



HIGH PRECISION PRECISION LOW POWER SWITCH

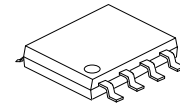
■ DESCRIPTION

USRB04 is a high performance, high precision and low cost PWM Power switch for non-isolated buck and buck-boost application. It combines a dedicated current mode PWM controller with a high voltage power Bipolar in SOP8 package. Its built-in error amplifier is optimized for good overshoot and dynamic response for low cost and component count. With precise inner resistor divider, precise reference of EA, constant voltage regulation of 5.0V at universal AC input can be guaranteed. Frequency reduction and burst mode control is implemented for high efficiency at light load. Good EMI performance is achieved with On-Bright proprietary frequency shuffling technique and soft base driver design. Low startup current and low operating current contribute to a reliable power on startup and low standby power consumption with USRB04. Constant power operation is supported at over load application with USRB04, which makes it suitable for small home appliance application where instant large power consumption is required such as start-up of a fan.

USRB04 offers power on soft start control and protection coverage with auto-recovery features including cycle-by-cycle current limiting, output short circuit protection, FB pin open loop protection, on-chip Over Temperature Protection (OTP), VDD Over Voltage Protection (OVP) and V_{DD} Under Voltage Lockout Protection (UVLO). The tone energy at below 20KHz is minimized in the design so that audio noise is eliminated during operation.

■ FEATURES

- * Universal AC input range and 5.0V output voltage
- * Constant power mode operation at over load application
- * Low cost and less BOM for buck and buck-boost applications
- * 40kHz (typical) maximum switching frequency
- * Frequency shuffling for EMI improvement
- * Power on soft-start
- * Built-in Leading Edge Blanking(LEB)
- * Cycle-by-cycle current limiting
- * FB pin open loop protection
- * Output short-circuit protection
- * V_{DD} Under Voltage Lockout with Hysteresis
- * V_{DD} OVP
- * On-Chip OTP
- * LED Lighting System



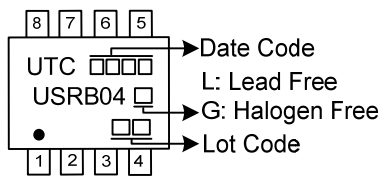
SOP-8

■ ORDERING INFORMATION

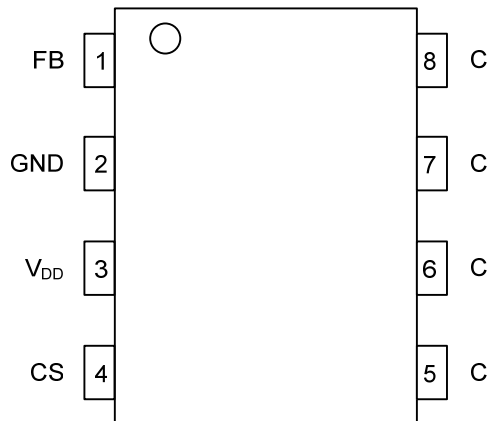
| Ordering Number | | Package | Packing |
|-----------------|---------------|---------|-----------|
| Lead Free | Halogen Free | | |
| USRB04L-S08-R | USRB04G-S08-R | SOP-8 | Tape Reel |

| | |
|--|---|
| <p>USRB04G-S08-R</p> <ul style="list-style-type: none"> (1) Packing Type (2) Package Type (3) Green Package | <ul style="list-style-type: none"> (1) R: Tape Reel (2) S08: SOP-8 (3) G: Halogen Free and Lead Free, L: Lead Free |
|--|---|

