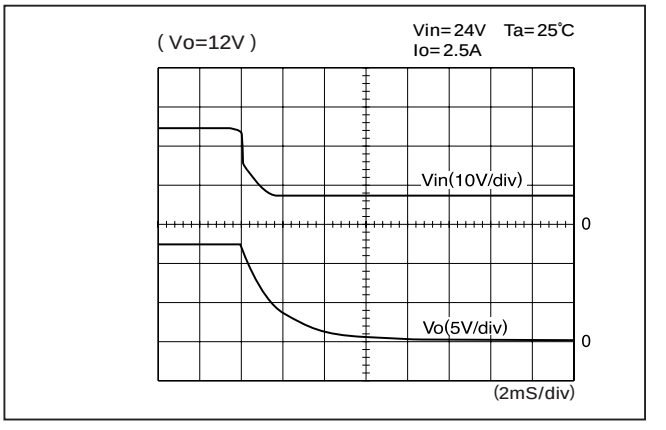
● Current limit characteristic (Temperature fluctuation)



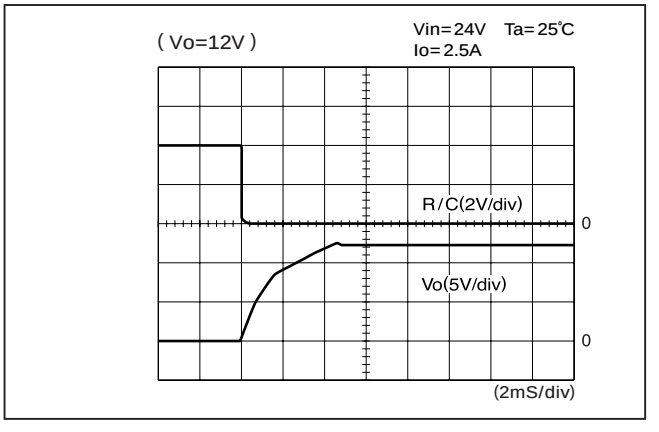
● Start-up rising characteristics



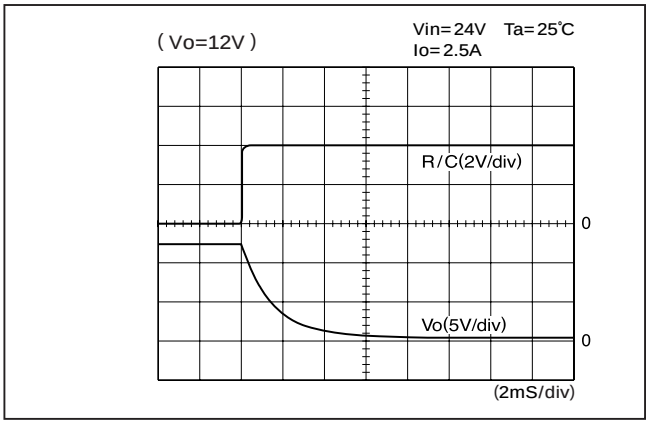
● Shut-down falling characteristics



● Rise characteristics with remote control turned ON



● Down characteristics with remote control turned OFF



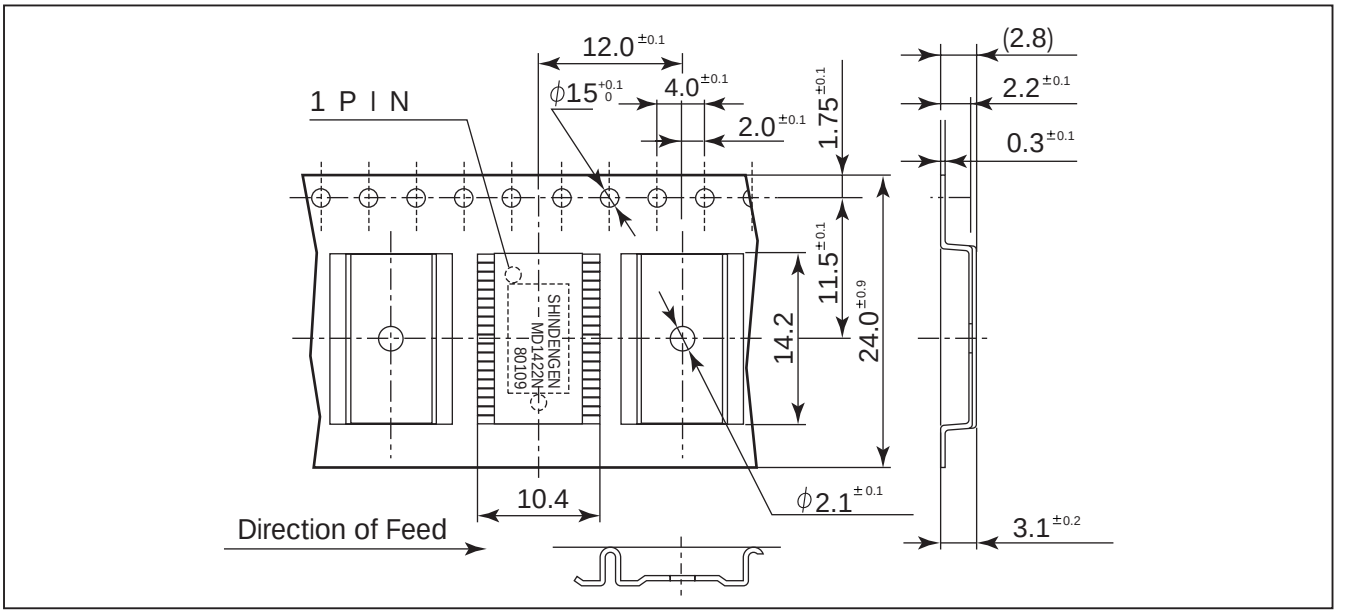
9 Packing

◆9 – 1 Tape & Reel

1） Tape

Material : PVC

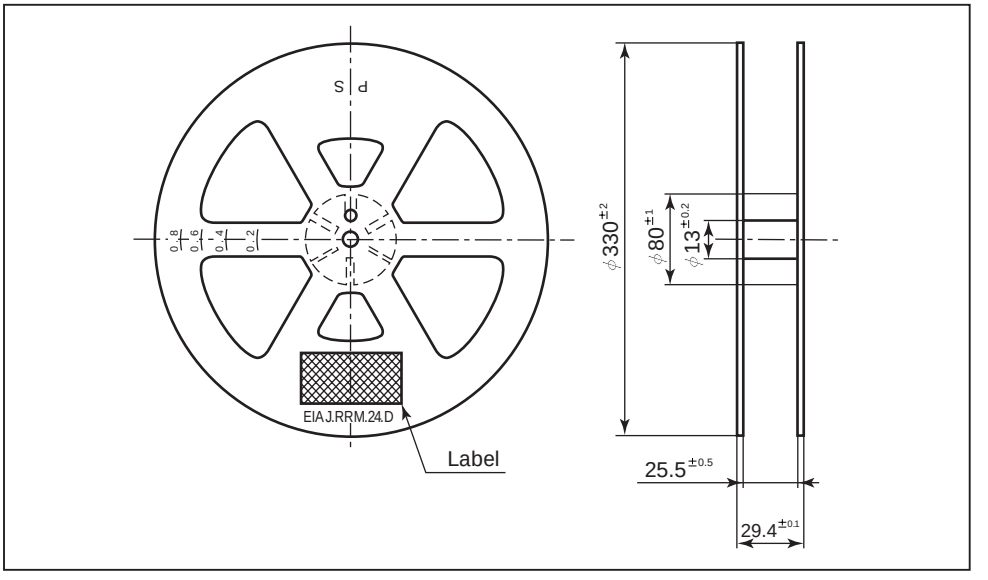
Dimensions Comply with JIS, C-0806



2） Reel

