

**Features**

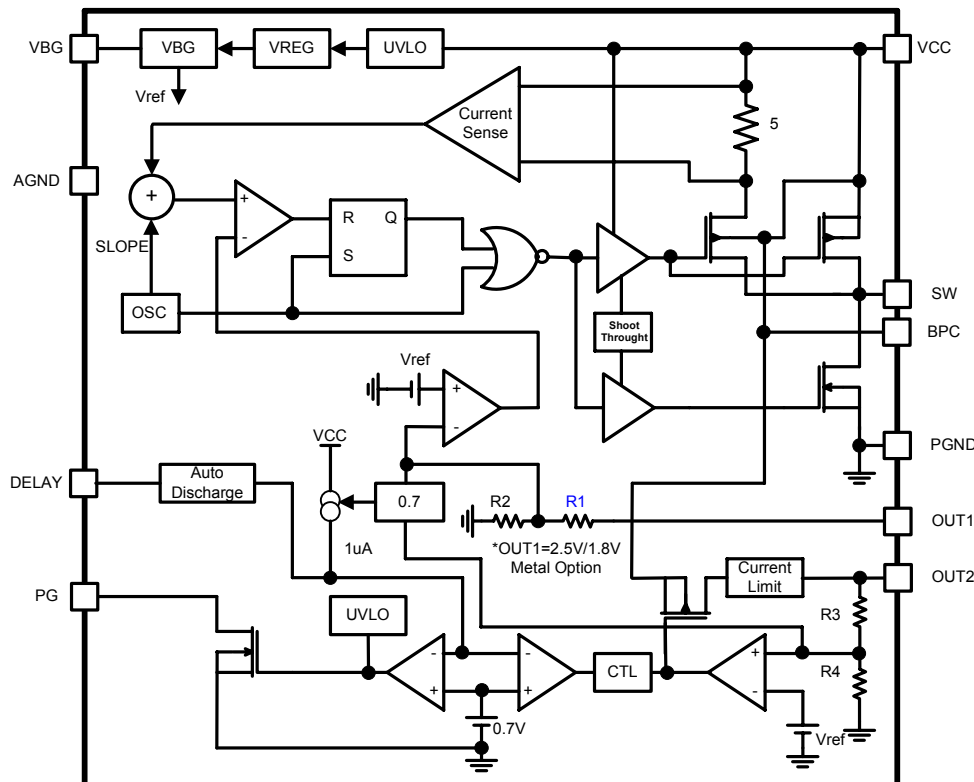
- Operation Voltage 2.5V~6.0V
- Oscillation frequency 1MHz
- Output Current Maximum 400mA (DC-DC Converter)
- Built-In 400mA/LDO
- Power Good Indicator with Time Delay Adjustable
- Built-In Current Limit
- Built-In UVLO
- Built-In Thermal ShutDown

**Applications**

- Power Supply for Slim Type devices

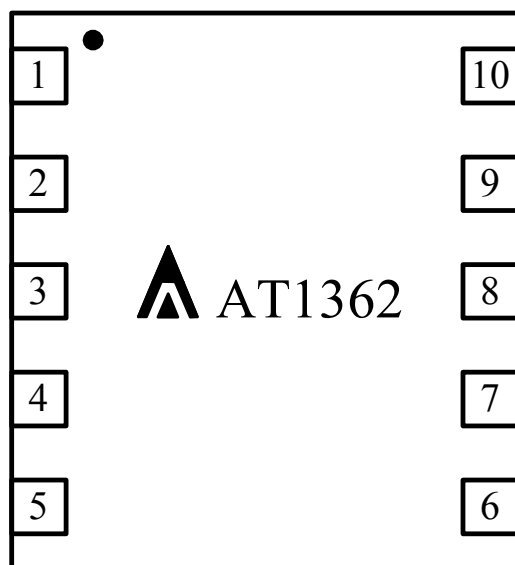
**General Description**

The AT1362A/B provides complete control for a DC/DC converter optimized for high-performance microprocessor applications. It consists of a synchronous step-down DC/DC converter and a high-speed LDO regulator connected in series with the DC/DC converter output. A power good detector and LDO ON/OFF control is also built-in (metal option). DC/DC converter is operated on current mode architecture for excellent line and load transient response. 1MHz operation frequency is allowing the use of small surface mount inductor and capacitor. The internal synchronous switch increases efficiency and eliminates the need for an external schottky diode. The AT1362A/B is a family of low-noise synchronous step-down DC/DC converters that is ideally suited for systems powered from a 1-cell Li-ion battery or from a 3-cell to 4-cell NiCd, NiMH, or alkaline battery. It can also be used to USB-based power system.

