30V 2A 500KHz Synchronous Step-Down Regulator

Features

- Wide 4.5V to 30V Operating Input Range
- 2A Continuous Output Current
- 500KHz Switching Frequency
- Short Protection with Hiccup-Mode
- Built-in Over Current Limit
- Built-in Over Voltage Protection
- PFM Mode for High Efficiency in Light Load
- Internal Soft-Start
- 110m/70m2 Low RDSON Internal PowerMOSFETs
- Output Adjustable from 0.6V
- No Schottky Diode Required
- Integrated internal compensation
- Thermal Shutdown
- Available in SOT23-6 Package
- -40°C to +85°C Temperature Range

Applications

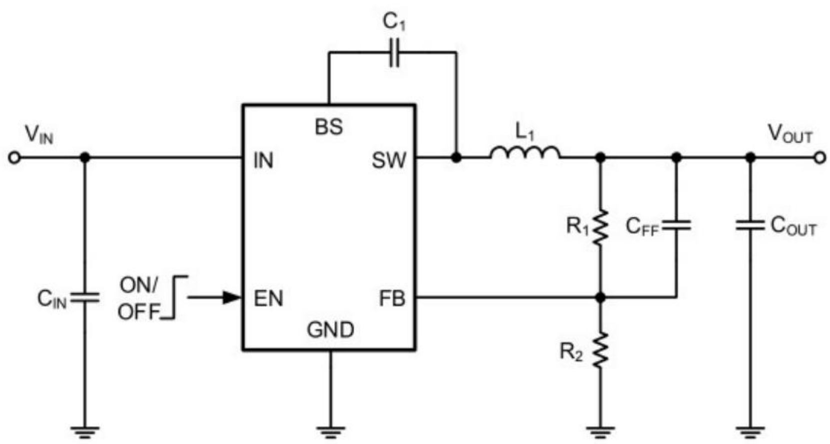
- Digital Set-top Box (STB)
- Tablet Personal Computer (Pad)
- Flat-Panel Television and Monitor
- Wi-Fi Router/AP
- Digital Video Recorder (DVR)
- Portable Media Player(PMP)
- Cable Modem /XDSL
- General Purposes

General Description

The CXM8320 is a high frequency, synchronous, rectified, step-down, switch-mode converter with internal power MOSFETs. It offers a very compact solution to provide a 2A continuous current over a wide input supply range,with excellent load and line regulation.

The CXM8320 requires a minimal number of readily available, cxternal components and is available in a space savingSOT23-6 package.

Typical Application Circuit

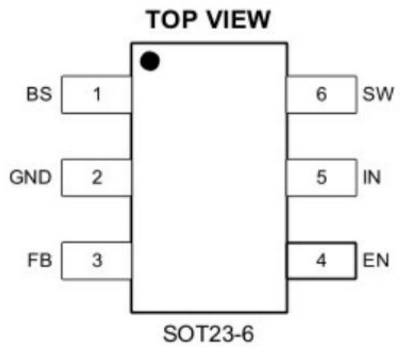


Basic Application Circuit

30V 2A 500KHz Synchronous Step-Down Regulator

Pin Description

Pin Configuration



Top Marking: GDYLL (device code: GD, Y=year code, LL= lot number code)

Pin Description

Pin	Name	Funetion
1	BS	Bootstrap. A capacitor connected between SW and BST pins is required to form afloating supply across the high-side switch driver.
2	GND	Ground Pin
3	FB	Adjustable Version Feedback input. Connect FB to the center point of the externalresistor divider
4	EN	Drive this pin to a logic-high to enable the IC. Drive to a logic-low to disable theIC and enter micro-power shutdown mode.
5	IN	Power Supply Pin
6	sw	Switching Pin

Order Information (1)

Marking	Part No.	Model	Description	Package	T/R Qty
GDYLL	70301510	CXM8320	CXM8320 Buck, 4. 5-30V, 2A. 00KHZ, VFB0. 6V. SOT23-6	SOT23-6	3000PCS

Note (1): All RYCHIP parts are Pb-Free and adhere to the RoHS directive.

