

18V Operation 3.0A Synchronous Step-Down DC/DC Converters

Advance Information (Design Target)

■GENERAL DESCRIPTION

The XCA204 series is 18V bootstrap synchronous step-down DC/DC converter with built-in Nch-Nch driver transistors, the operating voltage range is 4.5V~18.0V, designed to allow the use of ceramic capacitors.

0.765V reference voltage source is incorporated in the IC, and the output voltage can be set to a value from 1.2V to 7.0V using external resistors (R_{FB1} , R_{FB2}).

Switching frequency is 690KHz. In PWM/PFM automatic switchover control, IC can change the control method between PWM and PFM based on the output current requirement and as a result IC can achieve high efficiency over the full load range. XCA204 has a fixed internal soft start time which is 1ms (TYP.), with the built-in UVLO function, the driver transistor is forced OFF when input voltage goes down to 4.0V (TYP.) or lower. Over current protection and thermal shutdown are embedded and they secure a safety operation.

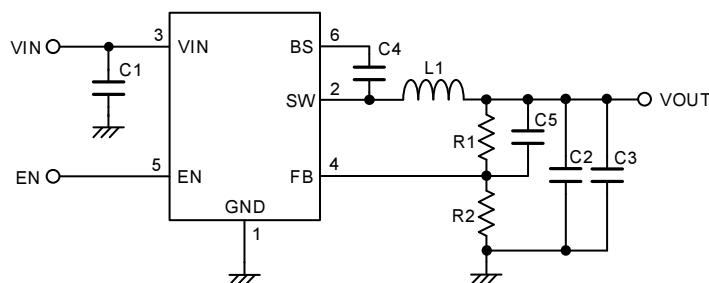
■APPLICATIONS

- Digital TV
- Set Top Box
- Security camera
- Smart meter
- Security system

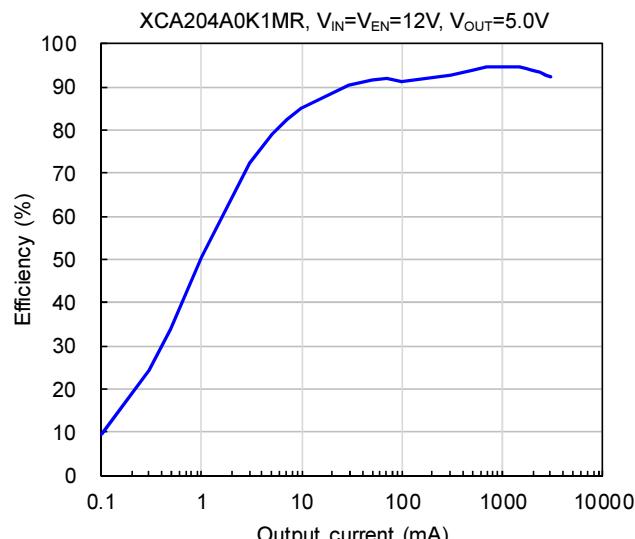
■FEATURES

Input Voltage Range	: 4.5V~18V(Absolute Max 20V)
Output Voltage Range	: 1.2V~7.0V or $V_{IN} \times 0.7$
FB Voltage	: 0.765V \pm 1.5%
Oscillation Frequency	: 690kHz
Output Current	: 3.0A
Control Method	: PWM/PFM Automatic
Soft-start Time	: 1ms
Protection Circuits	: UVLO Over Current Protection Thermal Shutdown
Low ESR Ceramic Capacitor	: Ceramic Capacitor
Package	: SOT23-6
Environmentally Friendly	: EU RoHS Compliant, Pb Free

