M1210

16V Input, 10A Step-down DC-DC Power SoC with Integrated Inductor

FEATURES

- Wide Input Voltage from 2.7V to 16V
  - 2.7V to 16V with External 3.3V VCC Bias
  - 4V to 16V with Internal VCC Bias or External 3.3V VCC Bias
- Adjustable Output Voltage from 0.6V to 5.5V
- 10A Continuous Output Current
- Constant On Time (COT) Control
- Stable with low ESR Ceramic Capacitors
- Selectable Switching Frequency from 600kHz, 800kHz and 1MHz
- Selectable Power Save Mode (PSM) or Forced Continuous Conduction Mode (FCCM) for Light Load
- Pre-Biased Start-Up
- Differential Output Voltage Sense
- Output Voltage Discharge
- Output Voltage Tracking and Reference
- Power Good Indicator
- Junction Temperature Range from −40℃ to 125℃
- Programable Soft-Start Time
- Programable Output Current Limit and Cycle-by-Cycle Output Current Limit Protection
- Hiccup Mode for Short Circuit and Over-Load Protection
- Thermal Shutdown Protection
- Over-Voltage Protection
- QFN-28 (7mm×7mm×3.95mm) Package
- Pb-Free RoHS Compliant

DESCRIPTION

The M1210 is a 10A step-down switching mode Power SoC (System on Chip) with integrated controller, power MosFETs, inductor and input decoupling capacitor in QFN-28 package. The input voltage is from 2.7V to 16V and the output voltage is adjustable from 0.6V to 5.5V. The M1210 also has flexible programable functions such as the switching frequency, soft-start time and output current limit.

The M1210 provides high efficiency with Constant On Time (COT) control mode for fast transient response and good loop stability. It can work on selectable Power Save Mode (PSM) or Forced Continuous Conduction Mode (FCCM) for light load with excellent load regulation and line regulation.

The M1210 can also indicate faults and provide over-load and short circuit hiccup protection, UVP, OVP and OTP protection.

APPLICATIONS

- Telecom Systems
- Servers & Data Centers
- FPGA & ASIC Cards
- Industrial Systems
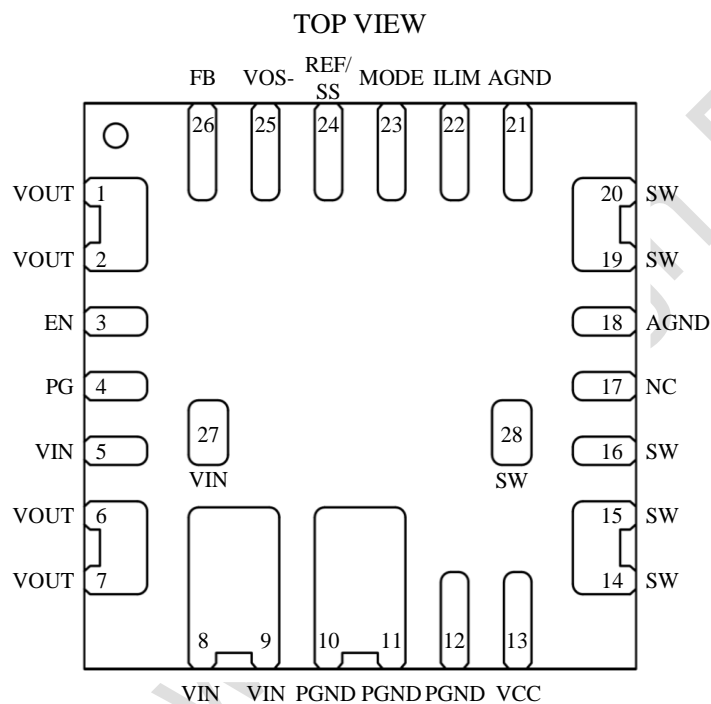
TYPICAL APPLICATION&EFFICIENCY

(Vin=12V, F_SW=800kHz, FCCM)
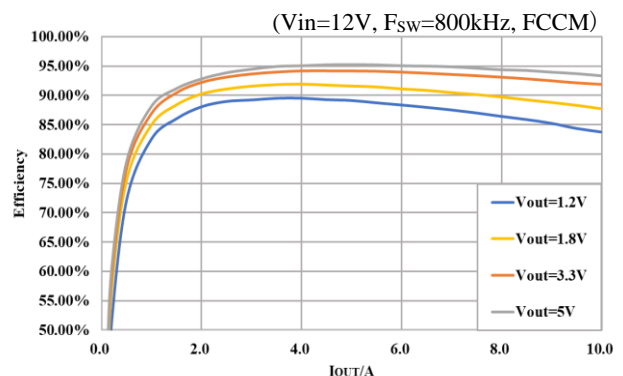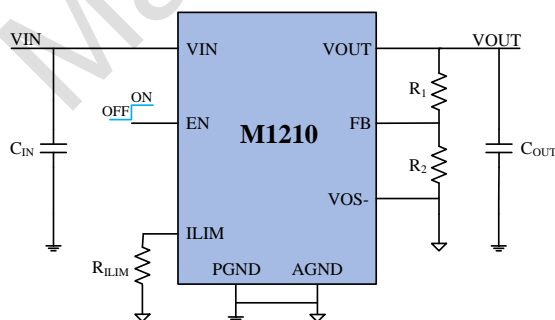
ORDERING INFORMATION

PART NUMBER	TOP MARKING	PACKAGE	MOQ	MSL LEVEL
M1210DQEE	M1210 YWWLLL	QFN-28 (7mm×7mm×3.95mm)	1000/ Tape & Reel	3

**NOTES:** Y: Year, WW: Week, LLL: Lot Number.

PACKAGE REFERENCE

TOP VIEW

PIN FUNCTIONS

PIN #	NAME	DESCRIPTION
1,2,6,7	VOUT	**Output Voltage.** Connect this pin with the load. Output capacitor is recommended to be placed between VOUT and PGND.
3	EN	**Enable Control.** Pulling this pin low can shut down the chip. Pulling it up can enable the chip.
4	PG	**Power Good.** The output of PG is an open drain, a pull-up resistor to power source is needed if used. If the chip works normally, PG is pulled high, else, PG is latched low.
5,8,9,27	VIN	**Input Voltage.**
10,11,12	PGND	**Power Ground.**
13	VCC	**Not Connected. Internal 3.3V LDO Output.** An output capacitor to AGND has been placed internally.
14,15,16,19,20,28	SW	**Not Connected. Internal SW Pad.**
17	NC	**Not Connected. Internal Bootstrap Pad.** A Bootstrap capacitor to SW has been placed internally.
18,21	AGND	**Analog Ground.**
22	ILIM	**Output Current Limit.** Connect a resistor to AGND to program the current limit.
23	MODE	**Operation Mode Selection.** Connect a resistor to AGND to program the operation mode and the switching frequency. This pin is floating for PSM and 800kHz as the default status.
24	REF/SS	**Output Voltage Tracking Reference/Soft Start.** The output voltage tracks this input signal. A decoupling ceramic capacitor is recommended to be placed close to this pin. The capacitance determines the soft-start time.
25	VOS−	**VOUT Sense−.** Connect to the negative side of the voltage sense point directly. Connect to AGND if not used.
26	FB	**Feedback (VOUT Sense+).** Connect this pin with an external resistor divider from the output to VOS- and keep them as close as possible to the pin.

