

- ◆ Synchronous, Bootstrap Nch-Nch Drive
- ◆ Input Voltage Range : 2.5V ~ 25.0V
- ◆ Switching Frequency : 300kHz (±15%)
- ◆ PWM/PFM Manual Switching Control
- ◆ Overcurrent Protection Circuit Built-In
- ◆ High Efficiency : 93% (TYP.)
- ◆ TSSOP-16 Package
- ◆ Ceramic Capacitor Compatible

■ GENERAL DESCRIPTION

XC9213 series is Nch-Nch drive, synchronous, step-down DC/DC controller ICs with a built-in bootstrap driver circuit. Output will be stable no matter which load capacitors, including a low ESR capacitor, are used.

Resistance (RSENSE) of about 100mΩ will be required as a current sense. The phase compensation is also run when a low ESR capacitor is used. In addition, the circuit is double protected by the ways of limiting the current while detecting overshoot current and making output shutdown at any given timing by a protection time setting capacitor (CPRO).

The output voltage can be set freely within a range of 1.5V~15.0V with 1.0V (accuracy ±1.5%) of internal reference voltage by using externally connected resistors (RFB1, 2). Synchronous rectification PWM control can be switched to non-synchronous 30mV current limit PFM/PWM automatic switchable control (= voltage between RSENSE pins) by using the MODE pin.

The series has a built-in voltage detector for monitoring a selected voltage by external resistors.

During stand-by (CE pin = low) all circuits are shutdown to reduce current consumption to as low as 3.0μA or less.

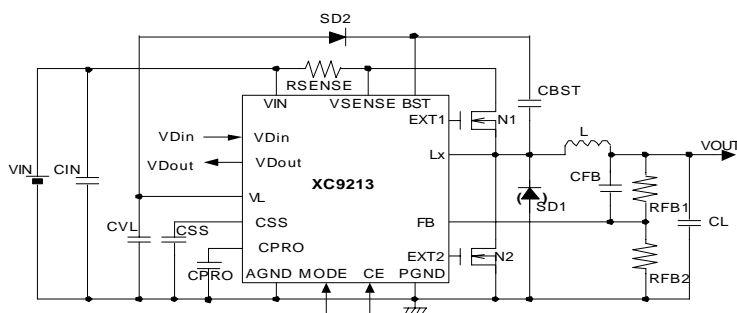
■ APPLICATIONS

- PDAs
- Mobile Phones
- Note book computers
- Portable Audio Systems
- Various Multi-function Power Supplies

■ FEATURES

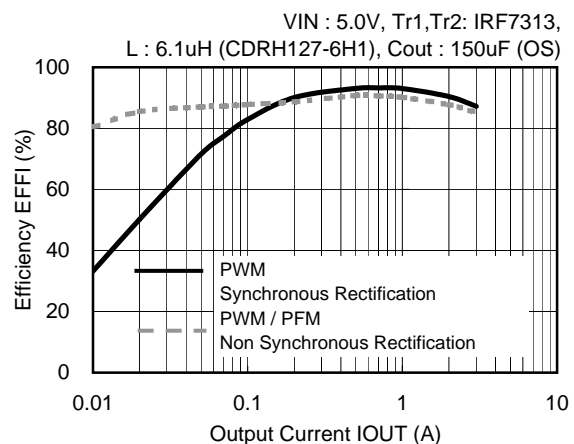
| | |
|-----------------------------|--|
| Input Voltage Range | : 2.5V ~ 25.0V |
| Output Voltage Range | : 1.5V ~ 15.0V externally set Reference voltage : 1.0V (±1.5%) |
| Oscillation Frequency | : 300kHz (±15%) |
| Output Current | : More than 5A (VIN=5.0V, VOUT=3.3V) |
| Control | : PWM/PFM manual-switching control. |
| Current Limiter, Protection | : Current limit operates at voltage sense 150mV. Shutdown time can be adjusted by CPRO. |
| High Efficiency | : 93% (TYP., PWM mode @ VIN=5.0V, VOUT = 3.3V, 1A) |
| Detect Voltage Function | : Detects 0.9V / Open-drain output |
| Stand-by Current | : ISTB = 3.0μA (MAX.) |
| Load Capacitor | : Low ESR (ceramic, etc.) capacitor compatible |
| Package | : TSSOP-16 |

■ TYPICAL APPLICATION CIRCUIT

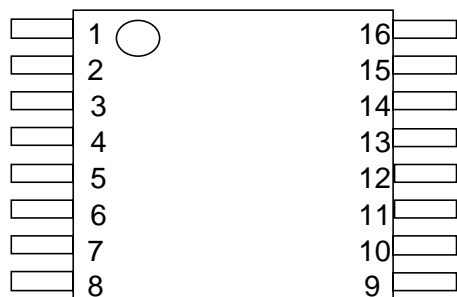


■ TYPICAL PERFORMANCE CHARACTERISTICS

XC9213B103V (FOSC:300kHz,3.0V)