**Block Diagram**

**Aimtron reserves the right without notice to change this circuitry and specifications.**

### Pin Assignment



**DFN10 (TOP VIEW)**

| AT1362A                     | AT1362B                     |
|-----------------------------|-----------------------------|
| <b>DC/DC</b><br><b>2.5V</b> | <b>DC/DC</b><br><b>1.8V</b> |
| <b>LDO</b><br><b>3.3V</b>   | <b>LDO</b><br><b>3.3V</b>   |

### Ordering Information

| Part Number | Package     | Marking |
|-------------|-------------|---------|
| 1362□N      | DFN10,Green | □□□□□□  |

□ : A:1362AN B:1362BN

□□□□□□ : Date Code

*\*For more marking information, contact our sales representative directly.*

### Pin Description

| Symbol | Pin No. | Descript                                                                  |
|--------|---------|---------------------------------------------------------------------------|
| 1      | PG      | Power Good Indicator Output(Ative Hi)                                     |
| 2      | OUT1    | DC/DC Output (2.5V or 1.8V)                                               |
| 3      | VCC     | Power Supply                                                              |
| 4      | SW      | DC/DC Inductor Node                                                       |
| 5      | PGND    | Power Ground                                                              |
| 6      | VBG     | Reference Output Voltage                                                  |
| 7      | AGND    | Analog Ground                                                             |
| 8      | DELAY   | The capacitor connection terminal for LDO control and PG delay time setup |
| 9      | OUT2    | LDO Output (3.3V)                                                         |
| 10     | BPC     | LDO Input By-pass Capacitor Node                                          |
| Bottom | GND     | Analog Ground                                                             |

### Absolute Maximum Ratings\*1

| Parameter                                                 | Symbol     | Rated Value |         | Unit                 |
|-----------------------------------------------------------|------------|-------------|---------|----------------------|
|                                                           |            | Min.        | Max.    |                      |
| Power Supply Voltage                                      | VCC        | -0.3        | +6.5    | V                    |
| Input Pin Voltage                                         | OUT1, OUT2 | -0.3        | VCC     | V                    |
|                                                           | SW, PG     | -0.3        | VCC+0.3 | V                    |
| P-Channel Switch Source Current (DC)                      | —          | -           | 0.5     | A                    |
| N-Channel Switch Sink Current (DC)                        | —          | -           | 0.5     | A                    |
| Peak SW Sink and Source Current                           | —          | -           | 0.75    | A                    |
| Thermal Resistance from Junction to Ambient $\theta_{JA}$ | DFN10      | -           | 35.25   | $^{\circ}\text{C/W}$ |
| Thermal Resistance from Junction to Case $\theta_{JC}$    | DFN10      | -           | 3       | $^{\circ}\text{C/W}$ |
| Operating temperature $T_A$                               | —          | -20         | +85     | $^{\circ}\text{C}$   |
| Storage temperature                                       | —          | -20         | +150    | $^{\circ}\text{C}$   |
| ESD Susceptibility*2                                      | HBM        | -           | 2       | KV                   |
|                                                           | MM         | -           | 200     | V                    |

1. Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.
2. Device are ESD sensitive. Handling precaution recommended. The Human Body model is a 100pF capacitor discharged through a 1.5K $\Omega$  resistor into each pin.

### Recommended Operating Conditions

( $T_a=+25^{\circ}\text{C}$ )

| Parameter                      | Symbol   | Values |      |      | Unit               |
|--------------------------------|----------|--------|------|------|--------------------|
|                                |          | Min.   | Typ. | Max. |                    |
| Power supply voltage           | $V_{IN}$ | 2.5    | --   | 6.0  | V                  |
| Operating temperature*         | $T_{OP}$ | -20    | +25  | +85  | $^{\circ}\text{C}$ |
| Operating junction temperature | $T_J$    | -      | -    | +150 | $^{\circ}\text{C}$ |

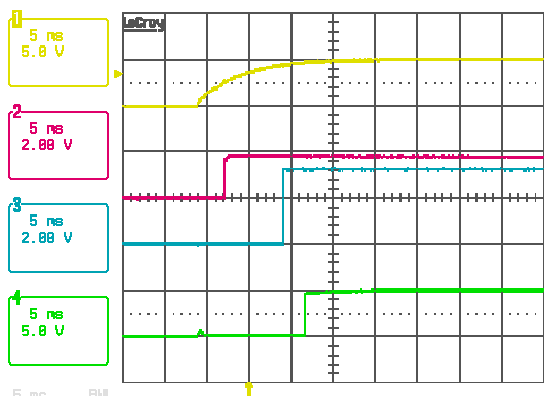
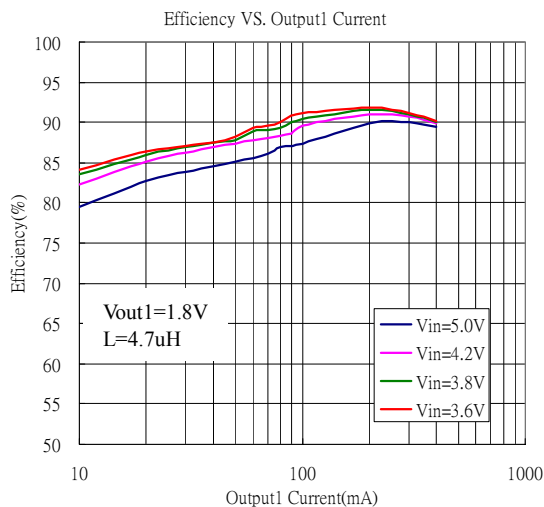
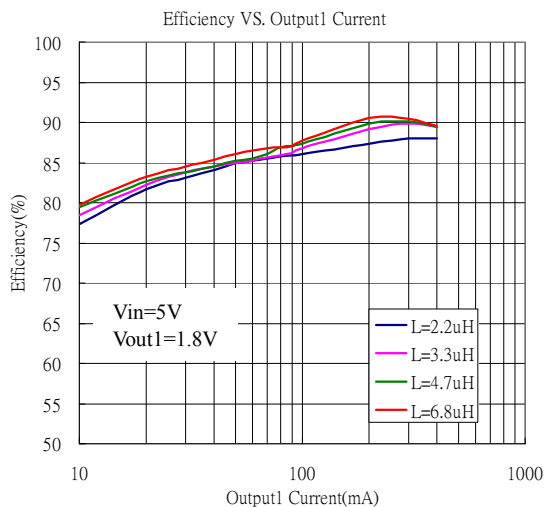
\*Using X5R or X7R input capacitors.

