### 1. General Description

AP1158 is an active filter IC for noise in the low frequency band in the various audio systems, and the like. It's possible to use AP1158 than a noise filter of discrete composition (RC Filter, LC Filter) that the noise filter is composed of a saving mounting area and low drop-out voltage. It is available to use as low I/O voltage/low noise regulator. (Need external reference voltage.) The AP1158 has a built-in thermal shutdown protection circuit, and is possible to provide two types of package, the AP1158ADSXX is the SOT23-5 package and the AP1158AEUXX is the PLP1822-6 package with Exposed Pad.

### 2. Features

- **Operating Temperature Range**: -40 to 85°C
- **Operating Voltage Range**: 1.8 to 14V
- **Output Current**: 150mA
- **Ripple Rejection**: 66dB at 1kHz
- **Available very low noise application**
- **Available to use a small ceramic capacitor**
- **f control (High active)**
- **Built-in Thermal Shutdown**

**Package**
- AP1158ADS : SOT23-5
- AP1158AEU : PLP1822-6 (with Exposed Pad)

### 3. Applications

- **RF Power Supplies**
- **Low Noise Image Sensor Unit**
- **High Speed/High Precision A-D, D-A, Amplifier**

PLL, VCO, Mixer, LNA
Digital Still Camera
Audio Equipment
Medical Equipment
Instrumentation
4. Table of Contents

1. General Description .................................................................................................................. 1
2. Features ................................................................................................................................... 1
3. Applications ............................................................................................................................. 1
4. Table of Contents .................................................................................................................... 2
5. Block Diagram .......................................................................................................................... 3
6. Ordering Guide .......................................................................................................................... 3
7. Pin Configuration and Functions .............................................................................................. 4
   ■ Pin Configurations .................................................................................................................. 4
   ■ Functions ............................................................................................................................... 4
8. Absolute Maximum Ratings ...................................................................................................... 5
9. Recommended Operating Conditions ......................................................................................... 5
10. Electrical Characteristic .......................................................................................................... 6
    ■ Electrical Characteristics of Ta=Tj=25°C ................................................................................ 6
    ■ Electrical Characteristics of Ta=-40°C to 85°C .................................................................... 7
11. Description ............................................................................................................................... 8
    11.1 DC Characteristics .......................................................................................................... 8
    11.2 DC Temperature Characteristics ..................................................................................... 10
    11.3 AC Characteristics .......................................................................................................... 12
    11.4 About stable operation .................................................................................................... 15
    11.5 On/Off Control ................................................................................................................. 16
    11.6 Filter Terminal .................................................................................................................. 16
    11.7 Notes on output terminal (V_{OUT}) to GND short-circuit evaluation ................................ 16
    11.8 Thermal Resistance and Power Dissipation ..................................................................... 17
    11.9 The ability of a built-in power transistor and setting of VDROP ....................................... 18
    11.10 Application Examples .................................................................................................... 19
12. Definition of term ...................................................................................................................... 21
    ■ Characteristics .................................................................................................................... 21
    ■ Protections .......................................................................................................................... 21
13. Recommended External Circuit ............................................................................................... 22
    ■ Recommended External Circuit ........................................................................................... 22
    ■ Recommended Layout ........................................................................................................... 22
14. Package ................................................................................................................................... 23
    ■ Outline Dimensions ............................................................................................................ 23
       ▪ SOT23-5 ............................................................................................................................ 23
       ▪ PLP1822-6 ........................................................................................................................ 23
15. Revise History .......................................................................................................................... 24

IMPORTANT NOTICE .................................................................................................................. 25
5. Block Diagram

Figure 1. Block Diagram

6. Ordering Guide

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Temperature Range</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>AP1158ADS</td>
<td>Ta = -40 to 85°C</td>
<td>SOT23-5</td>
</tr>
<tr>
<td>AP1158AEU</td>
<td>Ta = -40 to 85°C</td>
<td>PLP1822-6</td>
</tr>
</tbody>
</table>
## Pin Configuration and Functions

### Pin Configurations

<table>
<thead>
<tr>
<th>SOT23-5</th>
<th>PLP1822-6</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Top View" /></td>
<td><img src="image2" alt="Top View" /></td>
</tr>
</tbody>
</table>

