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# Power supply for MPPC

# C11204-01

# Operation Manual

Be sure to read the operation manual carefully before this board is used.
If operated differently from the standard procedure in the manual,
a serious accident may occur.
Keep this manual for future reference.

Doc. No. K29-B61072e

Revision. K Oct. 4, 2021

FormKXX-3513 B

# TABLE OF CONTENTS

# 1. OVERVIEW

This module is a high-voltage power supply that is optimized for driving HAMAMATSU MPPC (multi-pixel photon counter) series. It can provide up to 90V output. By connecting an external analog temperature sensor, this module has built-in temperature compensation function that MPPC can be operated optimumly even if an environment temperature is changed. It has built-in the output voltage monitor function and the output current monitor function.
All functions can be controlled via the serial interface. The C11204-01 is available in a 16-lead hybrid board.

## ■ Features

- Wide output voltage range: 20 V to 90 V
- Low ripple noise: 0.1mVp-p max.
- Superb temperatures stability: ±10ppm/°C typ.
- Finely adjustable resolution (in 1.8 mV steps)
- Serial interface

# 2. PRECAUTIONS FOR USE

**WARNING**

■ **High voltage hazard!**

This module includes a high-voltage parts needed to operate the MPPC. Touching the high voltage parts may cause electrical shock, numbness or tingling. Also, improper short circuit may cause malfunction or failure. If you have to touch this module, always first turn off the power and wait at least 10 seconds before touching.

■ **Do not disassemble.**

Do not disassemble any part of this module. Changing the adjustment or modifying this module may cause malfunctions and lead to fire or electrical shock.

■ **Keep away from water or any liquid.**

Electrical shock or damage may occur if this module becomes wet.

■ **Be sure to connect the wiring correctly.**

Incorrect wiring may cause excessive current flow, resulting in damage to components and connected devices, or fire.

■ **Always observe the absolute maximum ratings.**

Do not use this module under conditions that exceed the absolute maximum ratings. Damage to this module or fire may result if used in excess of the absolute maximum ratings.

■ **Be careful to avoid short-circuits.**

During operation do not bring any conductive objects such as metal close to the PC board. These may cause short-circuits that damage the module or cause fire.

■ **Take adequate care to make sure that the soldering iron tip temperature and the soldering time are correct. Do not attempt soldering at high temperatures or long periods.**

Soldering of this product should be made by using a soldering iron. Recommended solder temperature is 260 degree or less, the soldering time should be done within 10 seconds.

# 3. PIN ASSIGN

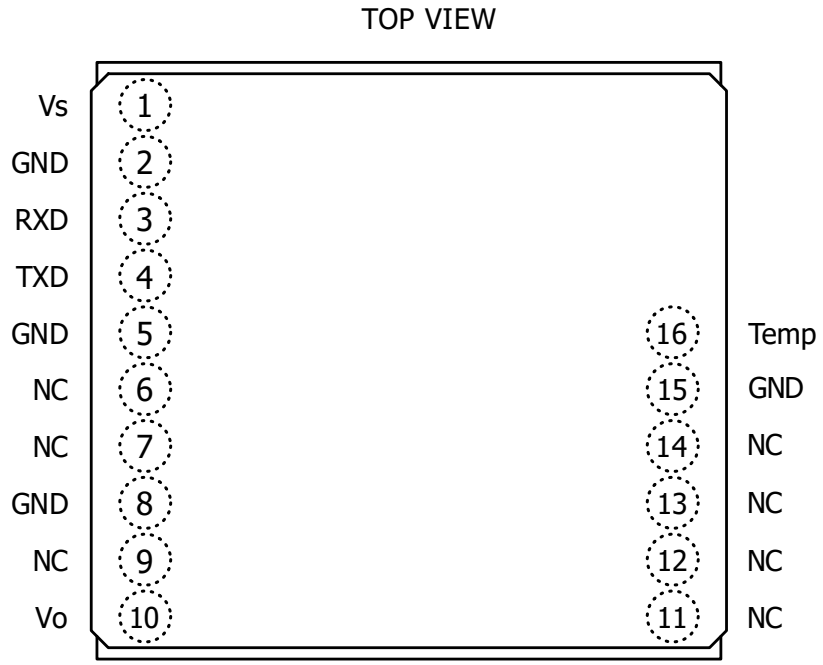



Fig.1 Pin assign

Table.1 Description of pin function

| Pin no. | Symbol | Function |
|---|---|---|
| 1 | Vs | Positive supply voltage<br>Furnish a bypass capacitor to ground as close to this pin as possible. |
| 2,5,8,15 | GND | GND<br>Connect directly to the ground plane using the shortest wire possible. |
| 3 | RXD | Serial data input |
| 4 | TXD | Serial data output |
| 6,7,9,11,<br>12,13,14 | NC | NC |
| 10 | Vo | High Voltage Output |
| 16 | Temp | Analog temperature sensor connection |

