

## Features

- Dual Mode Low Drop Out Voltage Regulator
- 1.8V Fixed Output Voltage
- 3V to 5.5V Supply Operation
- 80 mA Maximum Load Current in Full Power Mode
- Maximum Current Consumption 36  $\mu$ A in Full Power Mode and 14  $\mu$ A in Low Power Mode
- Power-down Mode Consumption Less Than 1  $\mu$ A
- More Than 70dB (Typical) PSRR at 1 KHz
- 46  $\mu$ V<sub>RMS</sub> Output Noise
- 0.35  $\mu$ m CMOS Technology
- Typical Application: Baseband Memory Section Supply in Mobile Terminals

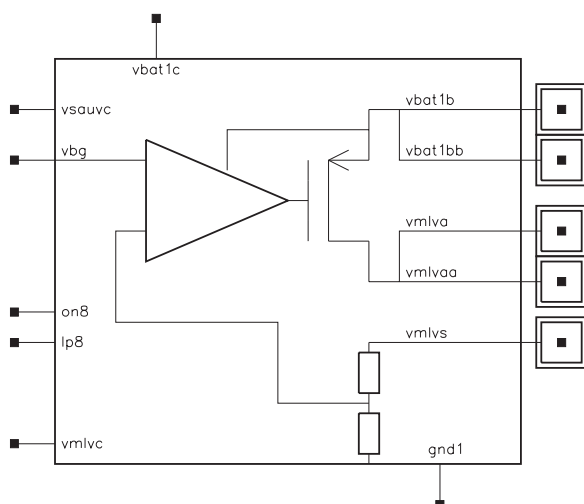
## Description

RE029 is a dual mode Low Drop Out (LDO) voltage regulator macrocell with a fixed 1.8V output voltage, rated for loads up to 80 mA in full power mode and 5 mA in low power mode. (Both modes can be selected by the LP8 signal.) It is designed to be integrated with other analog cells, digital logic, microcontrollers, DSP cores and memory blocks into system-on-chip products.

The circuit consists of a PMOS pass device, an error amplifier and a feedback resistive network, sized to achieve the required closed loop gain. These blocks make up the regulating loop. An over-current and short circuit protection circuit has been included to limit the output current delivered by the regulator, thus avoiding destruction in case of a short circuit.

An external reference voltage  $V_{BG}$  (bandgap voltage) is necessary for correct functionality. The target reference voltage is 1.231V delivered, for example, by BG019. Double pads on the supply voltage  $V_{BAT1B}/V_{BAT1BB}$  and output voltage  $V_{MLVA}/V_{MLVAA}$  are used to reduce the total output resistance. Current reference is generated inside the cell through a circuit supplied by a  $2.5V \pm 0.1V$  of regulated input voltage on  $V_{SAUVC}$ . Remote sense terminal  $V_{MLVS}$  provides regulation of the load by connecting it to the output terminal near a critical point to improve performance of the regulator (e.g., connecting it to the package pin by double-bonding, thus avoiding the bonding resistance influence). A ceramic capacitor of 2.2  $\mu$ F connected from  $V_{MLVA}/V_{MLVAA}$  to ground is needed as external compensation.

Figure 1. Symbol <sup>(1)</sup>



Note: 1. Pin names are written as they appear on the user screen when the symbol is opened in the design tool environment.



## Embedded ASIC Macrocell: Power Management for Mobile Terminals (PM)

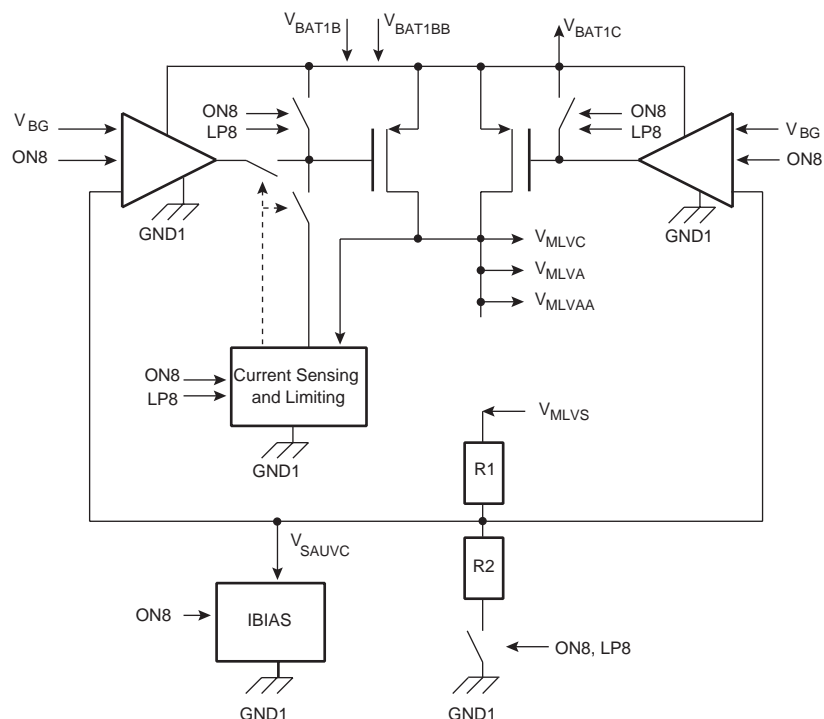
### RE029 1.8V 80 mA Dual Mode LDO Regulator