FUNCTIONAL BLOCK DIAGRAM
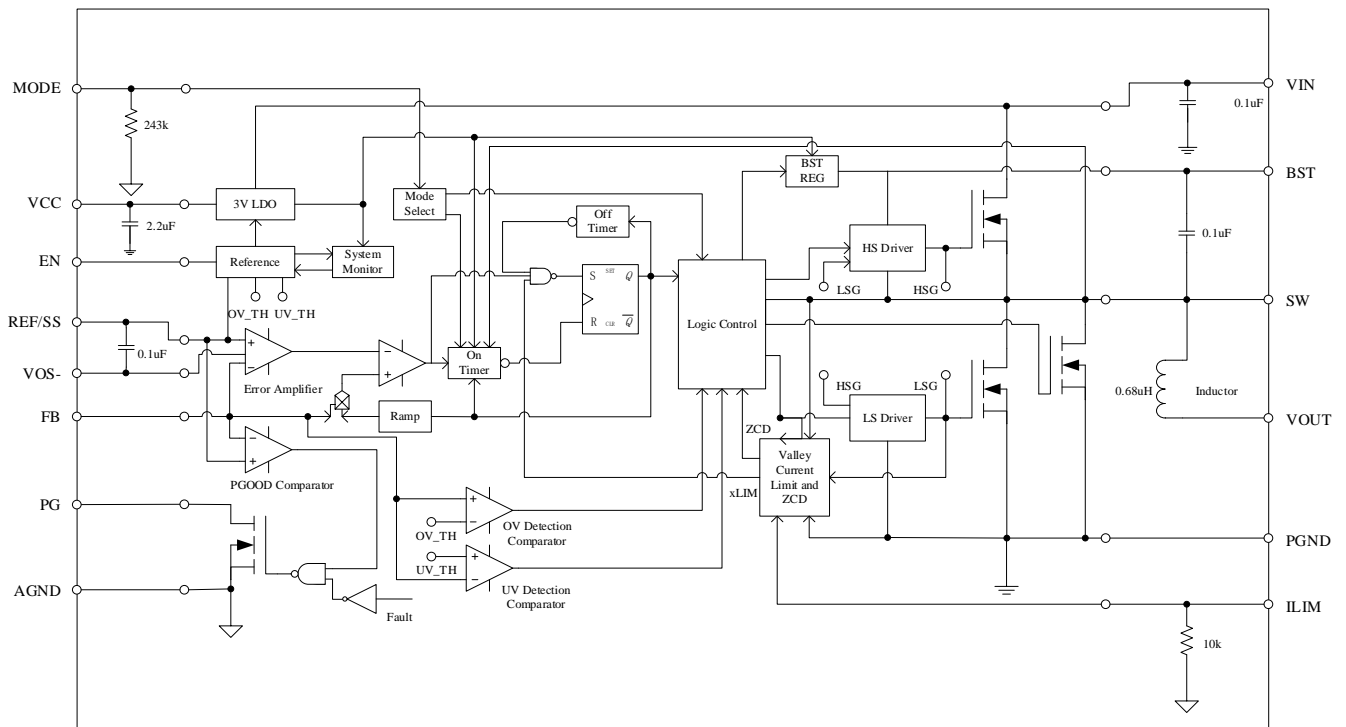
ABSOLUTE MAXIMUM RATINGS

	SYMBOL	MIN	MAX	UNIT
Voltage at Pins	V_{IN}	-0.3	18	V
Voltage at Pins	V_{SW}(DC)	-0.3	$V_{IN}+0.3$	V
Voltage at Pins	V_{SW}(25ns)	-5	25	V
Voltage at Pins	VCC/EN		4.5	V
Voltage at Other Pins		-0.3	4.3	V
Junction Temperature Range	T_J	-40	125	°C
Storage Temperature Range	T_S	-55	150	°C
Power Dissipation (T_A=+25℃)	P_D Note 1)		4.3	W

ESD Ratings

ESD	STANDARD	VALUE
Human Body Mode (HBM)	JEDEC EIA/JESD22-A114	2000V
Charge Device Mode (CDM)	JEDEC EIA/JESD22-C101F	750V

RECOMMANDED OPERATING CONDITIONS

	SYMBOL	MIN	MAX	UNIT
Input Voltage Range	V_{IN}	4	16	V
Output Voltage Range	V_{OUT}	0.6	5.5	V
Output Current Range	I_{OUT}		10	A
EN Voltage Range	V_{EN}		3.6	V
Junction Temperature Range	T_J	-40	125	°C

THERMAL RESISTANCE

	SYMBOL	MIN	MAX	UNIT
Junction to Ambient	θ_{JA}Note 2)		23	°C/W
Junction to Case	θ_{JC} Note 2)		1	°C/W

NOTES:

1) The maximum allowable continuous power dissipation at any ambient temperature (T_A) is calculated by $P_D(max)=(T_J(max)-T_A)/\theta_{JA}$. Exceeding the maximum allowable power dissipation will cause excessive die temperature, and the power module will go into thermal shutdown.

2) Measured on EVB, 6-layer PCB 1oZ.

ELECTRICAL CHARACTERISTICS

V_{IN}=12V, T_A=25℃, unless otherwise noted.

PARAMETERS	SYMBOL	CONDITION	MIN	TYP	MAX	UNIT
Input Voltage	V_{IN}	with Internal VCC Bias	4		16	V
Input Voltage	V_{IN}	with External VCC Bias	2.7		16	V
Input under Voltage Lockout rising Threshold	V_{UVLO_R}	V_{IN} Rising, V_{CC}=3.3V	2.3	2.4	2.5	V
Input under Voltage Lockout falling Threshold	V_{UVLO_F}	V_{IN} Falling, V_{CC}=3.3V	1.55	1.85	2.15	V
Shutdown Current	I_{SD}	V_{EN}=0V, V_{IN}=5.5V		10	20	µA
Quiescent Current (No Switching)	I_{Q1}	V_{EN}=2V, V_{FB}=0.62V		641	850	µA
Quiescent Current (No Load)		V_{IN}=12V, V_{OUT}=1.2V, PSM			1	mA
EN On Threshold	V_{EN_R}	V_{EN} Rising	1.17	1.22	1.27	V
EN Hysteresis	V_{EN_HYS}			210		mV
Output Discharge FET Resistance	R_{ON_DIS}			80	150	Ω
VCC under Voltage Lockout rising Threshold	VCC_{UVLO_R}	V_{CC} Rising	2.65	2.8	2.95	V
VCC under Voltage Lockout falling Threshold	VCC_{UVLO_F}	V_{CC} Falling	2.35	2.5	2.65	V
VCC Regulator	VCC		2.88	3.00	3.12	V
Feedback Voltage	V_{FB_REF}		594	600	606	mV
Current Limit	V_{ILIM}		1.15	1.2	1.25	V
I_{LIM} to I_{OUT} ratio	I_{LIM}/I_{OUT}	I_{OUT} >2A	18	20	22	µA/A
LS Negative Current Limit	I_{LIM_N}			−9		A
Switching Frequency	F_{SW}	MODE=AGND/VCC	480	600	720	kHz
		MODE=Float/34.8kΩ	680	800	920	kHz
		MODE=243kΩ/80.6kΩ	850	1000	1150	kHz
Soft-Start Time	T_{SS}	C_{SS} NC		1.5		ms
PG Delay	T_{PG_DELAY}		0.63	0.9	1.17	ms

ELECTRICAL CHARACTERISTICS (continued)

V_{IN}=12V, T_A=25℃, unless otherwise noted.

