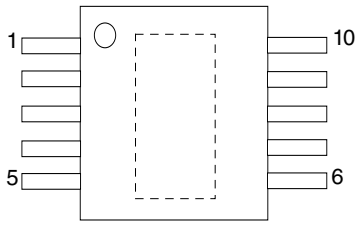
Preliminary Data

Negative Voltage Generator for biasing GaAs FET and Power Amplifier

Support chips – BGV503, BGV903 – for cellular phones

- BGV503: one-stage charge-pump with additional regulator for biasing GaAs-FET's
- BGV903: two-stage charge-pump without regulator

- Operating Voltage Range: +2.2V ... 5.0V
- Typical Output Voltage: -2.5V (BGV503)
  (Vcc=3.0V; Iout=3mA) -5.1V (BGV903)
- Output Current: 3mA
- p-p Output Voltage Ripple: 25mV .. 40mV @ Cout = 1µF; Iout = 3mA
- Integrated Oscillator f_{osz}: 230kHz
- Standby Supply Current: < 5µA
- Logic-Level Shutdown Mode
- Bare Chip Dimensions: 1.2 x 2.0mm^2



TSSOP10-1

Electrostatic discharge sensitive device – observe handling precautions

Type	Marking	Ordering code (taped)	Package
BGV503	BGV503	Q62702L0132	TSSOP10-1
BGV903	BGV903	Q62702L0131	TSSOP10-1

BGV503 (one-stage charge-pump with regulator)

Characteristics	Condition	Min	Typ	Max	Unit
Input Voltage Range		2.7		5.0	V
Ground (V_{ss})			0		V
Output Voltage	V_{in}=2.7V; I_{out} =3mA		-2.1	-1.4	V
	V_{in}=3.0V; I_{out} =3mA		-2.5	-1.7	V
	V_{in}=5.0V; I_{out} =3mA		-4.6	-3.9	V
Power Efficency	V_{in}=3.0V; R_{load}=1kΩ		76		%
Output Voltage Ripple ***	V_{in}=3.0V; I_{out} =0 mA		20		mV

	V_{in}=3.0V; I_{out} =3 mA		100		mV
No-Load Supply Current	V_{in} = 3.0V		0.4	2.0	mA
Voltage Conversion Efficency	I_{out} = 0mA		99.6		%
Shutdown/Enable Input Bias Current				1	µA
Shutdown Input Supply Current				5	µA
Turn On Time			51		µs
Temperature Range		-25˚		100˚	C

BGV903 (two-stage charge-pump)

Characteristics	**Condition**	**Min**	**Typ**	**Max**	**Unit**
Input Voltage Range		2.7		5.0	V
Ground (V_{ss})	0				V
Output Voltage	V_{in}=2.7V; I_{out} =3mA		-4.4	-3.3	V
	V_{in}=3.0V; I_{out} =3mA		-5.1	-4.0	V
	V_{in}=5.0V; I_{out} =3mA		-9.2	-8.2	V
Power Efficency	V_{in}=3.0V; R_{load}=1kΩ		72		%
Output Voltage Ripple ***	V_{in}=3.0V; I_{out} =0mA		30		mV
	V_{in}=3.0V; I_{out} =3mA		100		mV
No-Load Supply Current	V_{in} = 3.0V		0.9	2.0	mA
Voltage Conversion Efficency	I_{out} = 0mA		98.2		%
Shutdown/Enable Input Bias Current				1	µA
Shutdown Input Supply Current				5	µA
Turn On Time			77		µs
Temperature Range		-25˚		100˚	C

Bare Chip

Characteristics	**Condition**	**Min**	**Typ**	**Max**	**Unit**
Input Voltage Range		2.7		5.0	V
Ground (V_{ss})	0				V

Output Voltage *	V_{in}=2.7V; I_{out} =3mA		-4.4	-3.3	V
	V_{in}=3.0V; I_{out} =3mA		-5.0	-4.0	V
	V_{in}=5.0V; I_{out} =3mA		-9.2	-8.2	V
Power Efficency*	V_{in}=3.0V; R_{load}=1kΩ		73		%
Output Voltage Ripple ***	V_{in}=3.0V; I_{out} =0mA		30		mV
	V_{in}=3.0V; I_{out} =3mA		100		mV
No-Load Supply Current *	V_{in} = 3.0V		1.0	2.0	mA
Output Voltage **	V_{in}=2.7V; I_{out} =3mA		-3.6		V
	V_{in}=3.0V; I_{out} =3mA		-4.3		V
	V_{in}=5.0V; I_{out} =3mA		-8.5		V
Power Efficency**	V_{in}=3.0V; I_{out} =3mA		63		%
Output Voltage Ripple **	V_{in} =3V; I_{out} = 3mA		10		mV
Shutdown/Enable Input Bias Current				1	µA
Shutdown Input Supply Current				5	µA
Turn On Time *			77		µs
Temperature Range		-25˚		100˚	C

* without lowpass-filter, **with lowpass-filter C_{out} = 100nF; C_{filt} = 100nF, ***C_{out} = 100nF

Note**:** Typical values are measured at T_A=25˚C
Max- and Min-values are over the whole temperature-range of –25˚C<T_A<100˚C