### Electrical Characteristics

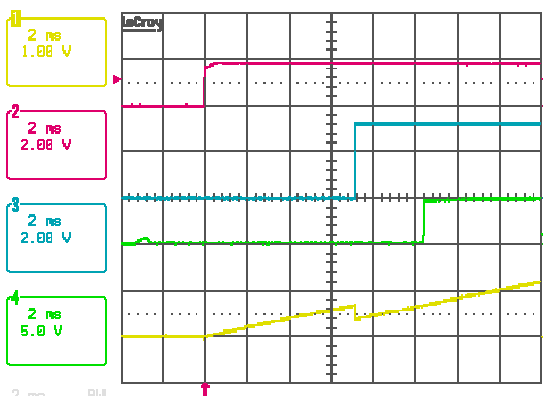
(VCC = 3.6V, T<sub>a</sub> = +25°C, unless otherwise noted.)

| Parameter                          | Symbol                 | Condition                                              | Values |      |      | Unit |
|------------------------------------|------------------------|--------------------------------------------------------|--------|------|------|------|
|                                    |                        |                                                        | Min.   | Typ. | Max. |      |
| DC/DC CONVERTER                    |                        |                                                        |        |      |      |      |
| VCC UVLO                           | V <sub>UV</sub>        | VCC=3V→2V Sweep                                        | -      | 2.4  | -    | V    |
| UVLO Hysteresis width              | V <sub>UVHY</sub>      |                                                        | -      | 100  | -    | mV   |
| Input Supply Range                 | V <sub>CC</sub>        |                                                        | 2.5    | -    | 6.0  | V    |
| Quiescent Current                  | I <sub>S</sub>         | Active Mode                                            | -      | 500  | -    | μA   |
| Output1 Voltage Accuracy           | V <sub>OUT1</sub>      |                                                        | -2     | -    | +2   | %    |
| Output1 Voltage line-regulation    | V <sub>OUT1-Line</sub> | VCC=3.5V to 6.0V                                       | -      | 0.1  | 0.5  | %    |
| Output1 Variation with Temperature |                        | T <sub>a</sub> =-20℃ to +85℃                           | -      | 0.5  | 1.0  | %    |
| Feedback current                   | I <sub>OUT1</sub>      |                                                        | -      | 6    | -    | uA   |
| Current Limit                      | I <sub>CL1</sub>       | VIN=5V, V <sub>OUT1</sub> =2.5V/1.8V                   | 0.6    | 0.7  | 0.8  | A    |
| Maximum Output Current             | I <sub>O</sub>         | VIN=5V, V <sub>OUT1</sub> =2.5V/1.8V, L=4.7uH          | 400    | -    | -    | mA   |
| Oscillator Frequency               | fosc1                  | Vout1=2.5V/1.8V                                        | 0.8    | 1.0  | 1.2  | MHz  |
|                                    | fosc2                  | Vout1=0V                                               | -      | 200  | --   | KHz  |
| RDS(ON) of P-Channel MOSFET        | R <sub>PFET</sub>      | I <sub>LX</sub> = 300mA                                | -      | 0.3  | 0.4  | Ω    |
| RDS(ON) of N-Channel MOSFET        | R <sub>NFET</sub>      | I <sub>LX</sub> = -300mA                               | -      | 0.25 | 0.35 | Ω    |
| SW Leakage Current                 | I <sub>SWL</sub>       |                                                        | -      | ±0.1 | ±1   | μA   |
| CONTROL BLOCK                      |                        |                                                        |        |      |      |      |
| PG on voltage                      | V <sub>PGON</sub>      | I <sub>PG</sub> =1mA                                   | -      | -    | 0.4  | V    |
| PG Hysteresis width                | V <sub>PGTHYS</sub>    |                                                        | -      | 80   | -    | mV   |
| PG pin leak current                | I <sub>PGTLK</sub>     | V <sub>PG</sub> =5.0V                                  | -      | -    | 1    | uA   |
| LDO control on Hysteresis width    | V <sub>LDTHYS</sub>    |                                                        | -      | 80   | -    | mV   |
| DELAY Pin Charge Current           | I <sub>DELAY</sub>     |                                                        | 0.8    | 1.0  | 1.2  | uA   |
| LDO                                |                        |                                                        |        |      |      |      |
| Output2 Voltage Accuracy           | V <sub>OUT2</sub>      |                                                        | -2     | -    | +2   | %    |
| Current Limit                      | I <sub>CL2</sub>       |                                                        | 450    | -    | -    | mA   |
| Dropout Voltage                    | V <sub>DV</sub>        | I <sub>OUT2</sub> =400mA                               | -      | 400  | 600  | mV   |
| Load Regulation                    | ΔV <sub>OUT2</sub>     | I <sub>OUT2</sub> =1mA→ 100mA                          | -      | 15   | 50   | mV   |
| Line Regulation                    | LR                     | I <sub>OUT2</sub> =100mA, V <sub>OUT1</sub> =3.6V→6.0V | -      | 0.05 | 0.25 | %    |
| Ripple Rejection Rate              | PSRR                   | I <sub>OUT2</sub> =100mA, f=1kHz                       | -      | 60   | -    | dB   |
| OUT2 Leakage Current               | I <sub>OUT2LK</sub>    |                                                        | -      | 6    | -    | uA   |

