# YB1210R

300mA, Ultra-Low-Noise, High PSRR LDO Regulator

## Description

The YB1210R is a series of ultra-low-noise, low dropout (LDO) linear regulators with 2.0% output voltage accuracy. The YB1210R regulators achieve a low 320mV dropout at 300mA load current of 3.3V output and are available in voltages ranging from 1.2V to 3.6V with 0.1 V per step (custom voltage is considerable at request).

The YB1210R regulators are optimized to work with low-ESR and low cost ceramic capacitors, reducing the amount of board space critical in portable devices. The YB1210R requires only 1.0μF output capacitor for stability with any load and consumes less than 1μA in shutdown mode.

Built-in thermal shutdown and short-circuit protect offer secure protection against fault operation. The YB1210R regulators are available in SOT-23 / SOT-25 / SOT-89 packages.

## Features

- High Accuracy Output Voltage : ± 2%
- Wide Output Voltage Range : 1.2 ~ 3.6V
- Ultra-Low-Noise Low-Drop-Out
- Typical Output Current : 300 mA
- Low Quiescent Current: ~60μA
- 320mV Dropout at 300mA 3.3V Output
- Stable with 1.0μF Ceramic Capacitor
- Only Need Input and Output Capacitors
- Thermal Protection Shutdown
- Output Short-Circuit Current Limit
- Built-In Internal Soft-Start
- Green Package (RoHS) Available

## Applications

- PDA, Notebook, PC Computers
- DSC, Handset Camera Modules
- PCMCIA Cards, PC Cameras
- USB Based Portable Devices
- GSM/GPRS/3G RF Transceiver
- Wireless LANs
- Bluetooth Portable Radios
- Battery-Powered Devices

## Typical Application Circuit

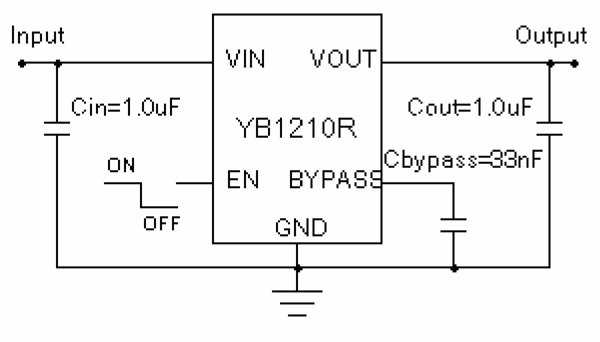



Figure 1-1: SOT-25 Application Circuit

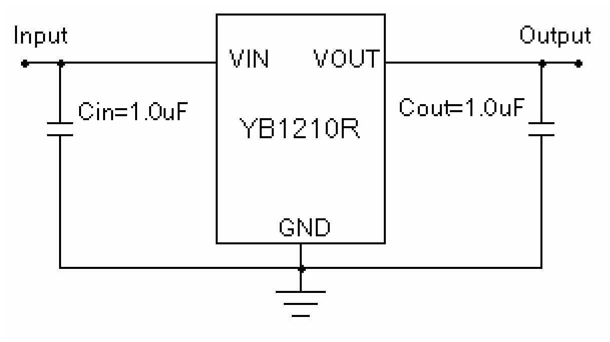



Figure 1-2: SOT-23/SOT-89 Application Circuit

## Pin Configuration

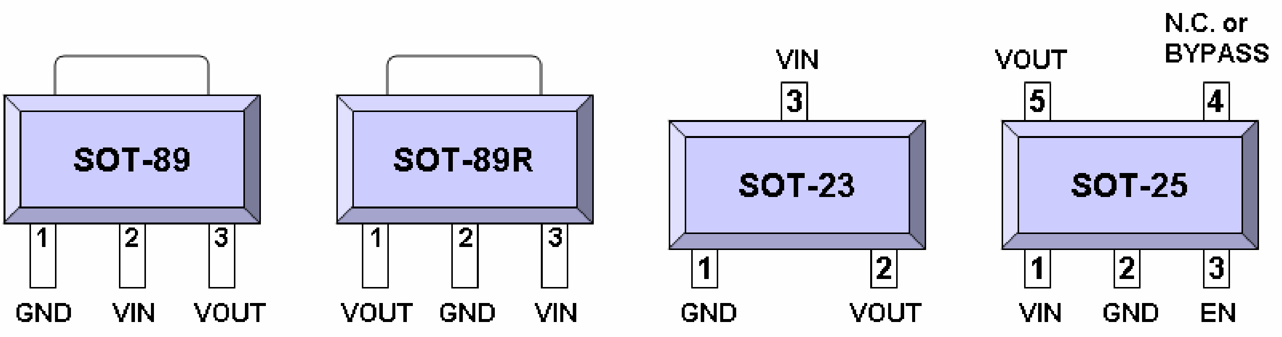



**Figure 2: Pin Configuration**

## Pin Description

**Table 1**

| Name | Description |
|---|---|
| VIN | Unregulated input supply. Bypass with a capacitor to GND. |
| GND | Ground pin. |
| EN | Pull high to enable the regulator. |
| N.C. or BYPASS | Connect a 33nF capacitor to GND for low noise operation or N.C. |
| VOUT | Regulated output voltage. Bypass with a capacitor to GND. |