Functional Block Diagram

The applied supply voltage (V_{cc}) is inverted (BGV503) and additionally doubled (BGV903) to a negativ output voltage (*nv*). Regarding the Bare-Chip you have two alternatives:
Either you prefer an output voltage that is only inverted (capacitor between c1d and c2p) or one that is inverted and doubled (capacitors between c1d-c1p and c2d-c2p).
The switching frequency (*clk*) of the charge-pump is determined by the integrated oscillator and is between 100kHz and 400kHz. It is possible to stop the operating of the IC by connecting *disq* to a voltage lower than 1V (shutdown mode). The driver (*drive*) ensures that the MOS-switches of the charge-pump are operated at the correct time. To reduce the ripple in the output voltage the low pass filter can be used in the Bare-Chip-Solution connecting an external filter-capacitor between pin *cfilt* and V_{ss}. This filtered voltage can be taken out at pin *fnv*. The regulator can be used to control the biasing of GaAs-FET current-mirrors (see Figure 5).

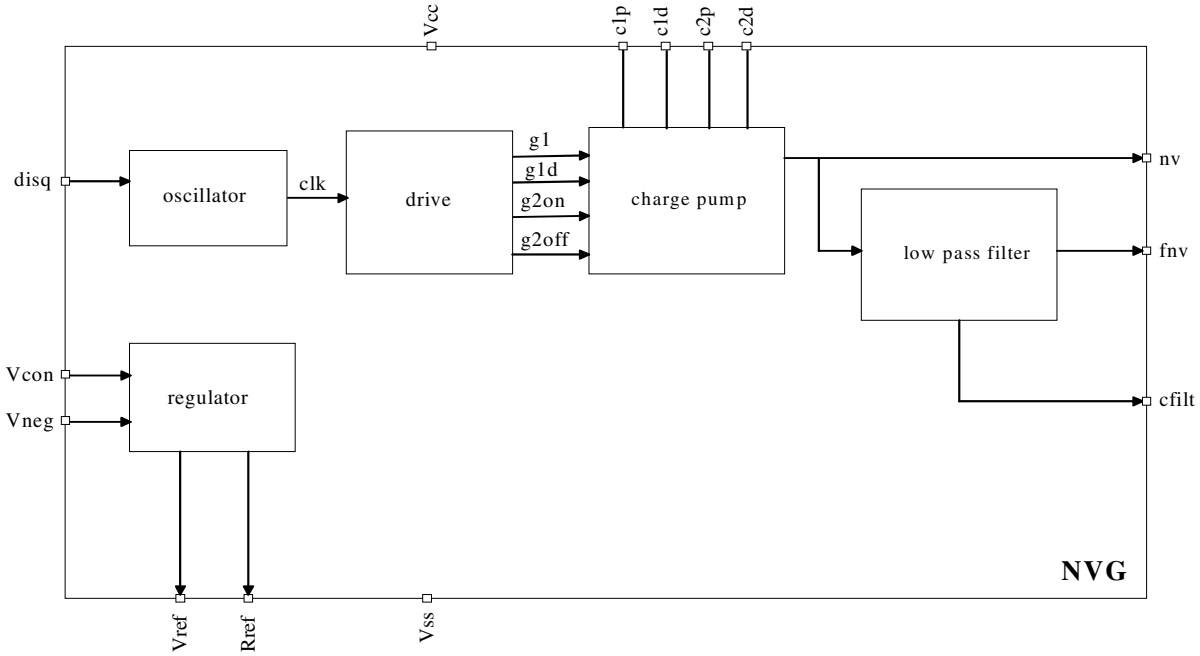


Figure 1: Block Diagram of the Negative Voltage Generator

Pin Configuration of packaged devices BGV503 / BGV903

Package: P-TSSOP-10-1

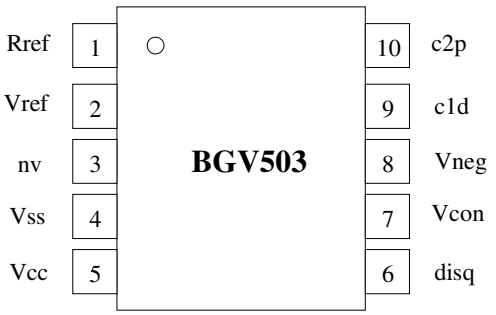


Figure 2: **BGV503** one-stage charge pump with regulator

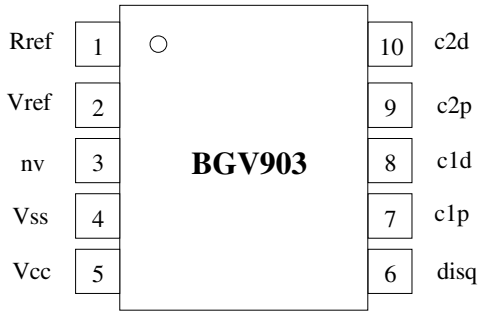


Figure 3: **BGV903** two-stage charge pump without regulator

Pin #	BGV503	BGV903	Configuration
1	Rref	Rref (n.c.)	Reference resistor of the regulator
2	Vref	Vref (n.c.)	Reference voltage of the regulator
3	nv	nv	Negative output-voltage
4	Vss	Vss	Ground connection
5	Vcc	Vcc	Positive supply voltage

6	disq	disq	Disable, active low (enable)
7	Vcon	-	Control-voltage of the regulator
	-	c1p	Pump-capacitor 1
8	Vneg	-	Negative supply-voltage of the regulator
	-	c1d	Pump-capacitor 1
9	c1d	-	Pump-capacitor 1
	-	c2p	Pump-capacitor 2
10	c2p	-	Pump-capacitor 1
	-	c2d	Pump-capacitor 2

