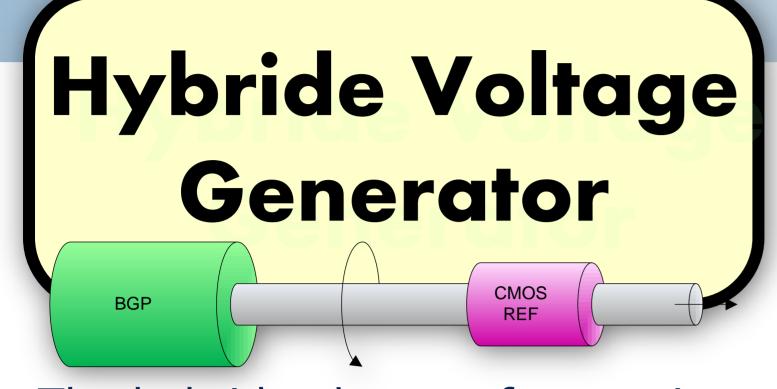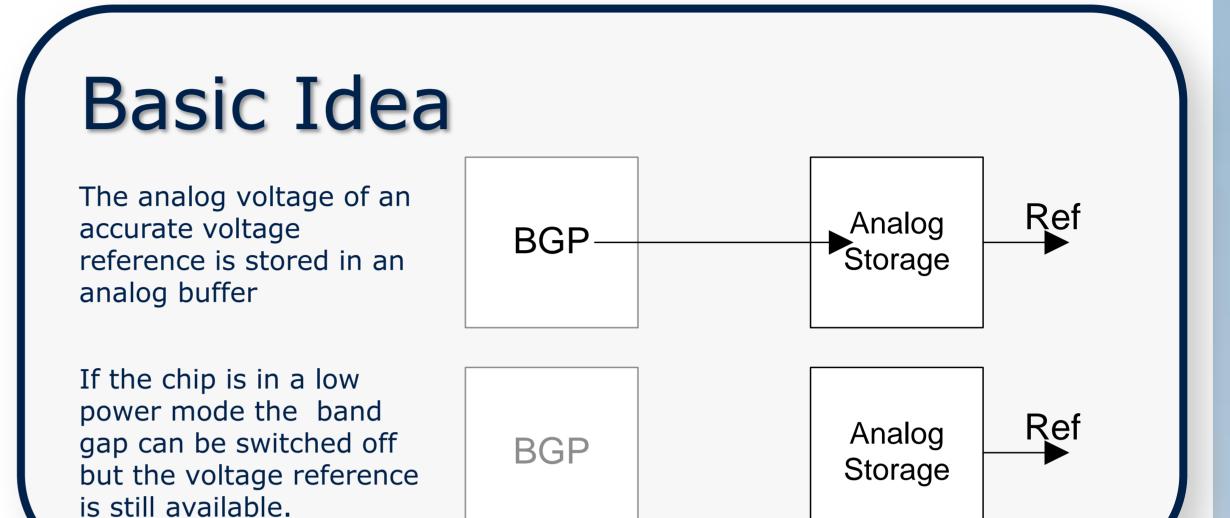# Hybride Voltage Generator

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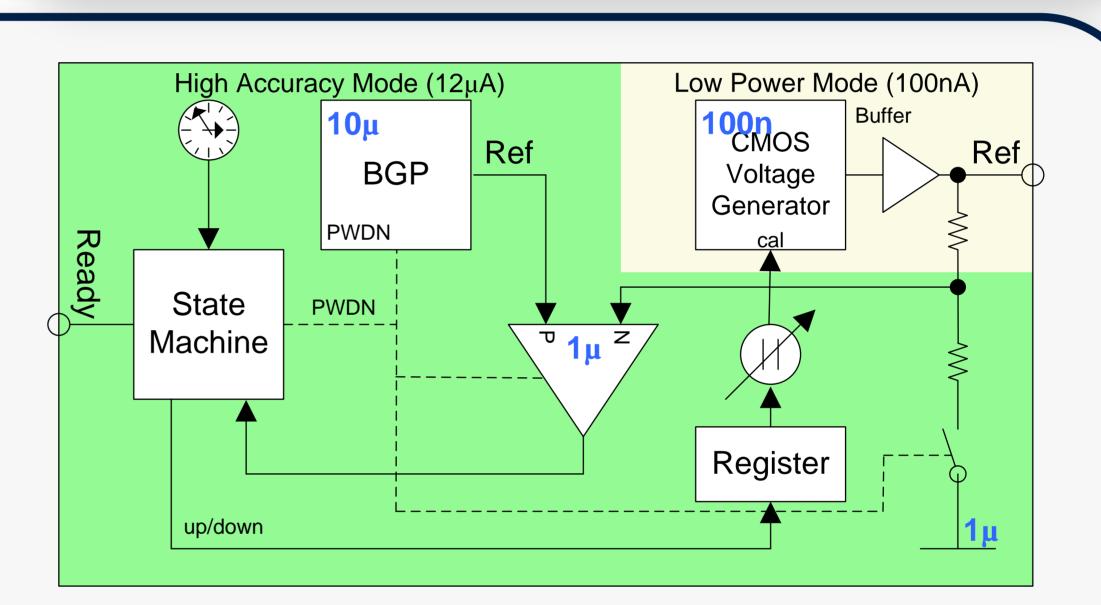
Hybride Voltage Generator