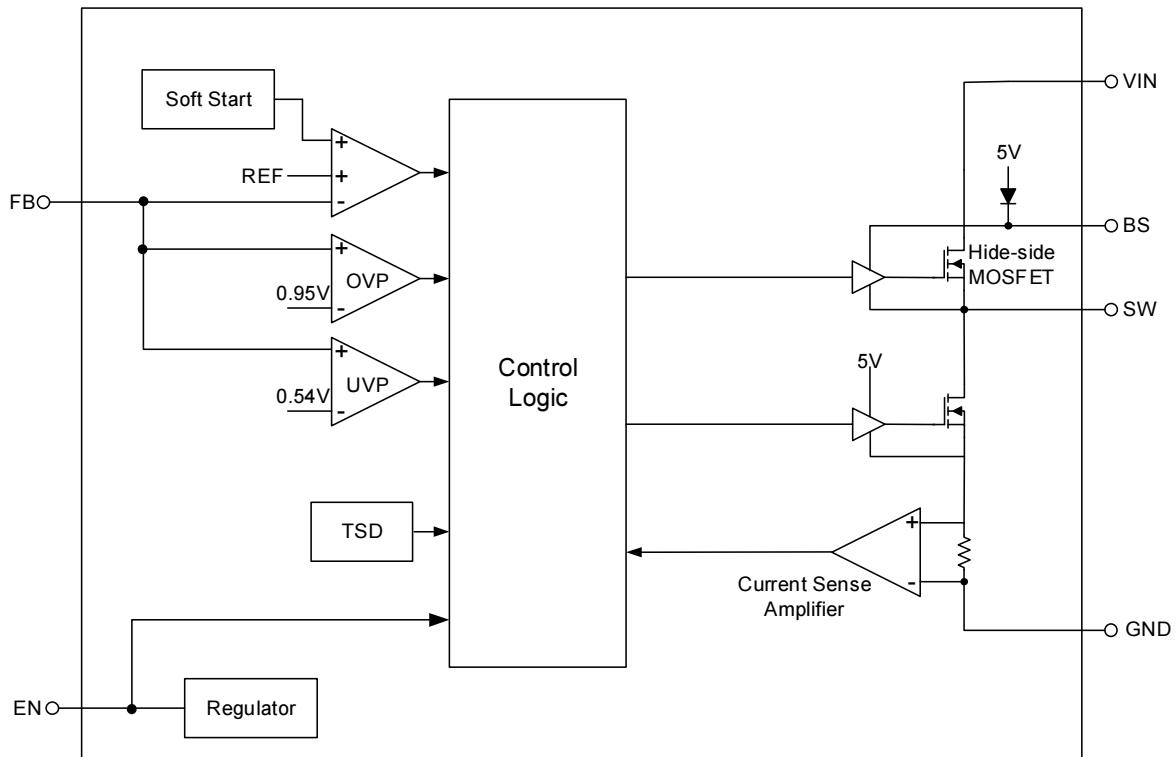
■TYPICAL APPLICATION CIRCUIT



■TYPICAL PERFORMANCE CHARACTERISTICS



■ BLOCK DIAGRAM



< XCA204A0K1MR BLOCK DIAGRAM >

■ PRODUCT CLASSIFICATION

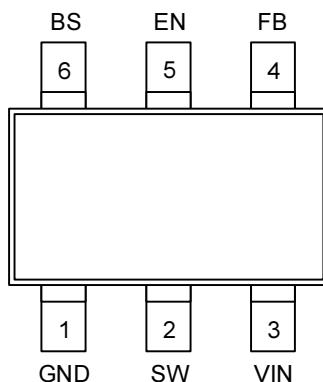
● Ordering Information

Product Name	Pakage Name	Order Unit	Shipment
XCA204A0K1MR	SOT23-6	3,000 pcs/Reel	Tape & Reel

● Selection Guide

TYPE	Chip Enable	Over Voltage Protection	Thermal Shutdown	Soft Start	UVLO	Current Limitter
A	YES	YES	YES	YES	YES	YES

■PIN CONFIGURATION



SOT23-6 (TOP VIEW)

■PIN ASSIGNMENT

PIN NUMBER	PIN NAME	FUNCTION
1	GND	Ground. This pin is the voltage reference for the regulated output voltage. For this reason care must be taken in its layout.
2	SW	Switch Output. Connect this pin to the switching end of the inductor.
3	VIN	Power Supply Input. Drive 4.5V to 18V voltage to this pin to power on this chip. Connecting a 10uF~22uF ceramic bypass capacitor between VIN and GND to eliminate noise.
4	FB	Feedback. An external resistor divider from the output to GND, tapped to the FB pin sets the output voltage.
5	EN	On/Off Control Input. Pull EN above 1.5V to turn the device on.
6	BS	Bootstrap. A 100nF capacitor is connected between SW and BS pins to drive the power switch's gate above the supply voltage.