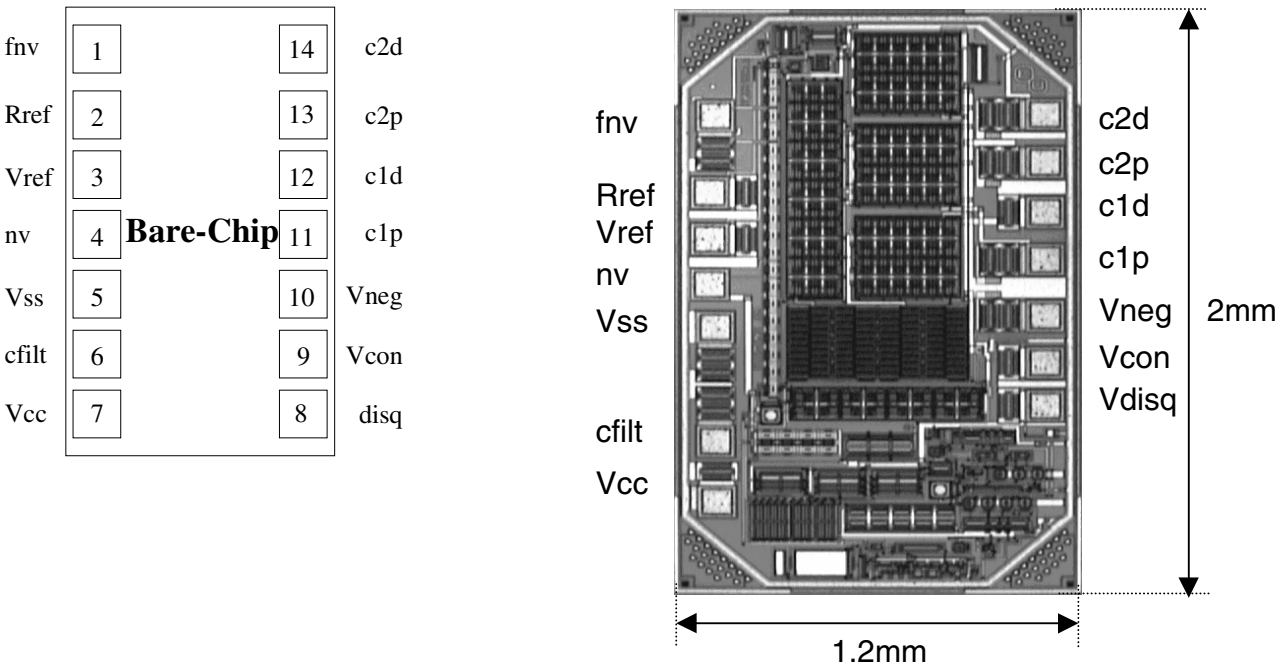


Figure 4: Pad definition and top view of the Bare-Chip with lateral dimensions.

Pin Configuration bare-chip:

Pin #	Bare-chip	Configuration
1	fnv	Filtered negative output voltage
2	Rref	Reference resistor of the regulator
3	Vref	Reference voltage of the regulator
4	nv	Negative output-voltage

5	Vss	Ground connection
6	cfilt	Filter-capacitor
7	Vcc	Positive supply voltage
8	disq	Disable, active low (enable)
9	Vcon	Control-voltage of the regulator
10	Vneg	Negative supply-voltage of the regulator
11	c1p	Pump-capacitor 1
12	c1d	Pump-capacitor 1
13	c2p	Pump-capacitor 2
14	c2d	Pump-capacitor 2

Typical Applications:

For all applications use capacitors with low effective series resistance (ESR) to maintain a low dropout voltage and a low p-p voltage ripple.
An additional capacitor in the supply line (between *Vcc* and *Vss*) is useful to reduce both the AC input impedance and, as a consequence, the spikes in the supply voltage, resulting from the current peaks when the IC is switching. The value of this capacitance depends on the circuit configuration; 1µF is regarded as sufficient.