30V 2A 500KHz Synchronous Step-Down Regulator

Specifications

Absolute Maximum Ratings (1)(2)

Item	Min	Max	Unit
Vin voltage	-0.3	32	V
EN voltage	-0.3	32	V
SW voltage	-0.3	ViN+0.5V	V
BS voltage	-0.3	Vsw+5V	V
FB voltage	-0.3	6	V
Power dissipation (3)	Internally Limited		
Operating junction temperature, Tj	-40	150	℃
Storage temperature, Tstg	-55	150	℃
Lead Temperature (Soldering, 10sec.)		260	℃

Note (1): Exceeding these ratings may damage the device.

Note (2): The device is not guaranteed to function outside of its operating conditions.

Note (3): The maximum allowable power dissipation is a function of the maximum junction temperature, TJAX)the junction-to-ambient thermal resistance, RoA, and the ambient temperature, TA. The maximum allowable powerdissipation at any ambient temperature is calculated using: PDMAX) = (TJMAX) - TA)/RA. Exceeding the maximumallowable power dissipation causes excessive die temperature, and the regulator goes into thermal shutdown.Internal thermal shutdown circuitry protects the device from permanent damage. Thermal shutdown engages atT=160°C (typical) and disengages at T= 130 °C(typical).

ESD Ratings

Item	Description	Value	Unit
V(ESD-HBM)	Human Body Model(HBM) ANSI/ESDA/JEDEC JS-001-2014 Classification,Class:2	±2000	V
V(ESD-CDM)	Charged Device Mode(CDM) ANSIESDA/JEDEC JS-002-2014 Classification,Class: C0b	±200	V
ILATCH-UP	JEDEC STANDARD NO.78E APRIL 2016 Temperature Classification, Class:I	±150	mA

Recommended Operating Conditions

Item	Min	Max	Unit
Operating junction temperature (1)	-40	125	℃
Operating temperature range	-40	85	℃
Input voltage ViN	4.5	30	V
Output current	0	2	A

Note (1): All limits specified at room temperature (TA = 25°C) unless otherwise specified. All room temperaturelimits are 100% production tested. All limits at temperature extremes are ensured through correlation using standard

30V 2A 500KHz Synchronous Step-Down Regulator

Statistical Quality Control (SOC) methods. All limits are used to calculate Average Outgoing Ouality Level(AOOL)

ThermalInformation

Item	Description	Value	Unit
RθJA	Junction-to-ambient thermal resistance (1)2)	105	℃/W
RθJC(top)	Junction-to-case (top) thermal resistance	55	℃/W
RθJB	Junction-to-board thermal resistance	17.5	℃/W
JT	Junction-to-top characterization parameter	3.5	℃/W
JB	Junction-to-board characterization parameter	17.5	℃/W

Note (1): The package thermal impedance is calculated in accordance to JESD 51-7.

Note (2): Thermal Resistances were simulated on a 4-layer, JEDEC board.

Electrical Characteristics (1)(2)

VIN=12V,TA=25˚C， unless otherwise specified.

Parameter	Test Conditions	Min	Typ.	Max	Unit
Input Voltage Range		4.5		30	V
Supply Current (Quiescent)	VEN=3.0V		0.6	0.8	mA
Supply Current(Shutdown)	VEN =0 or EN= GND			4	uA
Feedback Voltage		0.585	0.600	0.615	V
High-Side Switch On-Resistance	Isw=100mA		110		mΩ
Low-Side Switch On-Resistance	Isw=-100mA		70		mΩ
Upper Switch Current Limit		3			A
Over Voltage Protection Threshold			30.2		V
Switching Frequency			500		KHz
Maximum Duty Cycle	VFB=90%		93		%
Minimum On-Time			100		nS
EN Rising Threshold		1.4			V
EN Falling Threshold				0.8	V
Under-Voltage Lockout Threshold	Wake up Vin Voltage		3.9	4.0	V
	Shutdown Vin Voltage	3.2	3.4		V
	Hysteresis Vin voltage		400		mV
Soft Start			1		mS
Thermal Shutdown			160		℃
Thermal Hysteresis			30		℃

Note (1): MOSFET on-resistance specifications are guaranteed by correlation to wafer level measurements.