### Functions

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Pin No.</th>
<th>Pin Description</th>
<th>Internal Equivalent Circuit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOT89-5</td>
<td>PLP1822-6</td>
<td><strong>P</strong>in <strong>D</strong>escription</td>
<td><strong>I</strong>nternal <strong>E</strong>quivalent <strong>C</strong>ircuit</td>
<td><strong>D</strong>escription</td>
</tr>
<tr>
<td>1</td>
<td>6</td>
<td><strong>V</strong>IN</td>
<td><img src="image3" alt="Internal Circuit" /></td>
<td>Input Terminal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Connect a 1μF or more of the capacity between the GND terminal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td><strong>GND</strong></td>
<td><img src="image4" alt="Internal Circuit" /></td>
<td>GND Terminal</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td><strong>FIL</strong></td>
<td><img src="image5" alt="Internal Circuit" /></td>
<td>Filter Terminal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Output voltage setting resistance (R&lt;sub&gt;FIL&lt;/sub&gt;) is connected between Vin. Capacitor of the filter (C&lt;sub&gt;FIL&lt;/sub&gt;) is connected between GND.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td><strong>CONT</strong></td>
<td><img src="image6" alt="Internal Circuit" /></td>
<td>On/Off Control Terminal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(V_{CONT} &gt; 1.8V : ON) (V_{CONT} &lt; 0.4V : OFF)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>The pull-down resistor (500kΩ) is built-in.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td><strong>V</strong>OUT</td>
<td><img src="image7" alt="Internal Circuit" /></td>
<td>Output Terminal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Connect a 1μF or more of the capacity between the GND terminal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>2</td>
<td><strong>N.C</strong></td>
<td><img src="image8" alt="Internal Circuit" /></td>
<td>No Connection Terminal</td>
</tr>
<tr>
<td>-</td>
<td>Exposed Pad</td>
<td>-</td>
<td><img src="image9" alt="Internal Circuit" /></td>
<td>Ground Terminal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Heat dissipation pad</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Exposed Pad must be connected to GND.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 8. Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>min</th>
<th>max</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage</td>
<td>$V_{CC\text{(MAX)}}$</td>
<td>-0.4</td>
<td>16</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Reverse Bias Voltage</td>
<td>$V_{REV\text{(MAX)}}$</td>
<td>-0.4</td>
<td>8</td>
<td>V</td>
<td>$V_{OUT}-V_{IN}$</td>
</tr>
<tr>
<td>FIL Terminal Voltage</td>
<td>$V_{FIL\text{(MAX)}}$</td>
<td>-0.4</td>
<td>16</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{\text{CONT}(\text{MAX})}$ Terminal Voltage</td>
<td>$V_{\text{CONT}(\text{MAX})}$</td>
<td>-0.4</td>
<td>16</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Junction Temperature</td>
<td>$T_j$</td>
<td>-</td>
<td>150</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Storage Temperature Range</td>
<td>$T_{STG}$</td>
<td>-55</td>
<td>150</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Power Dissipation</td>
<td>SOT23-5</td>
<td>$P_D$</td>
<td>-</td>
<td>500</td>
<td>mW</td>
</tr>
<tr>
<td></td>
<td>PLP1822-6</td>
<td>-</td>
<td>1500</td>
<td>mW</td>
<td>(Note 1)</td>
</tr>
</tbody>
</table>

Note 1. Package thermal resistance($\theta_{JA}$)
If the temperature exceeds 25°C, be sure to derate at Figure 2.
SOT23-5 : $\theta_{JA} = 250^\circ\text{C} / \text{W}$
PLP1822-6 : $\theta_{JA} = 83^\circ\text{C} / \text{W}$

**WARNING**: The maximum ratings are the absolute limitation values with the possibility of the IC breakage. When the operation exceeds this standard quality cannot be guaranteed.

![Figure 2. Maximum Power Dissipation](image)

### 9. Recommended Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>min</th>
<th>typ</th>
<th>max</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Temperature Range</td>
<td>$T_a$</td>
<td>-40</td>
<td>-</td>
<td>85</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Operating Voltage Range</td>
<td>VOP</td>
<td>2.1</td>
<td>-</td>
<td>14</td>
<td>V</td>
<td></td>
</tr>
</tbody>
</table>
## Electrical Characteristics of Ta=Tj=25°C
The parameters with min or max values will be guaranteed at Ta=Tj=25°C.