■FUNCTION CHART

PIN NAME	SIGNAL	STATUS
EN	L	Stand-by
	H	Active
	OPEN	Undefined State ^(*1)

(*1) Please do not leave the EN pin open. Each should have a certain voltage

■ ABSOLUTE MAXIMUM RATINGS^{(*)1}

T_a=25°C

PARAMETER	SYMBOL	RATINGS	UNITS
Input Supply Voltage Pin	V _{IN}	-0.3 ~ +20	V
EN Voltage Pin	V _{EN}	-0.3 ~ +20	V
SW Voltage Pin	V _{SW}	-2.0 ~ +20	V
Boost Voltage Pin	V _{BS}	(V _{SW} - 0.3) ~ (V _{SW} + 6)	V
FB Voltage Pin	V _{FB}	-0.3 ~ +6	V
Maximum Junction Temperature	T _j	150	°C
Thermal resistance(Junction-Air)	θ _{JA}	88	°C/W
Thermal resistance(Junction-Case)	θ _{JC}	45	°C/W
Operating Ambient Temperature	T _{opr}	-40 ~ +85	°C
Storage Temperature	T _{stg}	-40 ~ +150	°C

(*)1) Stresses exceed those ratings may damage the device.

■ ELECTRICAL CHARACTERISTICS

XCA204A0K1MR

T_a=25°C

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Input Voltage Range	V _{IN}	V _{FB} =0.739V→0.761V, V _{FB} Voltage when Lx pin oscillates	4.5		18	V
Supply Current (Quiescent)	I _Q	V _{EN} = V _{IN} , no switching		300		μA
Supply Current (Shutdown)	I _{STBY}	V _{EN} = 0V		3	10	μA
Feedback Voltage	V _{FB}			0.765		V
Feedback Current	I _{FB}	V _{FB} = 1V		0.1		μA
Switch-On High-Side Resistance ^{(*)1}	R _{DSH(ON)}			85		mΩ
Switch-On Low-Side Resistance ^{(*)1}	R _{DSL(ON)}			45		mΩ
Switch Leakage	I _{SW}	V _{EN} = 0V, V _{SW} = 0V			3	μA
Current Limit ^{(*)1}	I _{LIM}			4.3		A
Oscillator Frequency	f _{SW}	V _{OUT} = 5V@1A Load		690		kHz
Soft-start time	T _{SS}	V _{FB} = 0V to 0.8V		1		ms
Minimum On-Time ^{(*)1}	T _{ON}			150		ns
Minimum On-Time ^{(*)1}	T _{OFF}			280		ns
Under Voltage Lockout Threshold	V _{UVLOR}	V _{IN} Rising		4		V
Under Voltage Lockout Threshold Hysteresis	V _{UVLOH}			250		mV
EN Up Threshold Voltage	V _{ENH}			1.6		V
Thermal Shutdown ^{(*)1}	T _{TSD}			150		°C

Test Condition: Unless otherwise stated, V_{IN}=9V, V_{EN}=2V

(*)1): Design reference value.

■TYPICAL APPLICATION CIRCUIT

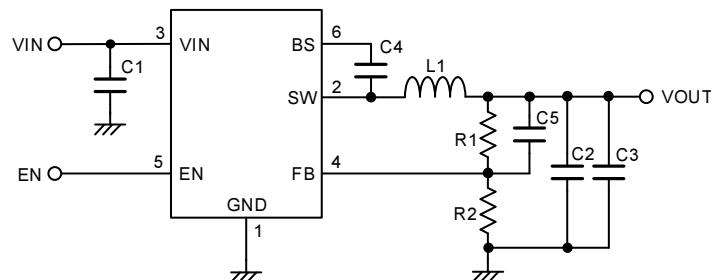


Figure.1 Typcal Application Circuit

【Table1 Recommended Component Selection】

VOUT	R1	R2	C5	L1	C1	C2	C3	C4
5.0V	54.9kΩ	10kΩ	15pF	4.7μH	10μF/25V Ceramic	22μF Ceramic	22μF Ceramic	100nF
3.3V	33.2kΩ	10kΩ	Optional	3.3μH	10μF/25V Ceramic	22μF Ceramic	22μF Ceramic	100nF
1.8V	13.7kΩ	10kΩ	Optional	2.2μH	10μF/25V Ceramic	22μF Ceramic	22μF Ceramic	100nF
1.0V	3.09kΩ	10kΩ	Optional	2.2μH	10μF/25V Ceramic	22μF Ceramic	22μF Ceramic	100nF