## Ordering Information

YB1210□□□□R□□□

Output Voltage
120 : 1.2 V
130 : 1.3 V
:
360 : 3.6 V

R : reserved

Package Type
ST23 : SOT-23
ST25 : SOT-25
ST89 : SOT-89
ST8R : SOT-89R

- Order example :
  YB1210ST89R250 for YB1210R of 2.5V output and SOT-89 package
- Shipping Quantity :
  SOT-23 : 3000 units tape & reel
  SOT-25 : 3000 units tape & reel
  SOT-89 : 1000 units tape & reel
  SOT-89R : 1000 units tape & reel
- Only green package

## Marking Information

XC□□

Package Type V : SOT-23, T : SOT-25, S : SOT-89, R : SOT-89R

Output Voltage

| Code | A | B | C | D | E | F | G | H | I | J | K | L | M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Voltage | 1.2 | 1.3 | 1.4 | 1.5 | 1.6 | 1.7 | 1.8 | 1.9 | 2.0 | 2.1 | 2.2 | 2.3 | 2.4 |

| Code | N | O | P | Q | R | S | T | U | V | W | X | Y | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Voltage | 2.5 | 2.6 | 2.7 | 2.8 | 2.9 | 3.0 | 3.1 | 3.2 | 3.3 | 3.4 | 3.5 | 3.6 | |

## Absolute Maximum Ratings (Note 1)

Supply Voltage ............................ -0.3V to 6V
Output Voltage ................ -0.3V to ($V_{IN}$+0.3V)
Output Short-Circuit Duration..............Infinite
Junction Temperature Range ............ +150℃
Storage Temperature Range ....-65℃ to +150℃
Lead Temperature............................ +250℃
ESD Susceptibility (HBM)………………..2KV
ESD Susceptibility (MM) .......................200V

## Recommended Operating Conditions

(Note 2)

Input Supply Voltage............... 2.0V to 5.5V
Operating Temperature........-40℃ to +85℃

## Thermal In formation (Note 3)

Thermal Resistance (SOT23/25, $\theta_{JA}$) .... 280℃/W
Thermal Resistance (SOT-89, $\theta_{JA}$)......... 180℃/W
Internal Power Dissipation (SOT-23/25, $P_D$) . 0.4W
Internal Power Dissipation (SOT-89, $P_D$) 0.55W

**Note:**

1. Exceeding these ratings may damage the device.
2. The device is not guaranteed to function outside of its operating conditions.
3. $\theta_{JA}$ is measured in free air at $T_A$ = 25℃ on a low effective thermal conductivity board.

## Electrical Characteristics

**Table 2 $V_{IN}$ = ( $V_{OUT}$ + 1V ), $C_{IN}$ = $C_{OUT}$ = 1.0µF, $V_{EN}$ = $V_{IN}$, $T_A$=25°C, unless otherwise noted.**

| Description | Symbol | Test Conditions | MIN | TYP | MAX | Units |
|---|---|---|---|---|---|---|
| Input Voltage Range | $V_{IN}$ | | 2.0 | | 5.5 | V |
| Output Voltage | $V_{OUT}$ | Predefined | 1.2 | | 3.6 | V |
| Output Voltage Accuracy | $\Delta V_{OUT}$ | $I_{OUT}$ = 10mA, $V_{OUT} \geqq$ 1.3V | -2.0 | | +2.0 | % |
| | | $I_{OUT}$ = 10mA, $V_{OUT}$ = 1.2V | 0 | | +4.0 | |
| Output Current Limit | $I_{SC}$ | Short-Circuit Output | | 200 | | mA |
| Dropout Voltage (Note 1) | $V_{DROP}$ | $V_{OUT}$ = 3.6V, $I_{OUT}$ = 300mA | | 300 | | mV |
| | | $V_{OUT}$ = 3.0V, $I_{OUT}$ = 300mA | | 350 | | |
| | | $V_{OUT}$ = 2.5V, $I_{OUT}$ = 300mA | | 450 | | |
| | | $V_{OUT}$ = 1.5V, $I_{OUT}$ = 300mA | | 700 | | |
| | | $V_{OUT}$ = 1.2V, $I_{OUT}$ = 300mA | | 870 | | |
| Ground Current | $I_G$ | Iground = $I_{IN}$ - $I_{OUT}$ | | 60 | | µA |
| Line Regulation | $\Delta V_{LINE}$ | $V_{IN}$=($V_{OUT}$+ 1V) to 5.5V, $I_{OUT}$=10mA | | 0.3 | 0.4 | %/V |
| Load Regulation | $\Delta V_{LOAD}$ | $I_{OUT}$ = 1mA to 300mA | | 1.0 | 1.5 | % |
| Shutdown Supply Current | $I_{SD}$ | EN = 0V | | | 1 | µA |
| Ripple Rejection (PSRR) | PSRR | f = 1KHz, $I_{OUT}$ = 1mA | | 50 | | dB |
| | | f = 10KHz, $I_{OUT}$ = 1mA | | 60 | | |
| | | f = 100KHz, $I_{OUT}$ = 1mA | | 40 | | |
| Start Up Delay (Note 2) | | Rload = 100 ohm, Cbypass = 0nF | | 20 | 50 | µs |
| | | Rload = 100 ohm, Cbypass = 33nF | | 2 | 3.5 | ms |
| Shutdown Delay (Note 3) | | Rload = 10K ohm, $V_{OUT}$ = 1.5V | | 1 | | ms |
| | | Rload = 10K ohm, $V_{OUT}$ = 1.2V | | 1 | | |
| EN Logic Low Level | $V_{IL}$ | $V_{IN}$ = 2.0V to 5.5V | | | 0.4 | V |
| EN Logic High Level | $V_{IH}$ | $V_{IN}$ = 2.0V to 5.5V | 1.2 | | $V_{IN}$ | V |
| EN Input Bias Current | $I_{BEN}$ | $V_{IN}$ = EN = $V_{OUT}$ +1V | | 0.01 | | µA |
| Thermal Shutdown | $T_{SD}$ | Shutdown Temperature | | 160 | | °C |
| Thermal Hysteresis | $T_{HYS}$ | | | 20 | | °C |

