High Speed and High Voltage Amplifier Module

- **AP/AS series**
  - ±300 to ±3 kV
  - ±1 to ±10 mA
  - 3 W, 5 W

- Fast responsibility  maximum 24 kHz
- Desired output waveform reference to input waveform
- Compact module type

www.matsusada.com
High Speed and High Voltage Amplifier Module

AP / AS series

FEATURES

1. Wide Output Range
   The wide lineup by frequency, output voltage and output polarity will enable users to select the best suitable model for various application among 10 different models.

2. Fast Responsibility Maximum 24 kHz
   AS series achieved the higher speed and wider bandwidth of maximum 24 kHz. 12 time faster than AP series.

3. Desired output waveform reference to input waveform.
   External control voltage to input terminal, -10 V to +10 V, controls the high voltage output with desired waveform.

4. Compact module type
   The compact size is ideal for developing compact products and systems as integrated module. The encapsulation molding which is well resistive to moisture, dust, vibration or impact gain the reliability of the product.

5. 24V input voltage
   Simple operation with only 24 V input voltage and -10 V to +10 V control voltage.

6. High reliability
   With Matsusada’s unique technology and know-how developed by High Voltage DC Power Supplies technologies, we provide highly reliable and safe products.

7. All-Solid-State
   Longer life time with all-solid-state configuration.

AS series is a fast response high voltage operational amplifier module. Matsusada’s long experience and expertise in HVPS field has made this high precision, high reliable product possible in the market.

AP series provides 250 Hz to 2 kHz, and produces high voltage output in sine waves, triangle waves, saw tooth waves and square waves proportional to the input wave type. 10 different models are available in this series. We also take a custom orders according to your requirements.

Compact and high performance module
### APPLICATIONS

- Beam deflection
- Insulation and breakdown voltage test
- Electro photography process
- Various Electrostatic tests
- Corona discharge
- Electrostatic chuck
- Electro viscosity fluid

### LINEUP

#### AP series

<table>
<thead>
<tr>
<th>Output voltage (Vdc)</th>
<th>Current (mA)</th>
<th>MODEL</th>
<th>Frequency Response(3 dB)*1</th>
<th>Case No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>-300 to +300</td>
<td>±10</td>
<td>AP-0.3B10(A)</td>
<td>DC to 2 kHz</td>
<td>C6A</td>
</tr>
<tr>
<td>-600 to +600</td>
<td>±5</td>
<td>AP-0.6B5(A)</td>
<td>DC to 2 kHz</td>
<td></td>
</tr>
<tr>
<td>-1 k to +1 k</td>
<td>±3</td>
<td>AP-1B3(A)</td>
<td>DC to 1 kHz</td>
<td>C6E</td>
</tr>
<tr>
<td>-1.5 k to +1.5 k</td>
<td>±2</td>
<td>AP-1.5B2(A)</td>
<td>DC to 500 Hz</td>
<td></td>
</tr>
<tr>
<td>-3 k to +3 k</td>
<td>±1</td>
<td>AP-3B1(A)</td>
<td>DC to 250 Hz</td>
<td>C7</td>
</tr>
</tbody>
</table>

*1 Response time remains same for small amplitude

#### AS series

<table>
<thead>
<tr>
<th>Output voltage (Vdc)</th>
<th>Current (mA)</th>
<th>MODEL</th>
<th>Frequency Response(3 dB)*2</th>
<th>Slew Rate (full scale)</th>
<th>Case No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>-300 to +300</td>
<td>±10</td>
<td>AS-0.3B10(A)</td>
<td>DC to 12 kHz</td>
<td>12 V / μs</td>
<td>C6A</td>
</tr>
<tr>
<td>-600 to +600</td>
<td>±5</td>
<td>AS-0.6B5(A)</td>
<td>DC to 6 kHz</td>
<td>DC to 12 kHz</td>
<td>C6E</td>
</tr>
<tr>
<td>-1 k to +1 k</td>
<td>±3</td>
<td>AS-1B3(A)</td>
<td>DC to 3.5 kHz</td>
<td>DC to 7 kHz</td>
<td>C7</td>
</tr>
<tr>
<td>-1.5 k to +1.5 k</td>
<td>±5</td>
<td>AS-1.5B2(A)</td>
<td>DC to 2.5 kHz</td>
<td>DC to 5 kHz</td>
<td>C6E</td>
</tr>
<tr>
<td>-3 k to +3 k</td>
<td>±1</td>
<td>AS-3B1(A)</td>
<td>DC to 1.5 kHz</td>
<td>DC to 3 kHz</td>
<td>C7</td>
</tr>
</tbody>
</table>

