

### Features

- PWM Buck Control Circuitry
- Operating voltage can be up to 27V
- Under voltage Lockout (UVLO) Protection
- Short Circuit Protection (SCP)
- Soft-start circuit
- Variable Oscillator Frequency -- 300Khz Max
- 1.25V voltage reference Output
- 8-pin SOP package
- SOP-8L: Available in "Green" Molding Compound (No Br, Sb)
- Lead Free Finish/ RoHS Compliant (Note 1)

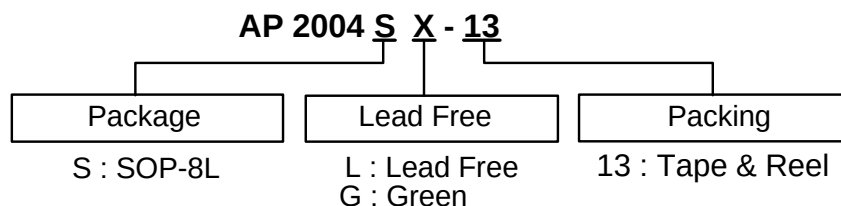
### General Description

The AP2004 integrates Pulse-Width-Modulation (PWM) control circuit into a single chip, mainly designs for power-supply regulator. All the functions include an on-chip 1.25V reference output, an error amplifier, an adjustable oscillator, a soft-start, UVLO, SCP circuitry, and a push-pull output circuit. Switching frequency is adjustable by trimming CT. During low VCC situation, the UVLO makes sure that the outputs are off until the internal circuit operates normally.

### Applications

- Backlight inverter
- LCD Monitor
- CDROM, XDSL Product
- DC/DC converters in computers, etc.

### Ordering Information



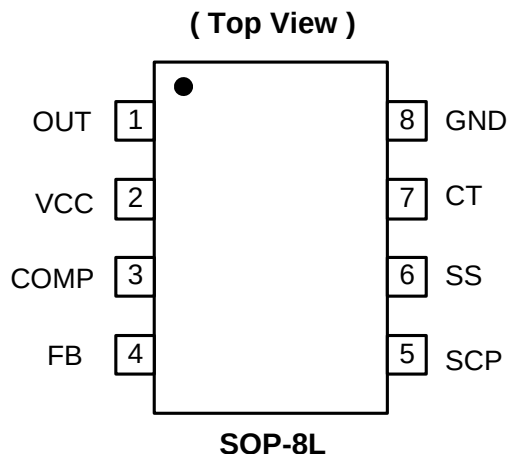
| Device      | Package Code | Packaging (Note 2) | 13" Tape and Reel |                    |
|-------------|--------------|--------------------|-------------------|--------------------|
|             |              |                    | Quantity          | Part Number Suffix |
| AP2004SL-13 | S            | SOP-8L             | 2500/Tape & Reel  | -13                |
| AP2004SG-13 | S            | SOP-8L             | 2500/Tape & Reel  | -13                |



Notes:

1. EU Directive 2002/95/EC (RoHS). All applicable RoHS exemptions applied. Please visit our website at [http://www.diodes.com/products/lead\\_free.html](http://www.diodes.com/products/lead_free.html).
2. Pad layout as shown on Diodes Inc. suggested pad layout document AP02001, which can be found on our website at <http://www.diodes.com/datasheets/ap02001.pdf>.

