# ELM601BA 1.5A 2.5MHz
## high efficiency synchronous PWM step-down DC/DC converter

## ■General description

ELM601BA is high efficiency synchronous step down DC/DC converter operated with current mode and 2.5MHz constant frequency; internal switch and synchronous rectifier are integrated for high efficiency. In application, ELM601BA does not require any external Schottky diode. Internal current consumption under operation of ELM601BA is as low as 300μA and shutdown current is Typ.1μA. With supply voltage from 2.9 V to 5.5V, ELM601BA can supply load current of 1.5A. The output voltage range of ELM601BA is 1V to 5V, and can be adjusted by FB pin.

With 2.5MHz switching frequency, ELM601BA makes it possible to adopt small surface amount inductors and capacitors. Switch duty cycle would be on continuously and 100% at maximum when input voltage is set to be lower than output voltage.

## ■Features

- Low output noise across load range
- Excellent transient response
- Start up into pre-bias output
- Internal soft start
- Input under-voltage lockout
- Over voltage protection
- Short circuit protection
- Thermal shutdown protection
- Input voltage : 2.9V to 5.5V
- Output voltage range (adj.) : 1V to 5V
- Output current : Max.1.5A
- Shutdown current : Typ.1μA
- High efficiency : 93%
- Constant frequency : Typ.2.5MHz
- Duty-cycle low dropout operation : 0 to 100%
- Package : SOT-25

## ■Application

- Bluetooth product
- DSC and PMP
- GPS device
- POL regulator
- Portable HDD
- Wireless LAN

## ■Maximum absolute ratings

| Parameter | Symbol | Limit | Unit |
|---|---|---|---|
| VIN power supply voltage | Vin | -0.3 to +6.0 | V |
| Apply voltage to SW | Vsw | GND-1 to Vin+1 (6V Max.) | V |
| | | GND-1 to Vin-3 (20ns Max.) | |
| Apply voltage to VOUT | Vout | -0.3 to +6.0 | V |
| Apply voltage to EN | Ven | GND-0.3 to Vin+0.3 | V |
| Power dissipation | Pd | 200 | mW |
| Operating temperature range | Top | -40 to +85 | °C |
| Storage temperature range | Tstg | -65 to +150 | °C |

Caution:Permanent damage to the device may occur when ratings above maximum absolute ones are used.

## ■Selection guide

ELM601BA-S

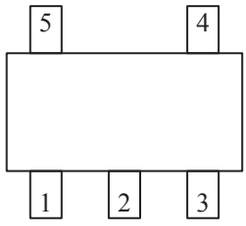
| Symbol | | |
|---|---|---|
| a | Package | B: SOT-25 |
| b | Product version | A |
| c | Taping direction | S: Refer to PKG file |

∗ Taping direction is one way.

ELM601BA - S
↑↑ ↑
a b c

## ■Pin configuration

SOT-25(TOP VIEW)




| Pin No. | Pin name | Pin description |
|---|---|---|
| 1 | VIN | Input power supply |
| 2 | GND | Ground |
| 3 | EN | Enable control input |
| 4 | FB | Feedback input |
| 5 | SW | Switching node. |

## ■Pins description

VIN : Input power supply. Powers the internal circuitry and is connected to the source of high side P channel MOSFET.

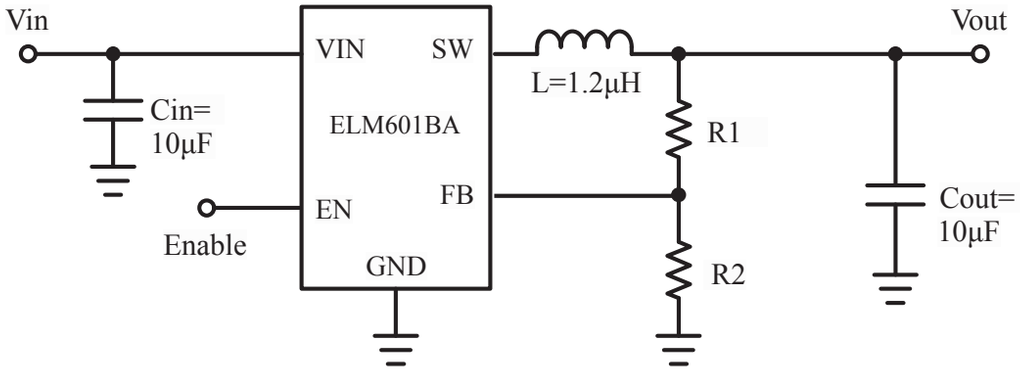
GND : Ground.