a) BGV503

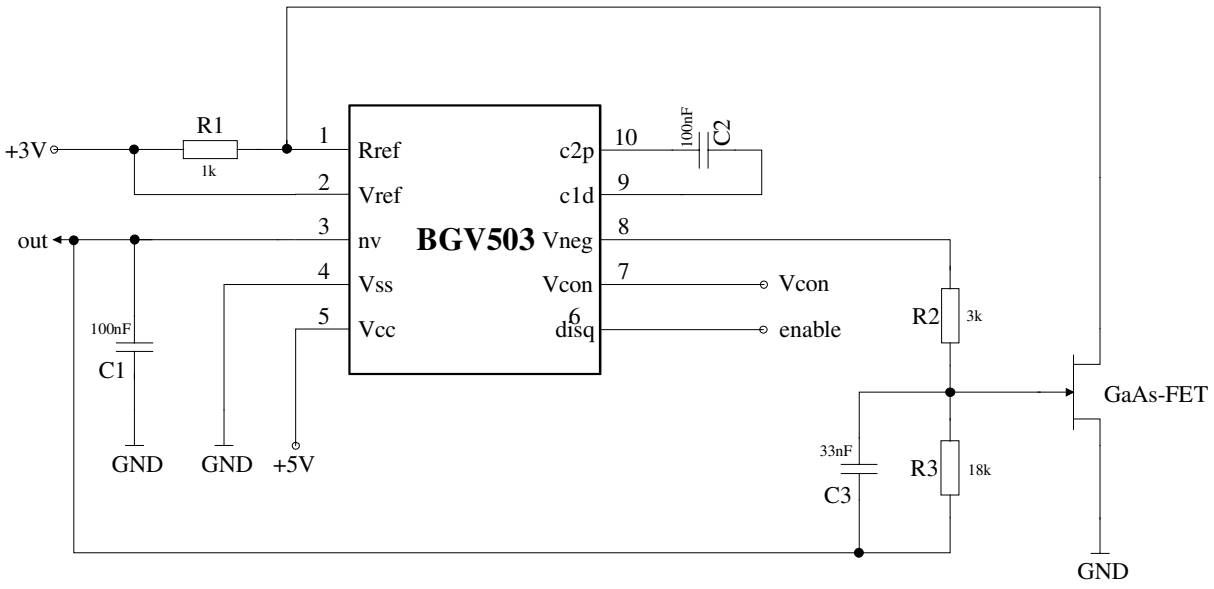


Figure 5: BGV503; One-Stage-Inverting Charge-Pump with GaAs-FET Regulator

b) BGV903

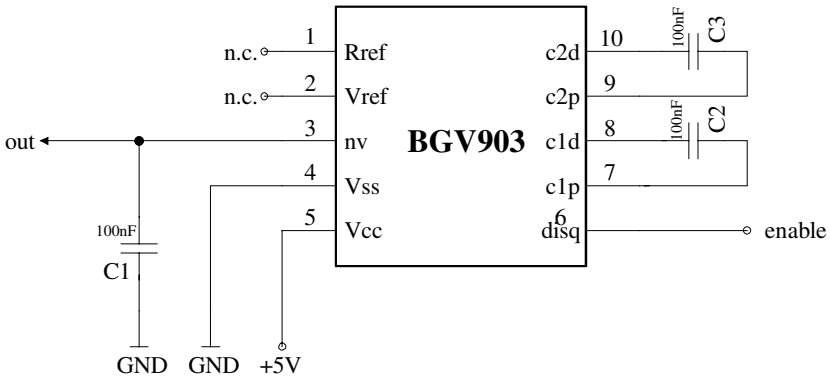


Figure 6: BGV903; Two-Stage-Inverting Charge-Pump

c) Bare Chip solution

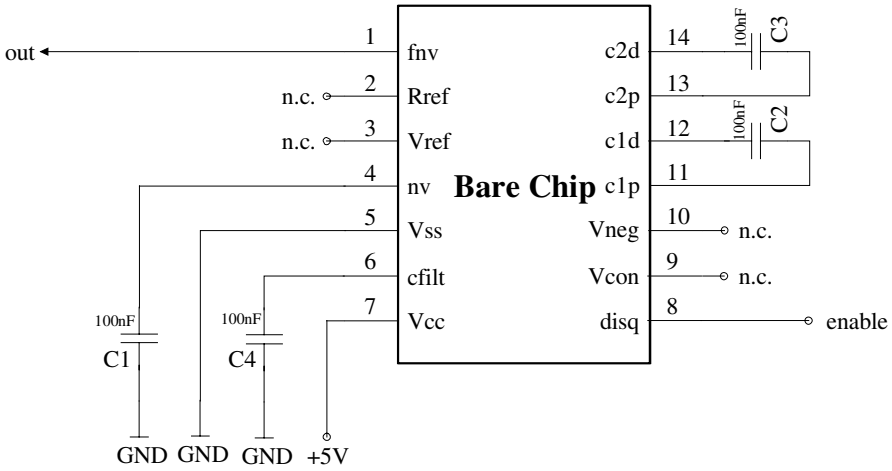
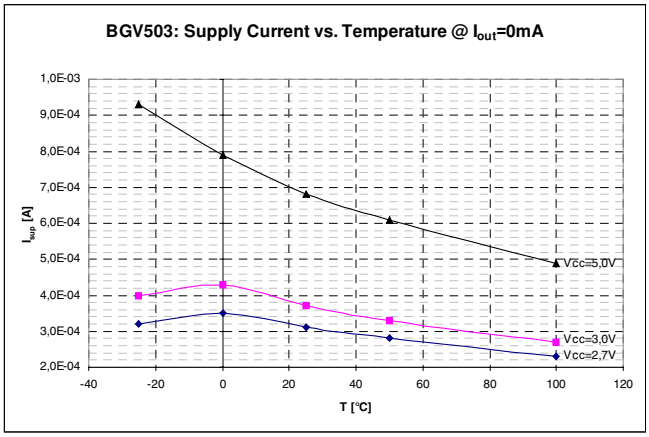
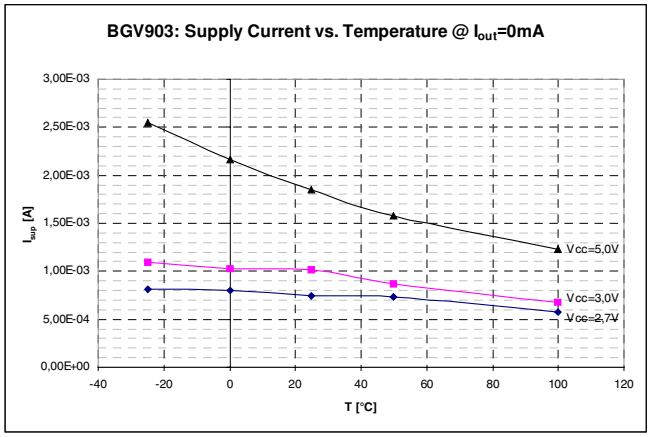