# 4. CONNECTION CIRCUIT EXAMPLE

Note: If you use an evaluation kit C12332, please refer to an operation manual of C12332.

## 4-1.Power Supply Pin (Vs) connection

Connect the power supply voltage to this pin (Pin 1). In this case, please connect a bypass capacitor between the GND. The bypass capacitor should be connected near the pin as possible.

## 4-2.High Voltage Output Pin (Vo) connect

Connect HAMAMATSU MPPC Series to this pin (Pin 10). This pin must be connected to low pass filter (resister and capacitor) to suppress the ripple noise (See Fig. 2). Low ESR capacitors should be used at the output to minimize the output voltage ripple.

## 4-3.RXD Pin and TXD Pin (RXD, TXD) connect

These are used for serial communication. The RXD (Pin 3) should be connected to a TXD of host. Similarly, the TXD (pin 4) should be connected to a RXD of host. Refer to Command Reference for the communication specification.
The details of the communication are described for "C11204-01 Command Reference".

## 4-4.Temperature sensor Pin (Temp) connect

Connect analog temperature sensor (Texas Instruments; LM94021) to this pin (Pin 16) (See Fig. 2). Put a low-pass filter (resister and capacitor) near this pin to remove a noise from C11204-01 (See Fig. 2). The pin 1 and pin 5 of the temperature sensor must be connected to GND. If you don’t use a temperature sensor, this pin must be connected to GND. When it is not connected, there is the case that the temperature compensation function will be malfunction.

*After the power is turned on it will be output immediately high voltage.