■ Function Description

The main control loop of XCA204 are adaptive on-time pulse width modulation (PWM) controller. The control mechanism combines adaptive on-time control with an internal compensation circuit for pseudo-fixed frequency and low external component count configuration with both low ESR and ceramic output capacitors. It is stable even with virtually no ripple at the output. At the beginning of each cycle, the high-side MOSFET is turned on. This MOSFET is turned off after internal one shot timer expires. This one shot duration is set proportional to the converter input voltage, VIN, and inversely proportional to the output voltage, VOUT, to maintain a pseudo-fixed frequency over the input voltage range, hence it is called adaptive on-time control. The one-shot timer is reset and the high-side MOSFET is turned on again when the feedback voltage falls below the reference voltage.

< Enable >

The XCA204 EN pin provides digital control to turn on/turn off the regulator. When the voltage of EN exceeds the threshold voltage, the regulator starts the soft start function. If the EN pin voltage is below than the shutdown threshold voltage, the regulator will be disable and into the shutdown mode.

< Output Over Voltage Protection >

When the FB pin voltage exceeds 25% of the regulation voltage, the output over voltage protection function will turn the high side MOSFET off.

< Input Under Voltage Lockout >

When the XCA204 power on, the internal circuits are held inactive until VIN exceeds the input UVLO threshold voltage. And the regulator will be disabled when VIN below the input UVLO threshold voltage. The hysteretic of the UVLO comparator is 250mV.

< Short Circuit Protection >

The XCA204 provides short circuit protection function to prevent the device damage from short condition. When the output short to ground, the oscillator frequency is reduced to prevent the inductor current increasing beyond the current limit. In the meantime, the current limit is also reduced to lower the short current. Once the short condition is removed, the frequency and current limit will return to normal.

< Over Temperature Protection >

The XCA204 incorporates an over temperature protection circuit to protect itself from overheating. When the junction temperature exceeds the thermal shutdown threshold temperature, the regulator will be shutdown.

■ Application Information

< Output Voltage Setting >

The external resistor divider is used to set the output voltage. XCA204 feedback resistors are unconcerned of compensation and provide an easy way to program output voltage. Table 1 shows a list of resistor selection for common output voltages:

$$V_{OUT} = 0.765 \times (1 + R_1/R_2) \text{ V}$$

< Selecting the Inductor >

A 4.7 μ H inductor with a DC current rating of at least 30% percent higher than the maximum load current is recommended for most applications. For highest efficiency, the inductor's DC resistance should be less than 50m Ω . For most designs, the required inductance value can be derived from the following equation:

$$\Delta I = 0.3 \times I_{L(MAX)}$$

$$L \geq \frac{V_{OUT}}{f_{SW} \cdot \Delta I} \cdot \left(1 - \frac{V_{OUT}}{V_{IN}} \right)$$

Where ΔI is the inductor ripple current.

Choose the inductor ripple current to be 30% of the maximum load current. The maximum inductor peak current is calculated from:

$$I_{L(MAX)} = I_{LOAD(MAX)} + \frac{\Delta I}{2}$$

Under light load conditions below 100mA, a larger inductance is recommended for improved efficiency.

< Selecting the Input Capacitor >

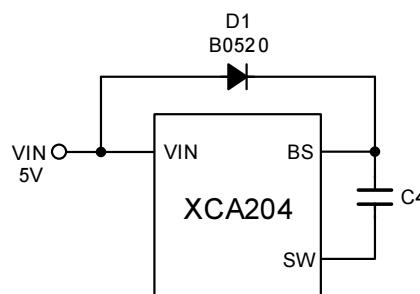
The input capacitor reduces the surge current drawn from the input supply and the switching noise from the device. The input capacitor impedance at the switching frequency should be less than the input source impedance to prevent high frequency switching current from passing through the input. Ceramic capacitors with X5R or X7R dielectrics are highly recommended because of their low ESR and small temperature coefficients. For most applications, a 10 μ F capacitor is sufficient.