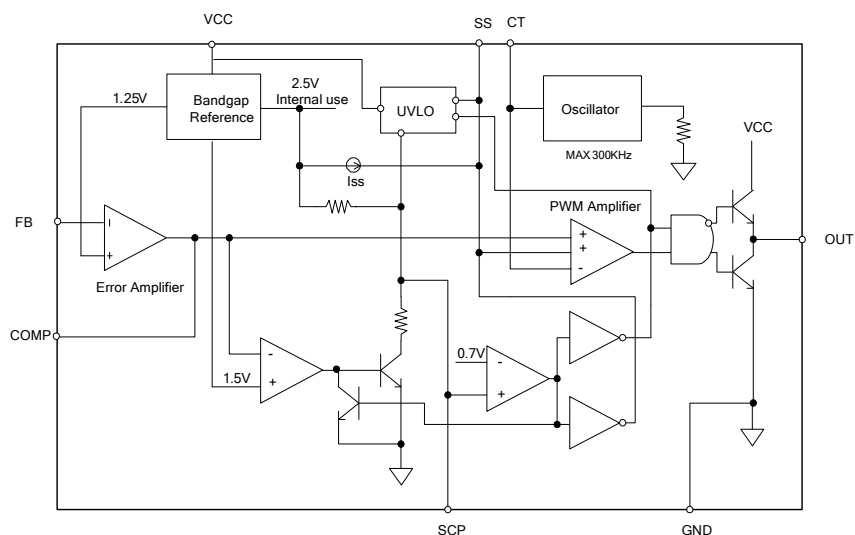
## Pin Assignments



## Pin Descriptions

| Pin Name | Description                |
|----------|----------------------------|
| CT       | Timing Capacitor           |
| FB       | Voltage Feedback           |
| SS       | Soft-Start.                |
| COMP     | Feedback Loop Compensation |
| OUT      | PWM Output                 |
| GND      | Ground                     |
| VCC      | Supply Voltage             |
| SCP      | Short Circuit Protection   |

### Block Diagram



### Absolute Maximum Ratings

| Symbol       | Parameter                            | Rating        | Unit |
|--------------|--------------------------------------|---------------|------|
| $P_D$        | Power dissipation at 25°C            | 600           | mW   |
| $V_{CC}$     | Supply voltage                       | 28            | V    |
| $V_I$        | Amplifier input voltage              | 20            | V    |
| $V_O$        | Collector output voltage             | $V_{CC}-1.0V$ | V    |
| $I_{SOURCE}$ | Source current                       | 200           | mA   |
| $I_{SINK}$   | Sink current                         | 200           | mA   |
| $T_{OP}$     | Operating junction temperature range | -20 to +125   | °C   |
| $T_{ST}$     | Storage temperature range            | -65 to +150   | °C   |

### Recommended Operating Conditions

| Symbol    | Parameter                      | Min  | Max          | Unit |
|-----------|--------------------------------|------|--------------|------|
| $V_{CC}$  | Supply voltage                 | 3.6  | 27           | V    |
| $V_I$     | Amplifier input voltage        | 1.05 | 1.45         | V    |
| $V_O$     | Collector output voltage       |      | $V_{CC}-1.5$ | V    |
| $I_{FB}$  | Current into feedback terminal |      | 45           | μA   |
| $R_F$     | Feedback resistor              | 100  |              | kΩ   |
| $C_T$     | Timing capacitor               | 100  | 6800         | pF   |
| $F_{OSC}$ | Oscillator frequency           | 10   | 300          | KHz  |

**Electrical Characteristics** ( $T_A = 25^\circ\text{C}$ ,  $V_{CC} = 6\text{V}$ ,  $f = 200\text{ KHz}$ )

**Reference (REF)**

| Symbol    | Parameter                              | Conditions                                      | Min   | Typ. | Max     | Unit |
|-----------|----------------------------------------|-------------------------------------------------|-------|------|---------|------|
| $V_{REF}$ | Comp connect to FB                     |                                                 | 1.225 | 1.25 | 1.275   | V    |
|           | Output voltage change with temperature | $T_A = -20^\circ\text{C} \sim 25^\circ\text{C}$ |       | -0.1 | $\pm 1$ | %    |
|           |                                        | $T_A = 25^\circ\text{C} \sim 85^\circ\text{C}$  |       | -0.2 | $\pm 1$ | %    |