EN : Enable pin. When connected to logic high or tied to VIN pin, ELM601BA is on. When connected to logic low, the device enters shutdown and current consumption Typ.1uA. The enable pin has a 1MΩ internal pull-down resistor. This resistor is switched in circuit whenever the EN pin is below the enable input high threshold, or when the part is in under-voltage lockout.

FB : Input to control output voltage.

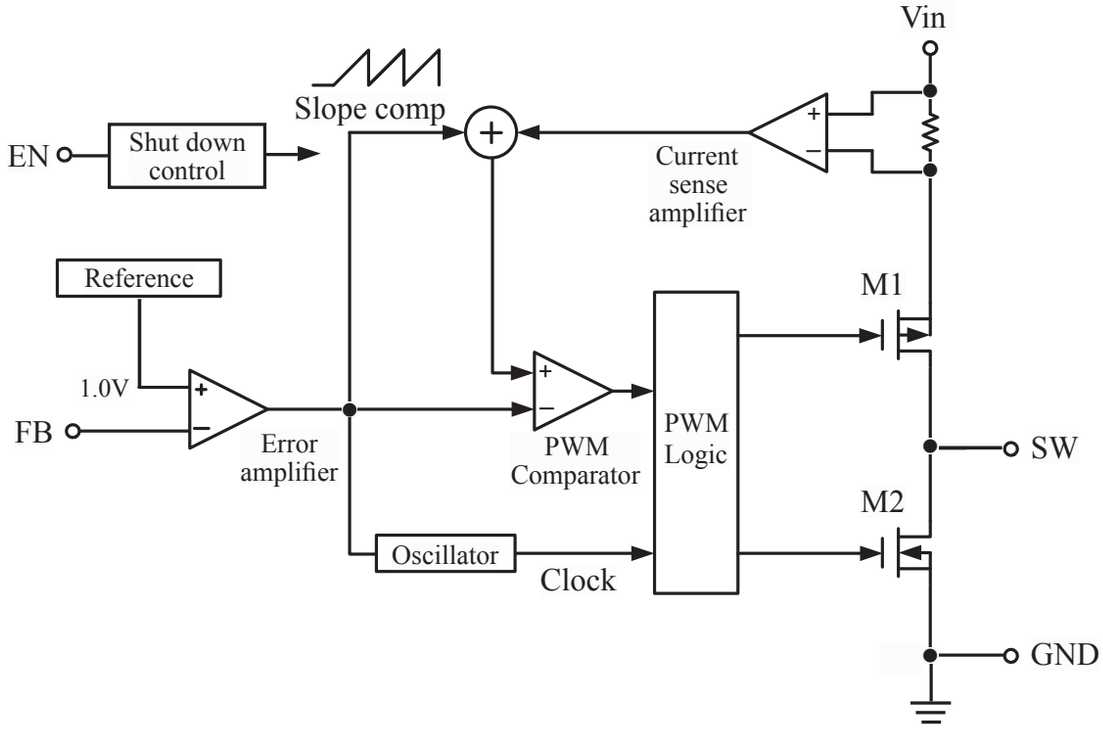
SW : Switching node. The inductor should be connected between this pin and output capacitor.

