36V 4.5A Synchronous Buck Converter With 2CH CC/CV

❖ GENERAL DESCRIPTION

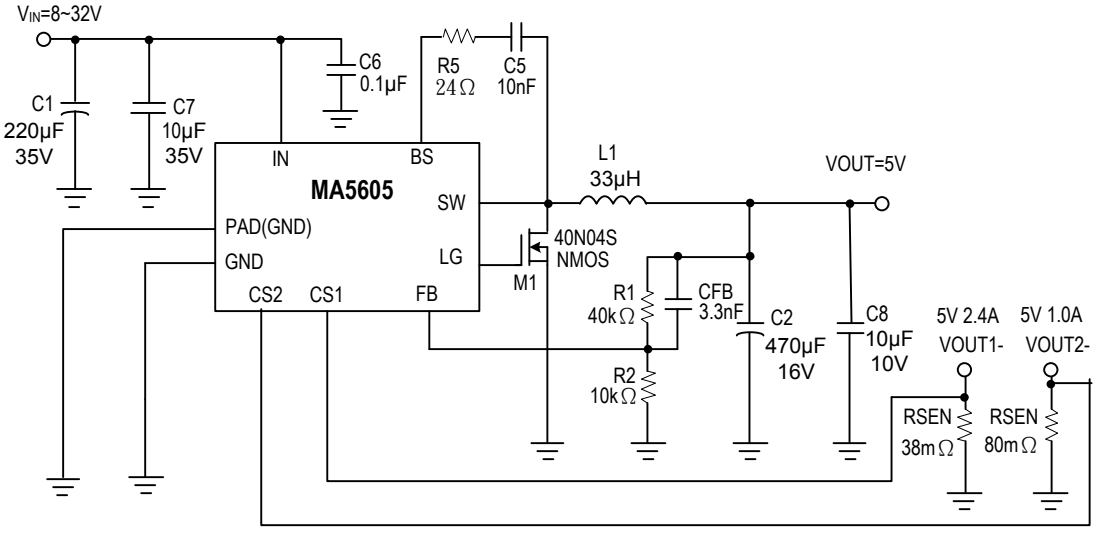
The MA5605 is a monolithic synchronous buck regulator. The device integrates internal high side and external low side power MOSFETs, and provides 4.5A of continuous load current over a wide input voltage. Current mode control provides fast transient response and cycle-by-cycle current limit.

An internal soft-start prevents inrush current at turn-on, this device available in SOP8L-EP (Exposed pad) package, and provides a very compact solution with minimal external components.

❖ FEATURES

- Wide 8V to 36V Operating Input Range
- Integrated 75mΩ high side Power MOSFET Switches
- Output Adjustable : VFB(1.00V±2%) .
- Up to 95% Efficiency
- Internal Soft-Start and Fixed 160KHz Frequency
- Stable with Low ESR Polymer Al-E-Capacitors
- Cycle-by-Cycle Over Current Protection
- Input Under/Over Voltage Lockout

❖ APPLICATION CIRCUIT

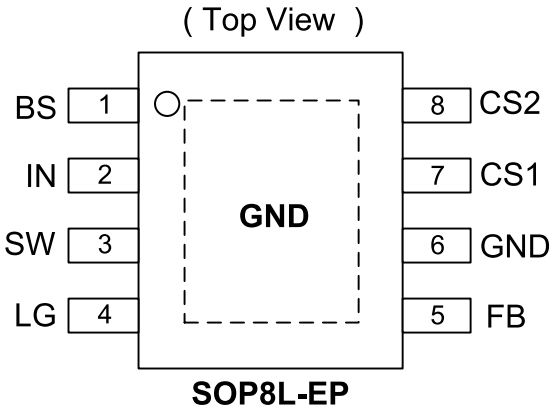


$V_{OUT}=V_{FB} \times (1+R1/R2)$, V_{FB} = 1.00V, R2 suggest 1k~40KΩ

I_{SEN} = 2.63A (I_{SEN}=VCS1(0.1V) / RSEN(38mΩ))

❖ PIN ASSIGNMENT

The package of MA5605 is SOP8L-EP(Exposed pad); the pin assignment is given by:

