MORNSUN®

SCM1316AFA Synchronous Step-Down DC/DC Converter

Features

- Wide VIN Range : 7V to 38V
- 6A Continuous Output Current
- Up to 95% Efficiency @ 24V Input
- Dual-Channel CC/CV Mode Control
- Adjustable Output Voltages
- ±2% Output Voltage Accuracy
- ± 6% Current Limit Accuracy
- Integrated 14mΩ High Side MOSFET
- Integrated 14mΩ Low Side MOSFET
- Programable Frequency(130kHz~300kHz)
- Burst Mode Operation at Light Load
- Internal Loop Compensation
- Internal Soft Start
- Thermally Enhanced QFN5*5 Package

Package

Mechanical package: QFN5*5-20,

(see "Ordering information" for details)

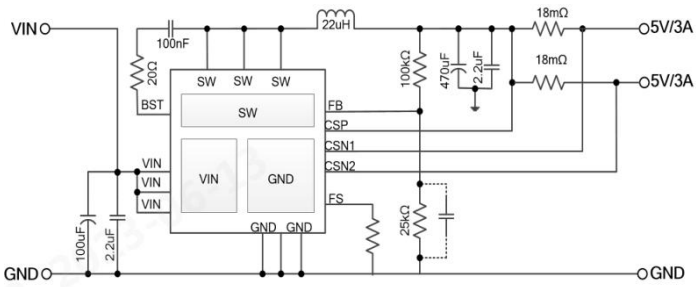
Applications

- Car Charger
- Rechargeable Portable Devices
- Networking Systems
- Distributed Power Systems

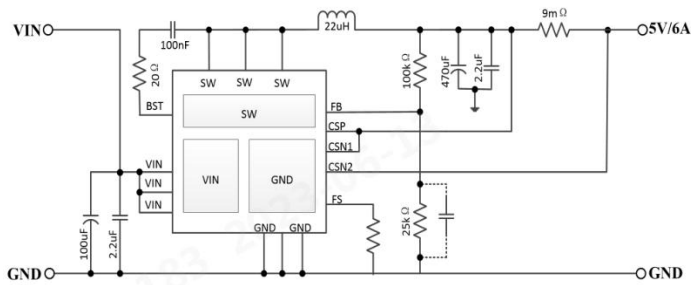
Functional

SCM1316AFA is a high efficiency, monolithic synchronous step-down DC/DC converter utilizing a jitter frequency, average current mode control architecture. Capable of delivering up to 6A continuous load with excellent line and load regulation. The device operates from an input voltage range of 7V to 38V and provides an adjustable output voltage from 3.3V to 25V. The SCM1316AFA features short circuit and thermal protection circuits to increase system reliability. The internal soft-start avoids input inrush current during start-up. The SCM1316AFA require a minimum number of external components. and a wide array of protection features to enhance reliability.