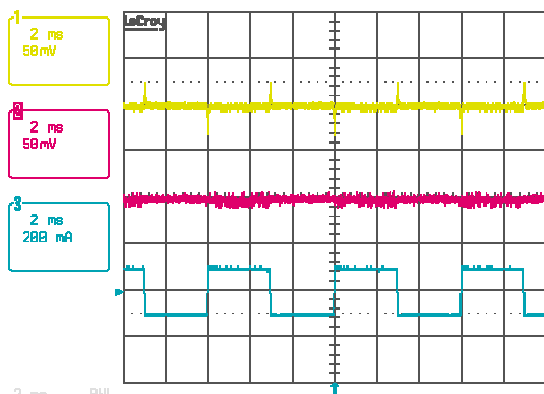
**Typical characteristics**



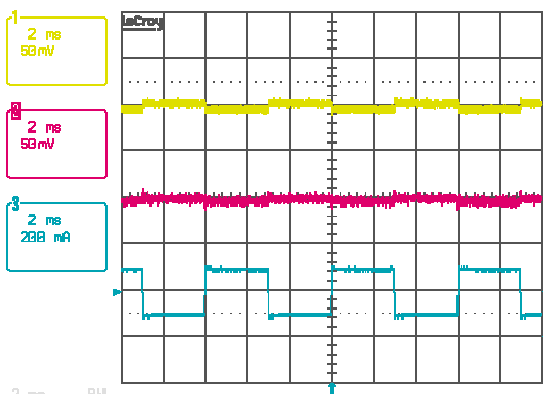
CH1 : Vin, CH2 : Vout1  
CH3 : Vout2, CH4 : PG