PARAMETERS	SYMBOL	CONDITION	MIN	TYP	MAX	UNIT
PG High threshold	PG$_{VTH\_H\_R}$	V_{PG} Rising, V_{FB} in respect to V_{FB_REF}	89.5	92.5	95.5	%
	PG$_{VTH\_H\_F}$	V_{PG} Falling, V_{FB} in respect to V_{FB_REF}	102	105	108	%
PG Low threshold	PG$_{VTH\_L\_R}$	V_{PG} Rising, V_{FB} in respect to V_{FB_REF}	113	116	119	%
	PG$_{VTH\_L\_F}$	V_{PG} Falling, V_{FB} in respect to V_{FB_REF}	77	80	83	%
Over-Voltage Protection	V_{OVP}	V_{FB} in respect to V_{FB_REF}	113	116	119	%
Under Voltage Protection	V_{UVP}	V_{FB} in respect to V_{FB_REF}	77	80	83	%
Thermal Shutdown				160		℃
Thermal Shutdown Hysteresis				30		℃

TYPICAL PERFORMANCE CHARACTERISTICS

V_{IN}=12V, T_A=25°C, FCCM, F_{SW}=800kHz, V_{OUT}=1.2V, unless otherwise noted.

Line Regulation

V_{OUT}=1V/1.2V/1.8V/3.3V, I_{OUT}=10A,

V_{IN}=4~16V
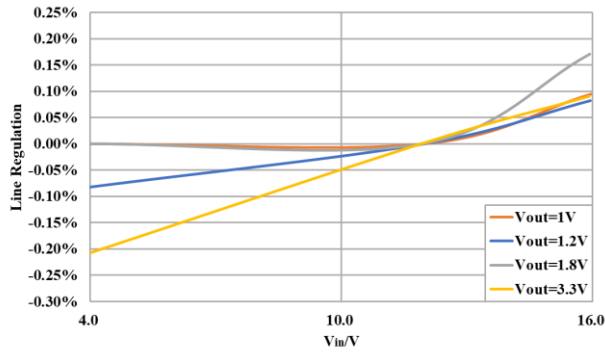
Load Regulation

V_{IN}=12V, V_{OUT}=1V/1.2V/1.8V/3.3V/5V,
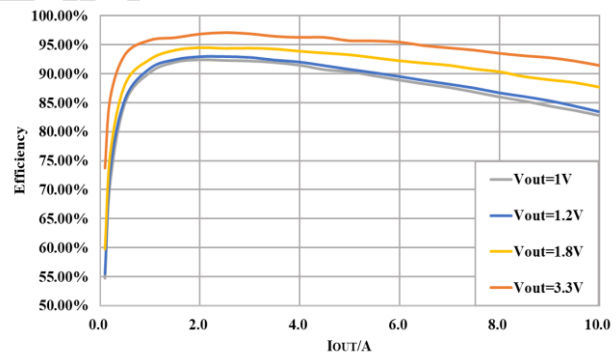
I_{OUT}=0~10A
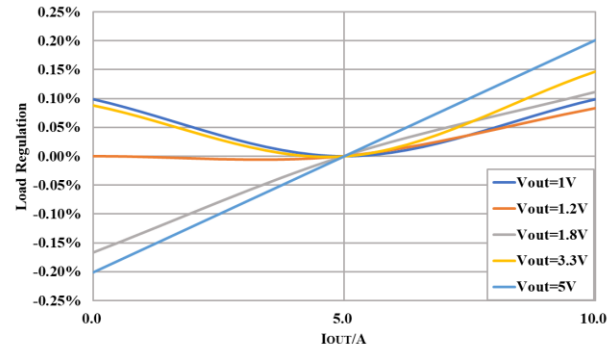
Efficiency

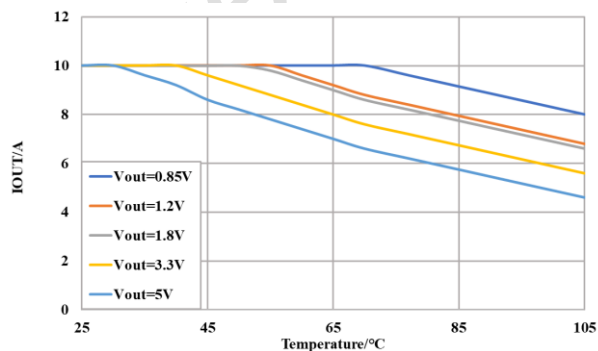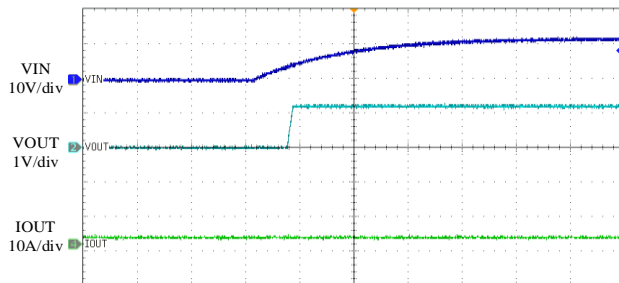V_{IN}=12V, V_{OUT}=1.2V/1.8V/3.3V/5V,

I_{OUT}=0~10A
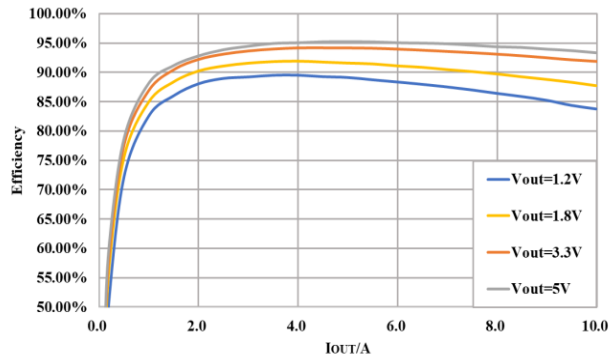
Efficiency

V_{IN}=5V, V_{OUT}=1V/1.2V/1.8V/3.3V,

I_{OUT}=0~10A

Thermal Derating

V_{IN} = 12V, V_{OUT}=0.85V/1.2V/1.8V/3.3V/5V

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

V_{IN}=12V, T_A=25℃, FCCM, F_{SW}=800kHz, V_{OUT}=1.2V, unless otherwise noted.
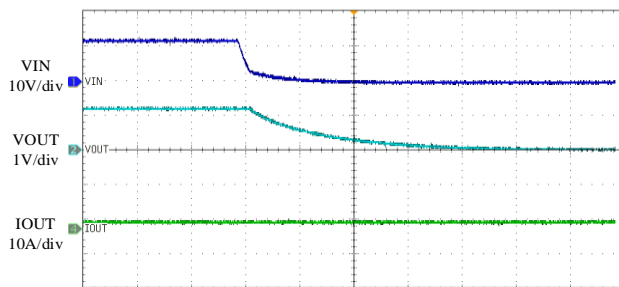
VIN Start-up