■ MARKING



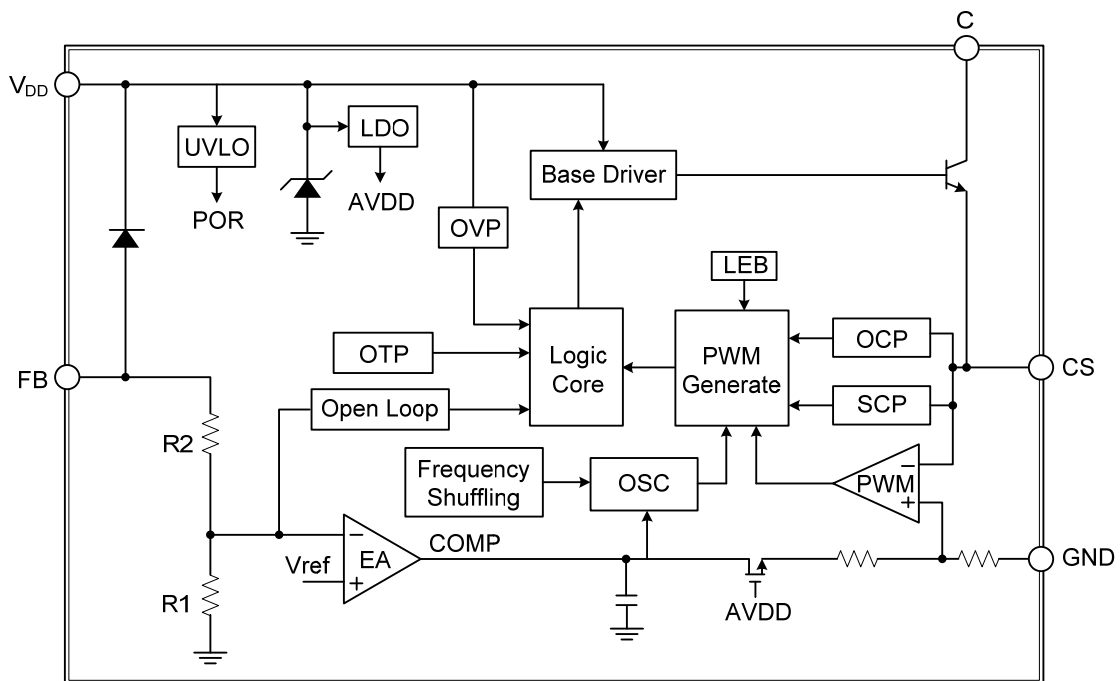
■ PIN CONFIGURATION



■ PIN DESCRIPTION

| PIN NO. | PIN NAME | DESCRIPTION |
|------------|-----------------|---|
| 1 | FB | Output Voltage Feedback. This pin should connect a capacitor to ground. |
| 2 | GND | Ground |
| 3 | V _{DD} | Power Supply |
| 4 | CS | Current sense input |
| 5, 6, 7, 8 | C | Power bipolar collector pins |

■ BLOCK DIAGRAM



■ ABSOLUTE MAXIMUM RATINGS

| PARAMETER | SYMBOL | RATINGS | UNIT |
|--|------------------|------------|------|
| V _{DD} Voltage | V _{DD} | -0.3 ~ 20 | V |
| C-B Voltage | V _{C-B} | 700 | V |
| CS Input Voltage | V _{CS} | -0.3 ~ 7 | V |
| FB Voltage | V _{FB} | -0.3 ~ 20 | V |
| Operating Ambient Temperature | T _A | -40 ~ +85 | °C |
| Min/Max Operating Junction Temperature | T _J | -40 ~ +150 | °C |
| Min/Max Storage Temperature | T _{STG} | -55 ~ +150 | °C |

Note: Absolute maximum ratings are those values beyond which the device could be permanently damaged. Absolute maximum ratings are stress ratings only and functional device operation is not implied.

■ ELECTRICAL CHARACTERISTICS (V_{CC}=6V, T_A = 25°C, unless otherwise specified)