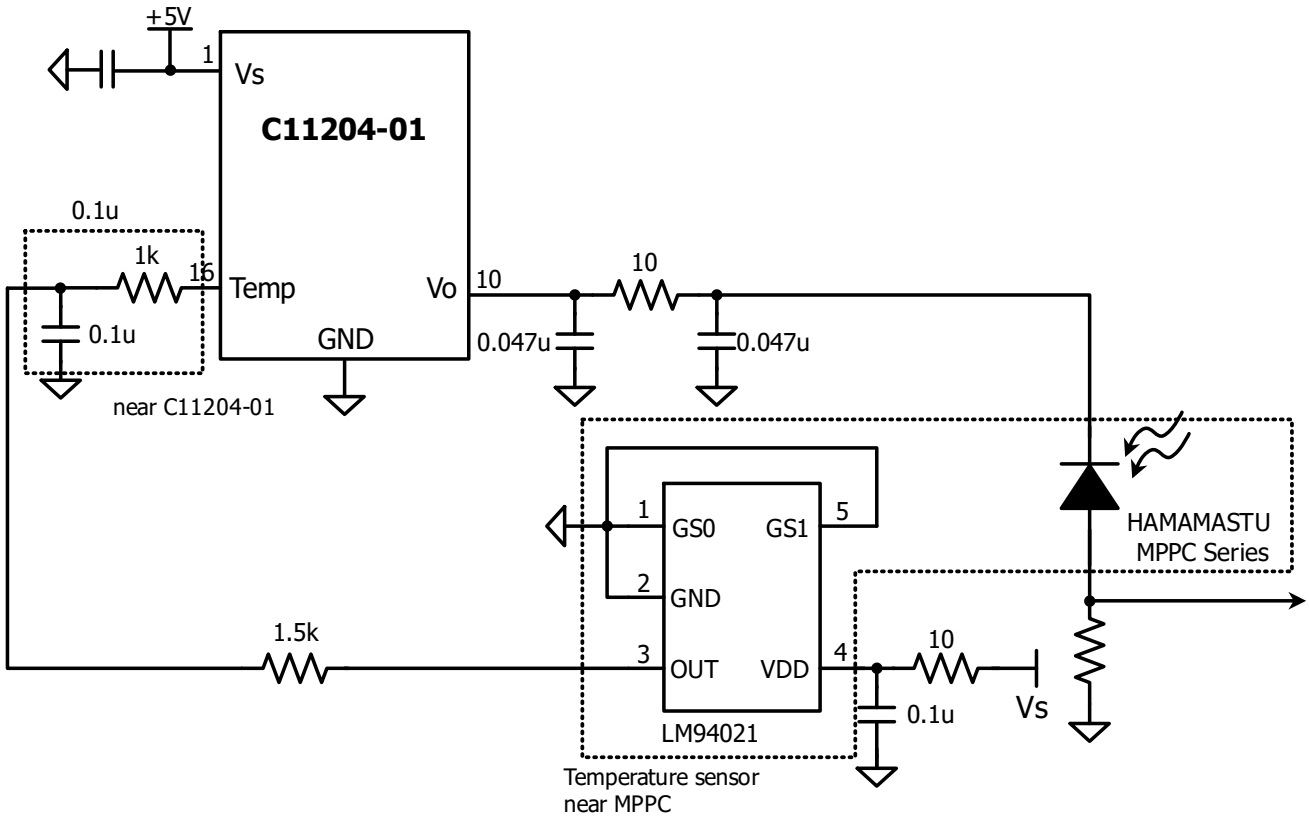



Fig.2 Connection circuit example

# 5. OPERATION METHOD

## 5-1.Installation method

■Mounting to socket

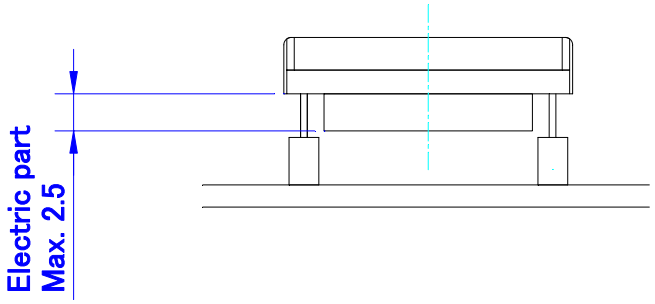



Fig.3 Mounting to the socket

*Recommendation socket: ME-10-10(MAC8)

■Soldering to PCB

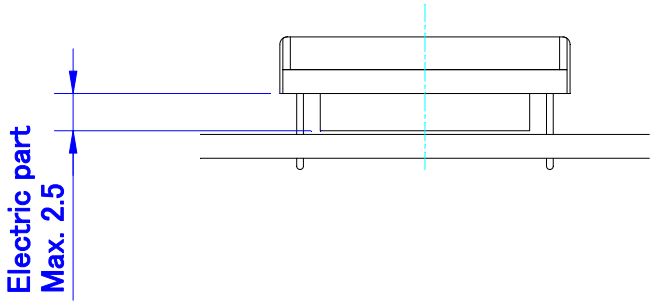



Fig.4 Soldering to PCB

If the tall parts are located at the under of the power supply, there is a possibility to contact with the electronic components of the power supply module. Do not locate the tall parts under the power supply as possible.

## 5-2.Power ON method

1. Turn the power on
The power supply module and turn on the power supply (+5V).
By default, the high voltage +40V is output.
After the power is turned on, check whether excessive current is flow the device and whether the device is operating abnormally, for example if smoke is coming out.
If any abnormal operation occurs, immediately power off.

2. Setting of the output voltage
Set the parameters of the power supply module so that the output voltage to match the MPPC you want to use. About the information about how to set the output voltage, refer to the temperature compensation function of 6.FUNCTIONS.

## 5-3.Power OFF method

Turn off the power of the power supply module.

# 6. FUNCTIONS

## 6-1.Temperature compensation function

When the ambient temperature of the MPPC is changed, is a function of outputting the calculated voltage value based on a correction coefficient set in the power module.
Set reference voltage Vb [V], reference temperature Tb [°C], primary temperature coefficient ΔT [mV/°C], and secondary temperature coefficient ΔT '[mV/°C$^2$], it can be performed "temperature compensation" by using the temperature T[°C] of the external temperature sensor.
All setting of the C11204-01 uses serial communication (UART).