Rev. 2705B-PMGMT-03/03



## Functional Diagram

### Figure 2. Functional Diagram



## Pin Description

Pin Name	I/O	Type	Function	Value
V <sub>BAT1B</sub>	Power Supply	External Pad	Power Supply	3V to 5.5V
V <sub>BAT1BB</sub>	Power Supply	External Pad	Power Supply	3V to 5.5V
V <sub>MLVA</sub>	Analog Output	External Pad	Output Voltage	1.7V to 1.9V
V <sub>MLVAA</sub>	Analog Output	External Pad	Output Voltage	1.7V to 1.9V
V <sub>MLVS</sub>	Analog Input	External Pad	Sense Voltage	1.7V to 1.9V
V <sub>MLVC</sub>	Analog Output	Internal Pin	Output Voltage	1.7V to 1.9V
V <sub>BAT1C</sub>	Auxiliary Power Supply	Internal Pin	Power Supply	3V to 5.5V
GND1	Analog Ground	Internal Pin	Ground	0
V <sub>SAUVC</sub>	Positive Power Supply	Internal Pin	Power Supply	2.5V ± 0.1V
V <sub>BG</sub>	Analog Input	Internal Pin	Voltage Reference	1.231V
ON8	Digital Input	Internal Pin	Enable Command	0V or V <sub>BAT1B</sub> /V <sub>BAT1BB</sub>
LP8	Digital Input	Internal Pin	Low Power Mode Command	0V or V <sub>BAT1B</sub> /V <sub>BAT1BB</sub>

## Absolute Maximum Ratings\*

Analog Signals .....	-0.3V to 6.5V
Digital Signals.....	-0.3V to 5.5V
Output Current.....	Internally limited
Junction Temperature .....	-20°C to 150°C

\*NOTICE: Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## Electrical Specifications<sup>(1)</sup>

$T_J = -20^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ ,  $V_{\text{BAT1B}}/V_{\text{BAT1BB}} = 3\text{V}$  to  $5.5\text{V}$  unless otherwise specified, output capacitance =  $2.2\ \mu\text{F}$ .

**Table 1.** Electrical Characteristics

Symbol	Parameter	Condition	Min	Typ	Max	Unit
$V_{\text{BAT1B}}/V_{\text{BAT1BB}}$	Operating Supply Voltage		3		5.5	V
$V_{\text{SAUVC}}$	Auxiliary Operating Supply Voltage		2.4	2.5	2.6	V
$T_J$	Temperature Range		-20		125	°C
<b>Full Power Mode</b>						
$V_{\text{MLVA}}/V_{\text{MLVAA}}$	Output Voltage		1.72		1.87	V
$I_{\text{MLVA}}/I_{\text{MLVAA}}$	Output Current				80	mA
$I_{\text{QQ}}$	Quiescent Current		25	30	36	μA
$\Delta V_{\text{DC}}$	Line Regulation	$I_{\text{MLVA}}/I_{\text{MLVAA}} = 80\text{ mA}$		2	3	mV
$\Delta V_{\text{TRAN}}$	Transient Line Regulation	$I_{\text{MLVA}}/I_{\text{MLVAA}} = 80\text{ mA}$ rise time = fall time = $5\ \mu\text{s}$		2	3	mV
$\Delta V_{\text{DC}}$	Load Regulation	10% - 90% of max $I_{\text{MLVA}}/I_{\text{MLVAA}}$		2	4.2	mV
$\Delta V_{\text{TRAN}}$	Transient Load Regulation	10% - 90% of max $I_{\text{MLVA}}/I_{\text{MLVAA}}$ rise time = fall time = $5\ \mu\text{s}$		5	23	mV
PSRR <sup>(2)</sup>	Power Supply Rejection Ratio at Full Load	$V_{\text{BAT1B}}/V_{\text{BAT1BB}} = 3\text{V}$	@ 100 Hz	-75		dB
			@ 1 kHz	-75		dB
			@ 20 kHz	-55		dB
			@ 100 kHz	-35		dB
		$V_{\text{BAT1B}}/V_{\text{BAT1BB}} = 4.25\text{V}$	@ 100 Hz	-70		dB
			@ 1 kHz	-70		dB
			@ 20 kHz	-60		dB
			@ 100 kHz	-35		dB
		$V_{\text{BAT1B}}/V_{\text{BAT1BB}} = 5.5\text{V}$	@ 100 Hz	-65		dB
			@ 1 kHz	-65		dB
			@ 20 kHz	-55		dB
			@ 100 kHz	-35		dB
$V_{\text{N}}$	Output Noise <sup>(3)</sup>	Bandwidth = 10 Hz to 100 kHz		46	80	μV <sub>RMS</sub>