(\(V_{IN}=2.5V, V_{CONT}=2V, R_{FIL}=390k\Omega, C_{IN}=1\mu F, C_{FIL}=4.7\mu F, C_L=1\mu F\), C, unless otherwise specified.)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Condition</th>
<th>min</th>
<th>typ</th>
<th>max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quiescent Current</td>
<td>(I_Q)</td>
<td>(I_{OUT}=0mA)</td>
<td>-</td>
<td>65</td>
<td>100</td>
<td>(\mu A)</td>
</tr>
<tr>
<td>Standby Current</td>
<td>(I_{STANDBY})</td>
<td>(V_{IN}=8V, V_{CONT}=0V)</td>
<td>-</td>
<td>0.1</td>
<td>100</td>
<td>nA</td>
</tr>
<tr>
<td>Output Current</td>
<td>(I_{OUT})</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>150</td>
<td>mA</td>
</tr>
<tr>
<td>Maximum Output Current (Note 2) (Note 5)</td>
<td>(I_{OUT(MAX)})</td>
<td>(V_{OUT}=V_{OUT(TYP)}\times0.9)</td>
<td>-</td>
<td>360</td>
<td>-</td>
<td>mA</td>
</tr>
<tr>
<td>Load Regulation</td>
<td>LoaReg</td>
<td>(I_{OUT} = 1mA to 100mA)</td>
<td>-</td>
<td>6</td>
<td>20</td>
<td>mV</td>
</tr>
<tr>
<td>Reverse Bias Current</td>
<td>(I_{REV})</td>
<td>(V_{IN}=0V, V_{CONT}=0V, V_{OUT}=8V)</td>
<td>-</td>
<td>0.1</td>
<td>100</td>
<td>nA</td>
</tr>
<tr>
<td>Filter Terminal Sink Current</td>
<td>(I_{SINK})</td>
<td>FIL terminal voltage = (V_{IN} - 0.3V)</td>
<td>0.5</td>
<td>0.6</td>
<td>0.72</td>
<td>(\mu A)</td>
</tr>
<tr>
<td>Error Amp. off-set Voltage</td>
<td>(V_{ERROR})</td>
<td>(I_{OUT} = 30mA)</td>
<td>20</td>
<td>40</td>
<td>60</td>
<td>mV</td>
</tr>
</tbody>
</table>

**Control Terminal (CONT)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Condition</th>
<th>min</th>
<th>typ</th>
<th>max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Terminal Current</td>
<td>(I_{CONT})</td>
<td>(V_{CONT}=2.0V)</td>
<td>-</td>
<td>4.5</td>
<td>8.0</td>
<td>(\mu A)</td>
</tr>
<tr>
<td>Control Terminal Voltage</td>
<td>(V_{CONT})</td>
<td>(V_{OUT}) ON state</td>
<td>1.8</td>
<td>-</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(V_{OUT}) OFF state</td>
<td>-</td>
<td>-</td>
<td>0.4</td>
<td>V</td>
</tr>
</tbody>
</table>

**Reference Value**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Condition</th>
<th>min</th>
<th>typ</th>
<th>max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ripple Rejection (Note 3)</td>
<td>R.R.</td>
<td>(I_{OUT} = 30mA) Ripple Noise =200mV_{P-P}(@1kHz)</td>
<td>-</td>
<td>66</td>
<td>-</td>
<td>dB</td>
</tr>
<tr>
<td>Output Noise (Note 4) (Note 5)</td>
<td>-</td>
<td>at 1kHz</td>
<td>-</td>
<td>60</td>
<td>-</td>
<td>nV/(\sqrt{Hz})</td>
</tr>
</tbody>
</table>

**Note 2.** The maximum current value is limited to the allowable power consumption.

**Note 3.** The ripple rejection depends on the value and the characteristic of I/O voltage difference (set by \(R_{FIL}\)) and capacitor (\(C_{FIL}\)). Please consider the tolerance of resistor and capacitor.

**Note 4.** At the condition of no ripple noise. The noise is generated from the IC due to semiconductor integrated circuit.

**Note 5.** Parameters with only typical values are for reference only.
Electrical Characteristics of Ta=-40°C to 85°C

The parameters with min or max values will be guaranteed at Ta=-40°C to 85°C.