The output voltage Vo[V] is determined by the following formula.

$$Vo = (\Delta T' * (T - Tb)^2 + \Delta T * (T - Tb)) / 1000 + Vb$$

Temperature coefficient ΔT'[mV/°C$^2$] and ΔT[mV/°C] can have four of the high-temperature side of the ΔT'1[mV/°C$^2$], ΔT1[mV/°C] and the low-temperature side of the ΔT'2[mV/°C$^2$], ΔT2[mV/°C] than reference temperature Tb [°C].
Because of the temperature coefficient of the MPPC is nearly straight, set the temperature coefficient listed in the MPPC of the data sheet to be used in primary temperature side coefficient. Please set to 0 in the secondary temperature coefficient ΔT'[mV/°C$^2$].
However, if you want to curve rather than a straight line the temperature coefficient for some reason, such as the temperature characteristics of the amplifier, correction in the curve as described in Fig.5 Temperature compensation function by setting the secondary temperature coefficient becomes possible.
Incidentally, the value of the correction coefficient to be input is because there is a possibility of greatly varies the voltage, use without having a strong confirmation when it is entered.

If you do not want to use the temperature compensation function, set to 0 ΔT'[mV/°C$^2$] and ΔT[mV/°C].

When the temperature of the temperature sensor deviates significantly, the temperature compensation function becomes OFF forcibly. In this case, the output voltage will be set to the reference voltage Vb[V].

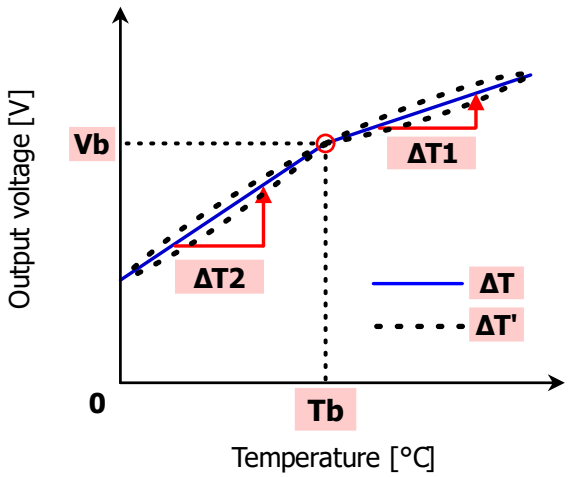



Fig.5 Temperature compensation function

## 6-2.Monitor function

It can be measured the output voltage Vo[V], output current Id[mV], and external temperature sensor value T[°C]. If you want to get the monitor value, "Get the monitor information and status", "Get output voltage", "Get output current", use the "Get MPPC temperature" command (See C11204-01 Command Reference).