**Table 1. Electrical Characteristics (Continued)**

Symbol	Parameter	Condition	Min	Typ	Max	Unit
$T_R$	Rise Time	Full Load 10% - 90% of $V_{MLVA}/V_{MLVAA}$			130	$\mu s$
$I_{SD}$	Shut Down Current				1	$\mu A$
$I_{CC}$	Short-circuit Current Threshold				130	mA
<b>Low Power Mode</b>						
$V_{MLVA}/V_{MLVAA}$	Output Voltage		1.7		1.9	V
$I_{MLVA}/I_{MLVAA}$	Output Current				5	mA
$I_{QQ}$	Quiescent Current		9.75	11.5	13.75	$\mu A$
$\Delta V_{DC}$	Line Regulation	$I_{MLVA}/I_{MLVAA} = 5 \text{ mA}$		2	3	mV
$\Delta V_{TRAN}$	Transient Line Regulation	$I_{MLVA}/I_{MLVAA} = 5 \text{ mA}$ rise time = fall time = 5 $\mu s$		2	3	mV
$\Delta V_{DC}$	Load Regulation	10% - 90% of max $I_{MLVA}/I_{MLVAA}$		2	5	mV
$\Delta V_{TRAN}$	Transient Load Regulation	10% - 90% of max $I_{MLVA}/I_{MLVAA}$ ; rise time = fall time = 5 $\mu s$		5	8	mV
PSRR <sup>(2)</sup>	Power Supply Rejection Ratio at Full Load	$V_{BAT1B}/V_{BAT1BB} = 3V$	@ 100 Hz		-70	dB
			@ 1 kHz		-70	dB
			@ 20 kHz		-65	dB
			@ 100 kHz		-35	dB
		$V_{BAT1B}/V_{BAT1BB} = 4.25V$	@ 100 Hz		-65	dB
			@ 1 kHz		-65	dB
			@ 20 kHz		-55	dB
			@ 100 kHz		-35	dB
		$V_{BAT1B}/V_{BAT1BB} = 5.5V$	@ 100 Hz		-45	dB
			@ 1 kHz		-45	dB
			@ 20 kHz		-45	dB
			@ 100 kHz		-40	dB
$V_N$	Output Noise <sup>(3)</sup>	Bandwidth = 10 Hz to 100 kHz		90	170	$\mu V_{RMS}$
$T_R$	Rise Time	Full Load 10% - 90% of $V_{MLVA}/V_{MLVAA}$			170	$\mu s$
$I_{SD}$	Shut Down Current				1	$\mu A$

- Notes:
1. Obtained by considering the parasitics of a TFBGA100 Package.
  2. This parameter shows the immunization of the circuit taking into account a voltage ripple on battery voltage for different frequencies shown.
  3. Obtained by using BG019 as reference voltage generator.

## Control Modes

All digital signals are referred to the supply voltage  $V_{BAT1B}$ ,  $V_{BAT1BB}$ .