< Selecting the Output Capacitor >

The output capacitor keeps the output voltage ripple small and one or two 22 μ F ceramic capacitor with X5R or X7R dielectrics is recommended for its low ESR characteristics.

< External Boost Diode Selection >

An external bootstrap diode is recommended if the input voltage is less than 5V or if there is a 5V system rail available. This diode helps improve the efficiency. Low cost diodes, such as B0520 are suitable for this application.



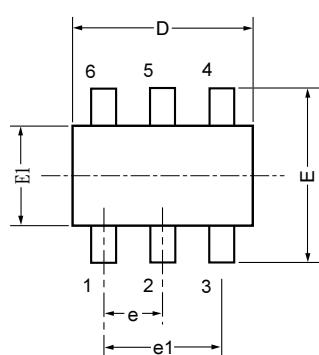
< PCB Layout Recommendation >

The device's performance and stability is dramatically affected by PCB layout. It is recommended to follow these general guidelines show bellow:

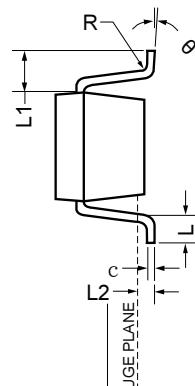
1. Place the input capacitors, output capacitors as close to the device as possible. Trace to these capacitors should be as short and wide as possible to minimize parasitic inductance and resistance.
2. CIN must be closes to Pins VIN and GND. The loop area formed by CIN and VIN/GND pins must be minimized.
3. Place feedback resistors close to the FB pin.
4. Place compensation components close to the COMP pin.
5. Keep the sensitive signal (FB) away from the switching signal (SW).
6. The exposed pad of the package should be soldered to an equivalent area of metal on the PCB. This area should connect to the GND plane and have multiple via connections to the back of the PCB as well as connections to intermediate PCB layers. The GND plane area connects to the exposed pad should be maximized to improve thermal performance.
7. Multi-layer PCB design is recommended.

■PACKAGING INFORMATION

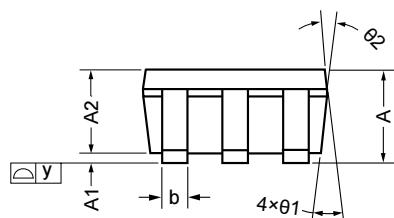
•SOT23-6 (unit:mm)



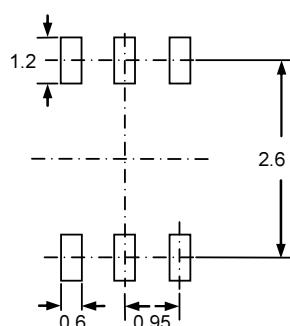
(TOP VIEW)



(FRONT VIEW)



(SIDE VIEW)

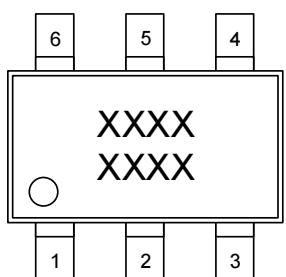


(PCB FOOTPRINT)

Unit:mm

SYMBOLS	Min	Typ	Max
A	1.05	-	1.35
A1	0.05	-	0.15
A2	1.00	1.10	1.20
b	0.30	-	0.50
c	0.08	-	0.20
D	2.80	2.90	3.00
E	2.60	2.80	3.00
E1	1.50	1.60	1.70
e	0.95 BSC		
e1	1.90 BSC		
L	0.35	0.45	0.55
L1	0.60 REF		
L2	0.25 BSC		
Y	-	-	0.10
R	0.10	-	-
Θ	0°	-	8°
Θ1	7° NOM		
Θ2	5° NOM		

■ MARKING RULE



XXXX: Denotes assembly Data Code & Lot No.

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