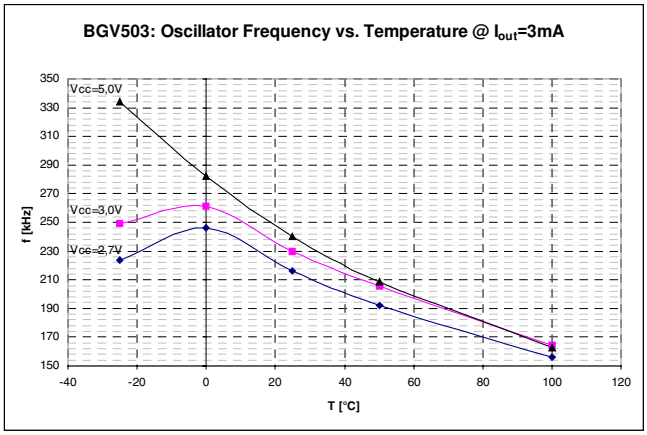
Figure 7: Bare-Chip-Solution; Two-Stage Inverting Charge-Pump with Integrated Lowpass-Filter

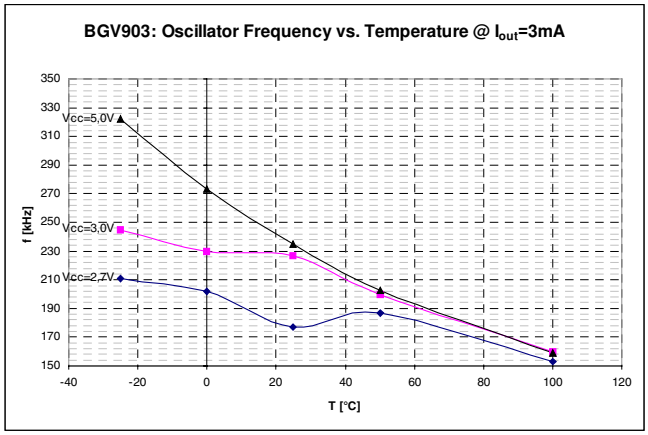
Typical Operating Characteristics (external configuration see figure 5, figure 6, figure 7).

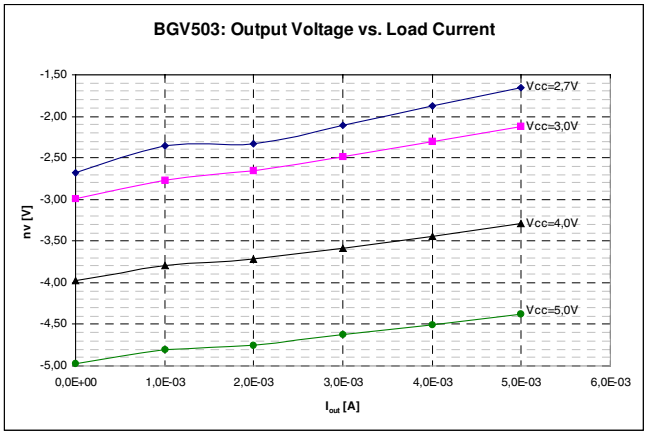
Operating conditions: V_{cc} = 3V, V_{disq} = 2V, T_A = 25°C, C1 = C2 = C3 = C4 =100nF, unless otherwise noted.