**Table 2.** Truth Table

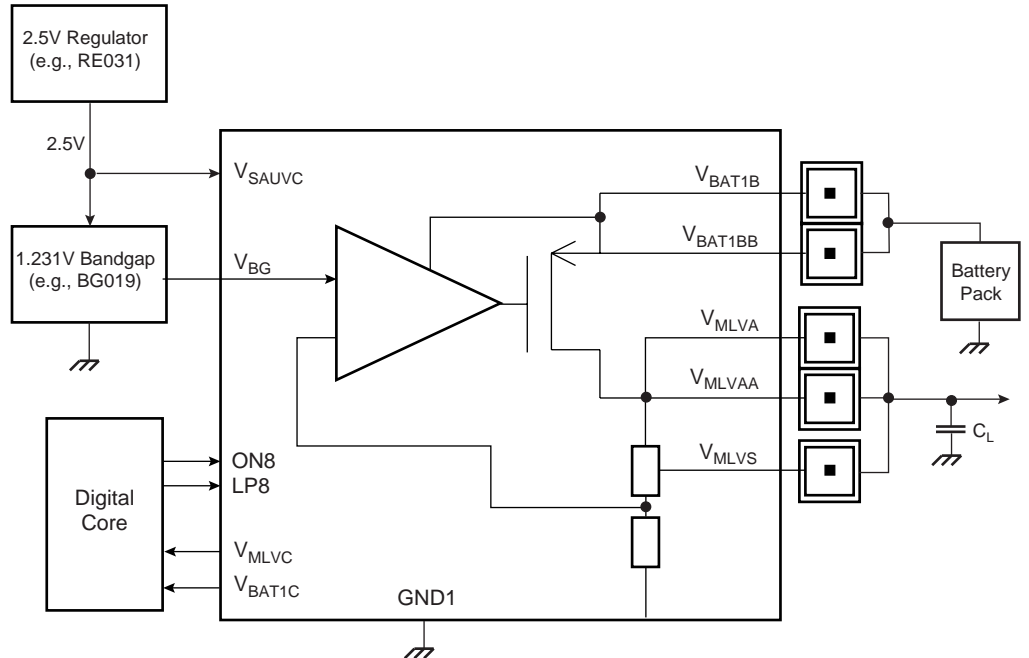
ON8	LP8	$V_{MLVA}/V_{MLVAA}$
0	X	Power down (High-Z)
1	0	Power on, Full Power Mode $V_{MLVA}/V_{MLVAA} = 1.8V$
1	1	Power on, Low Power Mode $V_{MLVA}/V_{MLVAA} = 1.8V$

## Application Example

A ceramic capacitor ( $C_L$ ) of 2.2  $\mu F$  with ESR between 20 m $\Omega$  and 250 m $\Omega$  connected from  $V_{MLVA}/V_{MLVAA}$  to ground is needed for external compensation.

Description	Min	Typ	Max	Units
Capacitor ( $C_L$ )	1.8	2.2	2.6	$\mu F$

**Figure 3.** Application Example



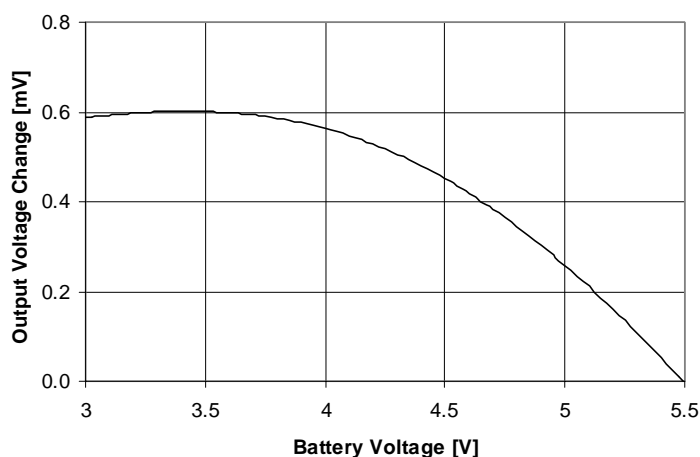
## Typical Performance Characteristics (Conditions specified on page 10)

### Note.

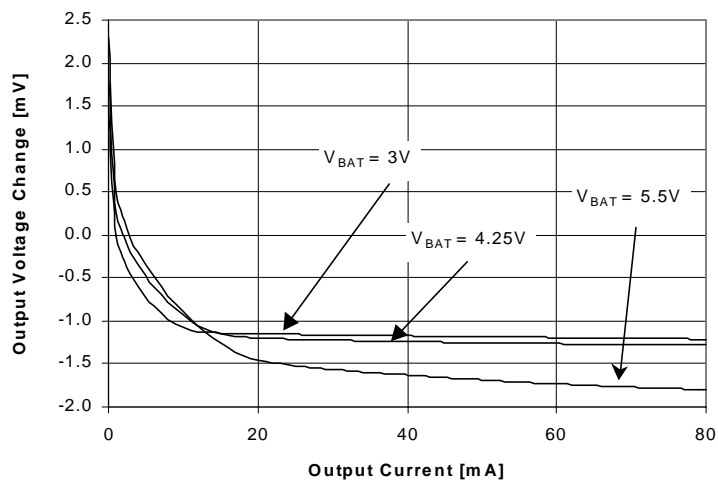
In these graphs:

- Output Voltage ( $V_{MLV}$ ) refers to  $V_{MLVA}/V_{MLVAA}$
- Battery Voltage ( $V_{BAT}$ ) refers to  $V_{BAT1B}/V_{BAT1BB}$
- Output Current ( $I_{MLV}$ ) refers to  $I_{MLVA}/I_{MLVAA}$