Typical Application Circuit



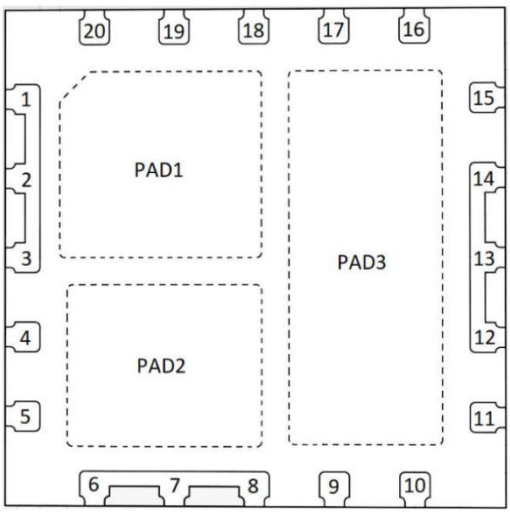
Dual Channel Application



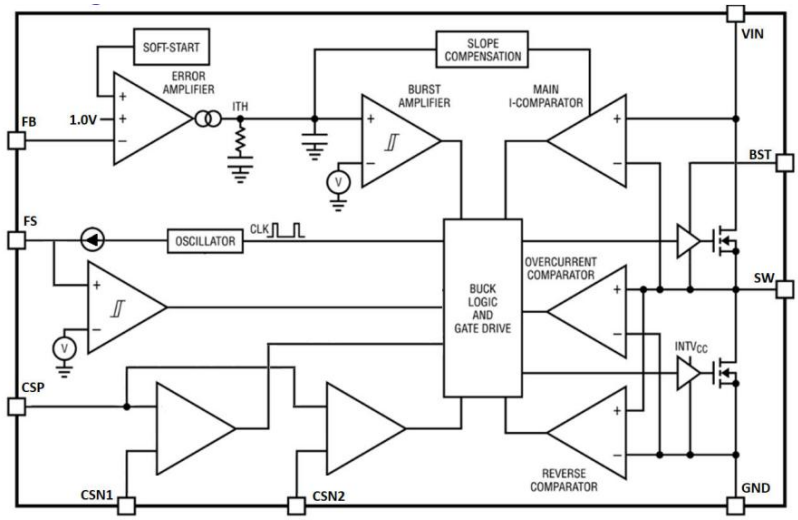
Single Channel Application

CONTENTS

Pin Connection



Internal Block



Pin Descriptions

Pin No.	Name	Description
1,2,3,PAD1	GND	Ground
4,5	NC	Not Connected
6,7,8,PAD2	VIN	Power Input Positive Pole
9	NC	Not Connected
10	BST	Boot Strap
11	NC	Not Connected
12,13,14,PAD3	SW	Switching, Connected With a Inductance
15	NC	Not Connected
16	VFB	Feedback Of Output Voltage
17	CSP	Positive Pole of Current Sense
18	CSN1	Negative Pole1 of Current Sense
19	CSN2	Negative Pole2 of Current Sense
20	FS	Connect a Resistor to GND for Frequency Configure

Absolute Maximum Ratings

TA=25°C, unless otherwise noted.

Parameter	SYMBOL	Min	Max	UNIT
VIN to GND		-0.3	42	V
SW to GND		-0.3	Vin+0.3	V
BST to GND		-0.3	Vin+7	V
FB, FS to GND		-0.3	+6	V

CSP, CSN1, CSN2 to GND		-0.3	25	V
Operating Junction Temperature		-40	150	℃
Storage Junction Temperature		-55	150	℃
Thermal Resistance from Junction to case	θ_{JC}	15		℃/W
Thermal Resistance from Junction to ambient	θ_{JA}	40		℃/W

Notes:

Stresses at or above those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress rating only;functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied.Operation beyond the maximum operating conditions for extended periods may Affect product reliability.

Recommended Operating Conditions

Parameter	Symbol	Min	Max	Unit
Input Voltage	V_{VIN}	7	38	V
Output Current	Io		6000	mA
Junction Temperature	T_J	-40	150	℃

Electrical Characteristics

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{in}	Input Voltage		7	-	38	V
V_{UVLO}	UVLO Voltage		-	6.2	7	V
V_{hys}	UVLO Hysteresis		-	0.8	-	V
V_{OVP}	Input over voltage protect		38	-	-	V
I_{CCQ}	Quiescent Current	VFB = 1.2V, no switch	-	1300	-	uA
I_{SB}	Standby Current	No Load	-	1.7	2.2	mA
V_{FB}	FB Reference Voltage		0.985	1	1.015	V
I_{FB}	V_{FB} bias Current		-	-	0.2	A
V_{CS1}	Current Sense AMP	CSP-CSN1	57	60	63	mV
V_{CS2}		CSP-CSN2	57	60	63	mV
F_{SW}	Switching Frequency	FS Floating	-	130	-	kHz
		connect 150k resister	-	300	-	kHz
V_{FSEN}	FS Shut down		-	0.6	-	V
D_{max}	Maximum Duty Cycle		-	98	-	%
T_{on-min}	Minimum On-Time		-	250	-	ns
I_{LIM}	Current Limit		8	-	-	A
VFB_{SCP}	Output short protect		-	0.6	-	V
T_{hiccup}	Hiccup Interval	FS Floating	-	500	-	ms
T_{SS}	Soft start Time		-	2	-	ms
High side	$R_{DS(ON)}$ Of Power MOS	Temp=25℃	-	-	14	mΩ
Low side			-	-	14	mΩ
T_{TR}	Thermal Regulation		-	145	-	℃
T_{SD}	Thermal shutdown Temp		-	165	-	℃
T_{SH}	Thermal Shutdown Hysteresis		-	30	-	℃