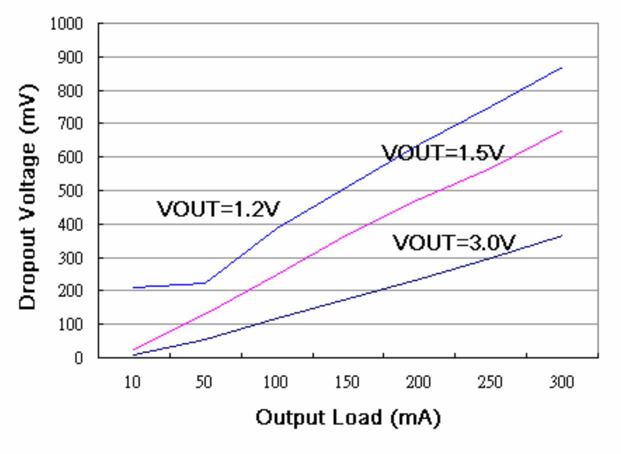
**Note :**

1. The drop out voltage varies depending on output voltage selection. Dropout is defined as $V_{IN}$ – $V_{OUT}$ when $V_{OUT}$ is 100mV below nominal $V_{OUT}$ where $V_{IN}$ = $V_{OUT}$ + 1V for nominal $V_{OUT}$.
2. Time needed for $V_{OUT}$ to reach 90% of final value.
3. Time needed for $V_{OUT}$ to discharge below 0.5V.

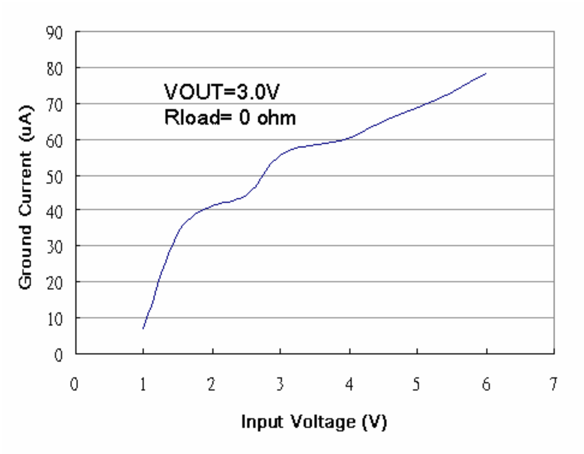
## Typical Performance Characteristics

**$V_{IN}$ = ( $V_{OUT}$ + 1V ), $C_{IN}$ = $C_{OUT}$ = 1.0μF, $V_{EN}$ = $V_{IN}$, $T_A$=25°C, unless otherwise noted.**