The hybrid voltage reference is a voltage reference circuit which is able to generate high accuracy in a highly efficient way.

Basic Idea

The analog voltage of an accurate voltage reference is stored in an analog buffer

BGP → Analog Storage → Ref

If the chip is in a low power mode the band gap can be switched off but the voltage reference is still available.
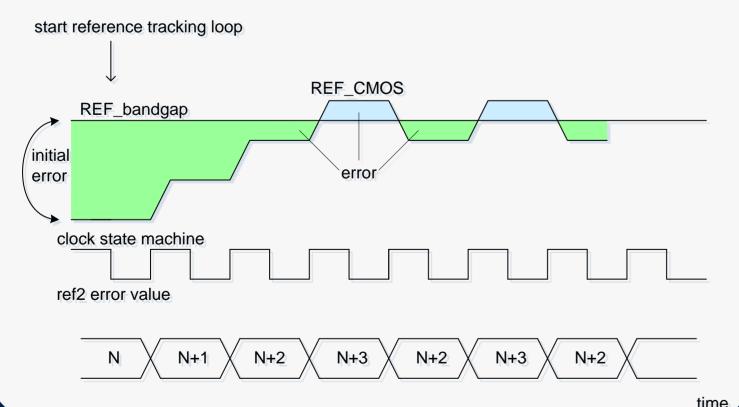
BGP → Analog Storage → Ref

Realization

The BGP produces a accurate voltage reference. A comparator is comparing this accurate voltage reference with a low power CMOS voltage reference. A digital logic is calibrating the CMOS voltage reference online in a way that there is the same output (or ratio) as at the BGP output.
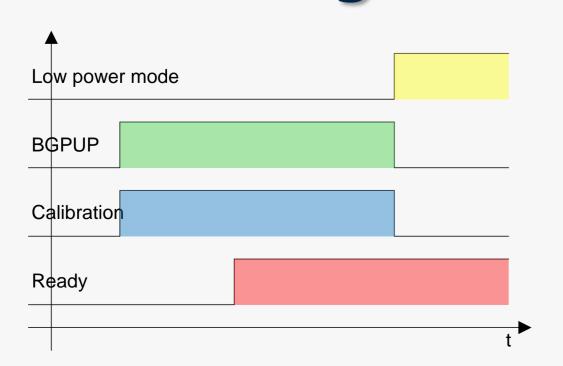
At the low power mode the BGP and the comparator can be switched off and the CMOS voltage reference is not calibrated anymore. Due to the drift from time to time a re-calibration gets necessary to keep the accuracy.

High Accuracy Mode (12µA)   Low Power Mode (100nA)

10µ BGP Ref   100n CMOS Voltage Generator Buffer Ref

Ready   State Machine   PWDN   1µ   Register   1µ   up/down

Online Calibration

start reference tracking loop

REF_bandgap   REF_CMOS

initial error   error

clock state machine

ref2 error value

N	N+1	N+2	N+3	N+2	N+3	N+2

time

Offset Compensation

If the BGP is calibrated, the comparator can be used in a way that the offset is compensated. The comparator has to be used for both: calibration of the band gap and updating the CMOS voltage generator.

The bandgap shows a systematic comparator-offset of 20mV after the calibration phase (other error sources are not included)

20mV   Ref   780mV
BGP   Same Offset!

CMOS Voltage Generator Buffer Ref 800mV ✓
cal

780mV   800mV
20mV

Offset from the comparator

State Diagram

Low power mode

BGPUP

Calibration

Ready

t