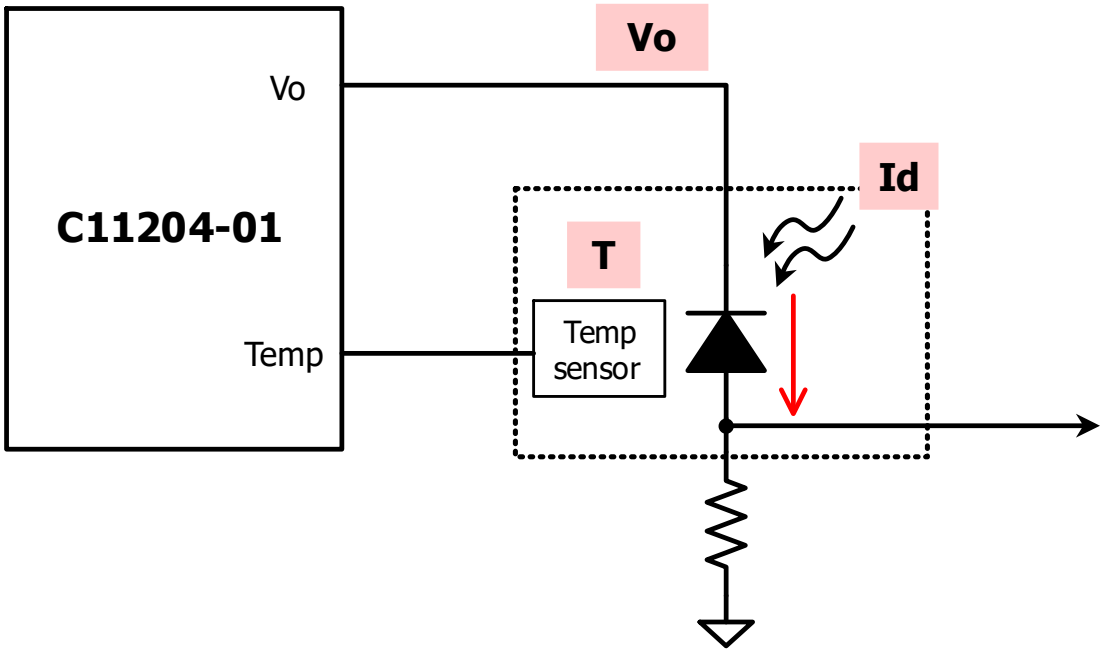



Fig.6 Monitor function

## 6-3.Output voltage ON/OFF control function

It is a function to ON / OFF the output voltage. In the case of state [ON], the voltage is output. In the case of state [OFF], the output voltage becomes 0V.

## 6-4.Overcurrent protection function

This function stops the output of the high voltage when the current flows from the greater than or equal to the threshold C11204-01.
When current load exceeded a threshold level more than four seconds, the output voltage becomes 0V. The threshold of the default is 3mA. When you want to output the high voltage again, please send a reset command or reboot the C11204-01.

# 7. SPECIFICATION

## 7-1.Absolute maximum ratings

| Parameter | Symbol | Condition | Value | Unit |
|---|---|---|---|---|
| Supply voltage | Vs | | 6 | V |
| Operating temperature | Topr | No dew condensation | 0 to +50 | °C |
| Storage temperature | Tstg | No dew condensation | -20 to +70 | °C |

## 7-2.Recommended operating ratings

| Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Supply voltage | Vs | | 4.75 | 5 | 5.25 | V |

## 7-3.Electrical characteristics

(Typ. Ta=25°C, Vs=+5V, unless otherwise noted)

| Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Current consumption | Icc | Vo=72V, No load | - | 20 | - | mA |
| Output voltage | Vo | No load | - | 20 to 90 | - | V |
| Output current | Io | | 0 | - | 2 | mA |
| Ripple noise*1 | Vn | Vo=72V, No load | - | 0.1 | 0.2 | mVp-p |
| Setting precision | - | Vo=72V, No load | - | ±10 | - | mV |
| Setting resolution | - | | - | 1.8 | - | mV |
| Temperature stability | - | 25°C±10°C<br>Vo=72V, No load | - | ±10 | - | ppm/°C |
| Interface*2 | - | | Serial communication (UART) | | | - |
| Low level input voltage | Vil | RXD | 0 | - | 0.4Vs | V |
| High level input voltage | Vih | RXD | 0.65Vs | - | Vs | V |
| Low level output voltage | Vol | TXD | - | - | 2.0 | V |
| High level output voltage | Voh | TXD | Vs-2.0 | - | Vs | V |