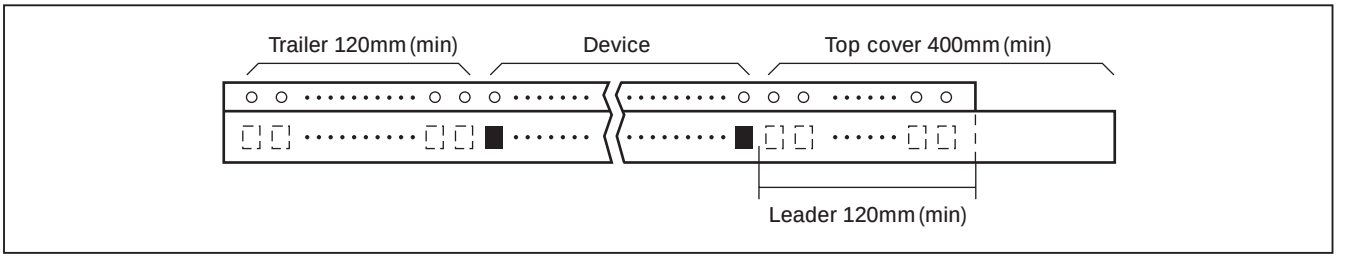
Material : Polystyrene

Demensions Comply with EIAJ, ETX-7001



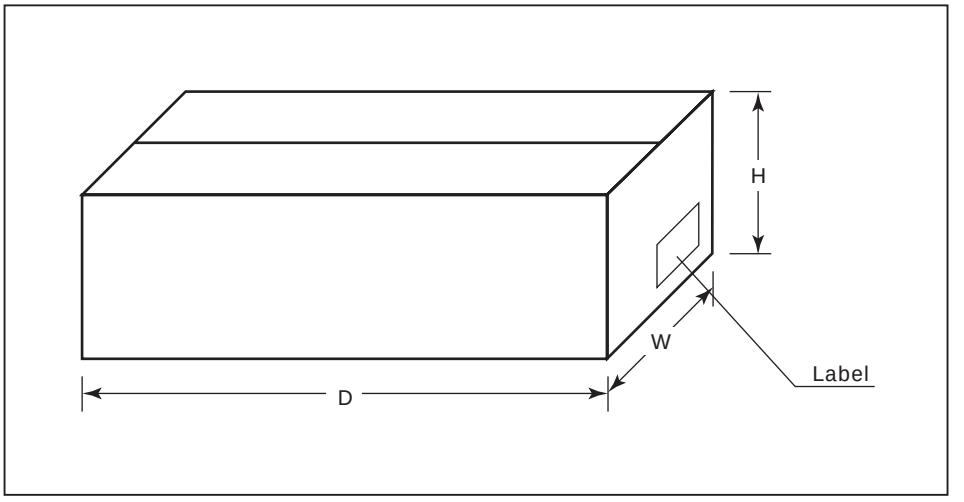
・Label
Type No.
Code No.
Date Code
Quantity
Manufacturer

3） Leader and Trailer



◆9 – 2 Packing

・Tape & Reel : 6,000pcs (3 Reels)/Outer Carton



・Marking

Type No.・Code No.・Date Code・Quantities

◆9 – 3 Ordering and Dimensions

Package	Code No.	Minimum Ordering Quantities	Quantities Per Inner Carton (pcs.)	Quantities per Outer Carton		Outer Carton(mm)		
				pcs./Carton	Weight (kg)	D	W	H
SSOP-32	4072	2000	2000	6000	7.6	363	363	160

All specificafions are subject to change without notice.

Please note that the information contained in this catalog may change for improvement or other purpose without notice.
Issued: April 2001

Export regulations of strategic materials, etc.
This product is classified as the integrated circuit specified in Item 7 in the Attached Table No. 1 to the Export Trade Control Order and in Article 6 of the Ordinance of the Ministry of International Trade and Industry.
This product is subject to the KNOW regulation.
April 2001

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