PIN CONFIGURATION



TSSOP-16
(TOP VIEW)

PIN ASSIGNMENT

| PIN NUMBER | PIN NAME | FUNCTION |
|------------|----------|--|
| 1 | VIN | Input Voltage |
| 2 | VSENSE | Current Detection |
| 3 | VL | Local Power Supply |
| 4 | CE | Chip Enable |
| 5 | AGND | Analog Ground |
| 6 | MODE | PWM / PFM Switch |
| 7 | CPRO | Protection Time Setting Capacitor Connection <Set shutdown time of VOUT when detecting overcurrent> |
| 8 | CSS | Soft-start Capacitor Connection <Set soft-start time> |
| 9 | VDIN | Voltage Detector Input (0.9V) |
| 10 | FB | Output Voltage Setting Resistor Connection < Set output voltage freely by split resistors > |
| 11 | VDOUT | Voltage Detector Output (Open-Drain) |
| 12 | PGND | Power Ground |
| 13 | EXT2 | Low Side Nch Driver Transistor <Connect to Gate of Low Side Nch MOSFET > |
| 14 | LX | Coil Connection |
| 15 | EXT1 | High Side Nch Driver Transistor <Connect to Gate of High Side Nch MOSFET > |
| 16 | BST | Bootstrap |

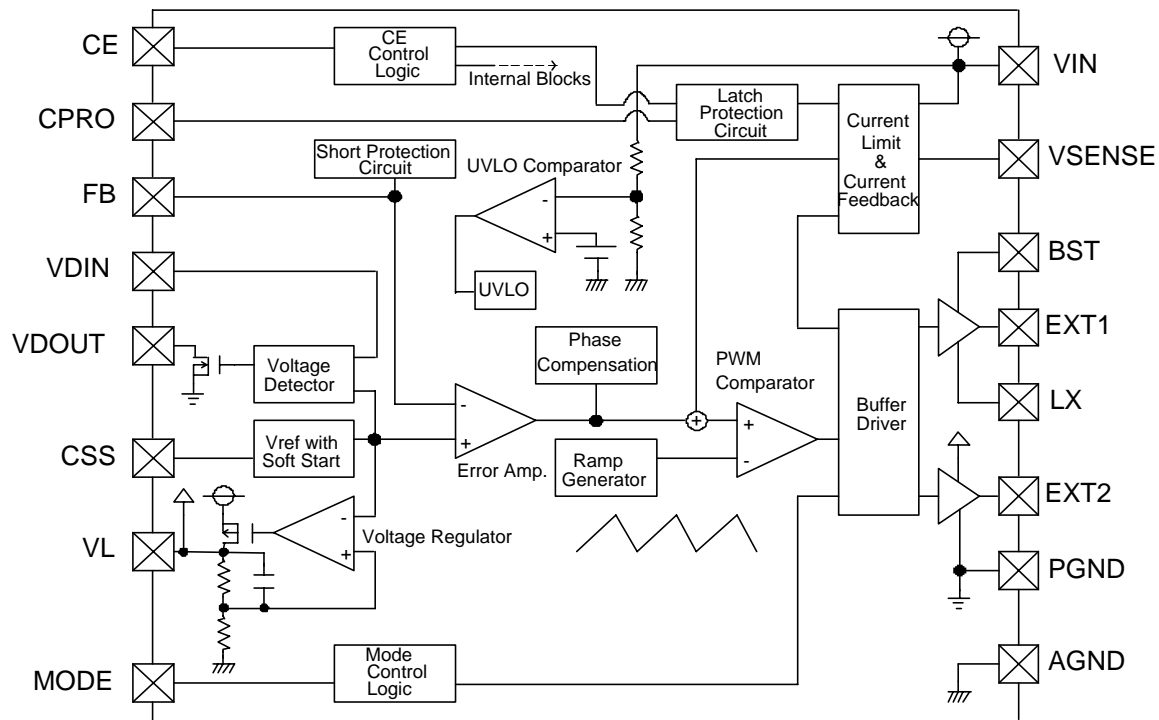
SELECTION GUIDE

ORDERING INFORMATION

XC9213B ① ② ③ ④ ⑤

| SYMBOL | PART NO. | DESCRIPTION |
|--------|----------|---|
| ①, ② | 10 | Reference Voltage Fixed |
| ③ | 3 | Oscillation Frequency : 300kHz |
| ④ | V | Package Types : TSSOP-16 |
| ⑤ | R | Device Orientation : Embossed Tape, Standard Feed |
| | L | Device Orientation : Embossed Tape, Reverse Feed |