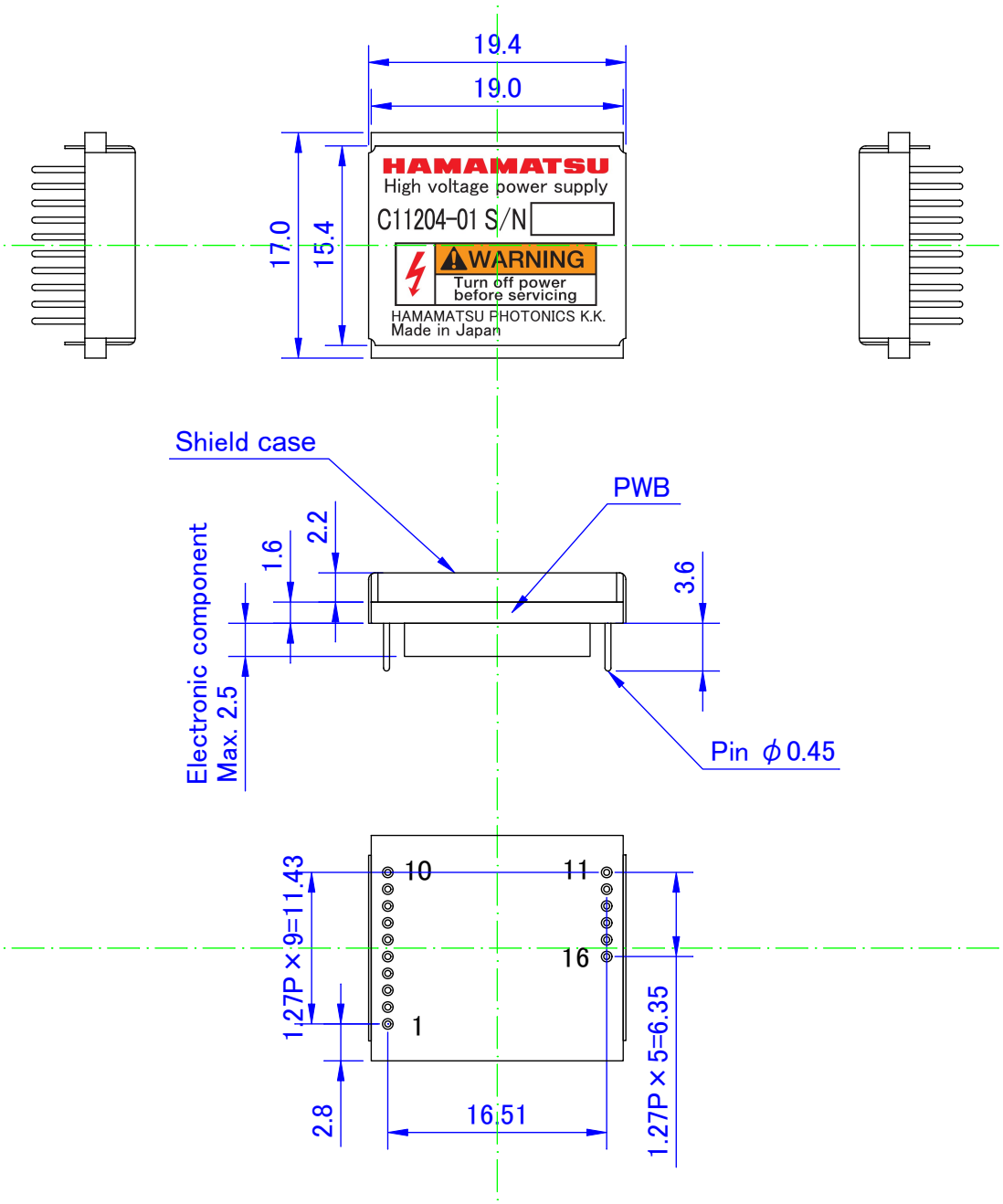
*1: In use recommended circuit.
*2:To control the C11204-01 from a PC, we recommend that you use the C12332 driver circuit (starter kit) for MPPC (sold separately, C11204-01 built in)

## Applicable standards

| | |
|---|---|
| EMC | EN61326-1:2013 Group 1 Class B |
| SAFETY | EN61010-1:2010 |
| RoHS | EN50581 |

## 7-4.Dimensional outlines

(Unit: mm)

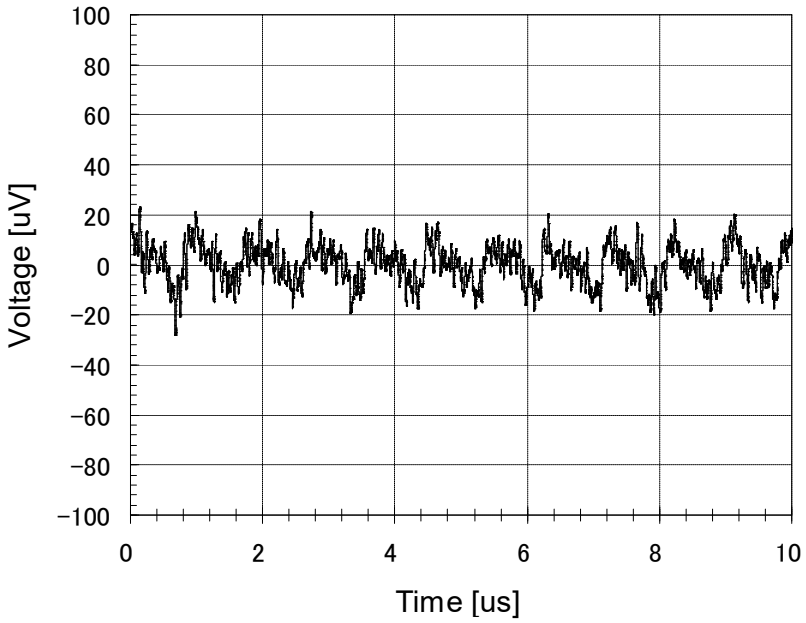



Tolerance unless otherwise noted: ±0.2mm

Fig.7 Dimensional outlines

7-5.Characteristic example

● Ripple noise (Vo=72V)