CH1 : DELAY, CH2 : Vout1  
CH3 : Vout2, CH4 : PG

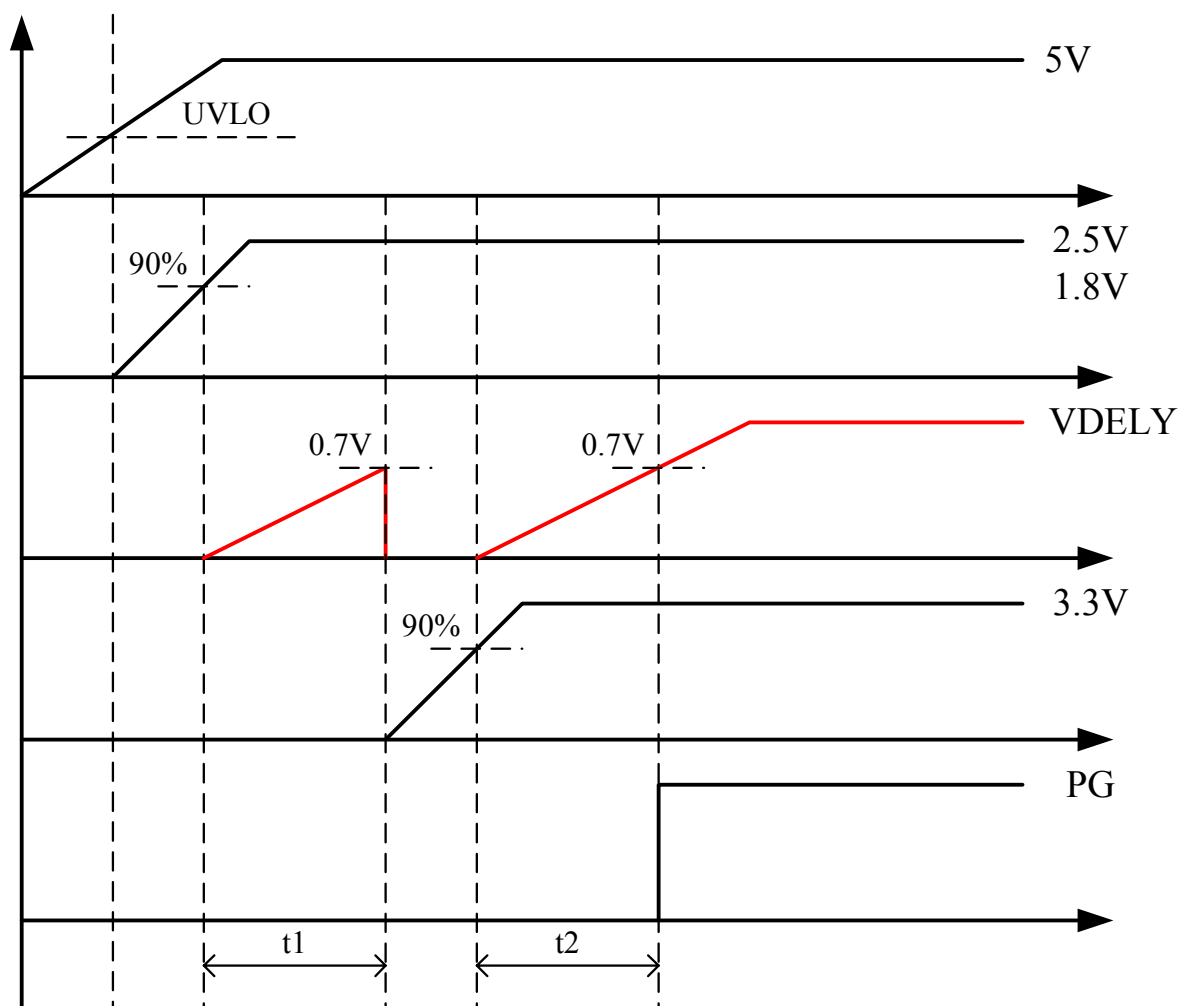


CH1 : Vout1, CH2 : Vout2, CH4 : Iout1  
Iout1=100mA~300mA, Iout2=200mA



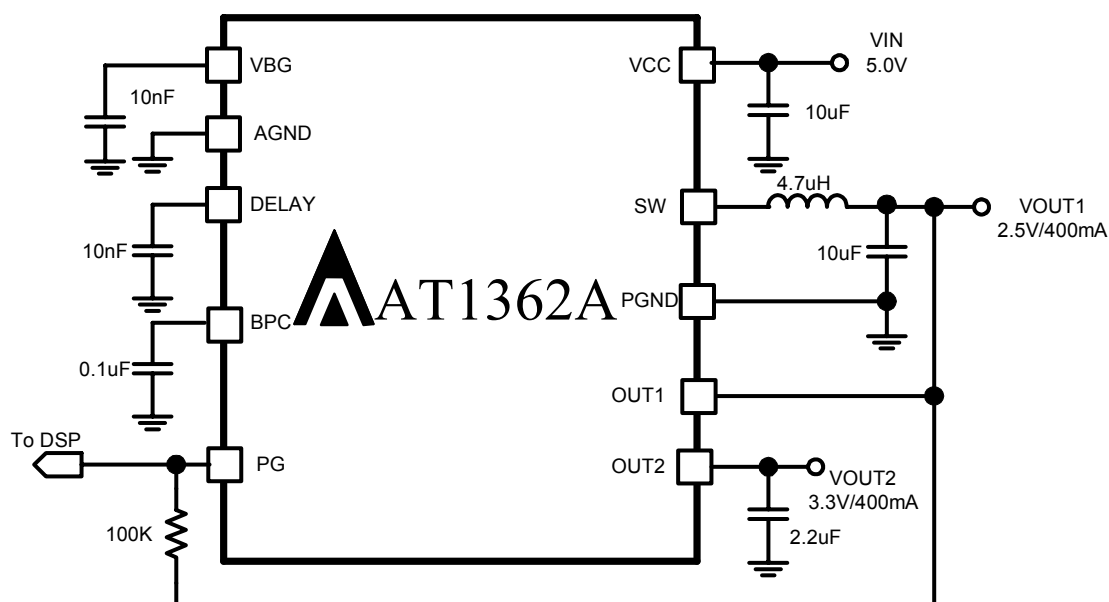
CH1 : Vout1, CH2 : Vout2, CH4 : Iout2  
Iout1=200mA, Iout2=100mA~300mA