( V<sub>IN</sub>=2.5V, V<sub>CONT</sub>=2V, R<sub>FIL</sub>=390kΩ, C<sub>I</sub>=1μF, C<sub>FIL</sub>=4.7μF, C<sub>L</sub>=1μF unless otherwise specified.)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Condition</th>
<th>min</th>
<th>typ</th>
<th>max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quiescent Current</td>
<td>I&lt;sub&gt;Q&lt;/sub&gt;</td>
<td>I&lt;sub&gt;OUT&lt;/sub&gt;=0mA</td>
<td>-</td>
<td>65</td>
<td>120</td>
<td>μA</td>
</tr>
<tr>
<td>Standby Current</td>
<td>I&lt;sub&gt;STANDBY&lt;/sub&gt;</td>
<td>V&lt;sub&gt;IN&lt;/sub&gt;=8V, V&lt;sub&gt;CONT&lt;/sub&gt;=0V</td>
<td>-</td>
<td>0.1</td>
<td>500</td>
<td>nA</td>
</tr>
<tr>
<td>Output Current</td>
<td>I&lt;sub&gt;OUT&lt;/sub&gt;</td>
<td>-</td>
<td>-</td>
<td>150</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>Maximum Output Current</td>
<td>I&lt;sub&gt;OUT(MAX)&lt;/sub&gt;</td>
<td>V&lt;sub&gt;OUT&lt;/sub&gt;=V&lt;sub&gt;OUT(TYP)&lt;/sub&gt;×0.9</td>
<td>-</td>
<td>360</td>
<td>-</td>
<td>mA</td>
</tr>
<tr>
<td>Load Regulation</td>
<td>LoaReg</td>
<td>I&lt;sub&gt;OUT&lt;/sub&gt; = 1mA to 100mA</td>
<td>-</td>
<td>6</td>
<td>55</td>
<td>mV</td>
</tr>
<tr>
<td>Reverse Bias Current</td>
<td>I&lt;sub&gt;REV&lt;/sub&gt;</td>
<td>V&lt;sub&gt;IN&lt;/sub&gt;=0V, V&lt;sub&gt;CONT&lt;/sub&gt;=0V, V&lt;sub&gt;OUT&lt;/sub&gt;=8V</td>
<td>-</td>
<td>0.1</td>
<td>2000</td>
<td>nA</td>
</tr>
<tr>
<td>Filter Terminal Sink Current</td>
<td>I&lt;sub&gt;SINK&lt;/sub&gt;</td>
<td>FIL terminal voltage = V&lt;sub&gt;IN&lt;/sub&gt; - 0.3V</td>
<td>0.4</td>
<td>0.6</td>
<td>0.84</td>
<td>μA</td>
</tr>
<tr>
<td>Error Amp. off-set Voltage</td>
<td>V&lt;sub&gt;ERROR&lt;/sub&gt;</td>
<td>I&lt;sub&gt;OUT&lt;/sub&gt;=30mA</td>
<td>-30</td>
<td>40</td>
<td>110</td>
<td>mV</td>
</tr>
</tbody>
</table>

Control Terminal (CONT)

| Control Terminal Current | I<sub>CONT</sub> | V<sub>CONT</sub>=2.0V | - | 4.5 | 10 | μA |
| Control Terminal Voltage | V<sub>CONT</sub> | V<sub>OUT</sub> ON state | 1.8 | - | - | V |
| | | V<sub>OUT</sub> OFF state | - | - | 0.4 | V |

Reference Value

| Ripple Rejection | R.R. | I<sub>OUT</sub>=30mA |
| Note 7 | Ripple Noise =200mV<sub>p-p</sub>(@1kHz) | 40 | 66 | - | dB |
| Output Noise | at 1kHz | - | 60 | - | nV/√Hz |

Note 6. The maximum current value is limited to the allowable power consumption.
Note 7. The ripple rejection depends on the value and the characteristic of I/O voltage difference (set by R<sub>FIL</sub>) and capacitor (C<sub>FIL</sub>). Please consider the tolerance of resistor and capacitor.
Note 8. At the condition of no ripple noise. The noise is generated from the IC due to semiconductor integrated circuit.
Note 9. Parameters with only typical values are for reference only.
11. Description

11.1 DC Characteristics

- **Filter Terminal Sink Current**

- **Error Amp. off-set Voltage**

- **Dropout Voltage**

- **Quiescent Current (I_{OUT}=0mA)**

- **Load Regulation**

- **GND Pin Current**
**V_{OUT} ON-Point**

![Graph of V_{OUT} vs V_{CONT}]

**CONT Current vs CONT Voltage**

![Graph of I_{CONT} vs V_{CONT}]

**Standby Current**

![Graph of I_{STANDBY} vs V_{IN}]

**Reverse bias Current**

![Graph of I_{STANDBY} vs V_{REV}]

**Maximum Output Current**

![Graph of I_{OUT} vs I_{OUT}]

**Maximum Output Current (V_{IN})**

![Graph of I_{OUT} vs V_{IN}]

---

AsahiKASEI

[AP1158]
11.2 DC Temperature Characteristics

- **Filter Terminal Sink Current**

- **Error Amp. off-set Voltage**

- **Dropout Voltage**

- **Quiescent Current (I_{OUT}=0mA)**

- **Load Regulation**

- **GND Pin Current**
- V_{OUT} ON-Point

- CONT Current vs CONT Voltage

- Maximum Output Current
11.3 AC Characteristics

• Ripple Rejection

Ripple rejection characteristics are dependent on the characteristics of the capacitor which is connected to the FIL terminal, to the capacitance value. Since it varies greatly in the capacitor and the PCB of FIL terminal for the ripple rejection characteristics of more than 50kHz, please check in the operating state, if necessary.