Thermal Resistance

Characteristics	Symbol	Rating	Unit
Thermal Resistance from Junction to case	θ_{JC}	15	℃/W
Thermal Resistance from Junction to ambient	θ_{JA}	40	℃/W

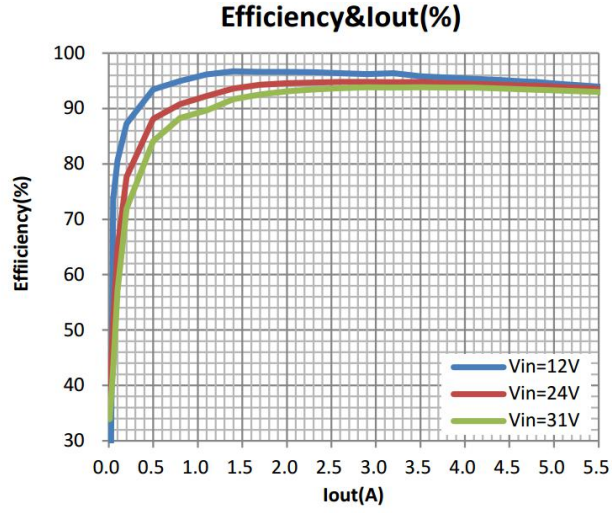


Figure1 Efficiency&Iout(%)

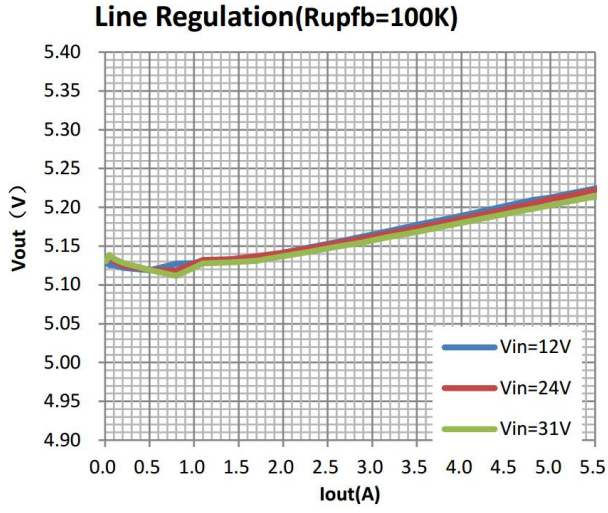


Figure2 Line Regulation(Rupfb=100k)

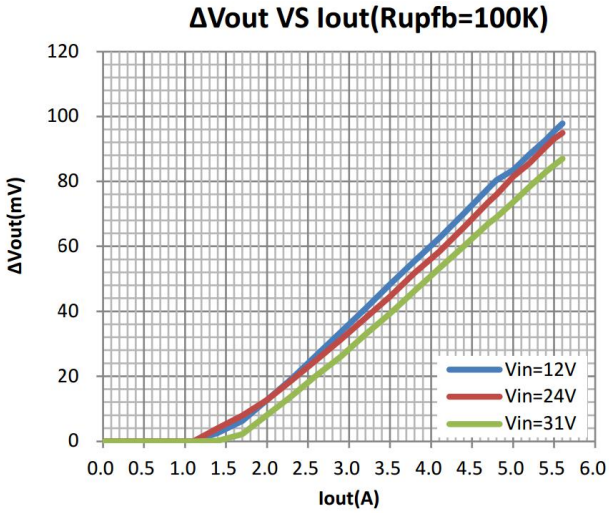


Figure3 ΔVout VS Iout(Rupfb=100k)

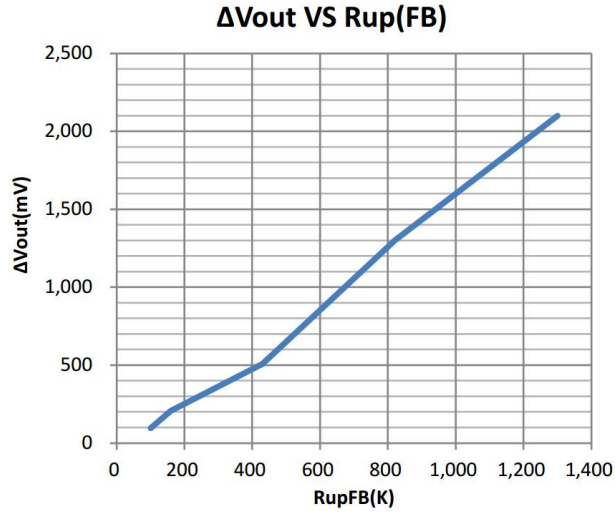


Figure4 ΔVout VS Rup(FB)