**Under voltage lockout (UVLO)**

| Symbol    | Parameter                            | Conditions                                              | Min | Typ. | Max | Unit |
|-----------|--------------------------------------|---------------------------------------------------------|-----|------|-----|------|
| $V_{UT}$  | Upper threshold voltage ( $V_{CC}$ ) | $I_{O(REF)} = 0.1\text{mA}$<br>$T_A = 25^\circ\text{C}$ |     | 2.9  |     | V    |
| $V_{LWT}$ | Lower threshold voltage ( $V_{CC}$ ) |                                                         |     | 2.4  |     | V    |
| $V_{HT}$  | Hysteresis ( $V_{CC}$ )              |                                                         |     | 500  |     | mV   |

**Short-circuit protection (SCP) control**

| Symbol    | Parameter                           | Conditions                                     | Min  | Typ. | Max  | Unit          |
|-----------|-------------------------------------|------------------------------------------------|------|------|------|---------------|
| $V_{IT}$  | Input threshold voltage             | $T_A = 25^\circ\text{C}$                       | 0.60 | 0.67 | 0.75 | V             |
| $V_{STB}$ | Standby voltage                     | No pull up                                     | 100  | 130  | 160  | mV            |
| $V_{LT}$  | Latched input voltage               | No pull up                                     |      | 50   | 100  | mV            |
| $I_{SCP}$ | Input (source) current              | $V_I = 0.7\text{V}$ , $T_A = 25^\circ\text{C}$ | -10  | -15  | -20  | $\mu\text{A}$ |
| $V_{CT}$  | Comparator threshold voltage (COMP) |                                                |      | 1.5  |      | V             |

**Oscillator (OSC)**

| Symbol           | Parameter                       | Conditions                             | Min | Typ. | Max | Unit |
|------------------|---------------------------------|----------------------------------------|-----|------|-----|------|
| $F_{OSC}$        | Frequency                       | $C_T = 270\text{ pF}$                  |     | 200  |     | KHz  |
| $\Delta F_{OSC}$ | Standard deviation of frequency | $C_T = 270\text{ pF}$                  |     | 10   |     | %    |
|                  | Frequency change with voltage   | $V_{CC} = 3.6\text{V} \sim 20\text{V}$ |     | 1    |     |      |

**Error-amplifier**

| Symbol   | Parameter                       | Conditions                                     | Min           | Typ. | Max       | Unit          |
|----------|---------------------------------|------------------------------------------------|---------------|------|-----------|---------------|
| $V_{IO}$ | Input offset voltage            | $V_O (\text{FB}) = 1.25\text{V}$               |               |      | $\pm 6$   | mV            |
| $I_{IO}$ | Input offset current            | $V_O (\text{FB}) = 1.25\text{V}$               |               |      | $\pm 100$ | nA            |
| $I_{IB}$ | Input bias current              | $V_O (\text{FB}) = 1.25\text{V}$               |               | 160  | 500       | nA            |
| $V_{CM}$ | Common-mode input voltage range | $V_{CC} = 3.6\text{V} \sim 20\text{V}$         | 1.05          |      | 1.45      | V             |
| AV       | Open-loop voltage amplification | $R_F = 200\text{ k}\Omega$                     | 70            | 80   |           | dB            |
| GBW      | Unity-gain bandwidth            |                                                |               | 1.5  |           | MHz           |
| CMRR     | Common-mode rejection ratio     |                                                | 60            | 80   |           | dB            |
| $V_{OH}$ | Max. output voltage             |                                                | $V_{ref}-0.1$ |      |           | V             |
| $V_{OL}$ | Min. output voltage             |                                                |               |      | 1         | V             |
| $I_{OI}$ | Output (sink) current (COMP)    | $V_{ID} = -0.1\text{V}$ , $V_O = 1.25\text{V}$ | 0.5           | 1.6  |           | mA            |
| $I_{OO}$ | Output (source) current (COMP)  | $V_{ID} = 0.1\text{V}$ , $V_O = 1.25\text{V}$  | -45           | -70  |           | $\mu\text{A}$ |