I_{OUT}=0A

20ms/div
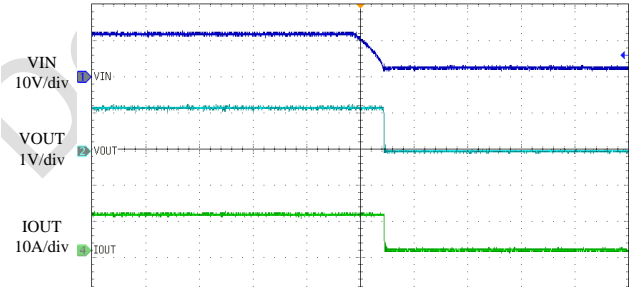
VIN Start-up

I_{OUT}=10A
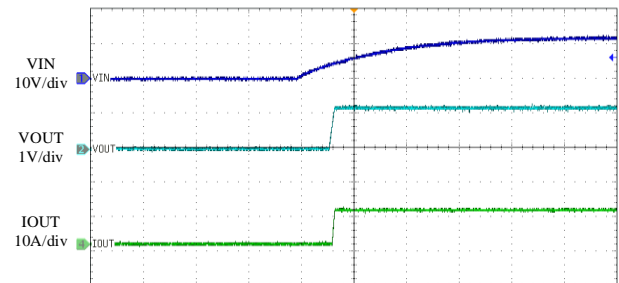
20ms/div

VIN Shutdown
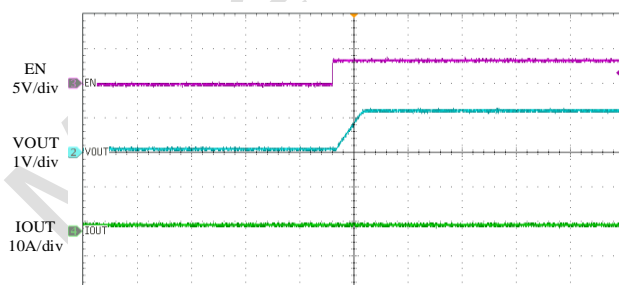
I_{OUT}=0A

400ms/div

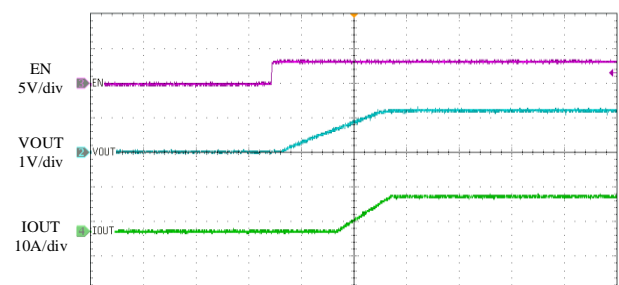**VIN Shutdown**

I_{OUT}=10A

2ms/div

EN Start-up

I_{OUT}=0A

4ms/div

EN Start-up

I_{OUT}=10A
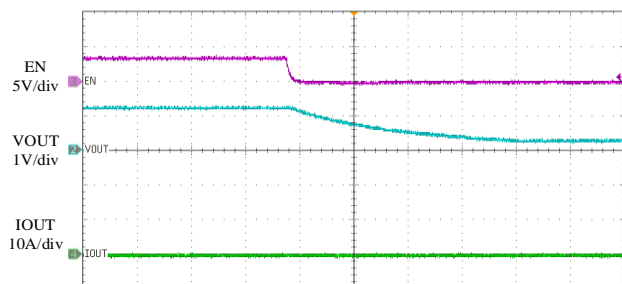
1ms/div

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

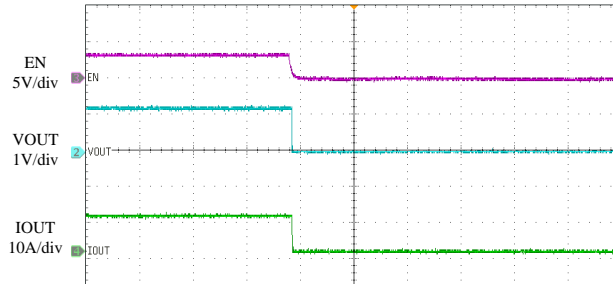V_{IN}=12V, T_A=25°C, FCCM, F_{SW}=800kHz, V_{OUT}=1.2V, unless otherwise noted.
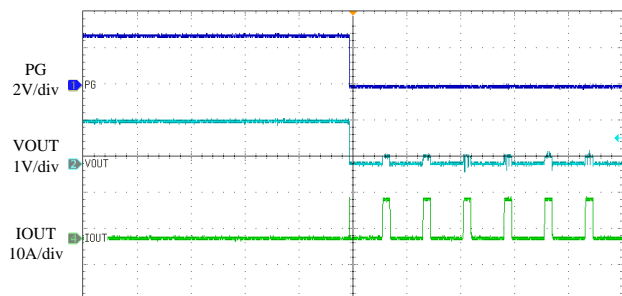
EN Shutdown

I_{OUT}=0A

4ms/div
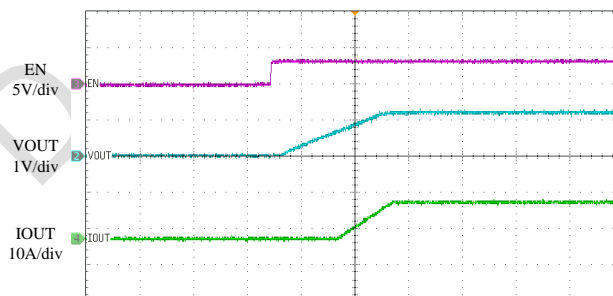
EN Shutdown

I_{OUT}=10A

4ms/div

SCP Entry

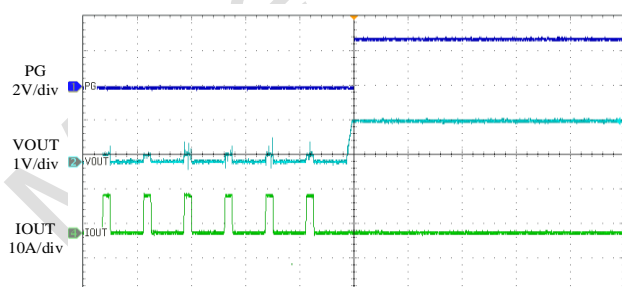I_{OUT}=0A

20ms/div

SCP Entry

I_{OUT}=10A

20ms/div

SCP Recovery

I_{OUT}=0A

20ms/div

SCP Recovery

I_{OUT}=10A
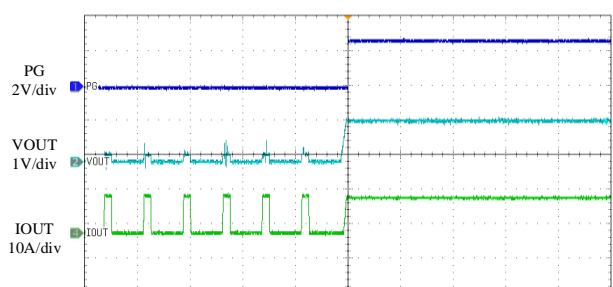
20ms/div

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

V_{IN}=12V, T_A=25℃, FCCM, F_{SW}=800kHz, V_{OUT}=1.2V, unless otherwise noted.