### Typical Application Circuits

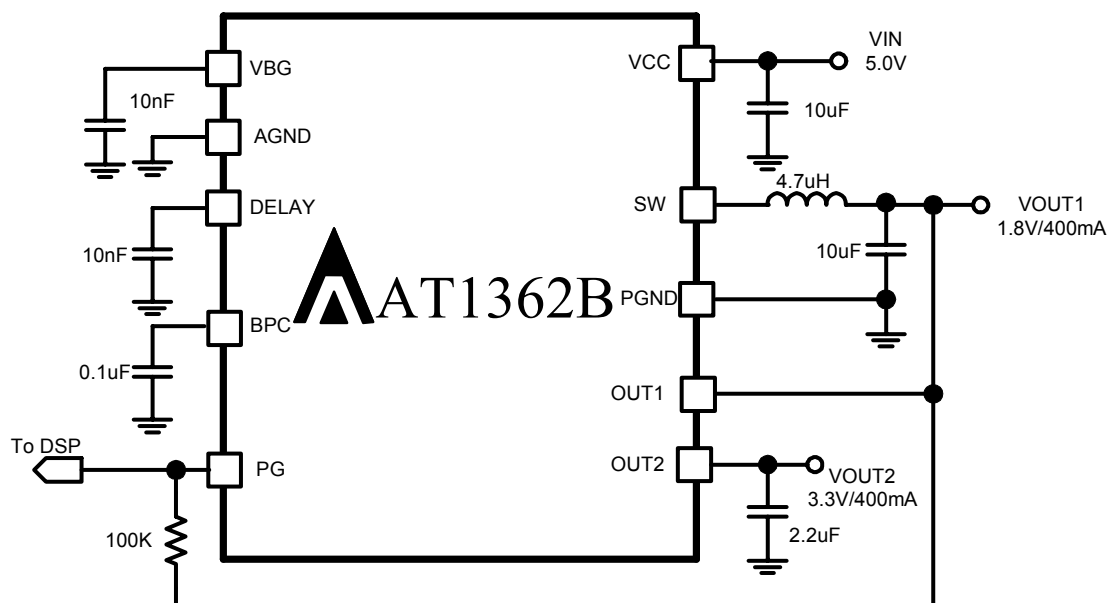


### Timing of Power-On Sequencing

**Typical Application Circuits ( Continued )**



**Figure 1**



**Figure 2**

## Application Information

### Capacitor Selection

In continuous mode, the source current of the top MOSFET is square wave of duty cycle. The Primary function of the input capacitor is to provide a low impedance loop for the edges of pulsed current drawn by the AT1362A/B. A load step at the output can induce ringing at the input VIN. This ringing can couple to the output and be mistaken as loop instability. The oscillation can be improved by add the capacitance of the input capacitor. A typical value is 10μF ceramic (X5R or X7R), POSCAP or Aluminum Polymer. These capacitors will provide good high frequency bypassing and their low ESR will reduce resistive losses for higher efficiency. The input capacitor RMS current varies with the input voltage and the output voltage. The equation for the maximum RMS current in the input capacitor is:

$$I_{RMS} = I_{OMAX} \sqrt{\frac{V_O}{V_{IN}} \left(1 - \frac{V_O}{V_{IN}}\right)}$$

The output capacitor depends on the suitable ripple voltage. Low ripple voltage corresponds to lower effective series resistance (ESR). The output ripple voltage is determined by:

$$\Delta V_{OUT} \cong \Delta I_L \left( ESR + \frac{1}{8fC_{OUT}} \right)$$

The output capacitor RMS ripple current is given by:

$$I_{RMS} = \frac{1}{2\sqrt{3}} \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{L \times f \times V_{IN}}$$

### VBG Capacitor

A VBG pin is provided to decouple the bandgap reference voltage. An external capacitor connected form VBG to GND reduces noise present on the internal reference voltage, which in turn significantly reduces output noise and also improves PSRR. Larger capacitor values may be used to further improve PSRR, but result in a longer time period (slower turn on) to settle output voltage when power is initially applied.



## LDO

For general purposes, use a 2.2uF capacitor on the LDO output. Larger capacitor values and lower ESR provide better supply noise rejection and transient response. A higher value input capacitor may be necessary if large, fast transients are anticipated. Ceramic capacitors have the lowest ESR, and will offer the best AC performance.

When choosing the input and output ceramic capacitors, choose the [X5R](#) or [X7R](#) dielectric formulations. These dielectrics have the best temperature and voltage characteristics of all the ceramics for a given value and size.

## Inductor Selection

The inductor is chosen based on the desired ripple current. Large value inductors lower ripple current and small value inductors result in higher ripple current. Always consider the losses associated with the DCR and its effect on the total converter efficiency when selecting an inductor. The inductor is selected to limit the ripple current to some predetermined value, typically 20~40% of the full load current at the maximum input voltage. The formula of inductance value is as below:

$$\Delta I_L = 0.2 \sim 0.4 \times I_{OUT(MAX)}$$

$$L = \frac{V_{OUT}}{f \times \Delta I_L} \left( 1 - \frac{V_{OUT}}{V_{IN}} \right)$$

$$I_{PK} = I_O + \frac{\Delta I_L}{2} = I_O + \frac{(V_{IN} - V_{OUT}) \times t_{ON}}{2 \times L}$$