*2 Typical value at sine wave.
### SPECIFICATIONS

**Input voltage**

24 Vdc ±5 % 0.6 A typ. (AS-1B5(A) : 0.8 A typ.)

**Output voltage control**

External control voltage

Vcon-in -10 V to +10 V *1

(input impedance : ≥ 10 kΩ)

**Regulation**

Line : ±0.1 %/±5 % line change)  
Load : 0.1 %/(10 % to 100 % load change) *2

**Ripple**

≤ 0.025 % rms *2

**Stability**

0.016 % / Hr typ. *2

**Protection**

Protection against input reverse connection, and intermittent output short circuit *3

**Output voltage monitor**

<table>
<thead>
<tr>
<th>Output Voltage (kV)</th>
<th>0.3 (0.3 to +0.3)</th>
<th>0.6 (0.6 to +0.6)</th>
<th>1 (-1 to +1)</th>
<th>1.5 (-1.5 to +1.5)</th>
<th>3 (-3 to +3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>monitor V-out</td>
<td>1 V / 100 V</td>
<td>1 V</td>
<td>1 V</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please use the voltage meter which input impedance is ≥ 10 MΩ. (Accuracy : ±2.5 % / Full scale)

**Operating Temp.**

0 °C to +45 °C

**Storage Temp.**

-20 °C to +60 °C

**Humidity**

20 to 80 %RH (no condensation)

**Input terminals**

8-pin connector

Mating connector and pins are assorted

Recommendations :

- wire for pin 1, 2 are AWG18
- wire for pin 3 to 8 are AWG22 to 18

**Output terminals**

High Voltage lead wire 500 mm

---

*1) Offset voltage : within 0.5 % of rated output at Vcon-in = 0 V

*2) Value at maximum rated output with resistive load and DC output.

*3) Single are shall be within 5sec and not to be repeated.

Frequent short shall shorten the life time and to be avoided.

★ No instruction manuals for module type power supply
CONNECTION

**OPTION**

-L1 Output current monitor
-10 V to +10 V (up to 2 kHz bandwidth)
Accuracy: ±2.5 %F.S. (Monitor voltage need to be measured by the voltmeter whose input impedance is more than 10 MΩ.)

DIMENSIONS inch(mm)

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Mounting hole pitch</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>C6A</td>
<td>6.69 (170)</td>
</tr>
<tr>
<td>C6E</td>
<td>7.68 (195)</td>
</tr>
<tr>
<td>C7</td>
<td>7.68 (195)</td>
</tr>
</tbody>
</table>
**HV Amplifier**

High voltage amplifier converts input voltage to high voltage waveform as it is as shown in fig. 1. These days the demand of HV amplifier is growing more and more, and now becoming an indispensable tool for research and development, experiments and integrating to a system for such fields as electronics, physics, biochemical and medical industries. With high voltage technologies Matsusada Precision Inc. manufactures various HV amplifiers to meet all requirements from customers.

*In addition to these models in this catalog we have amplifiers developed specially for electrostatic chuck or PZT. Please ask for details to our sales staff.*

**Slew Rate**

The responsiveness of AS series is determined with slew rate (SR). The step responsibility of our amplifier is as shown in fig.3.

\[
SR = \frac{\Delta V}{\mu S}
\]

In case of output amplitude is smaller the response time become shorter.

**Four-quadrant Output Range**

HV amplifier is generally equipped with the "sink" function for output currents that provides constant voltage operation without regard to the type of load whether it is capacitive or conductive. (Fig.2) As it gives fast response, it is an ideal power supply for applications which require AC output.

Matsusada HV amplifiers are all bi-polar type and can be operated in full four-quadrant area. (I · II · III · IV area)

**Slew Rate**

Step response can be indicated with rise time. (fig.4) Usually the rise time of amplifier of response (= bandwidth)fc (Hz) is given by a formula below.

\[
tr \approx 0.35 / fc
\]

The fall time tf is equals to tr.

*AC Operating range (frequency 50Hz and over/duty 50% and no DC bias)  
DC Operation range*
**Frequency Response**

Response of Matsusada amplifiers are described as “frequency bandwidth”. When swing the output with sinusoidal waveform with rated resistive load, output swing (amplitude) is reduced as input frequency become faster. Frequency response in the specification is the frequency $f_c$ is where output swing is 70% (-3dB). (fig.5)

In case clear output waveform is required, please select a HV amplifier which has high enough frequency bandwidth against required frequency. In general 3 to 5 times more frequency bandwidth for sinusoidal waveform, and about 10 times more for rectangular waveform, is required. In case of insufficient frequency bandwidth the output swing shall be reduced, and also the phase difference be large, so some solutions, such as monitoring output waveform, shall be required.