VOUT Ripple

I_{OUT}=0A

800ns/div

VOUT Ripple

I_{OUT}=10A

800ns/div

Load Transient

I_{OUT}=0A to 5A, 1A/µs

100µs/div

Load Transient

I_{OUT}=5A to 10A, 1A/µs

100µs/div

Load Transient

I_{OUT}=0A to 10A, 1A/µs

100µs/div

OPERATION

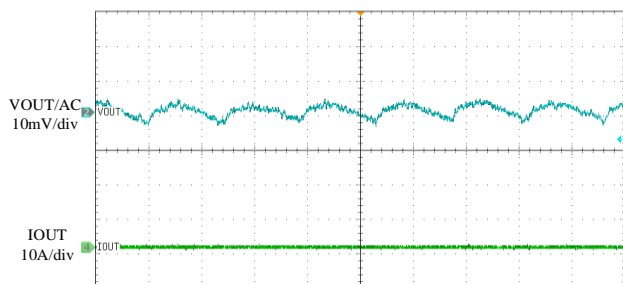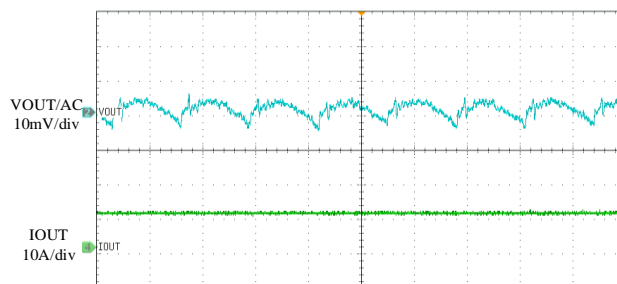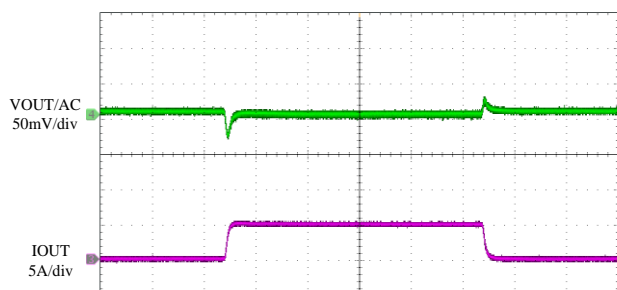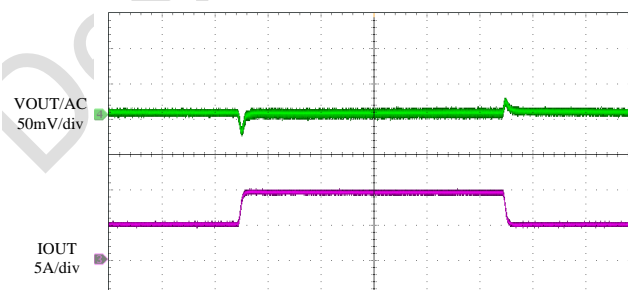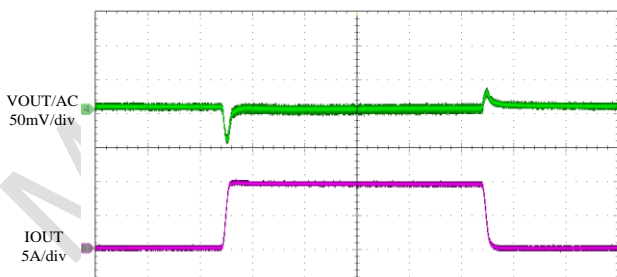The M1210 is a 10A synchronous step-down switching mode Power SoC with integrated high-side and low-side power MosFETs, inductor and input decoupling capacitor in QFN-28 package. And the integrated input decoupling capacitor can minimize the parasitic inductance of input circuit and reduce the voltage spike on switching pin to simplify the PCB layout.

M1210 works on COT control mode that offers excellent transient response over a wide input voltage range. M1210 can provide excellent load regulation at both Power Save Mode and Forced Continuous Conduction Mode for light load, which can be programmed by MODE pin. The switching frequency can also be programmed from 600kHz, 800kHz and 1MHz.

Fully integrated protection features include OCP, OVP, UVP, OTP and all these faults can be indicated by PG. The protection function details are shown below. And M1210 has a typical 80Ω discharge resistor internally which helps the output current drop down quickly when shutdown.

OVER CURRENT PROTECTION (OCP)

M1210 has a cycle-by-cycle Low-Side valley current limit protection to prevent inductor current from running away. This current limit value can be programmed as shown in the **USER GUIDE**. When the Low-Side switch reaches the current limit, M1210 will enter hiccup mode.

OCP hiccup mode is active 3ms after M1210 is enabled. If M1210 detects an over-current condition for 31 consecutive cycles, or if V_{FB} drops below the UVP threshold, the device enters hiccup mode. In hiccup mode, the M1210 latches off the High-Side MosFET immediately, and latches off the Low-Side MosFET after zero-current cross detection (ZCD).

The REF/SS capacitor is also discharged. M1210 automatically tries to soft start after about 11ms.

If the over-current condition remains after 3ms of running, the M1210 repeats this operation cycle until the over-current condition disappears.

M1210 also has the Low-Side negative current limit. When the Low-side MosFET detects a $-9A$ current, the part turns off the Low-side MosFET for 200ns to limit the negative current.

OVER VOLTAGE PROTECTION (OVP)

M1210 monitors the output voltage by connecting FB to the net between the output voltage feedback resistors to detect an over-voltage condition.

If V_{FB} exceeds 116% of V_{FB_REF}, it triggers OVP. When reaching the Low-Side negative current limit, Low-Side MosFET turns off for 200ns and the High-Side MosFET turns on. After 200ns, the Low-Side MosFET turns on again. The M1210 repeats this operation to discharge the over-voltage on the output. And M1210 exits OVP mode when V_{FB} drops 105% of the regulation.

However, M1210 employs output sinking mode (OSM) to regulate the output voltage to the target when V_{FB} exceeds 104% of V_{FB_REF} but is below the OVP threshold. During OSM, the Low-Side MosFET remains on until it reaches the $-5.5A$ negative current limit. Upon reaching $-5.5A$, the Low-Side MosFET turns off for 200ns and the High-Side MosFET turns on during this period. After 200ns, the Low-Side MosFET turns on. The M1210 maintains this operation until V_{FB} drops below 102% of V_{FB_REF}. Once it does, the M1210 exits OSM after 15 consecutive cycles of FCCM.

OVER TEMPERATURE PROTECTION (OTP)

M1210 will stop switching when the junction temperature exceeds typically 160 ℃. The device will power up again when the junction temperature drops below typically 130℃.

USER GUIDE

Output Voltage

The output voltage is programmed by the external feedback resistor divider as the typical application circuit on Page 1. The top feedback resistor R_1 can impact the loop stability, so its recommended value is $2k\Omega$. The bottom feedback resistor R_2 can be calculated as:

$$R_2 = \frac{R_1}{\frac{V_{OUT}}{V_{FB}} - 1}$$

Table 1 lists the recommended feedback resistor values for common output voltages when R_1 is $2k\Omega$.

Table 1：FB Resistor Value for Common Output Voltages.

V_{OUT}	R_2
5V	272Ω
3.3V	442Ω
1.8V	1kΩ
1.2V	2kΩ
1.0V	3kΩ

And a feedforward capacitor C_{FF} is recommended for better load transient response, which typical value is 4.7nF.

Input Capacitor Selection

The input current of the step-down converter is discontinuous with sharp edges, therefore putting filter capacitors is necessary. For better performance, low ESR ceramic capacitors with X5R or X7R dielectrics are highly recommended because of their lowest temperature variations. The RMS current of the input capacitors is calculated:

$$I_{CIN\_RMS} = I_{OUT} \cdot \sqrt{D(1-D)}$$

in which D is the Duty Cycle and when the current is continuous, $D = V_{OUT}/V_{IN}$; I_{OUT} is the output load current. As the equation above, when D is 0.5, the highest RMS current is approximately:

$$I_{CIN\_RMS} = \frac{I_{OUT}}{2}$$

So, it is recommended to choose the capacitors with the RMS current rating higher than $1/2$ I_{OUT}.