- $C_{FIL} = 0.1\mu F, 1.0\mu F, 4.7\mu F$

Common conditions are shown as follows:

- $V_{IN} = 2.5V$
- $V_{OUT} = 3.0V$
- $I_{OUT} = 10mA$
- Ripple Noise = $200mV_{P-P}$
- $f = 100Hz$ to $1MHz$
- $R_{FIL} = 390k\Omega$
- $C_{FIL} = 4.7\mu F$

- Ripple Rejection vs. Ripple Noise (Freq.=1kHz)
- Ripple Rejection vs. Output Current (Freq.=1kHz)
- **Output Noise**
  It is more effective if it increases the $C_{NP}$ than to increase the $C_L$. In the case that require low noise, $C_{NP}$ capacity is recommended 0.1μF to 1.0μF.
• **On/Off Transient**

The rise time of the IC will be slow and \( C_L \), \( C_{FIL} \) is large. Rise time is dependent \( C_L \), on the \( C_{FIL} \), fall time is dependent on the \( C_L \).

### On/Off control transient response

![Figure 3. On/Off control by CONT terminal](image)

\( C_{IN}=1 \mu F \), \( C_{FIL}=4.7 \mu F \), \( R_{FIL}=390 \Omega \), \( V_{IN}=2.5 V \), \( I_{OUT}=10 mA \)
\( C_L \) variable

### Input transient response

![Figure 4. On/Off control by \( V_{IN} \) terminal](image)

\( C_{IN}=1 \mu F \), \( C_L=1.0 \mu F \), \( R_{FIL}=390 \Omega \), \( V_{IN}=2.5 V \)
\( I_{OUT}=10 mA \)
\( C_{FIL} \) variable

\( V_{CONT} \) operates at high-speed when CONT pin is controlled with the input voltage added to \( V_{IN} \) pin. In this case, the on/off time of the \( V_{OUT} \) does not depend on the time constant of the filter.

It takes long time to charge \( C_{FIL} \) when \( V_{IN} \) is controlled directly. Please reduce the time constant of the filter to make the rise time early. Therefore, it is necessary to reduce the \( C_{FIL} \).

Moreover, the rise time becomes early by connecting diode parallel with \( R_{FIL} \). Voltage drop is \( V_F \times 1/2 \) of the diode. Charge time of \( C_{FIL} \) is given by the following formula.

\[
t = 5 \times C_{FIL} \times R_{FIL}[sec]
\]
• **Load Transient**
IC can improve the load change to keep some flow of load current. When there is a fast large current change, please increase the load side capacitor. It can reduce the voltage fluctuation.

![I\textsubscript{OUT} diagram](image)

11.4 About stable operation
AP1158 is required for input and output capacitors in order to maintain the loop stability.

• **Input Capacitor (C\textsubscript{IN})**
The input capacitor is necessary when the battery is discharged, the power supply impedance increases, or the line distance to the power supply is long. This capacitor might be necessary on each individual IC even if two or more regulator ICs are used. It is not possible to determine this indiscriminately. Please confirm the stability while mounted. The recommended value is C\textsubscript{IN} = 1.0\mu F.

• **Output Capacitor (C\textsubscript{L})**
Please select the output capacitor that equivalent series resistance (ESR) in the stable operation area. Please refer to Figure 5 mentioned below and select the capacitor of the best characteristic. Either ceramic or tantalum capacitor can be used for output terminal. Please choose the capacitor with 0.22\mu F or more and the equivalent series resistance 6\Omega or less. The capacitance and the equivalent series resistance have tolerance that depends on the product and the maker. Generally, a ceramic capacitor has both temperature characteristic and voltage characteristic. Please consider both characteristics when selecting the part. Please select a capacitance value that stable operation in the working voltage range. Capacitors, all temperatures are expected within the system, in the full voltage range, IC does not must be a minimum value or more of the rating to stable operation. The recommended value is C\textsubscript{L} = 1.0\mu F.
11.5 On/Off Control

Control terminal is active High. Control terminal is based on GND. When connected to GND, Input current is zero. (Operation stops)

If the load current is 0 (the load impedance very high), the $C_{OUT}$ electric charge remains. Therefore, if you on/off the ripple filter IC at the same time with the load, the electric charge of the $C_{OUT}$ remains, and quick response application will be available. In case not using on/off control, please connect this terminal to Vin.

The control current decreases when resistance is connected in series. Series res and pull-down resistor are built in this terminal. Therefore, when series resistance is connected, the control current will decrease though the control voltage may swerves to high side. There is no hysteresis in this terminal. Please apply High or Low level surely otherwise noise level will increase.

<table>
<thead>
<tr>
<th>$V_{CONT}$ (V)</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CONT} &gt; 1.8V$</td>
<td>ON</td>
</tr>
<tr>
<td>$V_{CONT} &lt; 0.4V$</td>
<td>OFF</td>
</tr>
</tbody>
</table>

11.6 Filter Terminal

Noise and ripple rejection characteristics will vary by FIL terminal capacity. Ripple rejection characteristics of the higher capacity of $C_{FIL}$ large low frequency region improves. Standard value is $C_{NP} = 4.7\mu F$. Please increase the $C_{FIL}$ in the output noise and ripple rejection is important design. IC does not break even by increasing the capacitor. Switching speed of the On / Off will change by the FIL terminal capacity. Switching speed will be slow and a large capacity.