## ■Standard circuit




• Vout = 1.0 × (1 + R1/R2)

## ■Block diagram



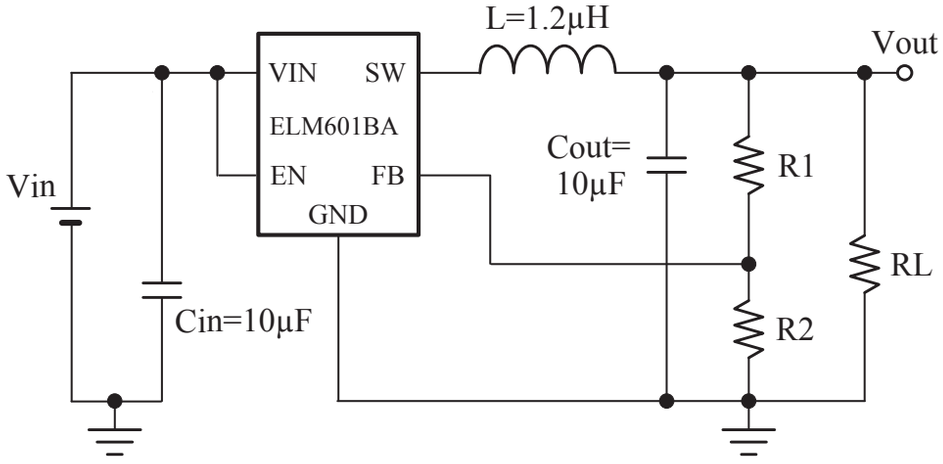
## ■Electrical characteristics

Vin=5.0V, Cin=10μF, Cout=10μF, L=1.2μH, Top=25°C, unless otherwise noted

| Parameter | Symbol | Test condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Supply voltage | Vin | | 2.9 | | 5.5 | V |
| Output voltage | Vout | Adjustable | 1 | | 5 | V |
| Output current | Iout | | | | 1.5 | A |
| Output voltage tolerance * | ΔVout | Vin=3.6V to 5.0V, no load | -2.5 | | +2.5 | % |
| Feedback voltage | Vfb | Top=+25°C | 0.98 | 1.00 | 1.02 | V |
| Current limit | Ilimit | Peak inductor current | 2.0 | | | A |
| Under-voltage lockout | UVLO | Rising Vin | 2.60 | 2.70 | 2.80 | V |
| | | Hysteresis | | 250 | | mV |
| Quiescent current | Iq | EN=Vin, no switching | | 300 | | μA |
| VIN shutdown current | Ishdn | EN=GND | | 1 | 10 | μA |
| High side switch resistance | RdsonP | Ilx=100mA | | 150 | | mΩ |
| Low side switch resistance | RdsonN | Ilx=-100mA | | 125 | | mΩ |
| SW leakage current | Ilk(sw) | Vin=5.5V, SW=0V, EN=GND | | 1 | 10 | μA |
| | | Vin=5.5V, SW=5.0V, EN=GND | -10 | -1 | | |
| Line regulation | ΔVline-reg | Vin=3.6V to 5.0V, Iout=0A | | -1.0 | | % |
| Load regulation | ΔVload-reg | Vin=5.0V, Iout=10mA to 1.5A | | -1.0 | | % |
| Oscillator frequency | Fosc | | 2.0 | 2.5 | 3.0 | MHz |
| Soft-start time | Tss | | | 100 | | μs |
| EN input high current | Ien_hi | EN=Vin | -2.0 | | 2.0 | μA |
| EN input low current | Ien_lo | EN=GND | -2.0 | | 2.0 | μA |
| EN input high threshold | Ven_hi | | 1.2 | | | V |
| EN input low threshold | Ven_lo | | | | 0.4 | V |
| FB over voltage protection | Vovp | | | 115 | | % |
| Thermal shutdown temperature | Tsd | Junction temperature | | +160 | | °C |
| Thermal shutdown hysteresis | Tsd_hys | Junction temperature | | 10 | | °C |

* : The “Output voltage tolerance” includes output voltage accuracy, voltage drift over temperature and line regulation.