The power dissipation on the input capacitors can be estimated with the RMS current and the ESR resistor.

Electrolytic or tantalum capacitors can also be used. There has been a small size $0.1\mu F$ ceramic capacitor placed close to VIN and PGND in M1210 already. The input voltage ripple caused by the capacitors can be calculated as:

$$\Delta V_{CIN} = \frac{I_{OUT}}{F_{SW} \cdot C_{IN}} \cdot \frac{V_{OUT}}{V_{IN}} \cdot (1 - \frac{V_{OUT}}{V_{IN}})$$

in which, F_{SW} is switching frequency.

Output Capacitor Selection

Output capacitors are required to keep output voltage stable. To minimize the output voltage ripple, low ESR ceramic capacitors should be used. The output voltage ripple can be estimated as:

$$\Delta V_{OUT} = \frac{V_{OUT}}{8 \cdot F_{SW}^2 \cdot C_{OUT} \cdot L} \cdot (1 - \frac{V_{OUT}}{V_{IN}})$$

In which, $L = 0.68\mu H$.

If electrolytic or tantalum capacitors are used, the ESR will dominate the output voltage ripple as:

$$\Delta V_{OUT} = R_{ESR} \cdot \frac{V_{OUT}}{F_{SW} \cdot L} \cdot (1 - \frac{V_{OUT}}{V_{IN}})$$

Enable Control

When input voltage is above the under-voltage-lock-out threshold, M1210 can be enabled by pulling the EN pin.

- EN can be driven by a logical signal to enable M1210. M1210 can be enabled by pulling the EN pin to above 1.22V.S

- EN pin can be connected to VIN directly by a pull-up resistor R_{PULL_UP}. As the maximum current going in to EN should be kept under $50\mu A$, the R_{PULL_UP} can be calculated as:

$$R_{PULL\_UP}(k\Omega) \geq \frac{V_{IN}(MAX)}{0.05(mA)}$$

- The UVLO of the input voltage also can be programmed by a resistor connected between EN and AGND. The pull up resistor R_{UP} and the pull-down resistor R_{DOWN} can be calculated as:

$$V_{IN\_UVLO} = V_{EN\_R} \cdot \frac{R_{UP} + R_{DOWN}}{R_{DOWN}}$$

The voltage of EN should not exceed 3.6V when choosing these resistors and the typical value of V_{EN_R} is 1.22V.

Power Good Indicator

M1210 has an open drain PG indicator. A pull-up resistor whose recommended value is about 100kΩ to VCC or any other power source less than 3.6V is needed if used. PG will be pulled down when the output voltage is out of regulation, otherwise PG is pulled up. PG goes high after a 0.9ms delay when V_{FB} reaches 92% of the regulation. The PG is latched low when V_{FB} drops to 80% or exceeds 116% of the regulation and will be pulled high after a new soft start.

Mode Selection & Switching Frequency

M1210 can work on FCCM or PSM under the light load by selecting different resistors connected with MODE pin. **PSM mode means M1210 works at DCM under light load. FCCM mode means M1210 is forced to work at CCM under light load.** And the switching frequency is also programmed by this pin. Table 2 shows the values of the resistors for different operating modes and switching frequency.

Table 2：Mode & Switching Frequency Selection

Mode	Light-Load Mode	F_{SW}
VCC	PSM	600kHz
Float (Default)	PSM	800kHz
243kΩ (±20%) to AGND	PSM	1000kHz
AGND	FCCM	600kHz
34.8kΩ (±20%) to AGND	FCCM	800kHz
80.6kΩ (±20%) to AGND	FCCM	1000kHz

Current Limit

M1210 features a current sense and a configurable current limit threshold. By using a resistor (R_{ILIM}) from ILIM to AGND, the current limit is programmed as:

$$\frac{R_{ILIM}(M\Omega) \times 0.01}{R_{ILIM}(M\Omega) + 0.01}$$

$$= \frac{V_{ILIM}}{G_{CS} \cdot (I_{ILIM} - \frac{(V_{IN} - V_{OUT}) \cdot V_{OUT}}{V_{IN}} \cdot \frac{1}{2F_{SW}(MHz) \cdot L(\mu H)})}$$

in which, V_{ILIM} =1.2V, G_{CS} =20μA/A, L=0.68μH.

Table 3 shows the recommended values of the resistor R_{ILIM} for different operating modes.

Table 3：R_{ILIM} & Operation

Operation	F_{SW}(Default)	$I_{LIM\ TYP}$	R_{ILIM}
V_{IN}=12V, V_{OUT}=5V	800kHz	12A	18kΩ
V_{IN}=12V, V_{OUT}=3.3V	800kHz	12A	16kΩ
V_{IN}=12V, V_{OUT}=1.8V	800kHz	12A	13kΩ
V_{IN}=12V, V_{OUT}=1.2V	800kHz	12A	12kΩ
V_{IN}=12V, V_{OUT}=1V	800kHz	12A	12kΩ

Output Voltage Tracking Reference

M1210 provides an analog input pin REF/SS to track another power supply or accept an external reference. When an external voltage signal is connected to REF/SS, it acts as a reference for the M1210 output voltage. V_{FB} follows this external voltage signal and the soft-start programs are ignored. The REF/SS input signal ranges from 0.3V to 1.4V. During initial start-up, REF/SS must reach 600mV to ensure proper operation. After that, it can be programmed to any value between 0.3V and 1.4V.

Soft Start Time

The defaulted soft-start time is 1.5 ms. The time can be increased by adding an external capacitor C_{SS} between REF/SS and AGND. C_{SS} can be calculated as：

$$C_{SS}(nF) = \frac{T_{SS}(ms) \cdot 36(\mu A)}{0.6(V)} - 100(nF)$$

Pre-Biased Start-Up

The M1210 has been designed for a start-up into pre-biased loads. If the output is pre-biased to a certain voltage during start-up, the IC disables switching for both the High-Side and Low-Side MosFETs until the voltage on the REF/SS capacitor exceeds the sensed

output voltage at FB. If the internal BST voltage (from BST to SW) is below 2.3V before the REF/SS voltage reaches the pre-biased FB level, the Low-Side MosFET turns on to allow the BST voltage to be charged through VCC. The Low-Side MosFET turns on for narrow pulses, so the drop in the pre-biased level is negligible.

## Snubber Circuit Recommendation

With good layout design, it is possible to operate M1210 within absolutely maximum ratings without ringing reduction techniques. To achieve a lower ringing level, a R-C snubber circuit is recommended. As a reference, a 2.7Ω resistor and 820pF capacitor between SW and PGND are recommended.

PCB Layout Guide

To optimize the electrical and thermal performance, some PCB layout guidelines should be considered as below:

1. Use wide trace for the high current paths and keep it as short as possible. It helps to minimize the PCB conduction loss and thermal stress.

2. The M1210 has integrated the input decoupling capacitor, and it is also better to place other input capacitors close to VIN and PGND.