■ BLOCK DIAGRAM



■ ABSOLUTE MAXIMUM RATINGS

| PARAMETER | SYMBOL | RATINGS | UNITS |
|---------------------------------|--------|--------------|-------|
| VIN pin voltage | VIN | - 0.3 ~ 30.0 | V |
| VSENSE pin voltage | VSENSE | - 0.3 ~ 30.0 | V |
| VL pin voltage | VL | - 0.3 ~ 6.0 | V |
| CE pin voltage | CE | - 0.3 ~ 30.0 | V |
| MODE pin voltage | MODE | - 0.3 ~ 30.0 | V |
| CPRO pin voltage | CPRO | - 0.3 ~ 6.0 | V |
| CSS pin voltage | CSS | - 0.3 ~ 6.0 | V |
| VDIN pin voltage | VDIN | - 0.3 ~ 6.0 | V |
| FB pin voltage | FB | - 0.3 ~ 6.0 | V |
| VDOUT pin voltage | VDOUT | - 0.3 ~ 30.0 | V |
| EXT2 pin voltage | EXT2 | - 0.3 ~ 6.0 | V |
| Lx pin voltage | Lx | - 0.3 ~ 30.0 | V |
| EXT1 pin voltage | EXT1 | - 0.3 ~ 30.0 | V |
| BST pin voltage | BST | - 0.3 ~ 30.0 | V |
| Power Dissipation | Pd | 350 | mW |
| Operational Ambient Temperature | Topr | - 40 ~ + 85 | °C |
| Storage Temperature | Tstg | - 55 ~ + 125 | °C |

ELECTRICAL CHARACTERISTICS

XC9213B103

(FOSC = 300kHz)

Ta=25°C

| PARAMETER | SYMBOL | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|------------------------------|---------|---|------|------|------|------|
| Input Voltage | VIN | | 2.5 | - | 25.0 | V |
| Output Voltage Setting Range | VOUTSET | | 1.5 | - | 15.0 | V |
| FB Control Voltage | VFB | | - | 1.0 | - | V |
| UVLO Voltage | UVLO | Voltage which EXT1 pin starts oscillation | - | 1.5 | - | V |
| Supply Current 1 | IDD1 | No external components, CE=VIN, FB=0.9V | - | 550 | - | μA |
| Supply Current 2 | IDD2 | No external components, CE=VIN, FB=1.1V | - | 450 | - | μA |
| Stand-by Current | ISTB | No external components, CE=FB=0V | - | - | 3.0 | μA |
| Oscillation Frequency | FOSC | Same as IDD1 | 255 | 300 | 345 | kHz |
| Max. Duty Ratio 1 | MAXDTY1 | Same as IDD1 | - | 95 | - | % |
| Max. Duty Ratio 2 | MAXDTY2 | Same as IDD2 | - | 98 | - | % |
| PFM Duty Ratio | PFMDTY | MODE=0V, IOUT=1mA, No RSENSE | - | 2 | - | μS |
| SENSE Voltage | VSENSE | | - | 150 | - | mV |
| CPRO time | TPRO | CPRO=100pF | - | 100 | - | μS |
| Soft-Start Time | TSS | CSS=100pF, VOUT x 0.95, CE=0V ⇒ 3V | - | 300 | - | μS |
| Efficiency | EFFI | IOUT=1A | - | 93 | - | % |
| CE "H" Voltage | VCEH | No external components, FB=0V, Voltage which EXT pin starts oscillation | 1.4 | - | - | V |
| CE "L" Voltage | VCEL | No external components, FB=0V, Voltage which EXT pin voltage holding "L" level | | - | 0.5 | V |
| MODE "H" Voltage | VPWMH | No load | 1.4 | - | - | V |
| MODE "L" Voltage | VPWML | No load | - | - | 0.5 | V |
| EXT1 "H" Resistance | REXT1H | FB=0.9V, EXT1=3.6V | - | 18 | - | Ω |
| EXT1 "L" ON Resistance | REXT1L | FB=1.1V, EXT2=0.4V | - | 10 | - | Ω |
| EXT2 "H" ON Resistance | REXT2H | FB=1.1V, EXT1=3.6V | - | 18 | - | Ω |
| EXT2 "L" ON Resistance | REXT2L | FB=0.9V, EXT2=0.4V | - | 3 | - | Ω |
| CE "H" Current | ICEH | CE=5.0V | - | - | 0.1 | μA |
| CE "L" Current | ICEL | CE=0V | - | - | -0.1 | μA |
| MODE "H" Current | IMODEH | MODE=5.0V | - | - | 0.1 | μA |
| MODE "L" Current | IMODEL | MODE=0V | - | - | -0.1 | μA |
| CSS "H" Current | ICSSH | CSS=3.8V | - | -0.7 | - | μA |
| CSS "L" Current | ICSSL | CSS=0V | - | -2.0 | - | μA |
| FB "H" Current | IFBH | FB=5.0V | - | - | 0.1 | μA |
| FB "L" Current | IFBL | FB=1.1V | - | - | -0.1 | μA |