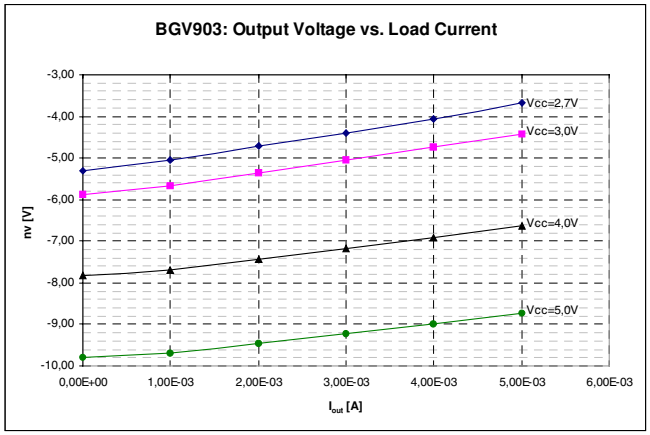


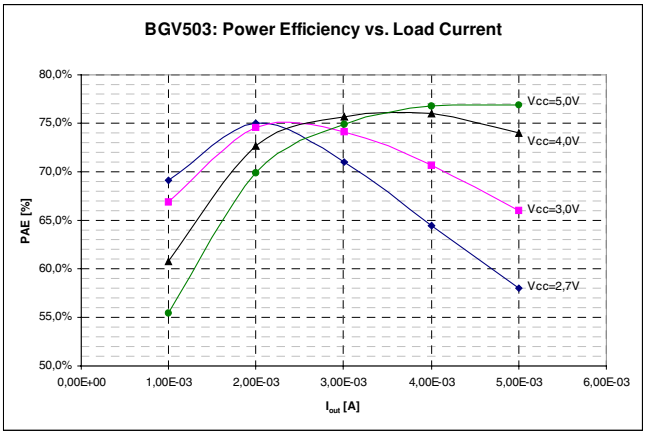


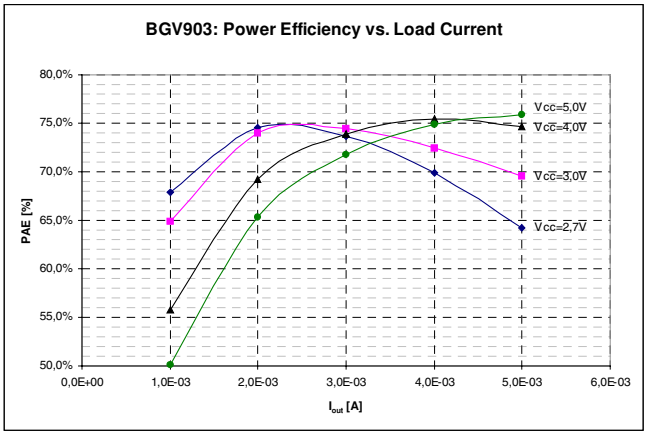


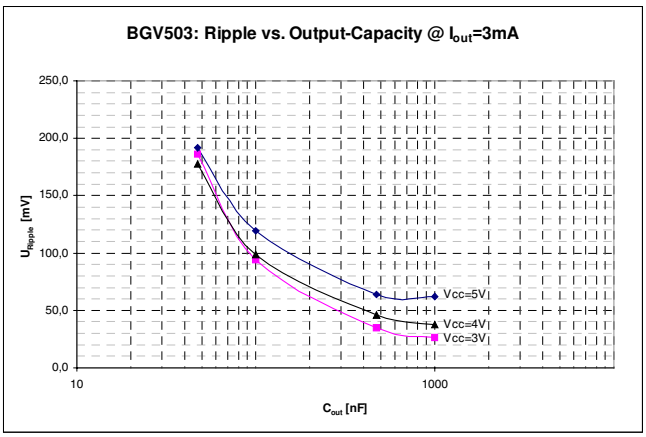


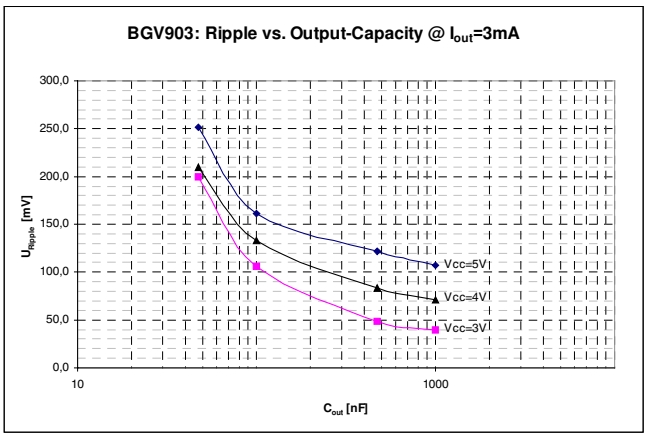


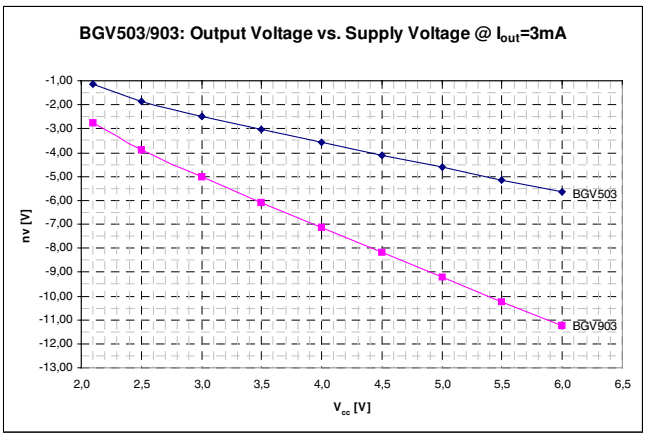


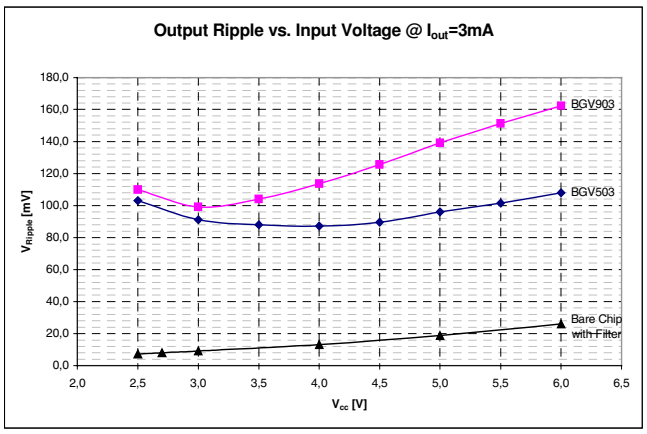

BGV503: Power Efficiency vs. Load Current
PAE [%]
80,0%
75,0%
70,0%
65,0%
60,0%
55,0%
50,0%
0,00E+00
1,00E-03
2,00E-03
3,00E-03
4,00E-03
5,00E-03
6,00E-03
I_out [A]
Vcc=5,0V
Vcc=4,0V
Vcc=3,0V
Vcc=2,7V