| PARAMETER | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|------------------------|---|------|-------|------|------|
| Supply Voltage(V_{DD}) Section | | | | | | |
| Start up Current | I _{STARTUP} | V _{DD} =UVLO_OFF-1V | | | 10 | uA |
| Operation current | I _{VDD_OP} | CS=0.5V | | 1.5 | 2 | mA |
| | | FB=6V | | 0.4 | | mA |
| V _{DD} Under Voltage Lockout Enter | U _{VLO(ON)} | | 3 | 3.7 | 3.9 | V |
| V _{DD} Under Voltage Lockout Exit | U _{VLO(OFF)} | | 10.5 | 11.5 | 12.5 | V |
| V _{DD} Over Voltage Protection | V _{DD_OVP} | | 14 | 15 | 16 | V |
| FB Regulation Voltage | V _{FB} | | | 5.15 | | V |
| Current Sense Input Section | | | | | | |
| LEB Time | T _{LEB} | | 0.25 | 0.3 | 0.35 | us |
| Over Current Threshold | V _{TH_OCP} | | 550 | 575 | 600 | mV |
| Short Current Protection Threshold Voltage | V _{TH_SCP} | | 0.6 | 0.7 | 0.8 | V |
| CS floating Protection Threshold Voltage | V _{TH_FLT} | | 0.9 | 1 | 1.1 | V |
| OCP Propagation Delay | t _{D_OC} | | | 50 | 100 | ns |
| EA Section | | | | | | |
| Reference Voltage for Feedback Threshold | V _{REF_FB} | | 1.44 | 1.5 | 1.56 | V |
| FB divider coefficient | K _{FB/VREF} | | | 3.43 | | |
| Frequency Section | | | | | | |
| IC Maximum Frequency IC Maximum Frequency | F _{req_MAX} | | 36 | 40 | 44 | KHz |
| Frequency Shuffling Range | Δf/F _{req} | | | ±8 | | % |
| Shuffling Frequency | F _{Shuffling} | | | 78 | | Hz |
| Maximum Duty Cycle | D _{MAX} | | 7 | 11 | 15 | % |
| Burst Mode Switch Frequency | F _{Burst} | | | 20 | | KHz |
| Base Driver Section | | | | | | |
| Base Sourcing Maximum Current | I _{S_MAX} | | | 90 | | mA |
| Base Sourcing Maximum Current After Pre-off | I _{S_Preoff} | | | 3 | | mA |
| Protection Section | | | | | | |
| FB Pin Open Loop Detection Voltage | V _{TH_OLD} | | | 0.515 | | V |
| For Exiting Over Temperature protection | OTP | | | 125 | | °C |
| For Entering Over Temperature Protection | | | | 150 | | °C |
| Power BJT Section | | | | | | |
| Collector-Emitter Breakdown Voltage | V _{CEO} | I _C =10mA, I _B =0 | 450 | | | V |
| Collector-Base Breakdown Voltage | V _{CBO} | I _C =10mA | 700 | | | V |
| Collector Peak Current | I _C | | | 1 | | A |

■ OPERATION DESCRIPTION

USRB04 is a cost effective PWM power switch optimized for off-line non-isolated buck or buck-boost applications for small home appliances and linear regulator replacement. It operates in current mode and regulates output voltage with dedicated features. High integration can afford low cost and component count solution.

Startup Current and Start up Control

Startup current of **USRB04** is designed to be very low so that V_{DD} could be charged up above UVLO threshold and starts up quickly. A large value startup resistor can therefore be used to minimize the power loss in application.

Operating Current

The Operating current of **USRB04** is as low as 1.2mA (typical). Good efficiency is achieved with the low operation current together with 'Multi-mode' control features.

PWM operation

The maximum switching frequency of **USRB04** is internally fixed at 40KHz (typical). No external frequency setting components are required for PCB design simplification.

At light load or zero load condition, most of the power dissipation in a switching mode power supply is from switching loss on the BJT. The magnitude of power loss is in proportion to the switching frequency. Lower switching frequency leads to the reduction on the power loss and thus conserves the energy. The frequency reduction and burst mode operation are implemented to achieve high efficiency at light load. The minimum switching frequency is 20KHz (typical).

Frequency shuffling for EMI improvement

The frequency shuffling (switching frequency modulation) is implemented in **USRB04**. The oscillation frequency is modulated so that the tone energy is spread out. The spread spectrum minimizes the conduction band EMI and therefore eases the system design.

Soft Start

USRB04 features an internal 256 cycles (typical) soft start to soften the electrical stress occurring in the power supply during startup. It is activated during the power on sequence. After V_{DD} reaches UVLO(OFF), the switching frequency is gradually increased from 10KHz to 40 KHz. Every restart up is followed by a soft start.

Current Sensing and Leading Edge Blanking

Cycle-by-Cycle current limiting is offered in **USRB04** current mode PWM control. The switch current is detected by a sense resistor into the CS pin. An internal leading edge blanking circuit chops off the sensed voltage spike at initial internal BJT on state so that the external RC filtering on sense input is no longer needed. The PWM duty cycle is determined by the current sense input voltage and the EA output voltage.

Constant Power Operation Mode

Along with the increase of output current, the inductance current is up to the V_{THOC} threshold. With the increase in output current, output voltage declines with output power is kept in a about constant level. This is suitable for peak current application.

Base Driver

The driver is a push pull stage with supply voltage V_{DD} . It provides the driving current for the external power bipolar transistor. The sourcing current is limited to I_{S_MAX} (typical 90mA).

Protection Control

Good power supply system reliability is achieved with its rich protection features including cycle-by-cycle current limiting, output short circuit protection, FB pin open loop protection, on-chip Over Temperature Protection (OTP), V_{DD} Over Voltage Protection (OVP), and V_{DD} Under Voltage Lockout Protection (UVLO).