Note (2): Thermal shutdown specifications are guaranteed by correlation to the design and characteristics analysis.

30V 2A 500KHz Synchronous Step-Down Regulator

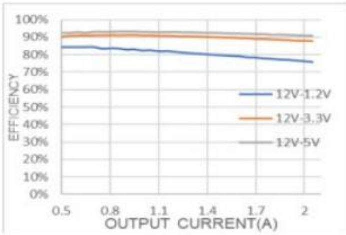
Typical Performance Characteristics (1) (2)

Note (1): Performance waveforms are tested on the evaluation board.

Note(2): Vn =12V,VouT=33V,TA =+2C,unless otherwise noted.

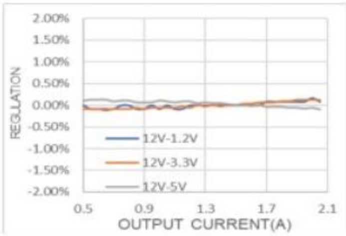
Efficiency vs Load Current

V_{OUT}=5V, 3.3V, 1.2V



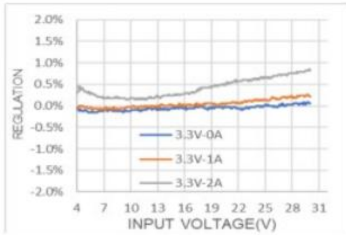
Load Regulation

V_{OUT}=5V, 3.3V, 1.2



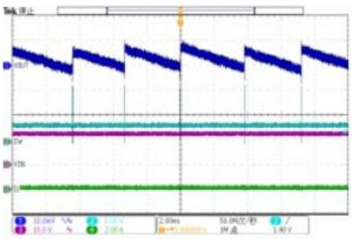
Line Regulation

V_{OUT}=3.3V



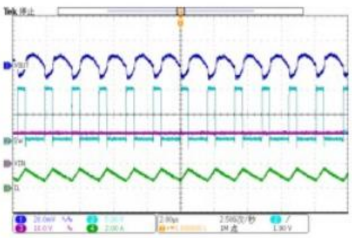
Output Ripple Voltage

V_{IN}=12V, V_{OUT}=3.3V, I_{OUT}=0A



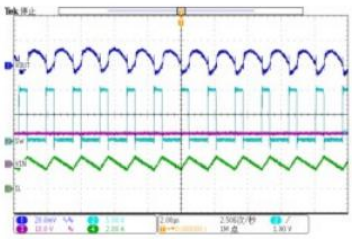
Output Ripple Voltage

V_{IN}=12V, V_{OUT}=3.3V, I_{OUT}=1A



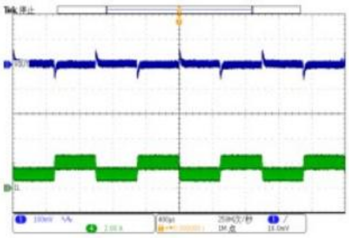
Output Ripple Voltage

V_{IN}=12V, V_{OUT}=3.3V, I_{OUT}=2A



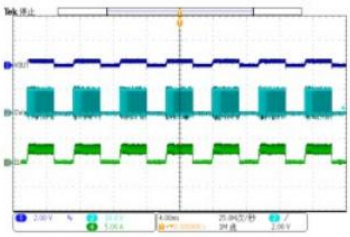
Loop Response

V_{IN}=12V, V_{OUT}=3.3V, I_{OUT}=1A-2A



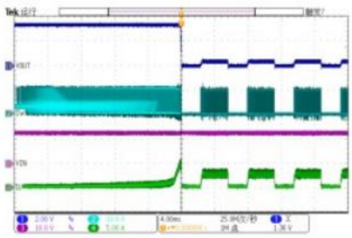
Output Short

V_{IN}=12V, V_{OUT}=3.3V



Short Circuit Entry

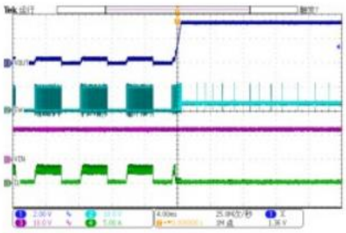
V_{IN}=12V, V_{OUT}=3.3V



30V 2A 500KHz Synchronous Step-Down Regulator

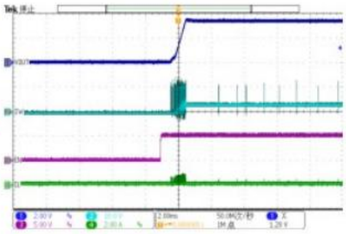
Short Circuit Recovery

V_{IN}=12V, V_{OUT}=3.3V



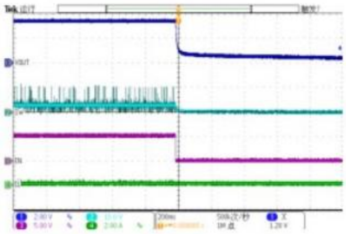
Enable Startup at No Load

V_{IN}=12V, V_{OUT}=3.3V, I_{OUT}=0A



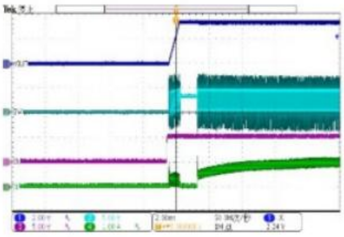
Enable Shutdown at No Load