11.7 Notes on output terminal ($V_{OUT}$) to GND short-circuit evaluation

The resonance phenomenon due to stick to the output terminal $C_L$ (C component) and the short-circuit line (L component), the output terminal will become a negative potential. Output terminal parasitic transistor operates in the IC enters the minus side, leads to the worst case burning for packages that latch-up phenomenon occurs in the IC (white smoke) or damage.

The resonance phenomenon appears remarkably In the ESR value is small ceramic capacitors and the like of the capacitor. As a measure of this phenomenon, we can to reduce the resonance phenomenon to be short-circuited by connecting the short-circuit line and the series in more than 2Ω resistance. This allows you to prevent latch-up phenomenon in the IC.

In large tantalum and electrolytic capacitor of ESR, it generally influence of there resonance...
phenomenon ESR value is greater than or equal to 2Ω is reduced. Also, if a constraint or the like on your set can not be performed the measures as described above, please insert a schottky diode between GND terminal and the output terminal. This parasitic transistor in the internal IC will not work. A result, you can avoid the latch-up because the parasitic transistor does not work.

11.8 Thermal Resistance and Power Dissipation

• How to determine the thermal resistance when mounted on PCB

The thermal resistance when mounted is expressed as follows:

\[ T_j = \theta_{ja} \times P_D + 25 \]

\( T_j \) of AP1158 is set around 150°C. \( P_D \) is the value when the thermal sensor is activated. If the ambient temperature is 25°C, then:

\[ 150 = \theta_{ja} \times P_D + 25 \]
\[ \theta_{ja} \times P_D = 125 \]
\[ \theta_{ja} = \frac{125}{P_D} \text{ (°C/W)} \]

• Simple method to calculate Power Dissipation \( (P_D) \)

Mount the IC on the print circuit board. \( P_D \) will be \( V_{\text{IN}} \times I_{\text{IN}} \) when the short circuit on the output side of the IC. The output terminal short-circuited with GND to measure gradually the input current gradually increase the input voltage. Increase gradually to 10V position the input voltage. Initial input current value is the maximum instantaneous output current value, but gradually decreased due to the temperature rise of the chip, it will eventually become a thermal equilibrium state (natural air cooling). This is calculated by using the input current value and the input voltage value when became constant.

\[ P_D \text{ (mW)} = V_{\text{IN}} \times I_{\text{IN}} \text{ (mA)} \]

• Maximum available current at the maximum temperature

Available at the time the highest operating temperature current, you can ask in the graph of Figure 8. Than \( DP \) value obtained from the graph of Figure 6, the maximum available current at the time of the maximum temperature can be calculated by the following equation.

\[ I_{\text{out}} = \left( \frac{DP}{V_{\text{IN,MAX}} - V_{\text{OUT}}} \right) \]

Procedure (When mounted on PCB.)
1. Find \( P_D \) (\( V_{\text{IN}} \times I_{\text{IN}} \) when the output side is short-circuited).
2. Plot \( P_D \) against 25°C.
3. Connect \( P_D \) to the point corresponding to the 150°C with a straight line.
4. In design, take a vertical line from the maximum operating temperature (e.g., 75°C) to the derating curve.
5. Read off the value of \( P_D \) against the point at which the vertical line intersects the derating curve. This is taken as the maximum power dissipation \( DP_D \).
6. \( DP_D = (V_{\text{IN,MAX}} - V_{\text{OUT}}) = I_{\text{OUT}} \) at 75°C

Figure 6. The simple method to calculate \( P_D \)
11.9 The ability of a built-in power transistor and setting of VDROP

Figure 7 shows the ability of a built-in power transistor. When input-output voltage drop of AP1158 is set to 300mV, it can supply an output current of 250mA at the maximum. But this is a current value when the input voltage does not have the ripple noise. When the input voltage has the ripple noise, it cannot supply the output current value more. When the input voltage has the ripple noise to show it in Figure 8, it can supply an output current only to 150mA at the maximum.

Figure 7. The ability of a built-in power transistor

Figure 8. When the input voltage has the ripple noise

If there is little output current to use, it lowers a value of \( R_{\text{FIL}} \) and can reduce input-output voltage drop. Figure 9 shows relations of \( R_{\text{FIL}} \) and \( V_{\text{DROP}} \). When it reduces input-output voltage drop, Load Regulation deteriorates to show it in Figure 10.

Figure 9. \( V_{\text{DROP}} \) vs \( R_{\text{FIL}} \) (\( I_{\text{OUT}}=5\text{mA} \))

Figure 10. Load Regulation (\( R_{\text{FIL}} \))
11.10 Application Examples

- Low ripple and low noise system output

The ripple rejection effect varies with a DC level of the input.