**Electrical Characteristics** (Continued) ( $T_A = 25^\circ\text{C}$ ,  $V_{CC} = 6\text{V}$ ,  $f = 200\text{ KHz}$ )

**Output section**

| Symbol     | Parameter                    | Conditions            | Min | Typ. | Max | Unit          |
|------------|------------------------------|-----------------------|-----|------|-----|---------------|
| $I_{LEAK}$ | Leakage current              | $V_O = 25\text{V}$    |     |      | 10  | $\mu\text{A}$ |
| $I_{DRV}$  | Sink current                 | $V_{IN} = 20\text{V}$ |     | 200  |     | $\text{mA}$   |
|            | Source current               | $V_{IN} = 20\text{V}$ |     | 200  |     | $\text{mA}$   |
| $V_{SAT}$  | Output saturation voltage    | $I_O = 10\text{ mA}$  |     | 1.0  | 1.5 | $\text{V}$    |
| $I_{SC}$   | Short-circuit output current | $V_O = 6\text{V}$     |     | 120  |     | $\text{mA}$   |

**PWM comparator**

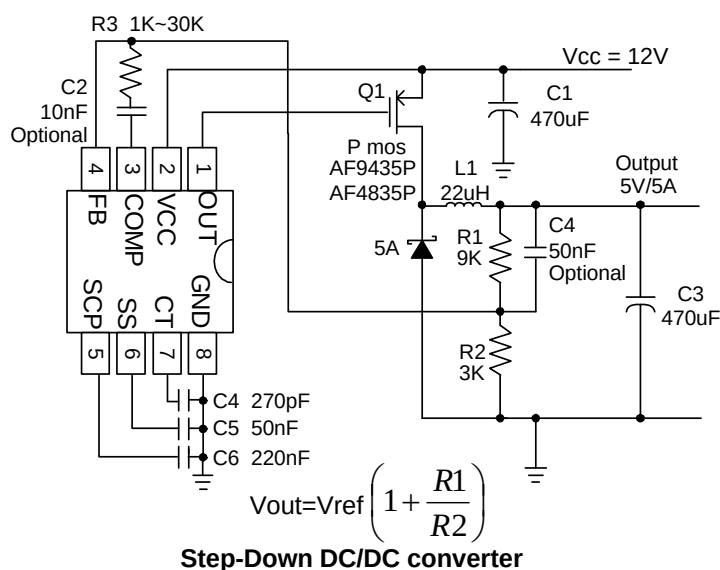
| Symbol     | Parameter                                                | Conditions         | Min | Typ. | Max | Unit       |
|------------|----------------------------------------------------------|--------------------|-----|------|-----|------------|
| $V_{T0}$   | Input threshold voltage at $f = 10\text{ KHz}$<br>(COMP) | CT                 |     | 0.6  | 0.7 | $\text{V}$ |
| $V_{T100}$ |                                                          | Maximum duty cycle | 1.2 | 1.3  |     | $\text{V}$ |