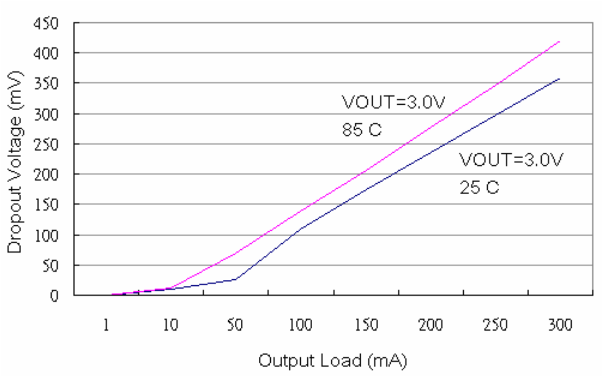
### Dropout Voltage vs. Output Load



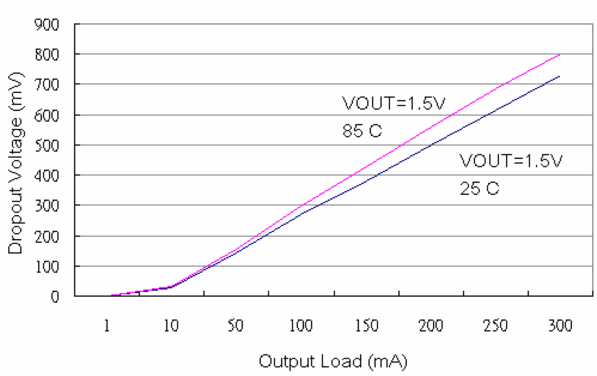

### Ground Current vs. Input Voltage



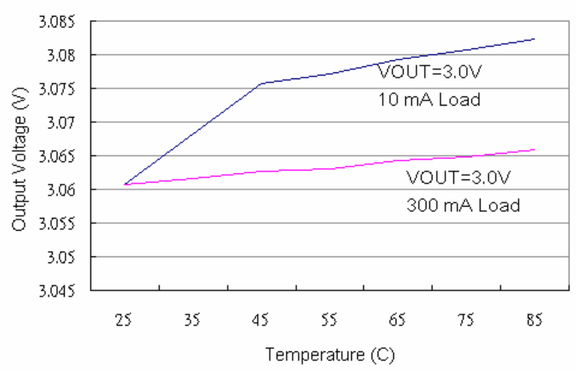

### Dropout Voltage vs. Temperature



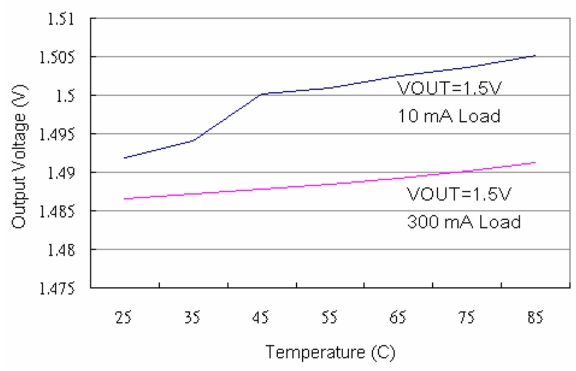

### Dropout Voltage vs. Temperature



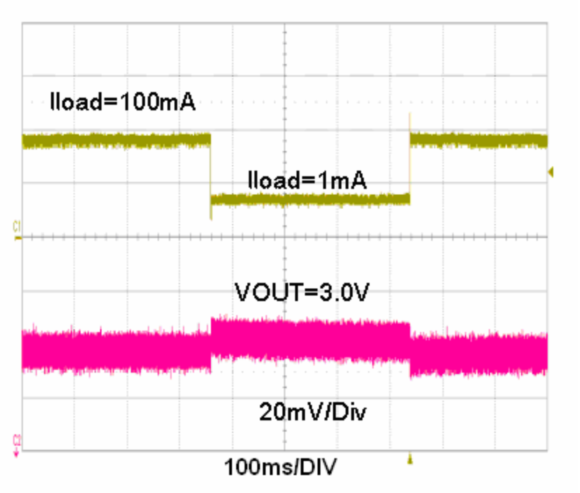

### Output Voltage vs. Temperature



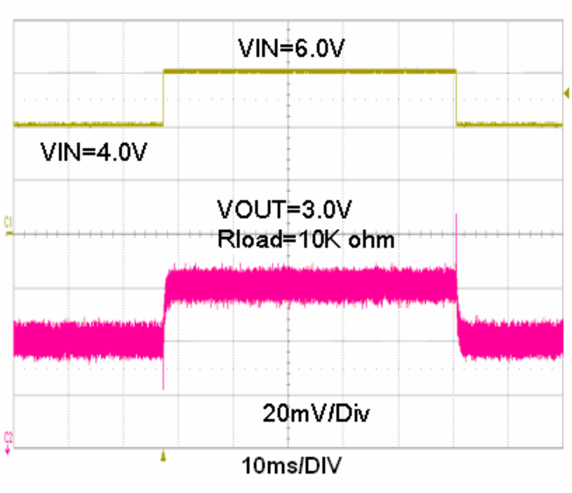

### Output Voltage vs. Temperature



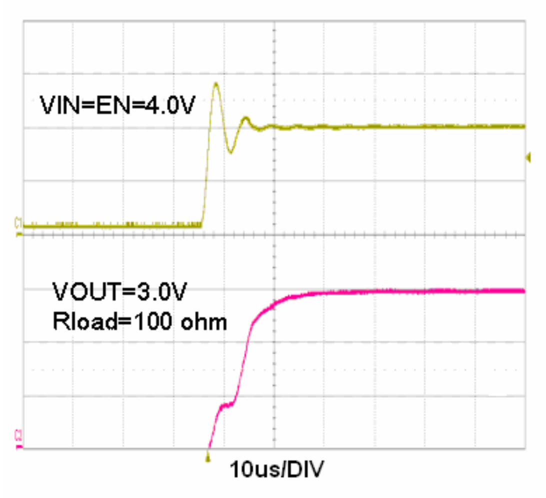
**Load Transient Response**



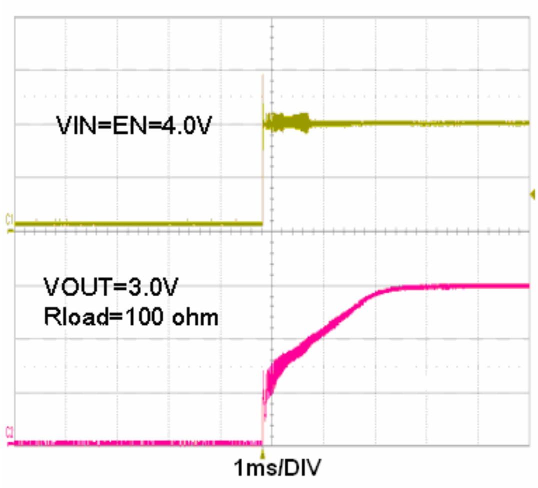

**Line Transient Response**



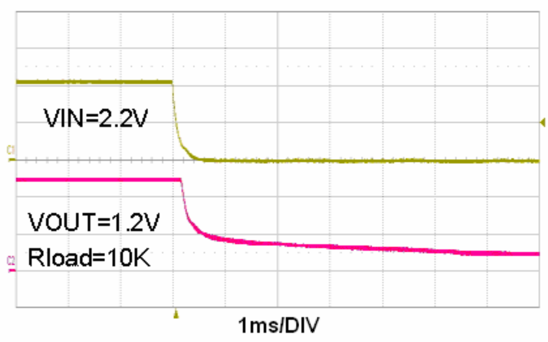

**Start Up Delay (Cbypass=0nF)**



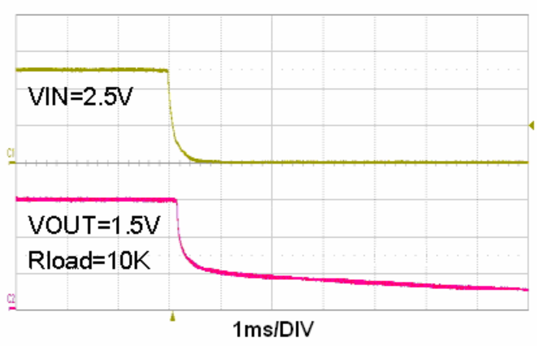

**Start Up Delay (Cbypass=33nF)**



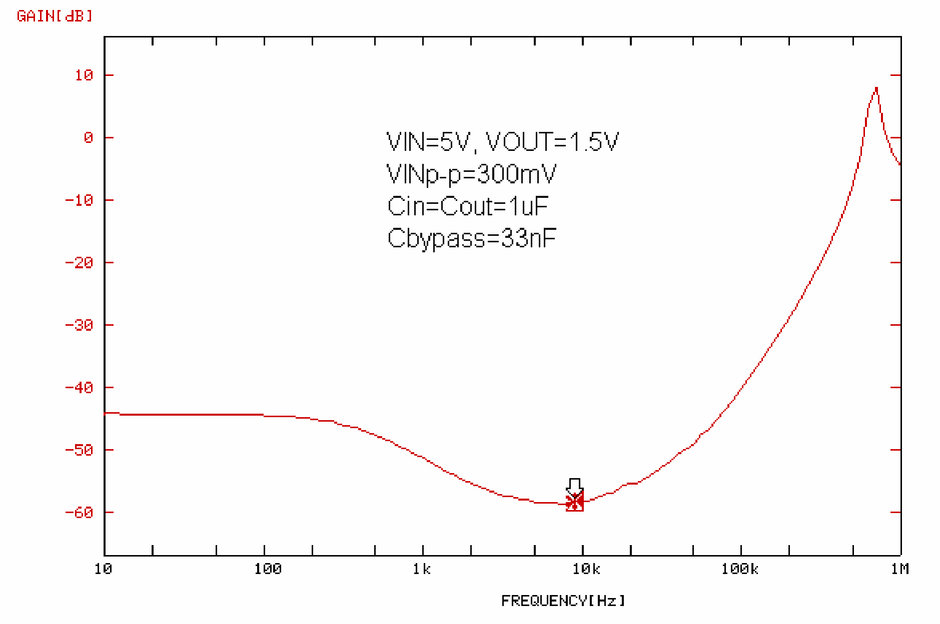

**Shutdown Delay ($V_{OUT}$=1.2V)**



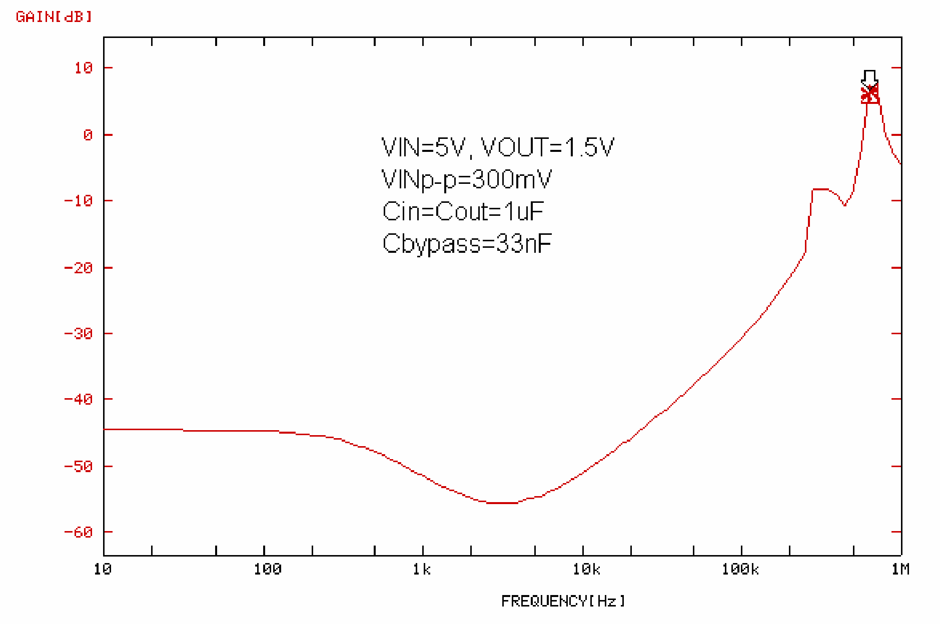

**Shutdown Delay ($V_{OUT}$=1.5V)**



**PSRR vs. Frequency (1mA load)**




**PSRR vs. Frequency (10mA load)**



## Function Block

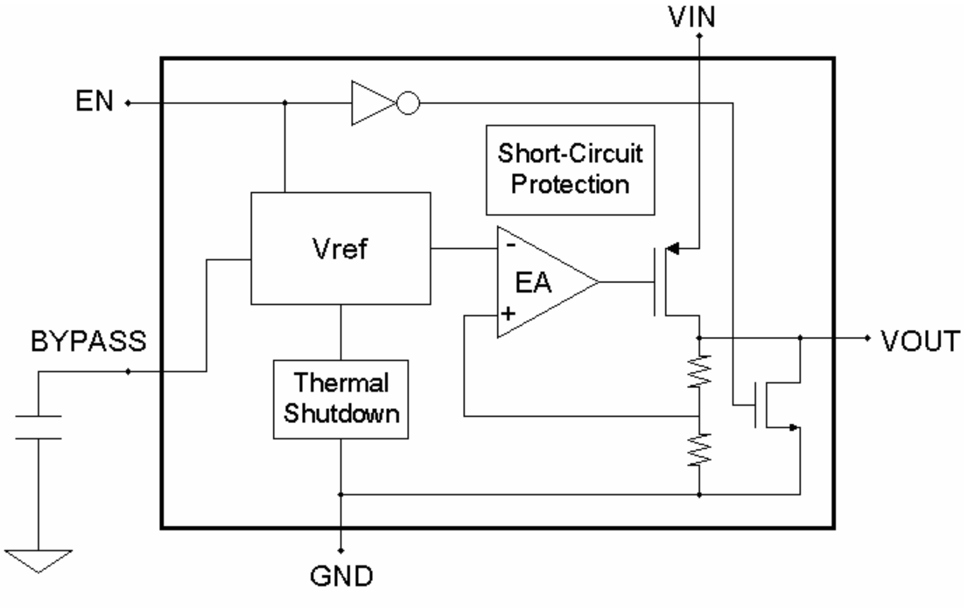



**Figure 3: Function Block**

## Functional Description

The YB1210R is an ultra-low-noise, low-quiescent current, low-dropout linear regulator. It is supplied in a SOT-23 / SOT-25 / SOT-89 package for different applications. YB1210R can supply loads up to 300mA (typical operation, not maximum) and output voltages are preset and ranging from 1.2V to 3.6V.