V_{IN}=12V, V_{OUT}=3.3V, I_{OUT}=0A



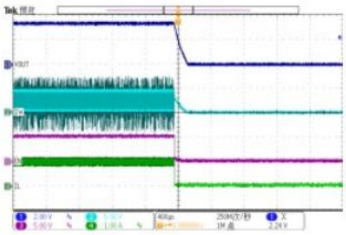
Enable Startup at Full Load

V_{IN}=12V, V_{OUT}=3.3V, I_{OUT}=2A



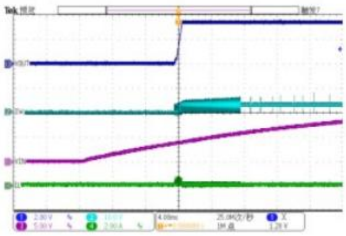
Enable Shutdown at Full Load

V_{IN}=12V, V_{OUT}=3.3V, I_{OUT}=2A



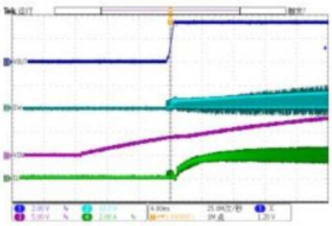
Power Up at No Load

V_{IN}=12V, V_{OUT}=3.3V, I_{OUT}=0A



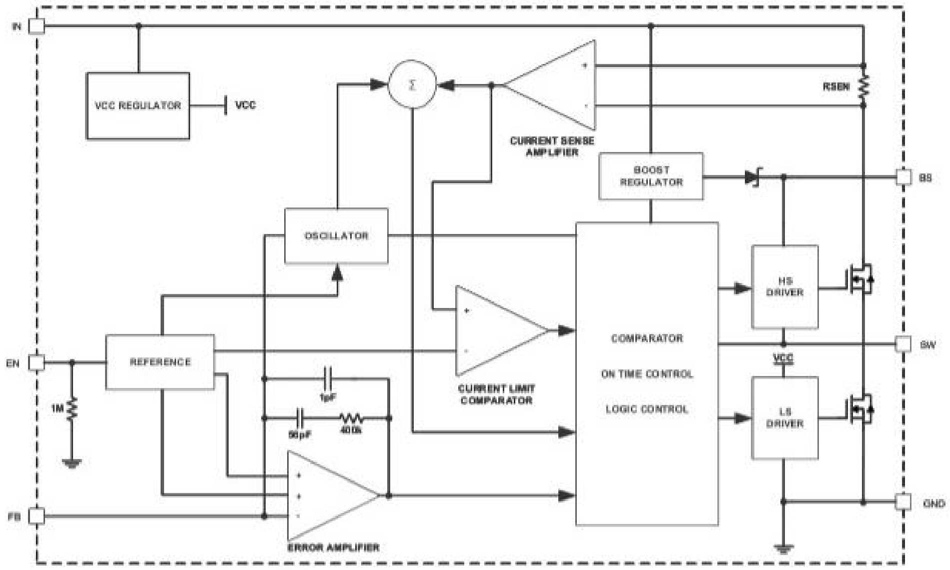
Power Up at Full Load

V_{IN}=12V, V_{OUT}=3.3V, I_{OUT}=2A



30V 2A 500KHz Synchronous Step-Down Regulator

Functional Block Diagram



Block Diagram

Functions Description

Internal Regulator

The CXM8320 is a current mode step down DC/DC converter that provides excellent transient response with no extraexternal compensation components. This device contains an internal, low resistance, high voltage power MOSFETand operates at a high 500KHz operating frequency to ensure a compact, high efficiency design with excellent ACand DC performance.

Error Amplifier

The error amplifier compares the FB pin voltage with the internal FB reference (VFB) and outputs a currentproportional to the difference between the two. This output current is then used to charge or discharge the internalcompensation network, which is used to control the power MOSFET current. The optimized internal compensationnetwork minimizes the external component counts and simplifies the control loop design.

Under-Voltage Lockout (UVLO)