BGV903: Power Efficiency vs. Load Current
PAE [%]
80,0%
75,0%
70,0%
65,0%
60,0%
55,0%
50,0%
0,0E+00
1,0E-03
2,0E-03
3,0E-03
4,0E-03
5,0E-03
6,0E-03
I_out [A]
Vcc=5,0V
Vcc=4,0V
Vcc=3,0V
Vcc=2,7V

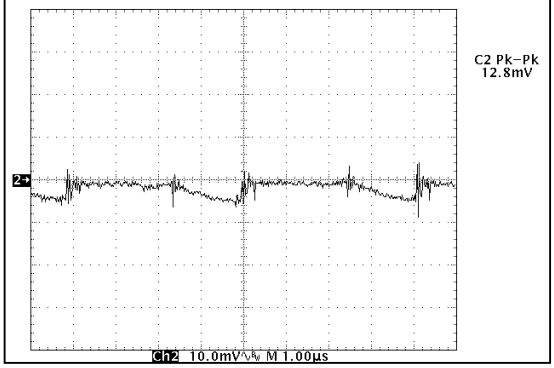

BGV503: Ripple vs. Output-Capacity @ I_out=3mA
U_Ripple [mV]
250,0
200,0
150,0
100,0
50,0
0,0
10
1000
C_out [nF]
Vcc=5V
Vcc=4V
Vcc=3V


BGV903: Ripple vs. Output-Capacity @ I_out=3mA
U_Ripple [mV]
300,0
250,0
200,0
150,0
100,0
50,0
0,0
10
1000
C_out [nF]
Vcc=5V
Vcc=4V
Vcc=3V

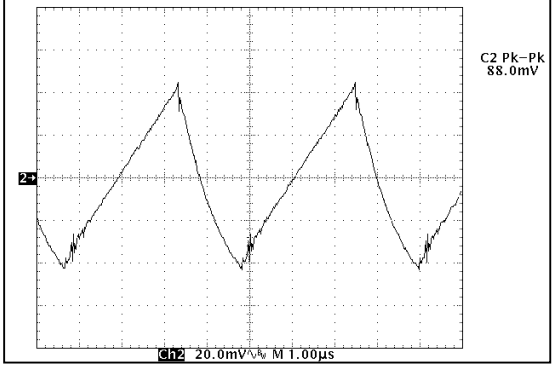

BGV503/903: Output Voltage vs. Supply Voltage @ I_out=3mA
nv [V]
-1,00
-2,00
-3,00
-4,00
-5,00
-6,00
-7,00
-8,00
-9,00
-10,00
-11,00
-12,00
-13,00
2,0
2,5
3,0
3,5
4,0
4,5
5,0
5,5
6,0
6,5
V_cc [V]
BGV503
BGV903


Output Ripple vs. Input Voltage @ I_out=3mA
V_Ripple [mV]
180,0
160,0
140,0
120,0
100,0
80,0
60,0
40,0
20,0
0,0
2,0
2,5
3,0
3,5
4,0
4,5
5,0
5,5
6,0
6,5
V_cc [V]
BGV903
BGV503
Bare Chip
with Filter

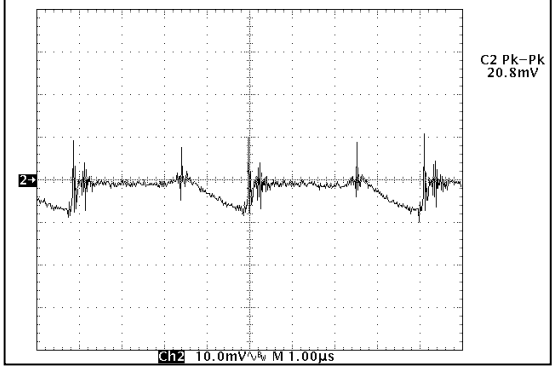
BGV503: Output Voltage, AC-coupled, Vcc=3V, Iout=0mA, Cout=100nF



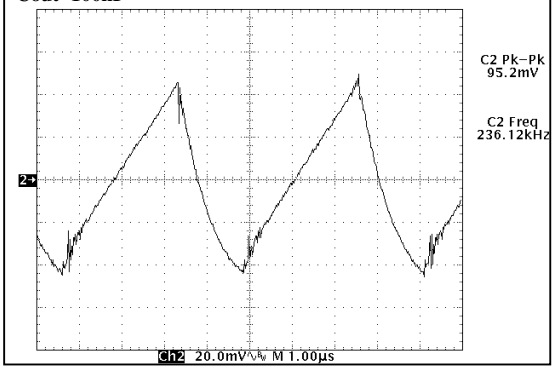
BGV503: Output Voltage, AC-coupled, Vcc=3V, Iout=3mA, Cout=100nF