As shown in the *Functional Block Diagram*, the YB1210R consists of a reference and noise bypass circuit, error amplifier, output drive transistor, internal feedback voltage divider, thermal sensor, and short circuit current limiter.

The internal reference is connected to the error amplifier's inverting input. The error amplifier compares this reference with the feedback voltage and amplifies the difference. If the feedback voltage is lower than the reference voltage, the gate of the pass-transistor is pulled low. This allows more current to pass to the output and increases the output voltage. If the feedback voltage is too high, the gate of the pass transistor is pulled high, allowing less current to pass to the output.

**Stability**

The YB1210R is a high performance LDO emphasizing stability with low output capacitance. It is able to maintain stability with an output capacitor as low as 1.0μF. The output capacitor can also be increased to optimize performance. The YB1210R will remain stable and in regulation with no load, unlike many other voltage regulators.

### Internal P-Channel Pass Transistor

The YB1210R features a low impedance P-channel MOSFET pass transistor. This provides several advantages over similar designs using a PNP pass transistor, including low operating power and longer battery life. The YB1210R consumes only 60μA of quiescent current under most conditions.

### Output Short-Circuit Current Limit

The YB1210R includes a current limiter, which monitors and controls the pass transistor's gate voltage, limiting the output current to about 200mA, for example, in a short-circuit output situation.

### Shutdown

The YB1210R also features a low-power active shutdown mode. It has a switch that turns off the device when disabled. This allows the output capacitor and load to discharge and de-energize the load. In the shutdown mode, the internal functional blocks, such as voltage reference and the error amplifier, are turned off completely, and the quiescent current is less than 1μA.

### Thermal Protection Shutdown

The thermal protection shutdown function protects the device from operating in over temperature condition. When the junction temperature exceeds +160°C, the thermal sensor signals the shutdown logic, turning off the pass transistor and allowing the IC to cool down. The thermal sensor turns the pass transistor on again after the IC's junction temperature drops to +140°C.

### Auto-Discharge Circuitry

The YB1210R deploys a NMOS connecting between $V_{OUT}$ and ground. When EN pin is pulled low, the NMOS is activated by an inverted signal from EN. The charge kept on output capacitor is discharged quickly through the NMOS. It prevents the system from abnormal operation at the beginning of shutdown mode.

### Soft-Start Circuitry

The YB1210R includes a soft-start circuitry to limit inrush current at turn-on. During power up, the output capacitor and output load are charged with a reduced output current. Shortly after the initial power up, the soft-start feature is terminated and normal operation is resumed.