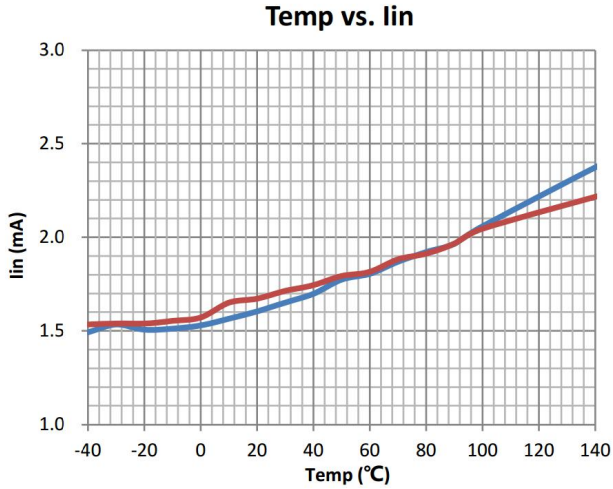


Figure 5 Temp vs Iin

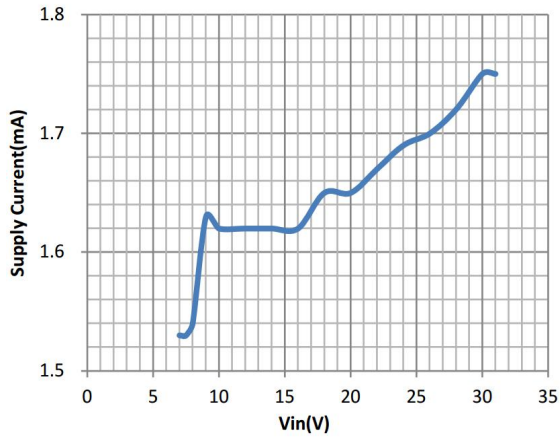
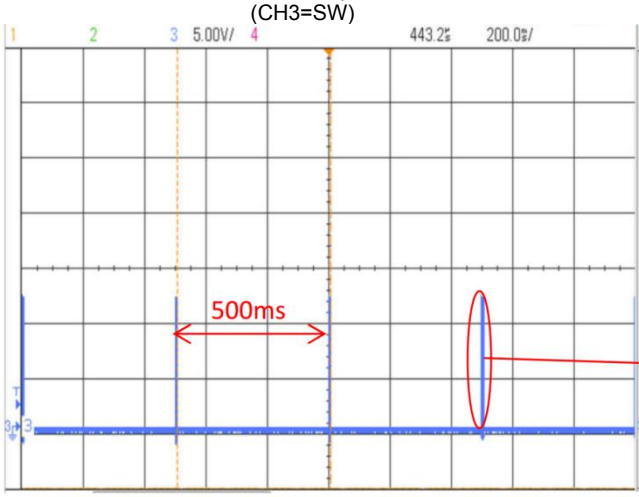


Figure 6 Supply Current vs. Input Voltage

Vin=12V, Freq=2Hz
(CH3=SW)



Vin=12V, Freq=34kHz
(CH3=SW)