## ■Test circuits



## ■Application notes

ELM601BA is constant frequency current mode PWM step down converter which is suitable for applications that require high efficiency and small assembly area and use low voltage, wuch as Li-ion battery . By external resistor divider, output voltage of ELM601BA can be set within the range from 1V to 5V. To provide operation with high efficiency, ELM601BA consists of main switch and synchronous rectifier while external Schottky diode is not necessary. Duty cycle of ELM601BA can reach upto 100%. Duty cycle of step down converter is defined as follows:

$$D = Ton \times Fosc \times 100\% \approx (Vout/Vin) \times 100\%$$

Ton=main switch on time; Fosc=oscillator frequency (2.5MHz); Vout=output voltage; Vin=input voltage

1) Current mode PWM control

Slope compensated current mode PWM control provides superior load and line response, and protection of internal main switch and synchronous rectifier to current limit by stable switching and switch cycle. ELM601BA switches at a constant frequency (2.5MHz) and regulates output voltage. During each cycle, the PWM comparator modulates the power transferred to the load by changing inductor peak current which is based on the feedback error voltage. Under normal operation, the main switch is turned on for a certain time to ramp the inductor current at each rising edge of the internal oscillator, and switched off when the peak inductor current is above the error voltage. When the main switch is off, the synchronous rectifier will be turned on immediately and stay on until either the next cycle starts or the inductor current drops to zero.

2) Dropout operation

ELM601BA allows the main switch to remain on for more than one switching cycle and increases duty cycle while the input voltage is dropping under the output voltage. When duty cycle reaches 100%, the main switch transistor would be on continuously to supply current to output until current limit generates. Output voltage then is input voltage minus voltage drop across main switch the inductor.

3) Short circuit protection

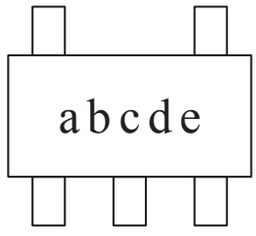
ELM601BA consists of short circuit protection; when output is short to ground, the oscillator frequency is reduced to prevent the inductor current from increasing beyond the P MOSFET current limit. The frequency will return to normal values once the short circuit condition is recovered and the feedback voltage goes back to 0.6V.

4) Maximum load current

ELM601BA can operatewhen input voltage is down to 2.5V; however, the maximum load current would descend because of the increase IR drop which results from the ON resistor of main switch and synchronous rectifier. along with the drop of input voltage. The slope compensation signal would reduce the peak inductor current to avoid sub-harmonic oscillations when duty cycle is larger than 50%; on the contrary, it would increase the peak inductor current when duty cycle is decreased, as which is shown in the graph.