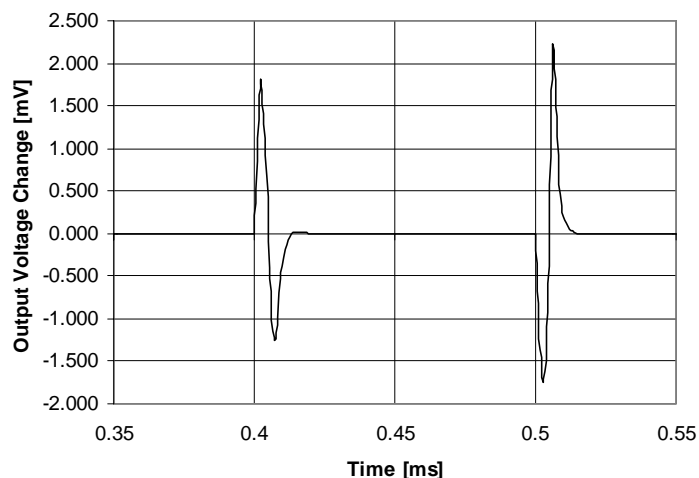
**Static Line Regulation at Full Load in Full Power Mode**



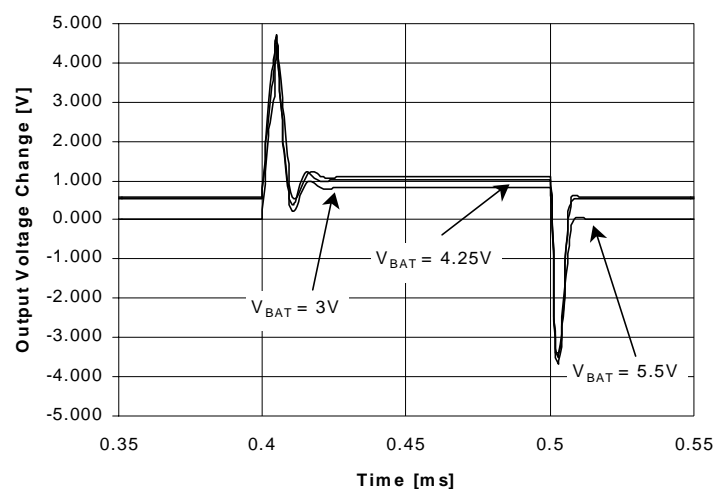
**Static Load Regulation in Full Power Mode**