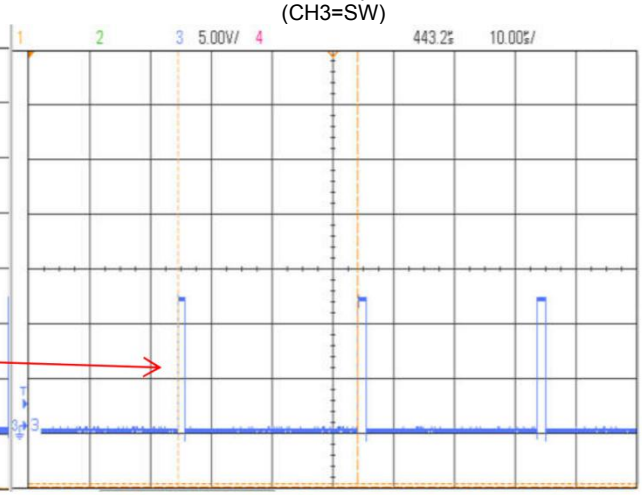
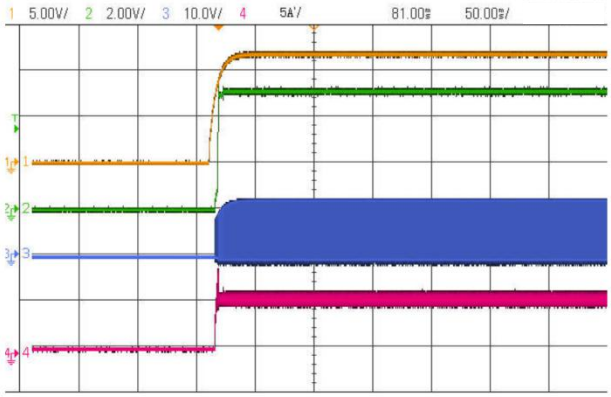
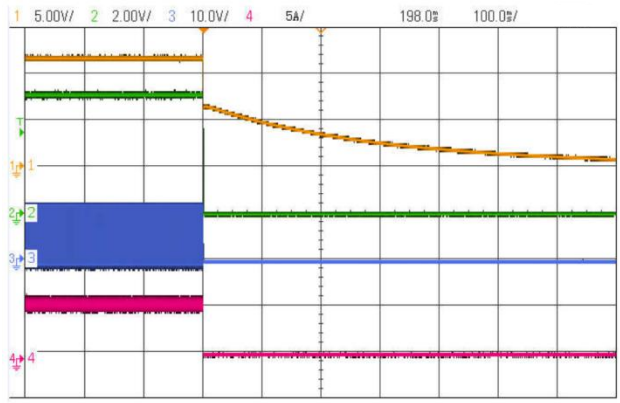


Figure 7 Short Circuit

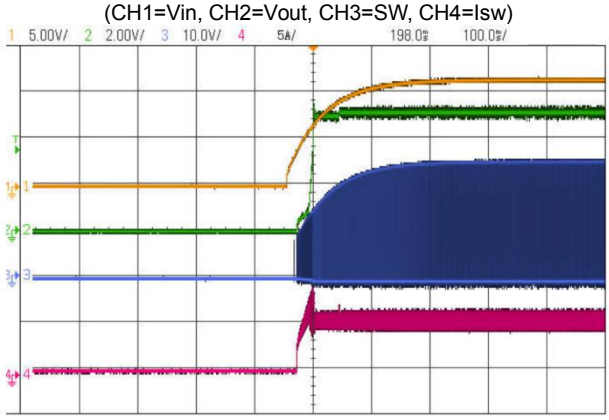
Power On
Vin=12V, Vout=5.05V, Iout=5.5A
(CH1=Vin, CH2=Vout, CH3=SW, CH4=Isw)



Power Off
Vin=12V, Vout=5.05V, Iout=5.5A
(CH1=Vin, CH2=Vout, CH3=SW, CH4=Isw)



Power On
Vin=24V, Vout=5.05V, Iout=5.5A
(CH1=Vin, CH2=Vout, CH3=SW, CH4=Isw)



Power Off
Vin=24V, Vout=5.05V, Iout=5.5A
(CH1=Vin, CH2=Vout, CH3=SW, CH4=Isw)