Note 1: In use recommended

Fig. 8 Ripple noise

● Temperature dependence

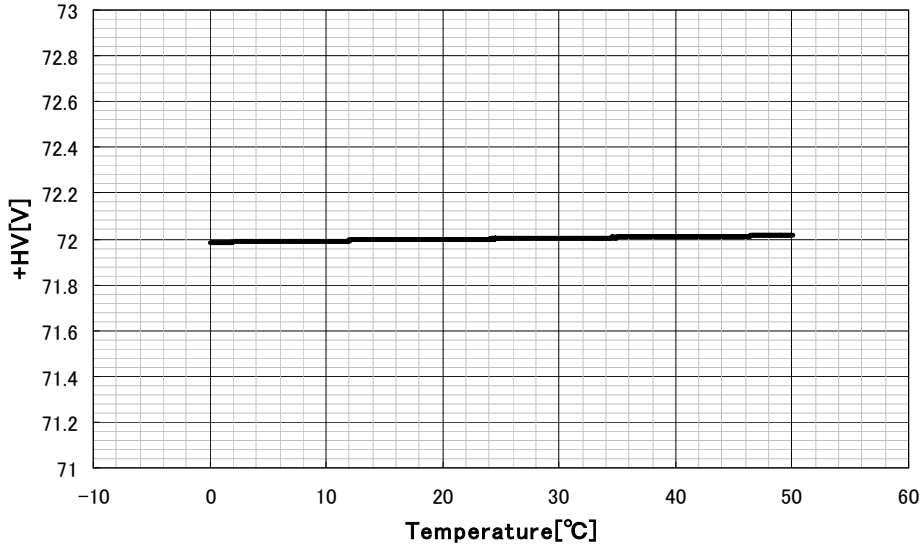



Fig. 9 Temperature dependence

● Current load

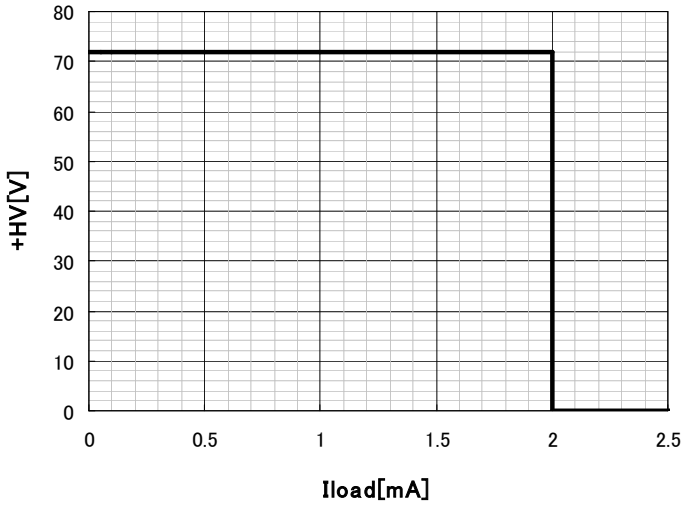



Fig. 10 Current load

● Consumption current (Vo=72V)

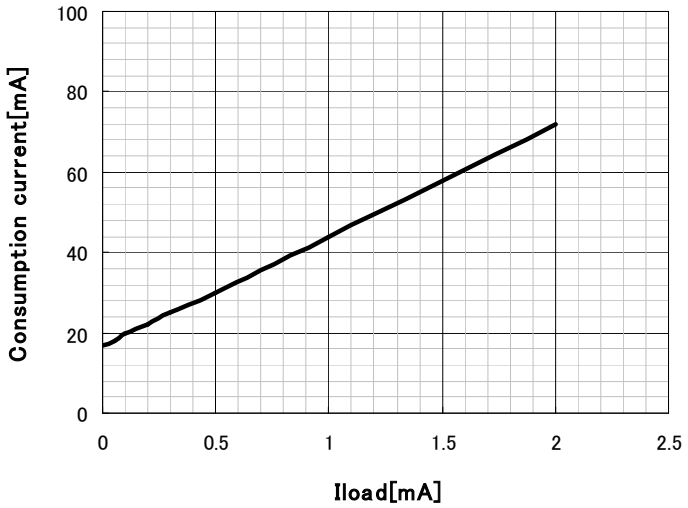



Fig. 11 Consumption current

# 8. NOTICE

Hamamatsu products should not be used in excess of their absolute maximum ratings. Attention must be paid to all documented precautions.

