250 W Grid Connected Microinverter

Enabling new generation of PV systems
250 W microinverter for PV applications

- Key features:
  - 250 W power capability
  - Output voltage $V_{out} = 230\text{Vac} 50\text{Hz} - 240\text{Vac} 60\text{Hz}$
  - High conversion efficiency (>94%, 93.5% CEC)
  - MPPT efficiency (99%)
  - Decoupled control of active and reactive power
  - Overcurrent and anti-islanding protection
  - Galvanic isolation between the panel and the grid

- Key products:
  - STM32F103ZE (32-bit microcontroller)
  - STB18N65M5, STH180N10F3-2 (power MOSFETs)
  - PM8834, L6390 (MOSFET drivers)
  - STPSC606, STPS1545C, STTH12R06 (diodes)
  - SMBJ (EOS surge protection)
  - ST3232EB (RS-232 interface)

System evaluation board order code: STEVAL-ISV003V1(*)

(*) Available at the end of Q1 2012
250 W microinverter: block diagram
250 W microinverter: DC-DC section

**Electrical Specs**

- **Vin** = 18V to 55V
- **Vmppt** = 20V to 40V
- **lin** = 7.6A (nominal)
- **Vout** = 370Vdc to 430Vdc
- **Iout** = 0.65A (nominal)
- **Pout** = 250W
- **fsw** = 35kHz

**Max Efficiency**

DC-DC converter 97.4%

**The topology**

ISOLATED INTERLEAVED BOOST CONVERTER

Vout

Vin

L1

L2

MOSFETs

driver

32-bit MCU

STM32F

PM8834

STH180N10F3-2

STH12R06

HF transformer
250 W microinverter: DC-AC section

**Electrical Specs**
- Vin = 370Vdc to 430Vdc
- Vin (nominal) = 380 V
- Vout = 230Vac / 240Vac
- fout = 50Hz / 60Hz
- Iout = 1.1 A / 1.06A

Max conversion efficiency 94.1%

**The topology**

- Vin
- L6390 + PM8834
- STPS1545C
- STB18N65M5
- STPSC606
- Vin
- MOSFETs drivers
- STPS1545C
- STB18N65M5
- STPSC606
- 32-bit MCU
- STM32F
- Vout
- L6390 + PM8834
- STB18N65M5
- MOSFETs drivers

- HIGH FREQUENCY LEG
- MIXED FREQUENCY INVERTER
- LOW FREQUENCY LEG

### Microinverter Efficiency

![Efficiency Graph](image_url)

- Output Power [W]
- Efficiency [%]
- Efficiency [%]
- Efficiency [%]
**250 W microinverter: MPPT algorithm**

**STM32F and MPPT**

- **STM32F** (Microcontroller)
  - A/D converter
  - Duty cycle calculation
- **Previous Power and Input voltage value register**
- **MPPT controller**

**The MPPT “Perturb and Observe” algorithm**

- Sense $V(k)$, $I(k)$
- $P(k) = V(k) \times I(k)$
- $P(k) > P(k-1)$
- $V(k) > V(k-1)$
- $V(k) < V(k-1)$
- 
- **Conditions**:
  - **DC**: Duty cycle value
  - **C**: Duty cycle step value
  - **V(k)**: input voltage
  - **P(k)**: Power

- **Flowchart**:
  - NO: $P(k) > P(k-1)$
  - YES: $V(k) > V(k-1)$
  - NO: $V(k) < V(k-1)$
  - YES: DC = DC - C
  - NO: DC = DC + C
  - YES: DC = DC - C
  - NO: DC = DC + C
  - YES: DC = DC - C

- MPPT is reached following PV panel curve

**Additional Text**

- Previous Power and Input voltage value register
- DC: Duty cycle value
- C: Duty cycle step value
- V(k): input voltage
- P(k): Power

- The MPPT “Perturb and Observe” algorithm
250 W microinverter: grid connection

The PARK transformation

FROM

$V_\alpha$ and $V_\beta$
(grid voltage and 90° phase shifted voltage on stationary frame)

TO

$V_d$ and $V_q$
(two voltage components on rotating DQ reference frame)

The DQ-Phase Locked Loop (PLL) structure

$V_d$ is controlled to zero with a PI regulator → **GRID ANGLE $\theta_e$ KNOWN**

- **ADVANTAGES of DQ-PLL**
  - $V_d$, $V_q$, $I_d$, $I_q$ are constants in DQ reference frame: *standard PI regulators for their control ensure zero steady state error*
  - Decoupled control of active P and reactive Q power
250 W microinverter: smart communication

Local monitoring & control

Remote monitoring & control

Communication section

AC bus

Microinverter

Data concentrator

To the AC Grid

Power Line Communication

ST75xx: STarGRID power line networking SoC
the most integrated and flexible solution for smart grid applications and smart metering

Wireless Communication

- STM32W RF MCUs (ZigBee®)
- SPZB32W ZigBee® modules
- Bluetooth® modules

Enabling onsite or remote monitoring of PV system