## Application Information

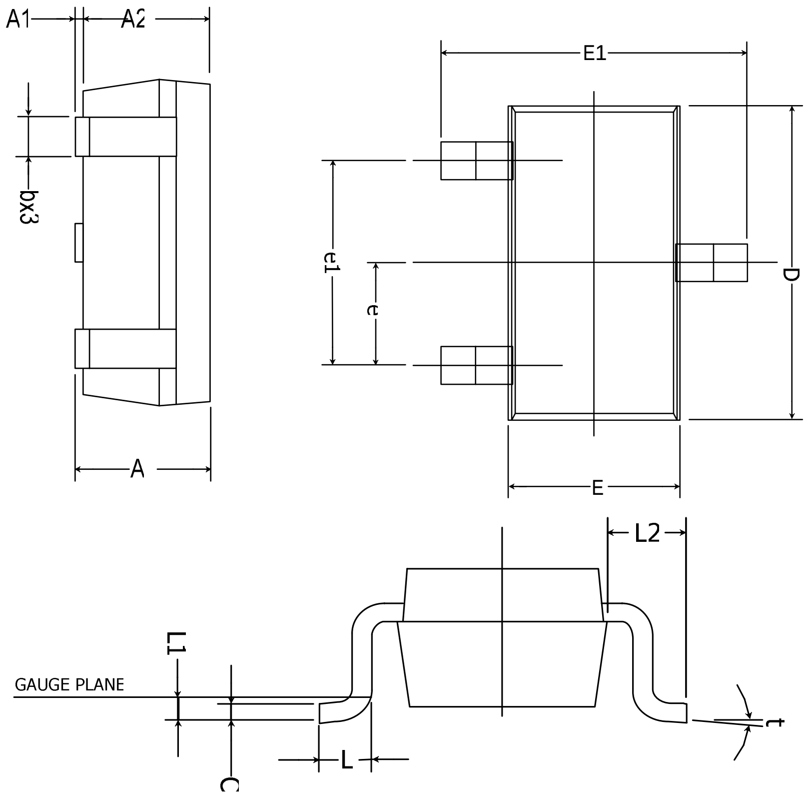
### Enable/Shutdown

The YB1210R comes with an active-high enable pin that allows the regulator to be enabled. Forcing the enable pin low disables the regulator and puts it into the shutdown mode. This pin cannot be left floating as it may cause an undetermined state.

### Input/Output Capacitor

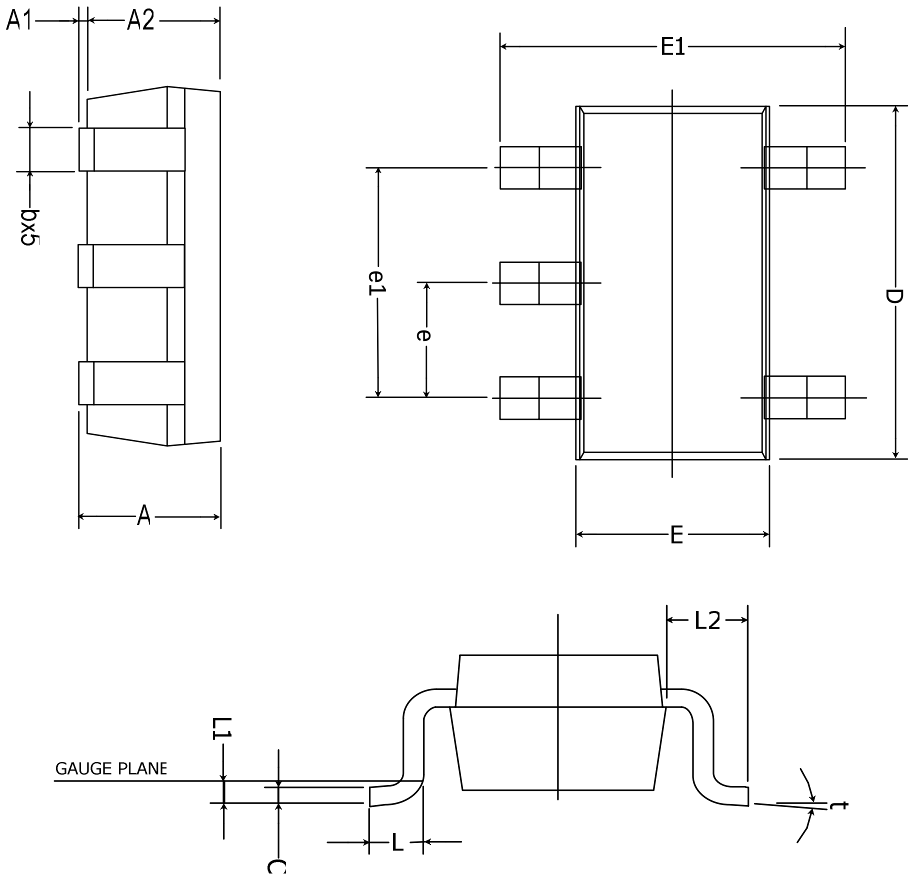
It is recommended to use a 1.0μF capacitor on the YB1210R input and a 1.0μF capacitor on the output. For high regulation performance, larger input capacitor values and lower ESRs provide better noise rejection and line-transient response. The output noise, load-transient response, stability, and power-supply rejection can be improved by using large output capacitors. Low ESR ceramic capacitors provide optimal performance and save space.