Hamamatsu continually makes efforts to improve the quality and reliability of its products; however these efforts cannot ensure 100% compliance with the manufacturing specifications. Sufficient safety design (such as redundant safety, fire preventative, and malfunction preventative features) are to be implemented in the development of equipment manufactured with the Hamamatsu product so that personal injury, fire, or damage to public property or welfare does not occur in the unlikely event of a malfunction of the Hamamatsu product. A dangerous condition could be created if sufficient consideration is not given to safety design that addresses potential problems, especially in the design of equipment where the failure or malfunction of the Hamamatsu product within the equipment could result in bodily harm, life-threatening injury, or serious property damage during the use of the equipment.

Appropriate descriptions of the functions, performance, and methods of operation of the Hamamatsu product and the equipment within which the Hamamatsu product is incorporated are to be provided to end-users of the equipment. All accompanying warnings and cautionary labeling are also to be provided to the end-user.

Warranty of the Hamamatsu product is limited to the repair or replacement of a product in which a defect is discovered within 1 year of delivery of the product and notification is made to Hamamatsu within that period, otherwise certain warranty is specified. However, even within the warranty period Hamamatsu shall not be responsible for damages caused by either natural disaster or improper use of the product (such as modification of the product or any use that contravenes the operating conditions, intended applications, operating instructions, storage method, disposal method, or any other term or condition described in our products' documents).

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| 型　号 | C11204-01 |
|---|---|

## 环保使用期限

本标志中的年数，是根据 2016 年 1 月 21 日公布的「电器电子产品有害物质限制使用管理办法」和 SJ / T 11364－2014 「电子电气产品有害物质限制使用标识要求」，适用于在中华人民共和国生产或进口的电器电子产品的「环保使用期限」。在遵守有关本产品安全和使用上的注意事项的情况下，在从生产日开始的上述年限内，使用该产品不会对环境造成严重污染或对使用者人身、财产造成严重损害。此年限是「环保使用期限」，而不是「产品质量保证期限」。

产品在适当地使用后予以废弃时，希望依照有关电器电子产品的回收・再利用的法律・规定进行处理。

## 产品中有害物质的名称及含量

| 部件名称 | 有害物质 | | | | | |
|---|---|---|---|---|---|---|
| | 铅（Pb） | 汞（Hg） | 镉（Cd） | 六价铬（Cr(VI)） | 多溴联苯（PBB） | 多溴二苯醚（PBDE） |
| C11204-01 | × | ○ | ○ | ○ | ○ | ○ |
| | | | | | | |
| | | | | | | |

本表格依据SJ/T 11364 的规定编制。
○：表示该有害物质在该部件所有均质材料中的含量均在GB/T 26572 规定的限量要求以下。
×：表示该有害物质至少在该部件的某一均质材料中的含量超出GB/T 26572 规定的限量要求。

| Type Number | C11204-01 |
|---|---|

## Environment-friendly Use Period


The number of year in the marking is “Environment-friendly Use Period” applying to electrical and electronic products that are manufactured in or imported into People’s Republic of China, based on “Management methods for the restriction of the use of hazardous substances in electrical and electronic products (issued on January 21th, 2016)” and “Marking for the restriction of the use of hazardous substances in electronic and electrical products (SJ/T11364-2014)”. It does not cause serious environmental contamination and injuries to body or property of the user during the year from the date of manufacture ONLY if under normal use following with operation and safety precautions of this product. It is the number of years for "Environment-friendly Use Period", NOT quality assurance period.

When disposing of this product, please follow applicable local rules and regulations for collection and recycling of electrical and electronic products.

## Names and Contents of the Hazardous Substances in product

| Part Name | Hazardous Substances | | | | | |
|---|---|---|---|---|---|---|
| | Lead (Pb) | Mercury (Hg) | Cadmium (Cd) | Hexavalent Chromium (Cr (VI)) | Polybrominated biphenyls (PBB) | Polybrominated diphenyl ethers (PBDE) |
| C11204-01 | X | O | O | O | O | O |
| | | | | | | |
| | | | | | | |

This table is prepared in accordance with the provisions of SJ/T 11364.
O: Indicates that said hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement of GB/T 26572.
X: Indicates that said hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement of GB/T 26572.