![Frequency Response Graph](image)

**Capacitive Load**

When a capacitive load is more than 100pF (including a stray capacitance of output wire), the resonance in the output may occur. In that case, install 100-ohm (@0.1μF) to 1000-ohm (@1000pF) of high voltage resistance in the output in series. Please note that the frequency band will be limited as the formula written in the right figure when an amplifier is used with a capacitive load.

In addition, when an amplifier is used for the use such as a corona discharge, the current which is higher than rating will flow and it will affect the amplifier badly. In this case, as well as the time to use an amplifier with a capacitive load, please install the output resistance and limit the current.

*Please avoid continuous inputting of high frequency which reduces output frequency of an amplifier.

An amplifier will be broken because of increase of internal loss.

![Capacitive Load Diagram](image)

**Important note to utilize the full performance of high speed HV amplifier**

Output cable of HV amplifiers is not shielded. If the output cable has some stray capacity against ground(earth ground or metal objects), output voltage will be sinusoidal or step waveform and extra current will be drawn. As this current draw parallel to load, the following appearance might be happened.

1. **Slew rate or response frequency drop**
2. **The waveform is distorted or changed**

When there is output stray capacitance $C$ the leak current $I_{oc}$ will be as below.

$$I_{oc} = \frac{dQ}{dt} = C \frac{dV}{dt} \quad Q: \text{capacity}(C)$$

**Solution**

- Make sure to have proper connection to make stray capacitance of HV cable as low as possible.

- (1) Keep the length of output cable as short as possible.
- (2) Keep the output cable away from floor, desks, or metal objects.
- (3) Have no shielding on the output cable.
Customer Inquiry Sheet (AP/AS series)

Please copy this page and above fax number after filling out form below.

- I would like
  - [ ] A quotation
  - [ ] An explanation of product
  - [ ] A demonstration
  - [ ] To purchase
  - [ ] Other ( )

- Give us your requirement / comment

- Please fill in below.

  Address:
  Company:
  Dept.: Title:
  Name:
  Tel: Fax:
  E-mail:

Manufacturer warranty

We warrant the specification, unless otherwise specified, at max. rated output after warm up, and scope of application is between 10% and 100% of max. rated output. We warrant that products contained in this catalog (hereinafter, the “Products”) are free from defects in material and workmanship under normal use for a period of one (1) year from the date of shipment thereof. However, the warranty period for X-ray detectors and X-ray source shall be either one (1) year from the date of shipment or 1,000 hours, whichever shorter. The above warranty shall not apply to any Product which, at our sole judgment, has been: i) Repaired or altered by persons unauthorized by us; or ii) Connected, installed, adjusted or used otherwise than in accordance with the instructions furnished by us (including being used in an inappropriate installation environment, such as in corrosive gas, high temperature and humidity). We are not liable for any loss, damage or failure of the Products after the shipment thereof caused by external factors such as disasters. We will not inspect, adjust or repair any of our power supply products in the field or at any customer site. If you suspect that there has been a power supply failure in the field, please inspect your whole unit by yourself in an effort to determine that the problem is, in fact, arising out of our power supply products. If it is found that the problem is arising out of such power supply product after inspection, please contact your local sales office for additional troubleshooting. A “Return Merchandise Authorization” is required in case the power supply must be sent back to the factory in Japan for inspection and repair. We, at our sole discretion repair or replace such defective products at no cost to the purchaser. We assume no liability to the purchaser or any third party for special, incidental, consequential, or other damages resulting from a breach of the foregoing warranty. This warranty excludes any and all other warranties not set forth herein, express or implied, including without limitation the implied warranties of merchantability or fitness for a particular purpose. The Products are not designed and produced for such applications as requiring extremely high reliability and safety, or involving human lives (such as nuclear power, aerospace, social infrastructure facility, medical equipment, etc.). The use under such environment is not covered by this warranty and may require additional design and manufacturing processes. No modification or supplement of this warranty shall be binding unless in writing and signed by a duly authorized officer of Matsusada. Matsusada reserves the right to make any changes in the contents of catalogs or specifications at any time without advance notice. Due to compelling reason such as unavailability of components used, products might be un available or unable to repair. The products specified in catalogs or specifications are designed for use by the person who has enough expertise or under the control of such person, and not for general consumers. Schematics of products shall not be submitted to users. Test result or test data for the products shall be available upon request with charge.

Make sure you read the specification in the latest catalog before you order. Contact nearby sales office for the latest catalog.

https://www.matsusada.com/site/warranty.html

Copyright © 2019 Matsusada Precision Inc. All rights reserved.