**Total device**

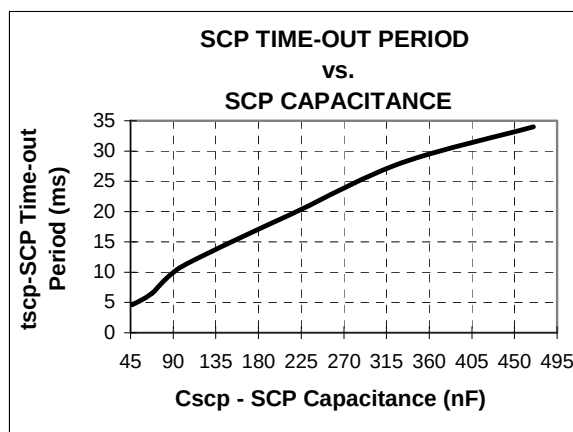
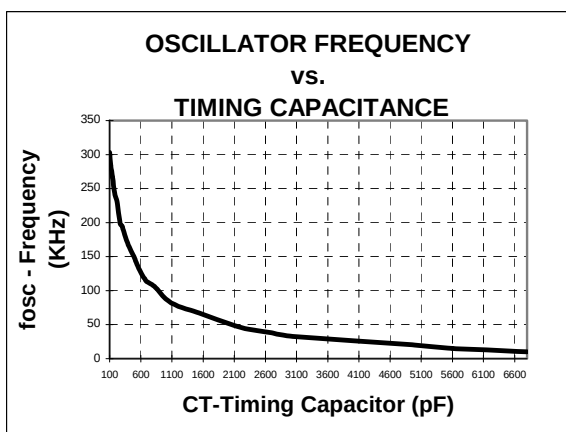
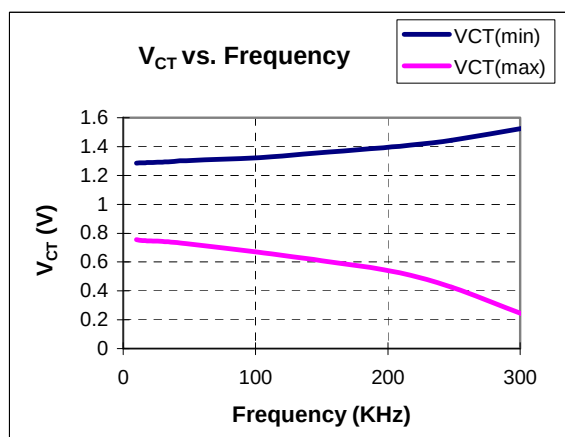
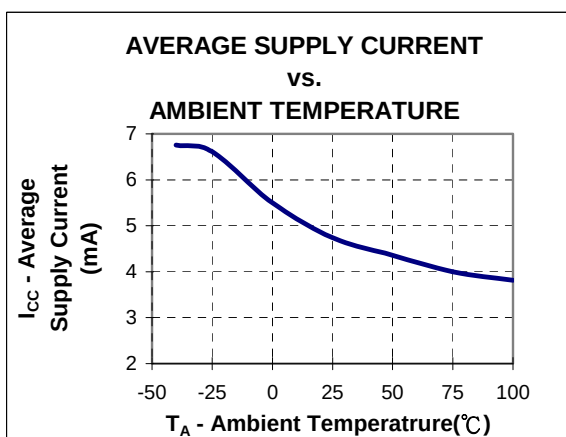
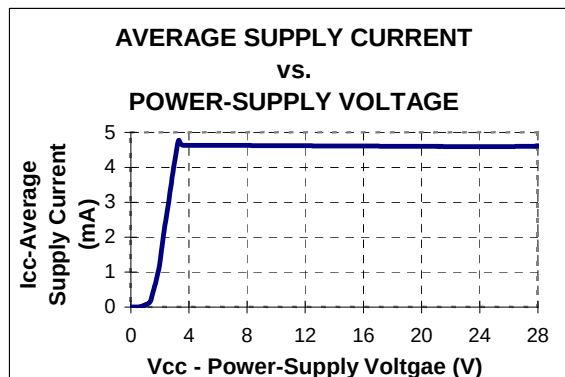
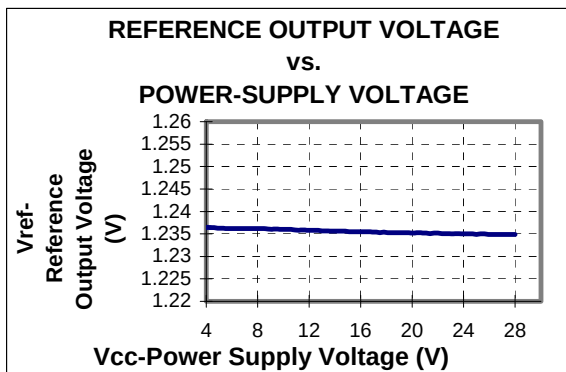
| Symbol    | Parameter              | Conditions           | Min | Typ. | Max | Unit        |
|-----------|------------------------|----------------------|-----|------|-----|-------------|
| $I_{CCA}$ | Average supply current | $C_T = 270\text{pF}$ |     | 6    | 10  | $\text{mA}$ |