○ Regulator

| PARAMETER | SYMBOL | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|-----------------|------------------------|--------------------------------------|------|------|------|------|
| Output Voltage | VLOUT | IOUT=10mA | - | 4.0 | - | V |
| Load Stability | Δ VOUT | 1mA≤IOUT≤30mA | - | 100 | - | mV |
| Input Stability | Δ VOUT Δ VIN x VOUT | IOUT=10mA VOUTVL + 1.0V≤VIN≤25.0V | - | 0.2 | - | %/V |

○ Detector

| PARAMETER | SYMBOL | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|-------------------|---------|----------------------|------|------|------|------|
| Detect Voltage | VDF | | - | 0.9 | - | V |
| Hysteresis Range | VHYS | | - | 6 | - | % |
| VD Input Current | VDIOUT | VDOUT=0.5V | - | 15 | - | mV |
| Delay Time | tDLY | VDR ⇒ VOUT inversion | - | - | 0.1 | mS |
| VDIN "H" Current | IVDINH | VDIN=5.0V | - | - | 0.1 | μA |
| VDIN "L" Current | IVDINL | VDIN=0V | - | - | -0.1 | μA |
| VDOUT "H" Current | IVDOUTH | VDOUT=5.0V | - | - | -0.1 | μA |
| VDOUT "L" Current | IVDOUTL | VDOUT=0V | - | - | -0.1 | μA |

Test conditions : Unless otherwise stated, VOUT = 3.0V, VIN = 5.0V, CE = 5.0V, MODE = 5.0V

Test circuits :

| | | | |
|---------|--------------------------------|----------|-------|
| Tr 1 : | 2SK2857 (NEC) | CFB : | 68pF |
| Tr 2 : | 2SK2857 (NEC) | RSENSE : | 0Ω |
| CL : | 22μF (OS-CON) | CPRO : | 0F |
| CIN : | 22μF (OS-CON) | CSS : | 100pF |
| SD 1 : | CRS02 (Schottky barrier diode) | CVL : | 1μF |
| RFB 1 : | 200kΩ | CBST : | 0.1μF |
| RFB 2 : | 110kΩ | | |

■ EXTERNAL COMPONENTS

<Setting of Output Voltage>

Output voltage can be set by adding external split resistors. Output voltage is determined by the following equation, based on the values of RFB1 and RFB2. The sum of RFB1 and RFB2 should normally be 2 MΩ or less.

$$V_{OUT} = R_{FB1} / R_{FB2} + 1$$

The value of CFB1, speed-up capacitor for phase compensation, should be $f_{zfb} = 1 / (2 \times \pi \times C_{FB} \times R_{FB1})$ which is equal to 10kHz. Adjustments are required from 1kHz to 50kHz depending on the application, value of inductance (L), and value of load capacity (CL).

[Example of Equation]

$$V_{OUT} = 3.0V$$

$$R_{FB1} = 200k\Omega, R_{FB2} = 110k\Omega, C_{FB} = 68pF$$

$$V_{OUT} = 220k / 110k + 1 = 3.0V$$

$$f_{zfb} = 1 / (2 \times \pi \times 68p \times 220k) = 10.64kHz$$

<External Components>

Tr 1, Tr 2

○ IOUT = 2 ~ 3A

IRF7313 (Nch x 2) (IR, SO-8)

○ IOUT = ~10A

SUP70N03-09 (Vishay, TO-220AB)

SUB70N03-09 (Vishay, TO-263)

L: 6.8μF (CDH127-6H1, SUMIDA)

SD 1 : CMS02 (Schottky barrier diode, TOSHIBA)

SD 2 : CRS02 (Schottky barrier diode, TOSHIBA)

* Please select SD2 with low reverse current.

RSENSE : Current Limit Value = 150mV / RSENSE

ex.) When RSENSE = 30mΩ,

Current Limit = 150mV / 30mΩ = about 5A

CPRO : TPRO = CPRO x 1e6

ex.) When CPRO = 100pF

TPRO = 100e -12 x 1e6 = 100μS

CSS= TSS = CSS x 3e6

ex.) When CSS = 3300pF,

TPRO = 3300e - 12 x 3e6 = 9.9mS

CBST : 0.1μF ~ 1μF

* Please adjust according to

reverse current characteristics of SD2.

CVL : 1μF

CIN : 22μF

CL : 150μF

(OS-CON, SANYO)

(OS-CON, SANYO)