**Transient Line Regulation at Full Load in Full Power Mode**

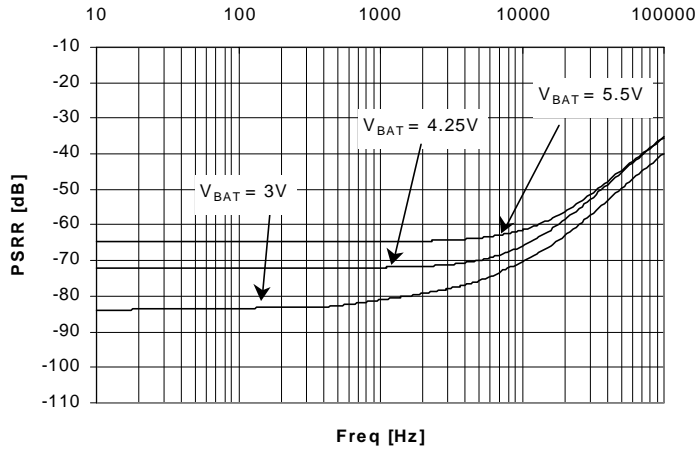


**Transient Load Regulation in Full Power Mode**

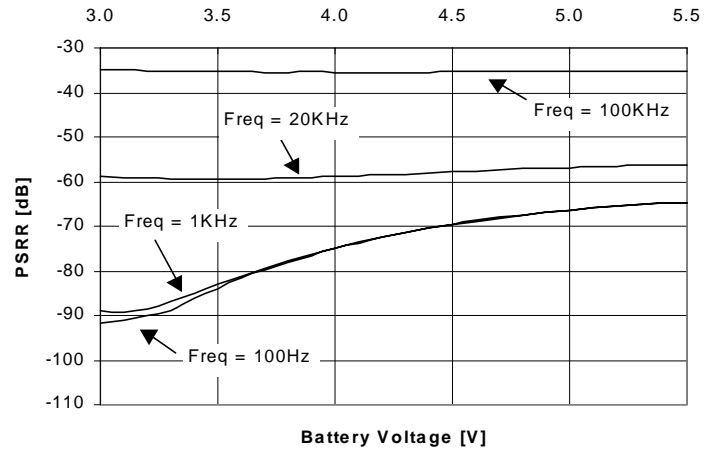


## Typical Performance Characteristics (Conditions specified on page 10)

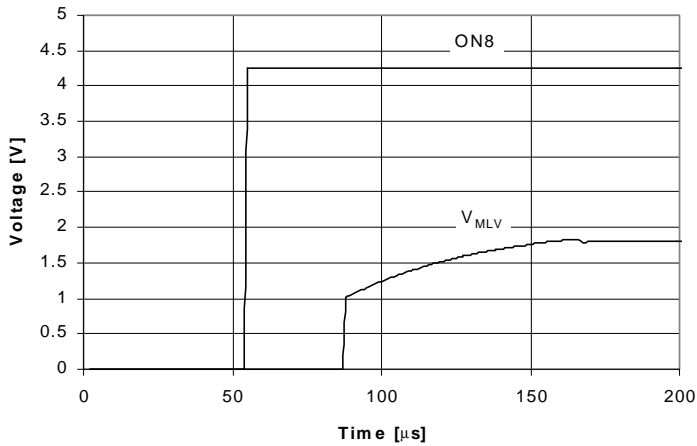
Power Supply Rejection Ratio at Full Load  
in Full Power Mode



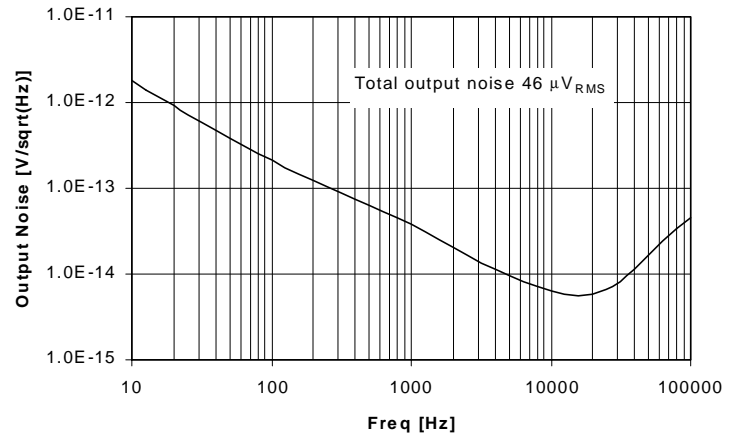
Power Supply Rejection Ratio at Full Load  
Versus Battery Voltage in Full Power Mode