There are Output 1 and an approximately equal ripple rejection effect. The DC level changes by the voltage of the input. The ripple rejection effect does not depend on a DC level of the input.

Output 3 is the output of low ripple and low noise more than Output 1.

\[ \Delta V = R_{fil} \times 0.6 \mu A + V_{offset} \ (Typ: 40mV) \]

Figure 11. Low ripple and low noise system

Figure 12. Input Voltage : 3.55V + Ripple Noise

Figure 13. Input Voltage : 3.35V + Ripple Noise
**Reduction of the DC-DC converter output ripple noise**

Ripple noise of the DC-DC converter is rejected by connecting AP1158 to the output of the DC-DC converter.

![Diagram of DC-DC converter with AP1158](image)

**Figure 14. Reduction of the DC-DC converter output ripple noise**

![Waveform comparison of output ripple noise](image)

**Figure 15. Output ripple noise**
### 12. Definition of term

**Characteristics**
Each characteristic will be measured in a short period not to be influenced by joint temperature (Tj).

- **Output Current (I\(_{\text{OUT}}\))**
  Normal output current that can be used. And a range of overheat protection does not operation.

- **Maximum Output Current (I\(_{\text{OUT(MAX)}}\))**
  The rated output current is specified under the condition when the output voltage drops 10% the value specified with I\(_{\text{OUT}}\)=5mA. The input voltage is set at V\(_{\text{OUT(TYP)}}\)+1V and the current is pulsed to minimize temperature effect.

- **Reverse Bias Current (I\(_{\text{REV}}\))**
  It is an electric current, which flows from the V\(_{\text{OUT}}\) pin to the IC. The measurement condition is as follows.
  \( V_{\text{IN}}=0V, V_{\text{CONT}}=0V, V_{\text{REV}(V_{\text{OUT}})}=8V \)

- **Input-Output Voltage Drop (V\(_{\text{DROP}}\))**
  \( V_{\text{DROP}} \) is set by R\(_{\text{FIL}}\). It is necessary to set \( V_{\text{DROP}} \) large when there is a margin between the input voltage and output voltage, or the ripple noise is large. Please fix the \( V_{\text{DROP}} \) according to ripple noise, maximum output current and operating voltage. The \( V_{\text{DROP}} \) is calculated as follows.
  \[ V_{\text{DROP}} = R_{\text{FIL}} \times 0.6\mu A + V_{\text{OFFSET}} \text{ (typ:40mV)} \]

- **Sink Current of FIL Terminal**
  The sink current of the FIL terminal is 0.6\( \mu \)A(typ).
  \( V_{\text{DROP}} = (\text{Sink Current}) \times (R_{\text{FIL}}) + \text{(Offset voltage)} \)
  Ripple rejection ratio largely depends on this value.
  Standard value: \( R_{\text{FIL}} = 390k\Omega \) \( (V_{\text{DROP}}=270mV) \), \( V_{\text{DROP}} \text{ (mV)} = R_{\text{FIL}} \text{ (k}\Omega) \times 0.6\mu A + 40mV \)

- **Ripple Rejection Ratio (R.R.)**
  Ripple rejection is the ability of the IC to attenuate the ripple content of the input voltage at the output. It is specified with the input voltage with AC voltage (condition: 1) overlapped with DC voltage (condition: 2)
  \[ \text{Condition1 : 200mV}_{\text{p-p}}, f=1kHz \]
  \[ \text{Condition2 : } V_{\text{IN}}=2.5V \]
  The measurement condition is as follows.
  \( C_{\text{IN}}=0.1\mu F, C_{\text{OUT}}=1\mu F, C_{\text{FIL}}=4.7\mu F, R_{\text{FIL}}=390k\Omega (V_{\text{DROP}}=270mV), V_{\text{IN}}: DC=2.5V, AC=200mV_{\text{p-p}} \) (at \( f=1kHz \))
  It is necessary to enlarge \( R_{\text{FIL}} \) and \( C_{\text{FIL}} \) to improve the ripple rejection ratio at the low frequency range. The ripple rejection depends on the set \( V_{\text{DROP}} \) and the characteristics of the capacitor. Please consider the tolerance of resistor and capacitor. Please adjust the value of \( R_{\text{FIL}} (=390k\Omega) \) and \( C_{\text{FIL}} (=4.7\mu F) \) depends on application.

- **Standby Current (I\(_{\text{STANDBY}}\))**
  Input current through the output voltage at the control terminal voltage when the OFF mode.