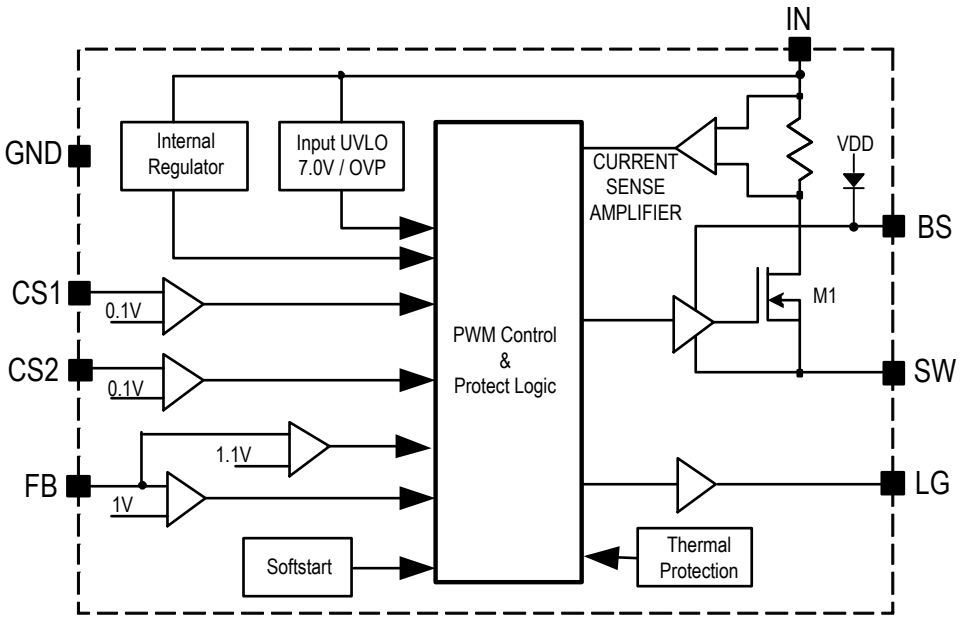


Name	Description
BS	Boot-Strap Pin. Supply high side gate driver.
IN	Power Input pin. Bypass IN to GND with a suitably large capacitor to eliminate noise on the input to the IC.
SW	Power Switching Output. SW is the switching node that supplies power to the output. Connect the output LC filter from SW to the output load.
LG	Gate drive for external low side N-MOSFET..
PAD	Ground (Connect to GND).
FB	Feedback Input. FB senses the output voltage to regulate that voltage. Drive FB with a resistive voltage divider from the output voltage.
GND	Ground
CS1	The Current Sense 1 pin.
CS2	The Current Sense 2 pin.

❖ ORDER/MARKING INFORMATION

Order Information	Top Marking (SOP-8L)
MA5605 XX X → Packing Blank: Tube A : Taping Package Type ES: SOP8L-EP	MA5605 → Part number XXXXX → ID code:internal WW:01~52 Year:16=2016

❖ BLOCK DIAGRAM



❖ A BSOLUTE MAXIMUM RATINGS (at T_A=25°C)

Characteristics	Symbol	Rating	Unit
Supply Voltage	V_{IN}	–0.3 to +42	V
Switch Node Voltage	V_{SW}	– 0.3 to V_{IN} + 0.3	V
Boost Voltage	V_{BS}	VSW – 0.3 to VSW + 6	V
All Other Pins		–0.3 to +6	V
Lead Temperature		260	°C
Storage Temperature		–65 to +150	°C
Junction Temperature	T_J	150	°C
Output Voltage	V_{OUT}	VFB to 20	V
Ambient Operating Temperature		–40 to +85	°C
Thermal Resistance from Junction to case	θ_{JC}	25	°C/W
Thermal Resistance from Junction to ambient	θ_{JA}	50	°C/W

Note: θ_{JA} is measured with the PCB copper area of approximately 1 in^2(Multi-layer). That need connect to exposed pad.

❖ ELECTRICAL CHARACTERISTICS

(V_{IN} = 12V, T_A = +25°C, unless otherwise noted.)

Characteristics	Symbol	Conditions	Min	Typ	Max	Units
Input Voltage Range			8	-	36	V
Quiescent Current	I_{CCQ}	V_{FB} = 1.05V	-	1.2	2	mA
Feedback Voltage	V_{FB}	8V ≤ V_{IN} ≤ 36V	0.98	1.00	1.02	V
Feedback Overvoltage Threshold	$OVP_{(FB)}$		-	1.1X	-	V_{FB}
Cable compensation current(Note)	I_{CFB}	V_{CS}=100mV	-	4	-	uA
High-Side Switch On Resistance (Note)	$R_{DS(ON)1}$		-	75	-	mΩ
High-Side Switch Leakage Current		V_{FB} = 1.05V, V_{SW} = 0V	-	-	10	μA
High-Side Switch Current Limit(Note)		Minimum Duty Cycle	4.7	5.7	-	A
LG Rise Time	T_{LGR}	C_{LX}=1200pF	-	40	-	ns
LG Fall Time	T_{LGF}	C_{LX}=1200pF	-	40	-	ns
LG driver bias supply voltage			-	5	-	V
Oscillation Frequency	F_{OSC1}		-	160	-	KHz
Short Circuit Oscillation Frequency	F_{OSC2}	V_{FB} < 0.4V	-	80	-	KHz
Short Circuit Retry time(Note)	RT_{SCP}	V_{FB} < 0.5V	-	1	-	mS
Maximum Duty Cycle(Note)	D_{MAX}		-	88	-	%
Minimum On Time (Note)	$T_{ON(min)}$		-	220	-	ns
Current Sense Voltage	$V_{CS1/2}$		95	100	115	mV
Input Under Voltage Lockout Threshold	UVLO	V_{IN} Rising	6.5	7.0	7.5	V
Input Under Voltage Lockout Threshold Hysteresis	UVLO-Hys		-	800	-	mV
Input Over Voltage Lockout Threshold	OVLO	V_{IN} Rising	-	36	-	V
Input Over Voltage Lockout Threshold Hysteresis	OVLO-Hys		-	3	-	V
Soft-Start Period			-	2	-	ms
Thermal Shutdown(Note)	T_{SD}		-	155	-	°C
Thermal Shutdown Hysterisis	T_{SH}		-	30	-	°C

Note: Guaranteed by design.