**Soft Start**

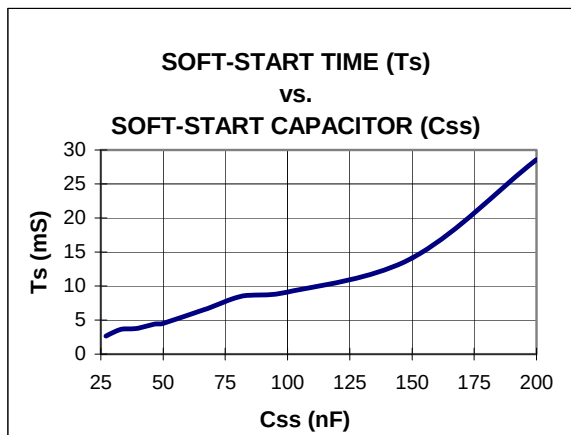
| Symbol   | Parameter               | Conditions | Min | Typ. | Max | Unit          |
|----------|-------------------------|------------|-----|------|-----|---------------|
| $V_{SS}$ | Soft-start Voltage      |            |     | 2.3  |     | $\text{V}$    |
| $I_{SS}$ | Constant Charge Current |            |     | 20   |     | $\mu\text{A}$ |

**Typical Application Circuit**


### Typical Characteristics

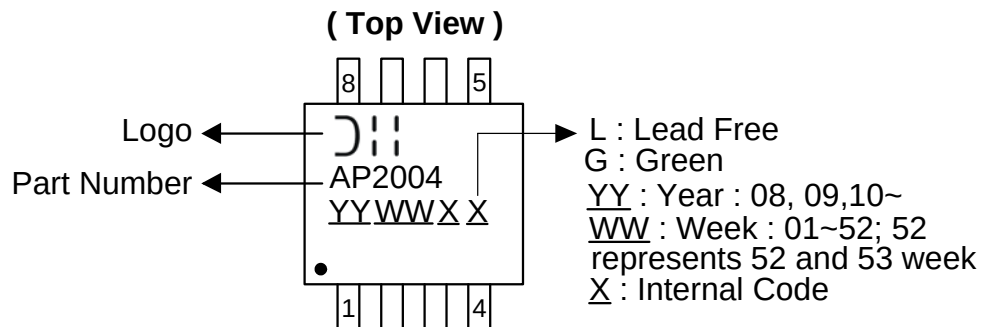


## Typical Characteristics (Continued)



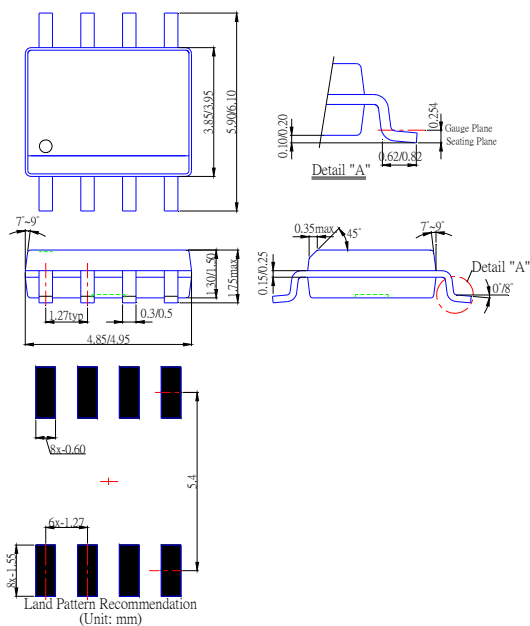
## Marking Information

### (1) SOP-8L



## Package Information (All Dimensions in mm)

### (1) Package Type: SOP- 8L



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