## ■Marking

SOT-25

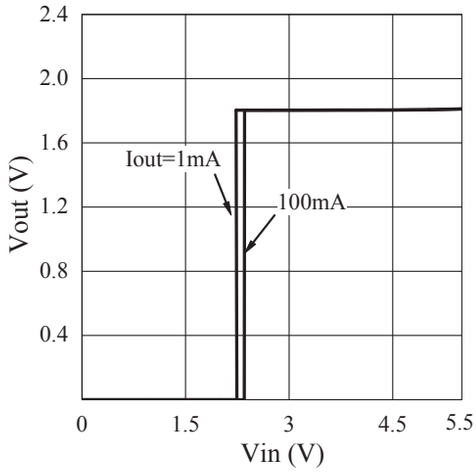



a to e : Assembly lot No. ——
A to Z (I, O, X excepted) and 0 to 9

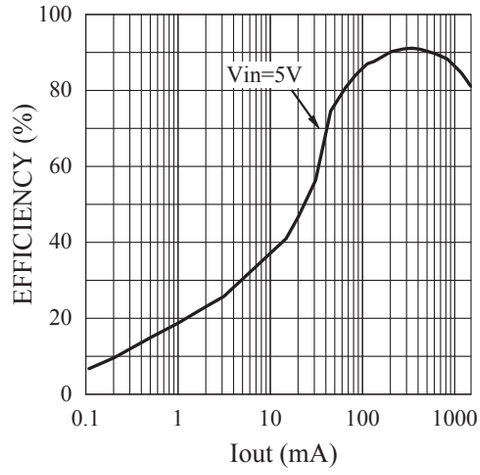
## ■Typical characteristics

• Vout=1.8V : Cin=10µF, Cout=10µF, L=1.2µH, R1=44kΩ, R2=55kΩ, Top=25°C

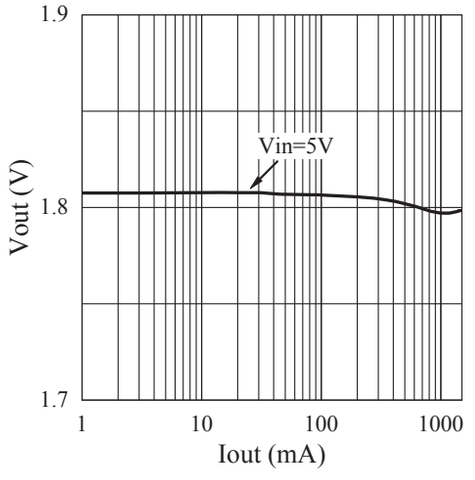
Vout-Vin



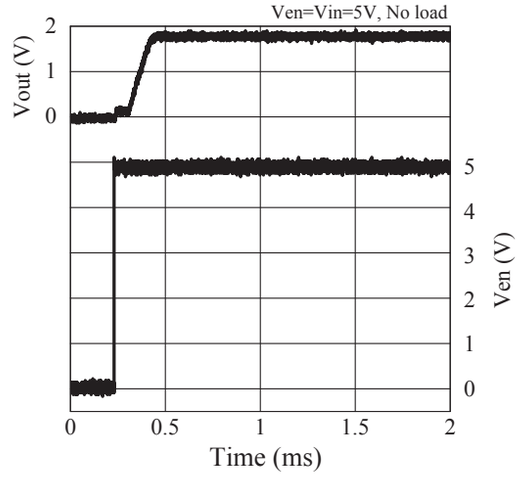

EFFICIENCY-Iout



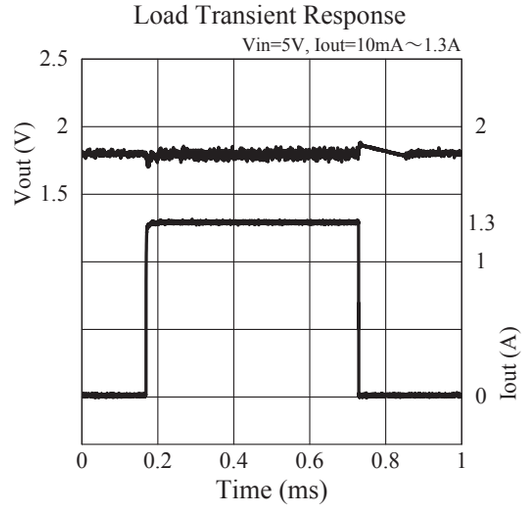

Vout-Iout



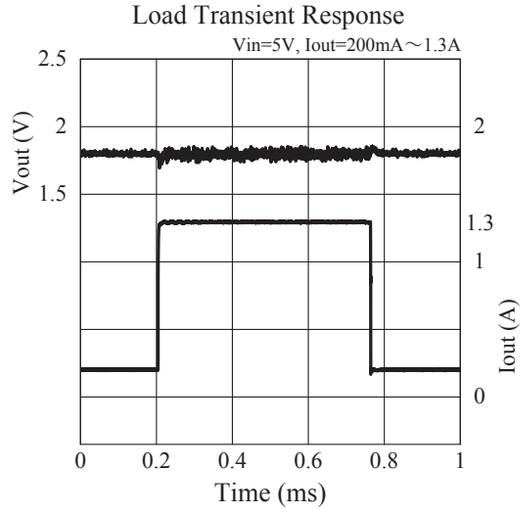