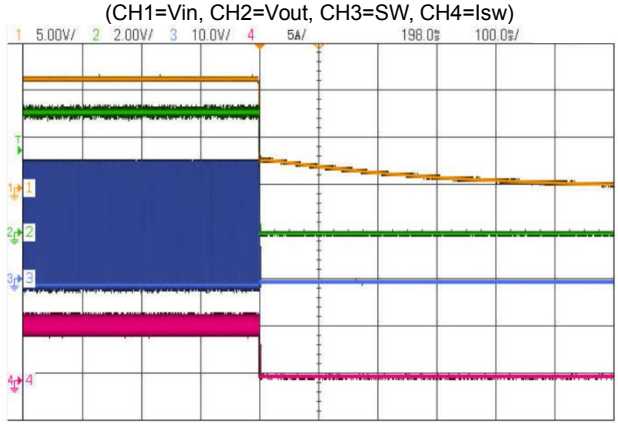


Figure 8 Power On & Off

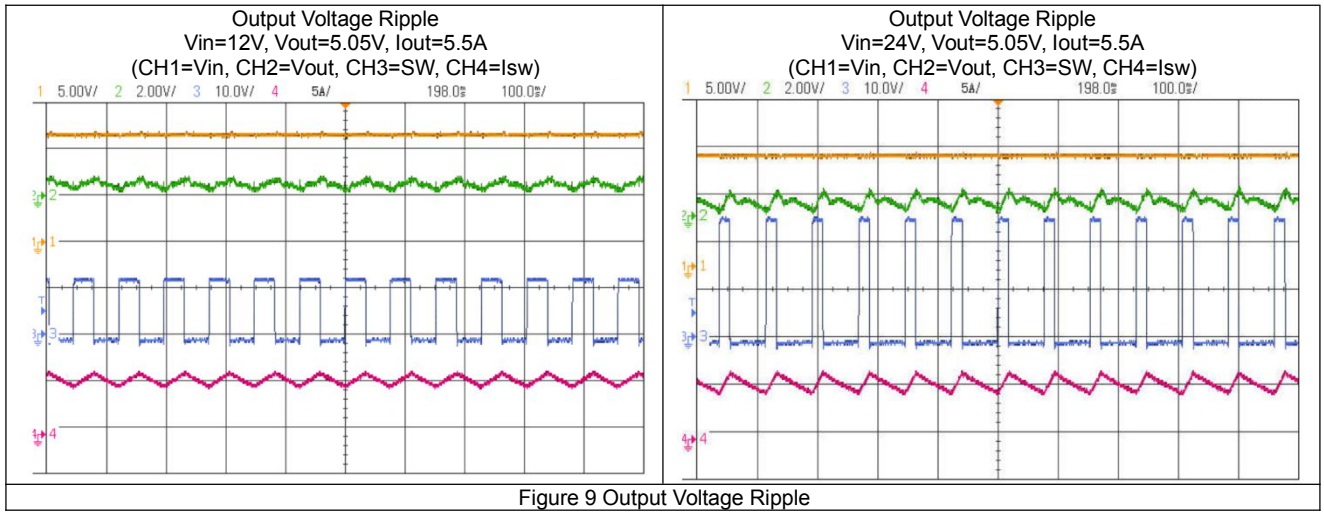


Figure 9 Output Voltage Ripple

Operation

The SCM1316AFA is a high efficiency, monolithic, synchronous step-down DC/DC converter utilizing a Jitter frequency, average current mode control architecture. Average current mode control enables fast and precise control of the output current. It operates through a wide VIN range and regulates with low quiescent current. An error amplifier compares the output voltage with a internal reference voltage of 1.0V and adjusts the peak inductor current accordingly. Over-voltage and under-voltage comparators will turn off the regulator.

Main Control Loop

During normal operation, the internal top power switch (N-channel MOSFET) is turned on at the beginning of each clock cycle, causing the inductor current to increase. The sensed inductor current is then delivered to the average current amplifier, whose output is compared with a saw-tooth ramp. When the voltage exceeds the v-duty voltage, the PWM comparator trips and turns off the top power MOSFET. After the top power MOSFET turns off, the synchronous power switch (N-channel MOSFET) turns on, causing the inductor current to decrease. The bottom switch stays on until the beginning of the next clock cycle, unless the reverse current limit is reached and the reverse current comparator trips. In closed-loop operation, the average current amplifier creates an average current loop that forces the average sensed current signal to be equal to the internal ITH voltage. Note that the DC gain and compensation of this average current loop is automatically adjusted to maintain an optimum current-loop response. The error amplifier adjusts the ITH voltage by comparing the divided-down output voltage (VFB) with a 1.0V reference voltage. If the load current changes, the error amplifier adjusts the average inductor current as needed to keep the output voltage in regulation.

Low Current operation

The discontinuous-conduction modes (DCM) are available to control the operation of the SCM1316AFA at low currents. Burst Mode operation automatically switch from continuous operation to the Burst Mode operation when the load current is low.