Under-voltage lockout (UVLO) protects the chip from operating at an insuficient supply voltage. UVLO protectionmonitors the internal regulator voltage. When the voltage is lower than UVLO threshold voltage, the device is shutoff. When the voltage is higher than UVLO threshold voltage, the device is enabled again.

Thermal Shutdown

Thermal shutdown prevents the chip from operating at exceedingly high temperatures. When the silicon dietemperature exceeds 160°C, it shuts down the whole chip. When the temperature falls below its lower threshold(Typ. 130°C) the chip is enabled again.

30V 2A 500KHz Synchronous Step-Down Regulator

Internal Soft-Start

The soft-start is implemented to prevent the converter output voltage from overshooting during startup.When thechip starts, the internal circuitry generates a soft-start voltage (SS) ramping up from 0V to 0.6V. When it is lowerthan the internal reference (REF), SS overrides REF so the error amplifier uses SS as the reference. When SS ishigher than REF, REF regains control. The SS time is internally max to lms.

Over Current Protection and Hiccup

The CXM8320 has cycle-by-cycle over curent limit when the inductor current peak value exceeds the set currentlimit threshold. Meanwhile, output voltage starts to drop until FB is below the Under-Voltage (UV) threshold. Oncea UV is triggered, the RY8320 enters hiccup mode to periodically restart the part. This protection mode is especiallyuseful when the output is dead-short to ground. The average short circuit current is greatly reduced to alleviate thethermal issue and to protect the regulator, The RY8320 exits the hiccup mode once the over current condition isremoved.