Start Response




Load Transient Response

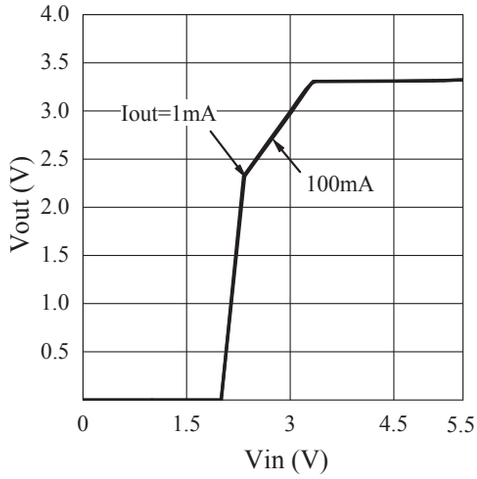



Load Transient Response

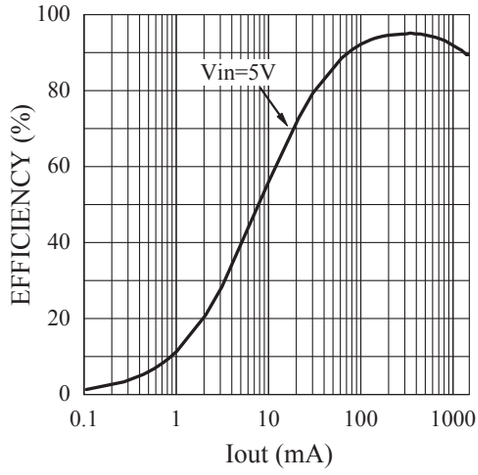


• Vout=3.3V : Cin=10µF, Cout=10µF, L=1.2µH, R1=69kΩ, R2=30kΩ,Top=25°C

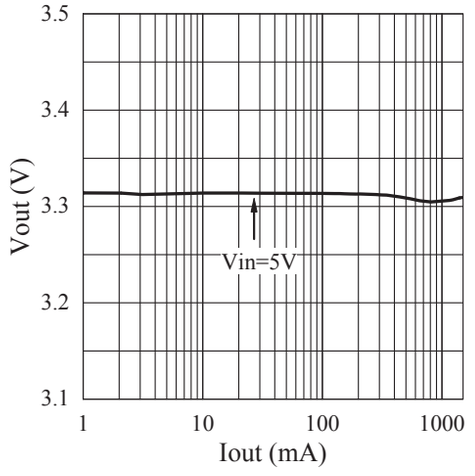
Vout-Vin



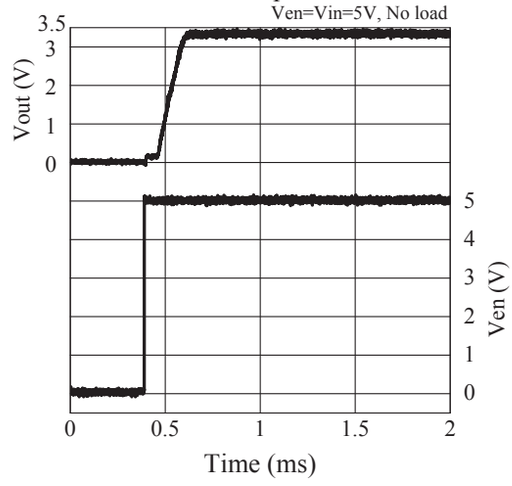

EFFICIENCY-Iout



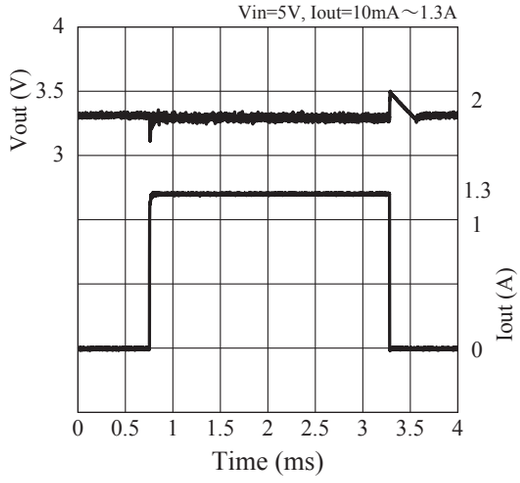

Vout-Iout




Start Response




Load Transient Response




Load Transient Response