**Protections**

- **Over Current Protection**
  The over current sensor protects the device when there is excessive output current. It also protects the device if the output is accidentally connected to ground.
13. Recommended External Circuit

**Table 2. Recommended external components example**

<table>
<thead>
<tr>
<th>Parts</th>
<th>min</th>
<th>typ</th>
<th>max</th>
<th>UNIT</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_{IN}$</td>
<td>-</td>
<td>1.0</td>
<td>-</td>
<td>μF</td>
<td></td>
</tr>
<tr>
<td>$C_L$</td>
<td>-</td>
<td>1.0</td>
<td>-</td>
<td>μF</td>
<td></td>
</tr>
<tr>
<td>$C_{FIL}$</td>
<td>-</td>
<td>4.7</td>
<td>-</td>
<td>μF</td>
<td></td>
</tr>
<tr>
<td>$R_{FIL}$</td>
<td>-</td>
<td>390</td>
<td>-</td>
<td>Ω</td>
<td>Setting at $V_{DROP}=274mV$</td>
</tr>
</tbody>
</table>

Note 10. The above table of values is the recommended example. Please apply the optimal value on the check prior to the time of your board.

**Recommended Layout**

1. Place the input capacitor $C_{IN}$ as close as possible to the $V_{IN}$ and GND.
2. Place the output capacitor $C_L$ as close as possible to the $V_{OUT}$ and GND.
3. PCB wiring, so as to strengthen the GND area.
4. PLP1822-6 of Exposed-Pad has become a shared with the ground of the IC. Please connect to the PCB ground always. Vias (heat dissipation hole) is an effective heat dissipation to the PCB of each layer.
14. Package

**Outline Dimensions**

- **SOT23-5**

![SOT23-5 Diagram]

- **PLP1822-6**

![PLP1822-6 Diagram]

**Unit:** mm

- (1) 1pin Indication
- (2) Market No.
- (3) Year code (last 1 digit)
- (4) Week code
- (5) Management code
### 15. Revise History

<table>
<thead>
<tr>
<th>Date (YY/MM/DD)</th>
<th>Revision</th>
<th>Page</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>15/5/26</td>
<td>00</td>
<td>-</td>
<td>First edition</td>
</tr>
<tr>
<td>17/3/24</td>
<td>01</td>
<td>-</td>
<td>Completely revised as PLP1822-6 package is added</td>
</tr>
</tbody>
</table>
IMPORTANT NOTICE

0. Asahi Kasei Microdevices Corporation ("AKM") reserves the right to make changes to the information contained in this document without notice. When you consider any use or application of AKM product stipulated in this document ("Product"), please make inquiries the sales office of AKM or authorized distributors as to current status of the Products.

1. All information included in this document are provided only to illustrate the operation and application examples of AKM Products. AKM neither makes warranties or representations with respect to the accuracy or completeness of the information contained in this document nor grants any license to any intellectual property rights or any other rights of AKM or any third party with respect to the information in this document. You are fully responsible for use of such information contained in this document in your product design or applications. AKM ASSUMES NO LIABILITY FOR ANY LOSSES INCURRED BY YOU OR THIRD PARTIES ARISING FROM THE USE OF SUCH INFORMATION IN YOUR PRODUCT DESIGN OR APPLICATIONS.

2. The Product is neither intended nor warranted for use in equipment or systems that require extraordinarily high levels of quality and/or reliability and/or a malfunction or failure of which may cause loss of human life, bodily injury, serious property damage or serious public impact, including but not limited to, equipment used in nuclear facilities, equipment used in the aerospace industry, medical equipment, equipment used for automobiles, trains, ships and other transportation, traffic signaling equipment, equipment used to control combustions or explosions, safety devices, elevators and escalators, devices related to electric power, and equipment used in finance-related fields. Do not use Product for the above use unless specifically agreed by AKM in writing.

3. Though AKM works continually to improve the Product's quality and reliability, you are responsible for complying with safety standards and for providing adequate designs and safeguards for your hardware, software and systems which minimize risk and avoid situations in which a malfunction or failure of the Product could cause loss of human life, bodily injury or damage to property, including data loss or corruption.

4. Do not use or otherwise make available the Product or related technology or any information contained in this document for any military purposes, including without limitation, for the design, development, use, stockpiling or manufacturing of nuclear, chemical, or biological weapons or missile technology products (mass destruction weapons). When exporting the Products or related technology or any information contained in this document, you should comply with the applicable export control laws and regulations and follow the procedures required by such laws and regulations. The Products and related technology may not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations.

5. Please contact AKM sales representative for details as to environmental matters such as the RoHS compatibility of the Product. Please use the Product in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. AKM assumes no liability for damages or losses occurring as a result of noncompliance with applicable laws and regulations.

6. Resale of the Product with provisions different from the statement and/or technical features set forth in this document shall immediately void any warranty granted by AKM for the Product and shall not create or extend in any manner whatsoever, any liability of AKM.

7. This document may not be reproduced or duplicated, in any form, in whole or in part, without prior written consent of AKM.