Startup and Shutdown

If both Vi and EN are higher than their appropriate thresholds, the chip starts. The reference block starts first.generating stable reference voltage and currents, and then the internal regulator is enabled. The regulator providesstable supply for the remaining circuitries. Three events can shut down the chip: EN low, Viy low and thermalshutdown. In the shutdown procedure, the signaling path is first blocked to avoid any fault triggering. The compvoltage and the internal supply rail are then pulled down. The floating driver is not subject to this shutdowncommand.

30V 2A 500KHz Synchronous Step-Down Regulator

Applications Information

Setting the Output Voltage

CXM8320 require an input capacitor, an output capacitor and an inductor, These components are critical to theperformance of the device. RY8320 are internally compensated and do not require external components to achievestable operation. The output voltage can be programmed by resistor divider.

$$V_{OUT} = V_{FB} \times \frac{R1 + R2}{R2}$$

V_{OUT}(V)	R1(KΩ)	R2(KΩ)	L1(μH)	C1(nF)	C_{IN}(μF)	C_{OUT}(μF)	C_{FF} (pF) Opt.
1.0	6.67	10	2.2	100	22	22×2	C_{FF} Chapter
1.05	7.5	10	2.2	100	22	22×2	C_{FF} Chapter
1.2	10	10	2.2	100	22	22×2	C_{FF} Chapter
1.5	15	10	2.2	100	22	22×2	C_{FF} Chapter
1.8	20	10	3.3	100	22	22×2	C_{FF} Chapter
2.5	31.67	10	3.3	100	22	22×2	C_{FF} Chapter
3.3	45	10	4.7	100	22	22×2	C_{FF} Chapter
5.0	73.33	10	4.7	100	22	22×2	C_{FF} Chapter

All the external components are the suggested values, the final values are based on the application testing results.

Selecting the Inductor

The recommended inductor values are shown in the Application Diagram. It is important to guarantee the inductorcore does not saturate during any foreseeable operational situation. The inductor should be rated to handle themaximum inductor peak current: Care should be taken when reviewing the different saturation current ratings thatare specified by different manufacturers. Saturation current ratings are typically specified at 25° C, so ratings atmaximum ambient temperature of the application should be requested from the manufacturer. The inductor valuecan be calculated with:

$$L = \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{V_{IN} \times \Delta I_L \times F_{OSC}}$$

Where Al is the inductor ripple current. Choose inductor ripple current to be approximately 30% to 40% of themaximum load current. The maximum inductor peak current can be estimated as:

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

Under light load conditions below 100mA, larger inductance is recommended for improved efficiency. Largerinductances lead to smaller ripple currents and voltages, but they also have larger physical dimensions, lowersaturation currents and higher linear impedance. Therefore, the choice of inductance should be compromisedaccording to the specific application.

30V 2A 500KHz Synchronous Step-Down Regulator

Selecting the Input Capacitor

The input current to the step-down converter is discontinuous and therefore requires a capacitor to supply AC' currentto the step-down converter while maintaining the DC input voltage. For a better performance, use ceramic capacitorsplaced as close to VIN as possible and a 0lpF input capacitor to filter out high frequency interference isrecommended. Capacitors with X5R and X7R ceramic dielectrics are recommended because they are stable withtemperature fluctuations.

The capacitors must also have a ripple current rating greater than the maximum input ripple current of the converterThe input ripple current can be estimated with Equation:

$$I_{CIN} = I_{OUT} \times \sqrt{\frac{V_{OUT}}{V_{IN}} \times \left(1 - \frac{V_{OUT}}{V_{IN}}\right)}$$

From the above equation, it can be concluded that the input ripple current reaches its maximum at $V_{IN}=2V_{OUT}$ where $I_{CIN} = \frac{I_{OUT}}{2}$. For simplification, choose an input capacitor with an RMS current rating greater than half of the maximum load current.