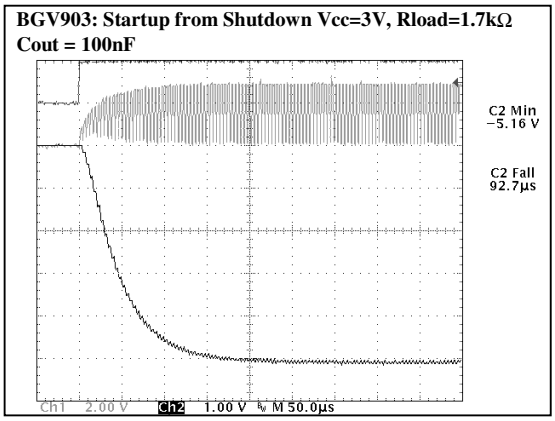
BGV903: Output Voltage, AC-coupled, Vcc=3V, Iout=0mA, Cout=100nF



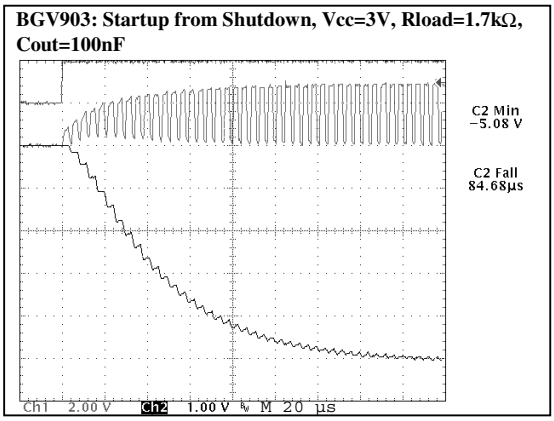
BGV903: Output Voltage, AC-coupled, Vcc=3V, Iout=3mA, Cout=100nF



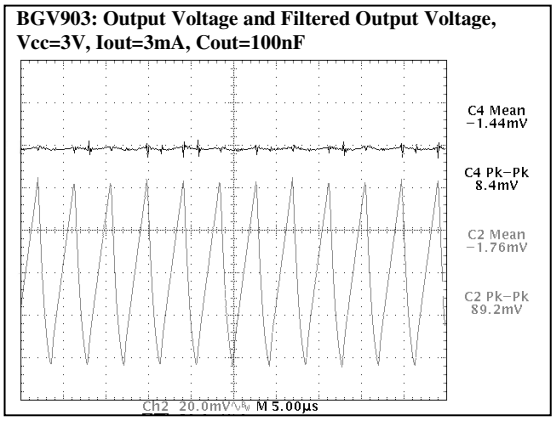
BGV903: Startup from Shutdown Vcc=3V, Rload=1.7kΩ Cout = 100nF



BGV903: Startup from Shutdown, Vcc=3V, Rload=1.7kΩ, Cout=100nF

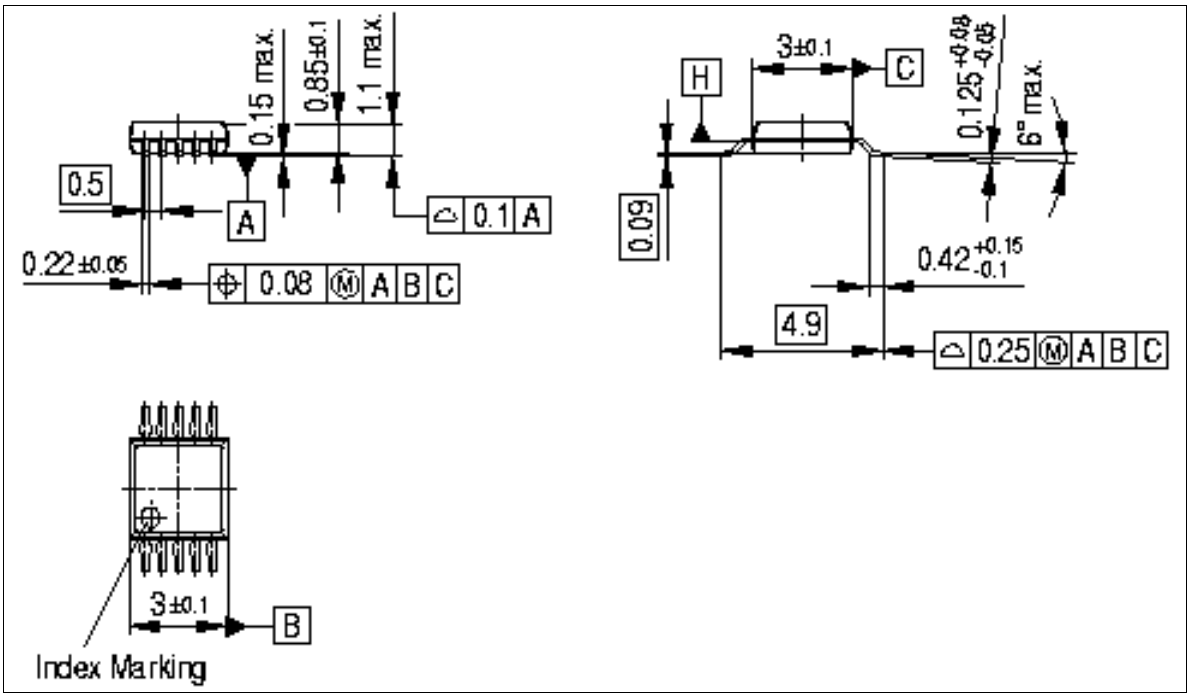


BGV903: Output Voltage and Filtered Output Voltage, Vcc=3V, Iout=3mA, Cout=100nF



Note: Bandwidth of oscilloscope is 20 MHz

Package Dimensions TSSOP10-1



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