## Power Good Indicator with Adjustable Time Delay

When OUT1 pin is above 2.25V or 1.62V (typ.) and with a delay time (t1) the OUT2 is start to regulation. The PG pin terminal is an open drain output of N-MOS. Connect a resistor from PG pin to VCC or OUT2 to create a logic signal. If OUT2 pin is less than 2.97V (typ.) this pin is pulled to ground. When OUT2 pin is above 2.97V (typ.) and with a delay time (t2) this pin is open. PG pin is forced low when in UVLO. The formula of adjustable delay time is as below:

$$delay - time = t1 = t2 = C \times \frac{0.7V}{I_{DELAY}}$$

### The Dissipation

The power loss is given by:

$$P_{LOSS(DC-DC)} = I_{OUT1}^2 \times R_{DS(ON)-P} \times D + I_{OUT1}^2 \times R_{DS(ON)-N} \times (1-D) + V_{IN} \times I_{OUT1} \times (t_r + t_f) \times f_s + I_s \times V_{IN}$$

$$P_{LOSS(LDO)} = I_{OUT2} \times (V_{IN} - V_{OUT2})$$

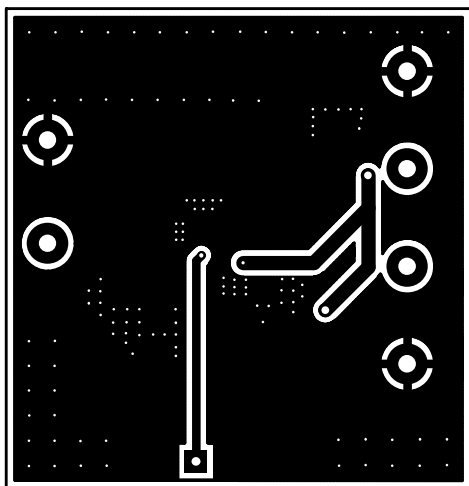
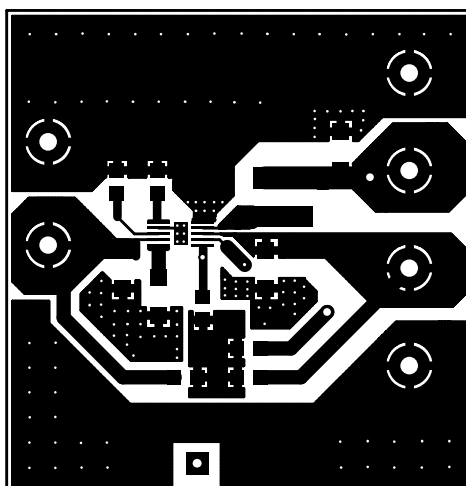
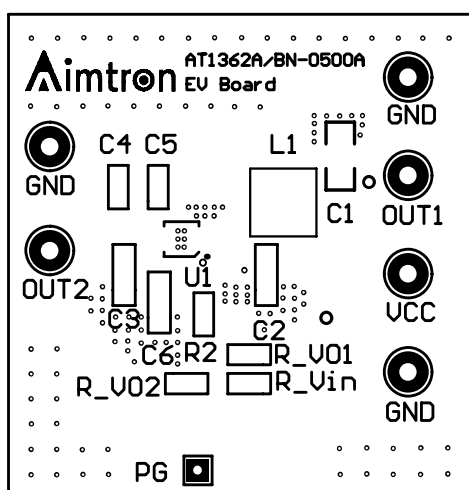
$$T_{J(MAX)} = T_A + \theta_{JA} \times (P_{LOSS(DC-DC)} + P_{LOSS(LDO)})$$

| Inductors Surface Mount |                                              |                                                            |
|-------------------------|----------------------------------------------|------------------------------------------------------------|
| Inductance(μH)          | Manufacturer/Part No.                        | Manufacturer Website                                       |
| 3.3                     | Sumida CDRH4D28-3R3                          | <a href="http://www.sumida.com">www.sumida.com</a>         |
| 4.7                     | Sumida CDRH5D18-4R7                          |                                                            |
| 3.3                     | Mitsumi C3-K1.8L-3R3<br>Mitsumi C4-K1.8L-3R3 | <a href="http://www.mitsumi.co.jp">www.mitsumi.co.jp</a>   |
| 3.3                     | ABC SH40283R3YSB                             | <a href="http://www.atec-group.com">www.atec-group.com</a> |
| 4.7                     | ABC SH40284R7YSB                             |                                                            |