The input capacitance value determines the input voltage ripple of the converter. If there is an input voltage ripple requirement in the system, choose the input capacitor that meets the specification. The input voltage ripple can be estimate with Equation:

$$\Delta V_{IN} = \frac{I_{OUT}}{F_{OSC} \times C_{IN}} \times \frac{V_{OUT}}{V_{IN}} \times \left(1 - \frac{V_{OUT}}{V_{IN}}\right)$$

Similarly, when $V_{IN}=2V_{OUT}$, input voltage ripple reaches its maximum of $\Delta V_{IN} = \frac{1}{4} \times \frac{I_{OUT}}{F_{OSC} \times C_{IN}}$.

Selecting the Output Capacitor

An output capacitor is required to maintain the DC output voltage. The output voltage ripple can be estimated withEquation:

$$\Delta V_{OUT} = \frac{V_{OUT}}{F_{OSC} \times L} \times \left(1 - \frac{V_{OUT}}{V_{IN}}\right) \times \left(R_{ESR} + \frac{1}{8 \times F_{OSC} \times C_{OUT}}\right)$$

There are some differences between different types of capacitors. In the case of ceramic capacitors, the impedanceat the switching frequency is dominated by the capacitance. The output voltage ripple is mainly caused by thecapacitance, For simplification, the output voltage ripple can be estimated with Equation:

$$\Delta V_{OUT} = \frac{V_{OUT}}{8 \times F_{OSC}{}^2 \times L \times C_{OUT}} \times \left(1 - \frac{V_{OUT}}{V_{IN}}\right)$$

A larger output capacitor can achieve a better load transient response, but the maximum output capacitor limitationshould also be considered in the design application. If the output capacitor value is too high, the output voltage willnot be able to reach the design value during the soft-start time and will fail to regulate. The maximum outputcapacitor value (COUT_MAx) can be limited approximately with Equation:

$$C_{OUT\_MAX} = (I_{LIM\_AVG} - I_{OUT}) \times T_{SS}/V_{OUT}$$

30V 2A 500KHz Synchronous Step-Down Regulator

Where LLIM Av is the average star-up current during the soft-start period, and Tss is the soft- start time.On the other hand, special attention should be paid when selecting these components. The DC bias of thesecapacitors can result in a capacitance value that falls below the minimum value given in the recommended capacitorspecifications tableThe ceramic capacitor's actual capacitance can vary with temperature. The capacitor type X7R, which operates overa temperature range of-55°C to +125°C, will only vary the capacitance to within +15%. The capacitor type X5Rhas a similar tolerance over a reduced temperature range of-55°C to +85°C. Many large value ceramic capacitors.larger than luF are manufactured with Z5U or Y5V temperature characteristics. Their capacitance can drop by morethan 50% as the temperature varies from 25°C to 85°. Therefore, X5R or X7R is recommended over Z5U andY5V in applications where the ambient temperature will change significantly above or below 25°C.

Feed-Forward Capacitor(CFF)

CXM8320 has internal loop compensation, so adding CFF is optional. Specifically, for specific applications, ifnecessary, consider whether to add feed-forward capacitors according to the situation.The use of a feed-forward capacitor (CFF) in the feedback network is to improve the transient response or higherphase margin. For optimizing the feed-forward capacitor, knowing the cross frequency is the first thing. The crossfrequency (or the converter bandwidth) can be determined by using a network analyzer. When getting the crossfrequency with no feed-forward capacitor identified, the value of feed-forward capacitor (CFF) can be calculatedwith the following Equation:

$$C_{FF} = \frac{1}{2\pi \times F_{CROSS}} \times \sqrt{\frac{1}{R1} \times \left(\frac{1}{R1} + \frac{1}{R2}\right)}$$

Where Fcross is the cross frequency.

To reduce transient ripple, the feed-forward capacitor value can be increased to push the cross frequency to higherregion.Although this can improve transient response, it also decreases phase margin and cause more ringing. In theother hand, if more phase margin is desired, the feed-forward capacitor value can be decreased to push the crossfrequency to lower region.

30V 2A 500KHz Synchronous Step-Down Regulator

Package Description

SOT23-6