VIN Over-voltage Protection

In order to protect the internal power MOSFET devices against transient voltage spikes, the SCM1316AFA constantly monitors the VIN pin for an over-voltage condition. When VIN rises above 38V, the regulator suspends operation by shutting off both power MOSFETS. Once VIN drops below 37V, the regulator immediately resumes normal operation. The regulator executes its soft-start function when exiting an over-voltage condition.

Frequency Selection and Shutdown

The switching frequency of the SCM1316AFA can be programmed through an external resistor between 130kHz and 300 kHz, Floating this pin set the switching frequency to 130kHz, an external resistor can set the frequency up to 300kHz. The switching frequency is set using the FS pins as shown in Table 1:

FS Resistor(kΩ)	Frequency(kHz)
Floating	130k
1000	140k
750	160k
510	170k
300	210k

200	255k
150	300k

Table 1Frequency & FS Resistor

When the FS pin is below 0.6V, the SCM13116AFA enters a low current shutdown state, reducing the DC supply current to 1.3mA.

Application Information

Input Capacitor (CIN) Selection:

To prevent large voltage transients from occurring, a low ESR input capacitor sized for the maximum RMS current should be used. The maximum RMS current is given by:

$$I_{RMS} = I_{OUT(MAX)} \frac{V_{OUT}}{V_{IN}} \sqrt{\frac{V_{IN}}{V_{OUT}} - 1}$$

This formula has a maximum at VIN = 2VOUT, where: IRMS ≅ IOUT/2. Several capacitors may also be paralleled to meet size or height requirements in the design. For low input voltage applications, sufficient bulk input capacitance is needed to minimize transient effects during output load changes.

Output Capacitor (COUT) Selection:

The output ripple, ▵VOUT, is determined by:

$$\triangle V_{OUT} < \triangle I_L \left(\frac{1}{8 \bullet f \bullet C_{OUT}} + ESR \right)$$

The output ripple is highest at maximum input voltage since ▵IL increases with input voltage.

Inductor Selection :

Given the desired input and output voltages, the inductor value and operating frequency determine the ripple current:

$$\triangle I_L = \frac{V_{OUT}}{f \bullet L} \left(1 - \frac{V_{OUT}}{V_{IN(MAX)}}\right)$$

Lower ripple current reduces power losses in the inductor, ESR losses in the output capacitors and output voltage ripple. Highest efficiency operation is obtained at low frequency with small ripple current.However, achieving this requires a large inductor, There is a trade-off between component size, efficiency and operating frequency, The choice of which style inductor to use mainly depends on the price versus size requirements and any radiated choose a ripple current that is about 40% of IOUT(MAX). To guarantee that ripple current does not exceed a specified maximum, the inductance should be chosen according to:

$$L = \frac{V_{OUT}}{f \bullet \triangle I_{L\ (MAX)}} \left(1 - \frac{V_{OUT}}{V_{IN(MAX)}}\right)$$

EMI/EMC:

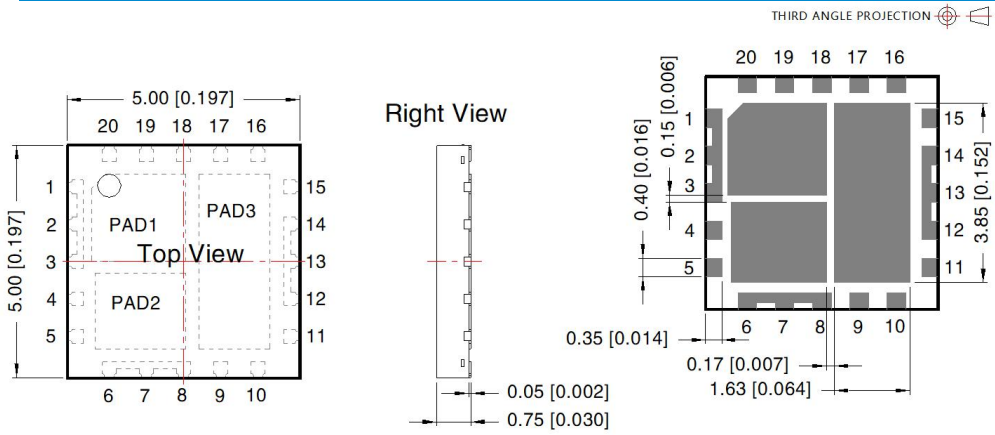
In order to solve EMI electromagnetic interference, SW pin should add a circuit of RC filter, a 20Ω resistor and a 1nF capacitor, BST pin reserved 20 Ω string 100nF.If the application version enough volume, can be reserved at input end type Π circuit.