3. Connect all feedback network to FB shortly.

4. Keep the sensitive components away from the SW.

5. The PGND should be connected to a strong ground plane for better heat dissipation and noise protection.

6. M1210 supports remote voltage sense to compensate any voltage drop in the leads/traces. Make Sure that differential lines are used to do Output Voltage Sense from capacitor terminals.
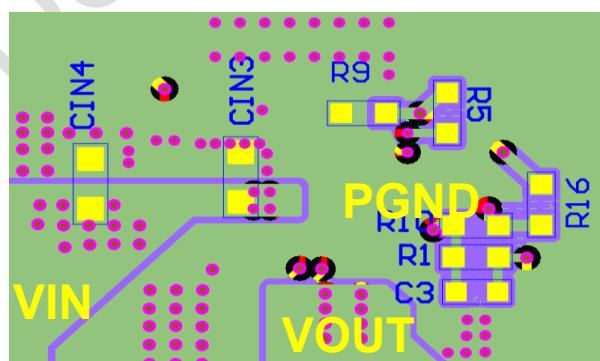
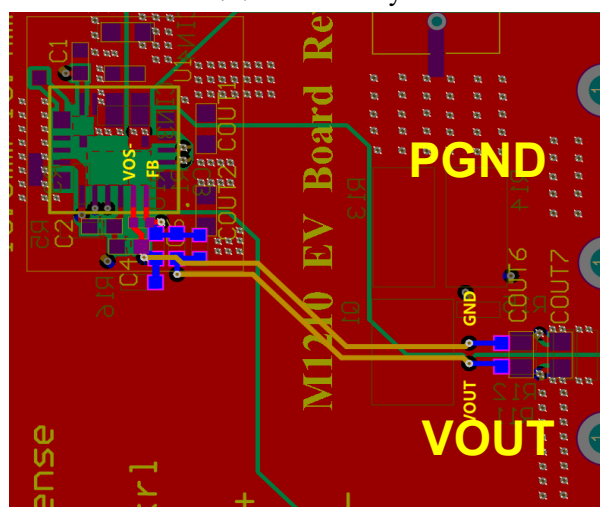Figure 1 gives a good example of the recommended layout.
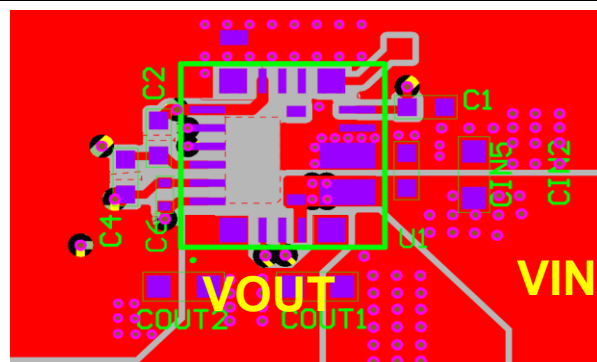
（a）Top Layer
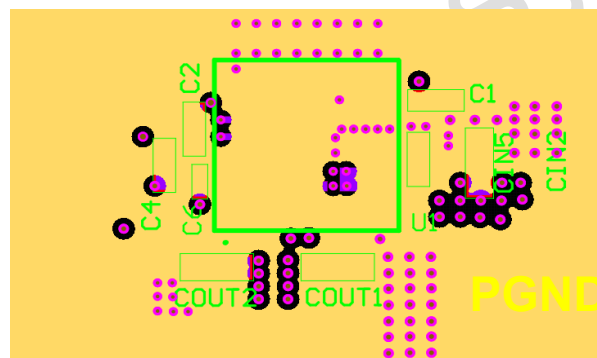
（b）Inner Layer 1/2/3/4

（c）Bottom Layer

（d）Remote Sense Traces

Figure 1. Recommended Layout
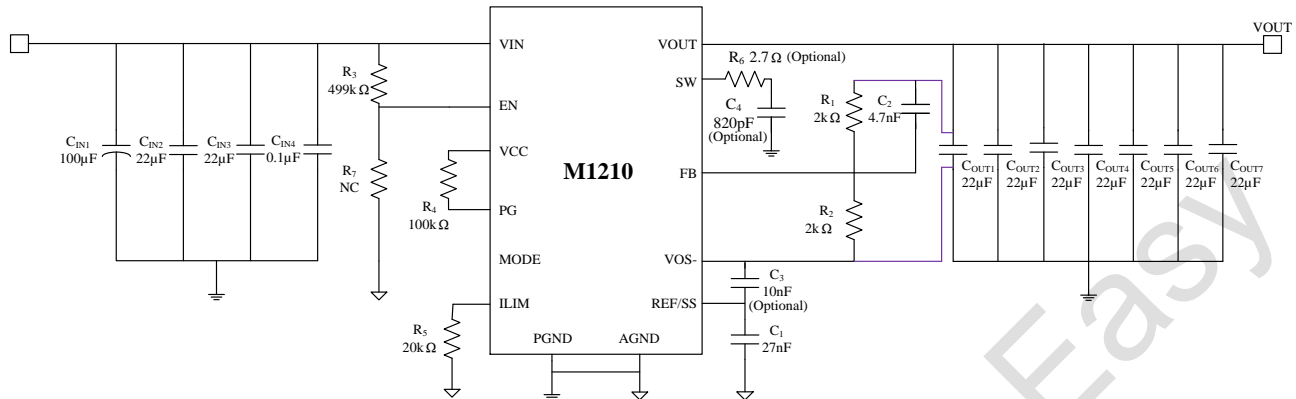
TYPICAL APPLICATION

● **VIN=12V**

Figure 2. Typical Application Circuits of M1210 for 12V Input 1.2V@10A Output, Fsw=800kHz

Table 4：Reference Design for 12V Input

VOUT	CIN	COUT	VOUT Ripple	R$_1$	R$_2$	R$_5$	I$_{LIM}$ TYP (Fsw=800kHz)
5.0V	100uF（E-CAP）+2×22uF	9×22uF	35mV		272Ω	18kΩ	12A
3.3V	5×22uF	8×22uF	25mV		442Ω	16kΩ	12A
1.8V	4×22uF	7×22uF	18mV	2kΩ	1kΩ	13kΩ	12A
1.2V	3×22uF	6×22uF	12mV		2kΩ	12kΩ	12A
1.0V	2×22uF	6×22uF	10mV		3kΩ	12kΩ	12A

NOTES:

CIN is the sum of the input capacitors, COUT is the sum of the output capacitors, please refer to Figure 2 for parameters of other components.
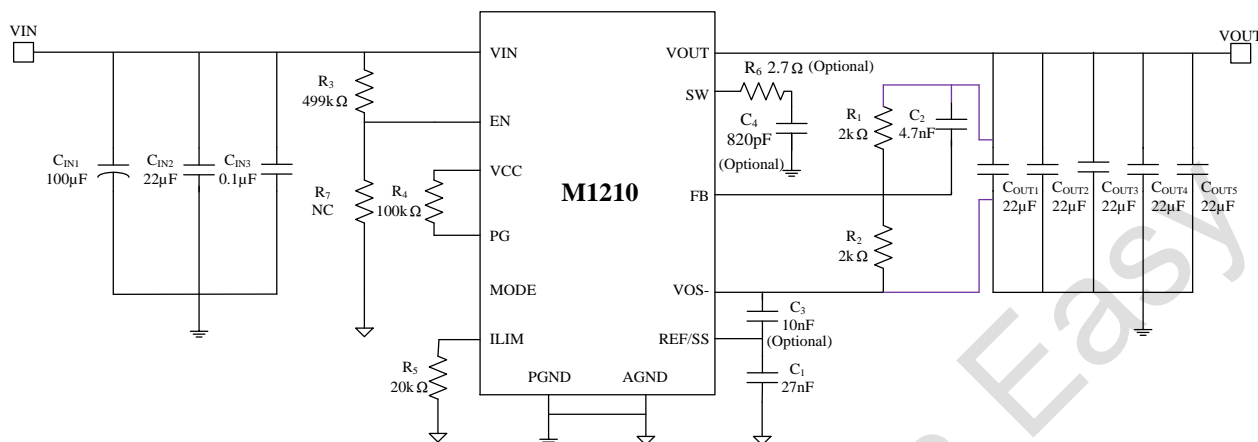
TYPICAL APPLICATION(continued)