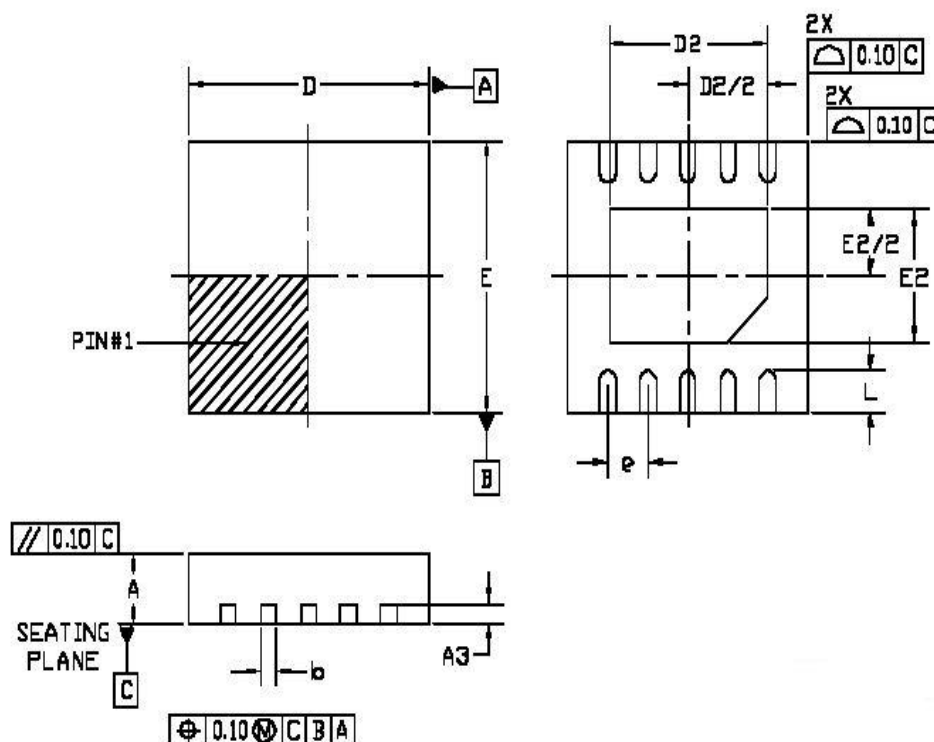
| Capacitors Surface Mount |                       |                                                      |
|--------------------------|-----------------------|------------------------------------------------------|
| Capacitance(μF)          | Manufacturer/Part No. | Manufacturer Website                                 |
| 22                       | TDK C3216X5R0J226M    | <a href="http://www.tdk.com">www.tdk.com</a>         |
| 47                       | TDK C3225X5R0J46M     | <a href="http://www.tdk.com">www.tdk.com</a>         |
| 10                       | GRM42-6X5R 106K6.3    | <a href="http://www.murata.com">www.murata.com</a>   |
| 2.2                      | TAIYO LMK212BJ225MD   | <a href="http://www.t-yuden.com">www.t-yuden.com</a> |
| 4.7                      | TAIYO JMK212BJ475MG   | <a href="http://www.t-yuden.com">www.t-yuden.com</a> |

## PC Board Layout

1. The most critical aspect of the layout is the placement of the input capacitor C2. It must be placed as close as possible to the AT1362A/B to reduce the input ripple voltage.
2. Power loops on the input and output of the converter should be laid out with the shortest and widest traces possible. The longer and narrower the trace, the higher resistance and inductance it will have. The length of traces in series with the capacitors increases its ESR and ESL and reduces their effectiveness at high frequency.
3. The OUT1 pin should connect to C1 directly. And the route should be away from the noise source, such as inductor of SW line.
4. Grounding all components at the same point may effectively reduce the occurrence of loop.



Package Outline : DFN10



| SYMBOL | COMMON                |       |       |                 |        |        |
|--------|-----------------------|-------|-------|-----------------|--------|--------|
|        | DIMENSIONS MILLIMETER |       |       | DIMENSIONS INCH |        |        |
|        | MIN.                  | NOM.  | MAX.  | MIN.            | NOM.   | MAX.   |
| A      | SEE VARIATIONS        |       |       |                 |        |        |
| A3     | 0.195                 | 0.203 | 0.211 | 0.0077          | 0.0080 | 0.0083 |
| b      | 0.18                  | 0.25  | 0.30  | 0.007           | 0.010  | 0.012  |
| D      | 2.95                  | 3.0   | 3.05  | 0.116           | 0.118  | 0.120  |
| E      | 2.95                  | 3.0   | 3.05  | 0.116           | 0.118  | 0.120  |
| e      | 0.50 BSC              |       |       | 0.020 BSC       |        |        |
| L      | 0.35                  | 0.40  | 0.45  | 0.014           | 0.016  | 0.018  |

| VARIATIONS "A"        |      |      |                 |       |       |
|-----------------------|------|------|-----------------|-------|-------|
| DIMENSIONS MILLIMETER |      |      | DIMENSIONS INCH |       |       |
| MIN.                  | NOM. | MAX. | MIN.            | NOM.  | MAX.  |
| 0.70                  | 0.75 | 0.80 | 0.027           | 0.029 | 0.031 |

| D2/E2                 |           |           | D2/E2           |             |             |
|-----------------------|-----------|-----------|-----------------|-------------|-------------|
| DIMENSIONS MILLIMETER |           |           | DIMENSIONS INCH |             |             |
| MIN.                  | NOM.      | MAX.      | MIN.            | NOM.        | MAX.        |
| 2.30/1.55             | 2.35/1.60 | 2.40/1.65 | 0.090/0.061     | 0.092/0.063 | 0.094/0.065 |