LDO Startup at Full Load for  $V_{BAT} = 4.25V$   
in Full Power Mode

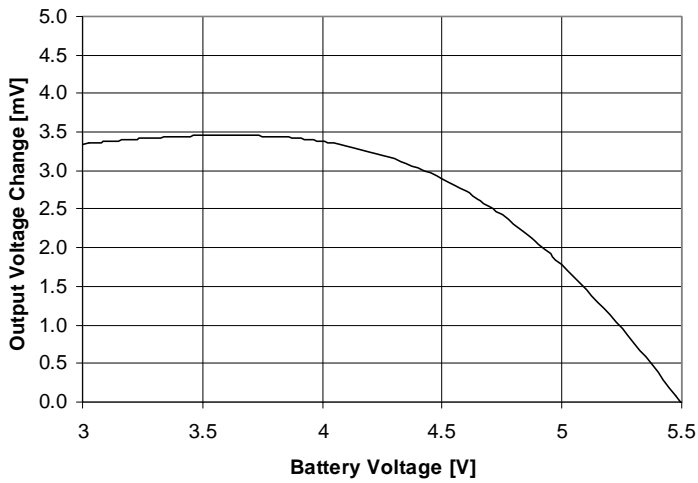


Output Noise Spectrum at Full Load and  $V_{BAT} = 4.25V$   
in Full Power Mode

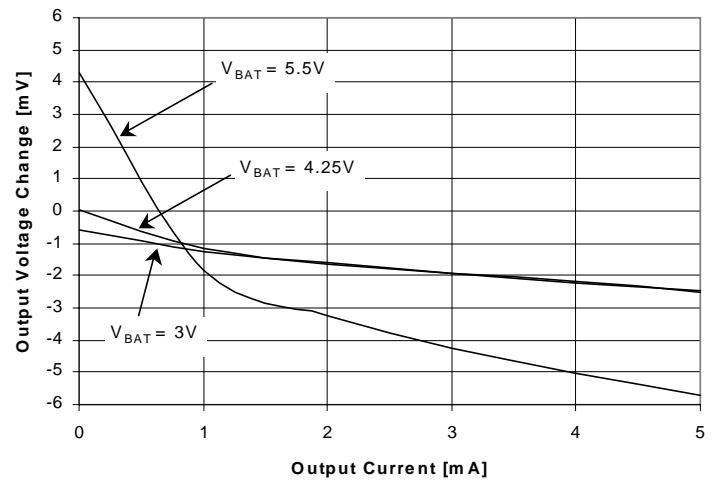


## Typical Performance Characteristics (Conditions specified on page 10)

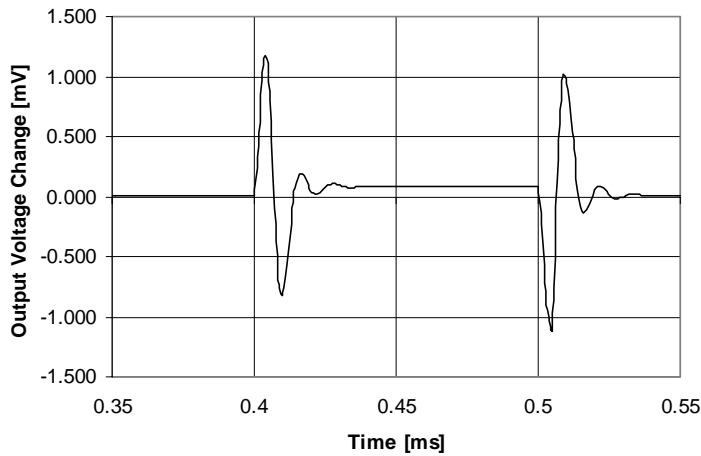
Static Line Regulation at Full Load in Low Power Mode



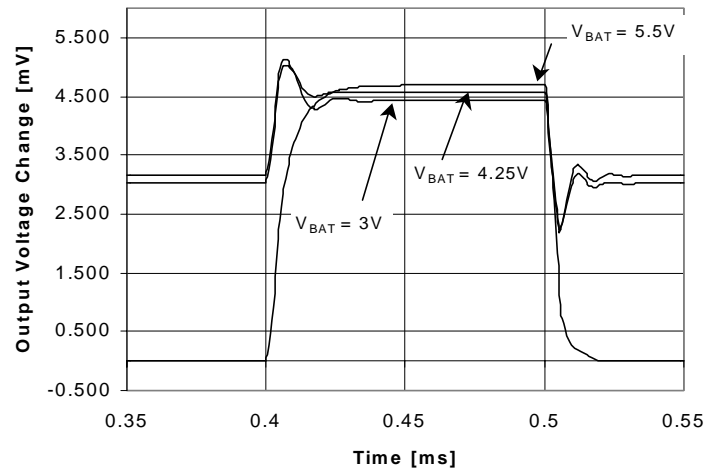
Static Load Regulation in Low Power Mode



Transient Line Regulation at Full Load in Low Power Mode



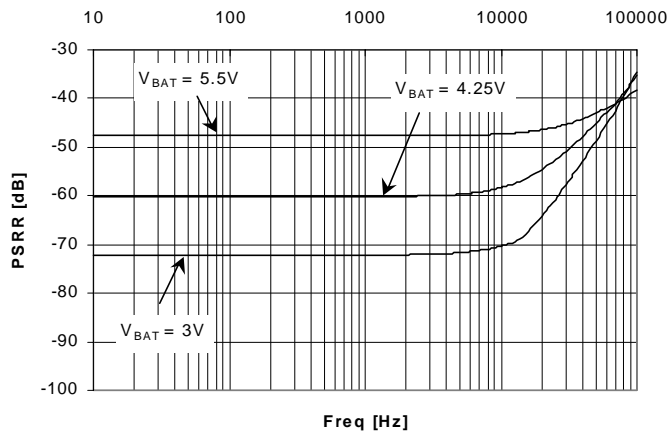
Transient Load Regulation in Low Power Mode