## Package Information (SOT-23)



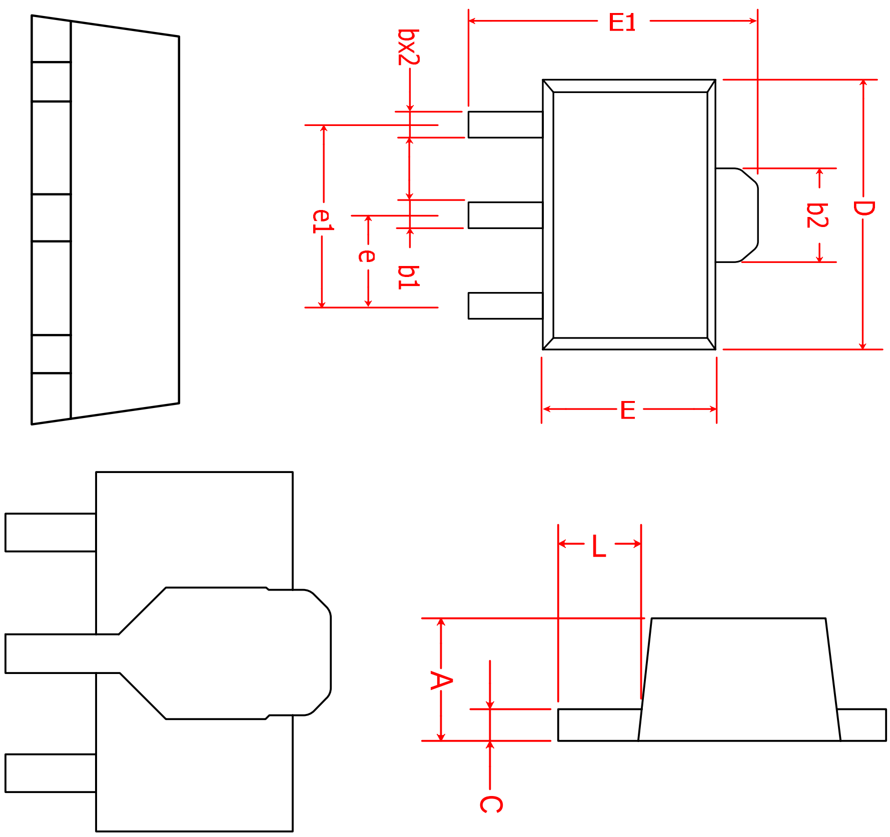

| Symbol | milimeters | | Inches | |
|---|---|---|---|---|
| | MIN. | MAX. | MIN. | MAX. |
| A | 0.95 | 1.45 | .037 | .057 |
| A1 | 0.05 | 0.15 | .002 | .006 |
| A2 | 0.90 | 1.30 | .035 | .051 |
| b | 0.30 | 0.50 | .0118 | .019 |
| C | 0.08 | 0.20 | .0031 | .0078 |
| D | 2.84 | 3.00 | .1118 | .118 |
| E | 1.50 | 1.70 | .059 | .0669 |
| E1 | 2.60 | 3.00 | .102 | .118 |
| e | 0.95 BSC. | | .0374 BSC. | |
| e1 | 1.90 BSC. | | .0748 BSC. | |
| L | 0.35 | 0.55 | .0137 | .0216 |
| L1 | 0.10 BSC. | | .0039 BSC. | |
| L2 | 0.60 REF. | | .0236 REF. | |
| t | 0° | 8° | 0° | 8° |

## Package Information (SOT-25)




| Symbol | milimeters | | Inches | |
|---|---|---|---|---|
| | MIN. | MAX. | MIN. | MAX. |
| A | 0.95 | 1.45 | .037 | .057 |
| A1 | 0.05 | 0.15 | .002 | .006 |
| A2 | 0.90 | 1.30 | .035 | .051 |
| b | 0.30 | 0.50 | .0118 | .019 |
| C | 0.08 | 0.20 | .0031 | .0078 |
| D | 2.84 | 3.00 | .1118 | .118 |
| E | 1.50 | 1.70 | .059 | .0669 |
| E1 | 2.60 | 3.00 | .102 | .118 |
| e | 0.95 BSC. | | .0374 BSC. | |
| e1 | 1.90 BSC. | | .0748 BSC. | |
| L | 0.35 | 0.55 | .0137 | .0216 |
| L1 | 0.10 BSC. | | .0039 BSC. | |
| L2 | 0.60 REF. | | .0236 REF. | |
| t | 0° | 8° | 0° | 8° |

## Package Information (SOT-89)




| Symbol | milimeters | | Inches | |
|---|---|---|---|---|
| | MIN. | MAX. | MIN. | MAX. |
| A | 1.40 | 1.60 | .055 | .063 |
| b | 0.36 | 0.48 | .014 | .019 |
| b1 | 0.44 | 0.56 | .017 | .022 |
| b2 | 1.50 | 1.83 | .059 | .072 |
| C | 0.35 | 0.44 | .014 | .017 |
| D | 4.40 | 4.60 | .173 | .181 |
| E | 2.29 | 2.60 | .090 | .102 |
| E1 | 3.94 | 4.25 | .155 | .167 |
| e | 1.50 BSC. | | .059 BSC. | |
| e1 | 3.00 BSC. | | .118 BSC. | |
| L | 0.89 | 1.20 | .035 | .047 |

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