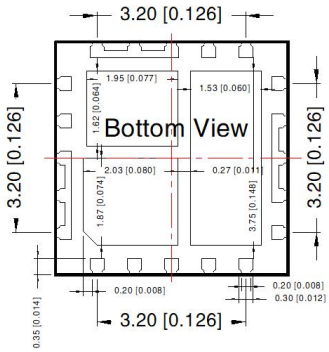
Ordering Information

Part number	Package	Number of pins	Product Marking	Tape&Reel
SCM1316AFA	QFN5*5-20	20	SCM1316AFA YM	4k/REEL

Product marking and date code
SCM1316XYZ:
(1)SCM1316=Product designation.
(2)X=Version code information(A-Z).
(3)Y=Packaging definition code; F for QFN package.
(4)Z=Operating temperature range; C : 0℃ to +70℃, I : -40℃ to +85℃, A : -40℃ to +125℃, M : -55℃ to +125℃.
(5)YM=Date code for product trace ability; Y=code for production year; M=code for production month.

Package Information(QFN5*5-20)

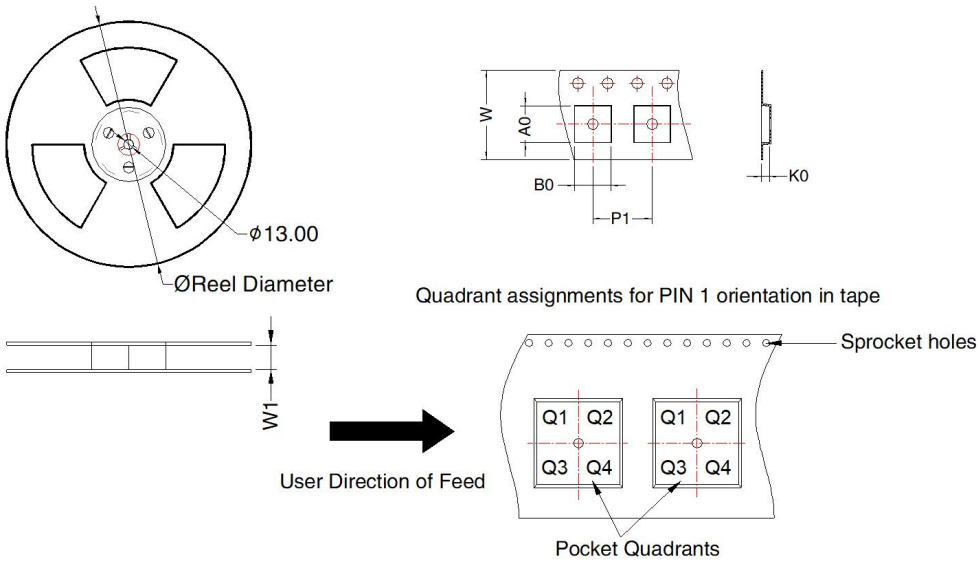




Note:
Unit: mm[inch]
General tolerances: ± 0.05[± 0.002]

Pin–Out		
Pin	Mark	Function
1,2,3,PAD1	GND	Ground
4	NC	Not Connected
5	NC	Not Connected
6,7,8,PAD2	Vin	Power Inupt Positive Pole
9	NC	Not Connected
10	BST	Boot Strap
11	NC	Not Connected
12,13,14,PAD3	SW	Switching, connected with a inducton
15	NC	Not Connected
16	VFB	Feedback of output voltage
17	CSP	Positive pole of current sense
18	CSN1	Negative pole1 of current sense
19	CSN2	Negative pole1 of current sense
20	FS	Connect a resistor to GND for frequency config

Tape & Reel Information



Device	Package Type	Pin	MPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
SCM1316AFA	QFN5*5–20	23	4000	330.0	12.5	5.35	5.35	1.1	8.0	12.0	Q1

Note: The minimum order quantity is the minimum packing quantity, and the order quantity shall be an integral multiple of MPQ.

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