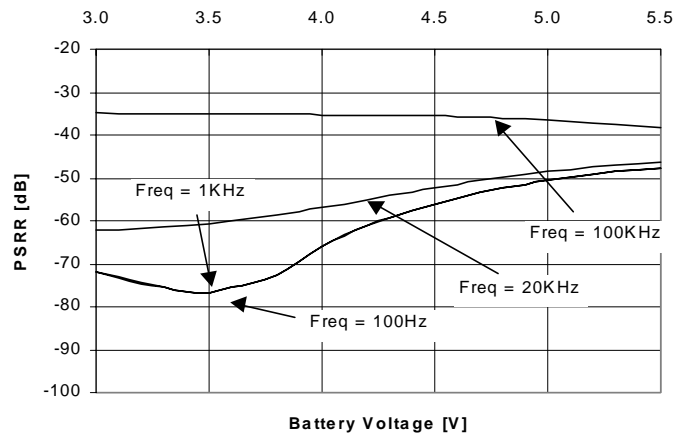


## Typical Performance Characteristics (Conditions specified on page 10)

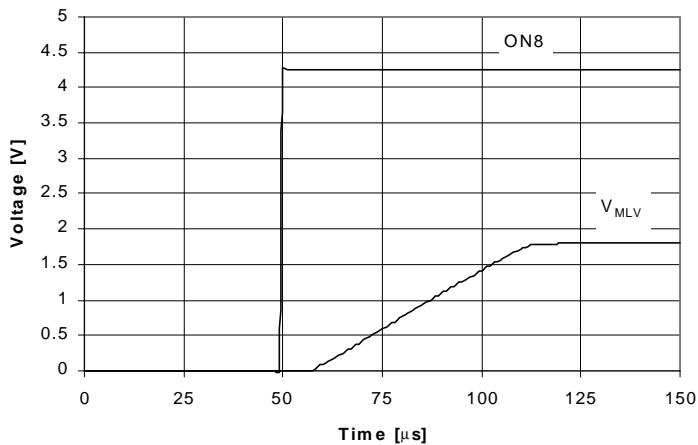
Power Supply Rejection Ratio at Full Load  
in Low Power Mode



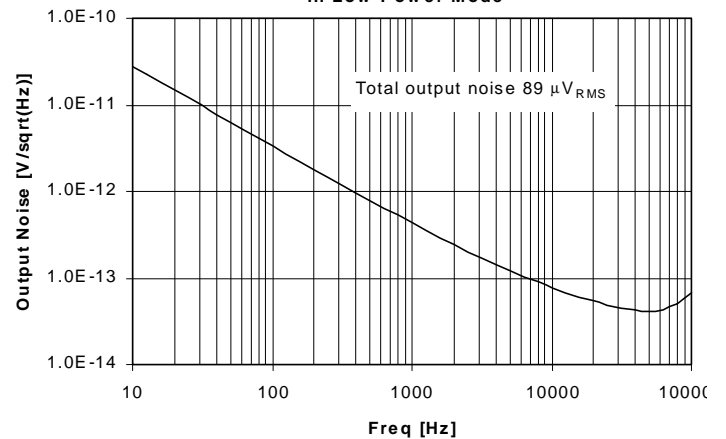
Power Supply Rejection Ratio at Full Load  
Versus Battery Voltage in Low Power Mode



LDO Startup at Full Load for  $V_{BAT} = 4.25V$   
in Low Power Mode



Output Noise Spectrum at Full Load and  $V_{BAT} = 4.25V$   
in Low Power Mode

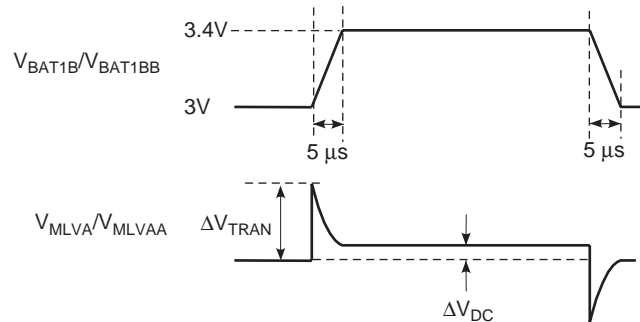


## Terminology

### Line Regulation

Measures the maximum transient and DC variations of the output voltage of the RE029 when the supply changes between two specified values with fixed load current; minimum rise time and fall time is 5  $\mu$ s.

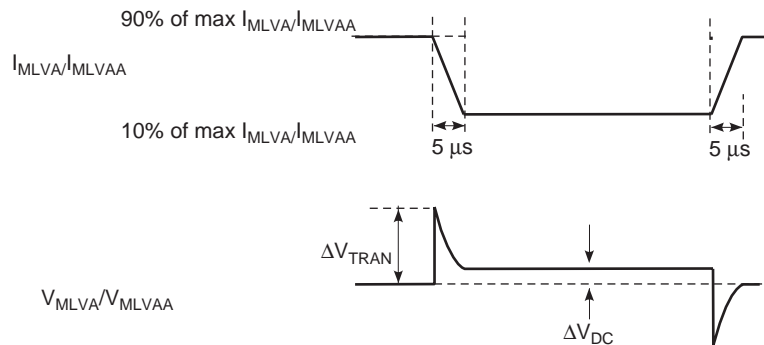
**Figure 4.** Line Regulation



### Load Regulation

Measures the maximum transient and DC variations of the output voltage of the RE029 when the load current changes between two specified values with fixed power supply; minimum rise time and fall time is 5  $\mu$ s.

**Figure 5.** Load Regulation





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