● **VIN=5V**

Figure 3. Typical Application Circuits of M1210 for 5V Input 1.2V@10A Output, Fsw=800kHz

Table 5：Reference Design for 5V Input

| VOUT	CIN	COUT	VOUT Ripple	R_1	R_2	R_5	I_{LIM} TYP (Fsw=800kHz)
3.3V	5×22uF	8×22uF	25mV		442Ω	12kΩ	12A
1.8V	4×22uF	7×22uF	18mV	2kΩ	1kΩ	12kΩ	12A
1.2V	3×22uF	6×22uF	12mV		2kΩ	12kΩ	12A
1.0V	3×22uF	6×22uF	10mV		3kΩ	12kΩ	12A

NOTES:

CIN is the sum of the input capacitors, COUT is the sum of the output capacitors, please refer to Figure 3 for parameters of other components.

PACKAGE INFORMATION

QFN-28 (7mm×7mm×3.95mm) Package

TOP VIEW

SIDE VIEW

BOTTOM VIEW

RECOMMENDED LAND PATTERN
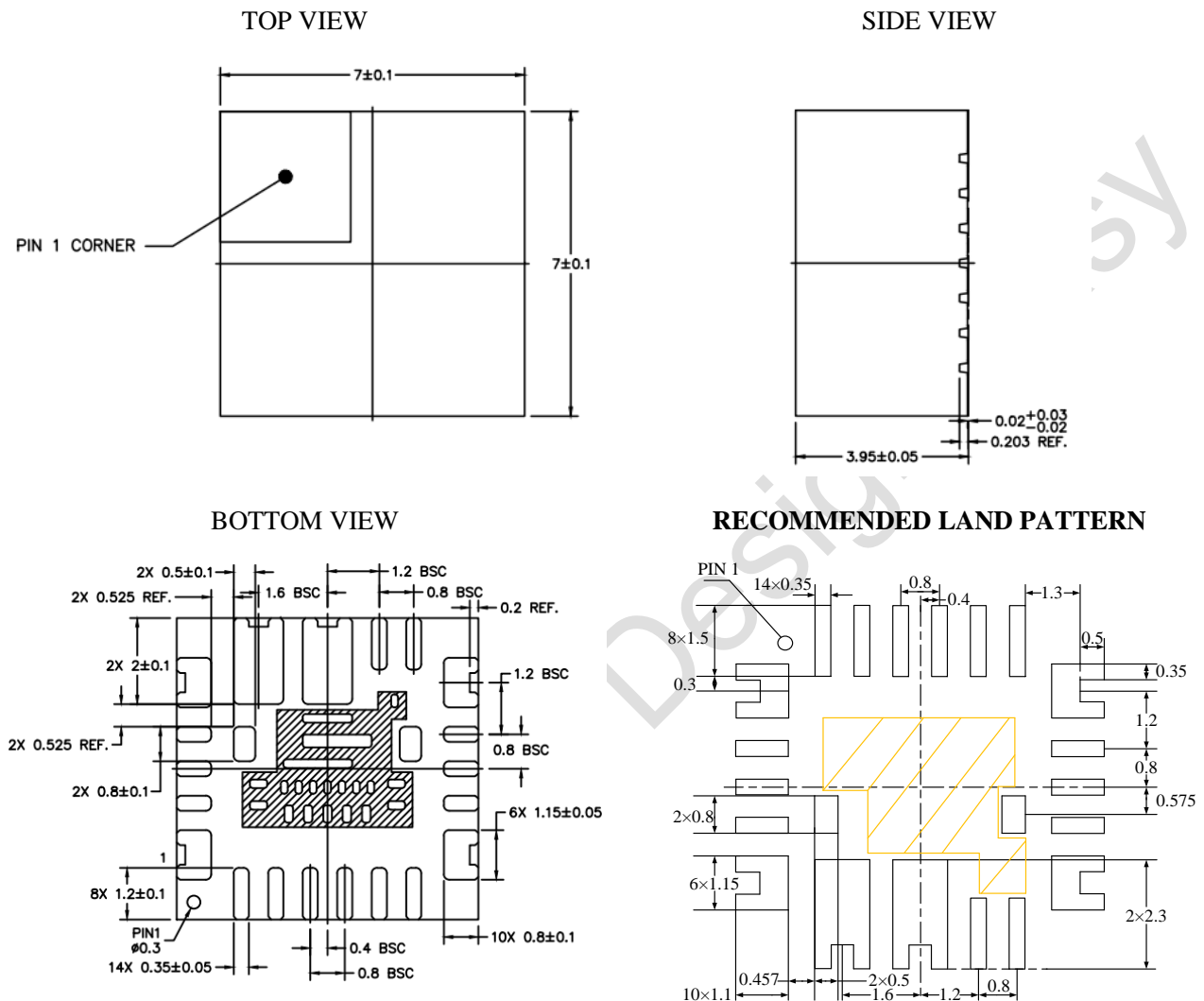
NOTES:

1) All dimensions are in MM.

2) The shaded area is the keep-out zone. Do not connect to any electrical or mechanical area.

CARRIER INFORMATION
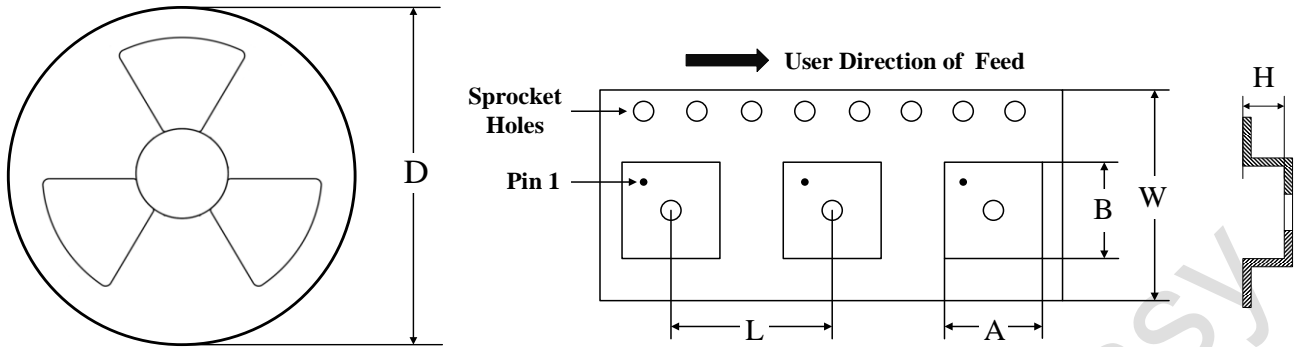
PART NUMBER	PACKAGE	QUANTITY /REEL	D	A	B	L	W	H
M1210DQEE	QFN-28 (7mm×7mm×3.95mm)	1000	13 in	7.7mm	7.7mm	12mm	16mm	4.2mm