❖ FUNCTION DESCRIPTIONS

The MA5605 is a synchronous rectified, current-mode, step-down regulator. It regulates input voltages from 8V to 36V down to an output voltage as low as V_{FB}, and supplies up to 4.5A of load current.

The MA5605 uses current-mode control to regulate the output voltage. The output voltage is measured at FB through a resistive voltage divider and amplified through the internal Tran conductance error amplifier. The voltage at the COMP pin is compared to the switch current measured internally to control the output voltage.

The converter uses internal N-Channel MOSFET switches to step-down the input voltage to the regulated output voltage. Since the high side MOSFET requires a gate voltage greater than the input voltage, a boost capacitor connected between SW and BS is needed to drive the high side gate. The boost capacitor is charged from the internal 5V rail when SW is low.

When the MA5605 FB pin exceeds 10% of the nominal regulation voltage of V_{FB}, the over voltage comparator is tripped and the COMP pin is discharged to GND, forcing the high-side switch off.

❖ APPLICATION INFORMATION

Setting the Output Voltage

The output voltage is set using a resistive voltage divider from the output voltage to FB pin. The voltage divider divides the output voltage down to the feedback voltage by the ratio.
Thus the output voltage is:

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

For example, V_{FB} =1.00V for a 5.0V output voltage, R2 is 10kΩ, and R1 is 40kΩ.

Inductor Selection

The inductor is required to supply constant current to the output load while being driven by the switched input voltage. A larger value inductor will result in less ripple current that will result in lower output ripple voltage. However, the larger value inductor will have a larger physical size, higher series resistance, and/or lower saturation current. A good rule for determining the inductance to use is to allow the peak-to-peak ripple current in the inductor to be approximately 30% of the maximum switch current limit.

VIN	<28V	<35V
Inductor	33uH	47uH

The choice of which style inductor to use mainly depends on the price vs. size requirements and any EMI requirements.

Output Short-Circuit protection

The MA5605 provides output short-circuit protection retry function. When VOUT is short (VFB<0.5V), the auto restart function can be started that restart the regulator cycle by cycle. (Retry time 1mS , Shutdown regulator time 20mS) .

Output Cable Resistance Compensation

To compensate for resistive voltage drop across the charger's output cable, the MA5605 integrates a simple, user-programmable cable voltage drop compensation using the impedance at the FB pin. Use the curve in Figure 1 to choose the proper feedback resistance values for cable compensation. R1 is the high side resistor of voltage divider.

$$V_{OUT} = V_{FB} \times (1+R1/R2) + R1 \times I_{CFB}$$

VIN12V TO 5VOUT (R_{ESE}=38mΩ)

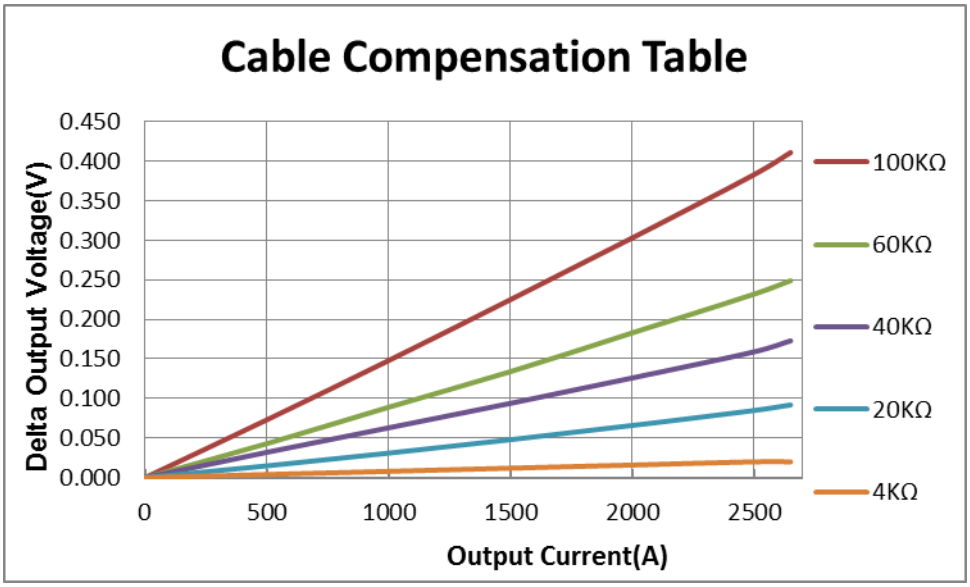


Figure1 Cable Compensation at Various Resistor Divider Values

When ISEN1 is max setting current, it can provide cable compensation amount (0.17V). And ISEN2 output current with ISEN1 at the same time, they totally can provide cable compensation amount (0.34V)

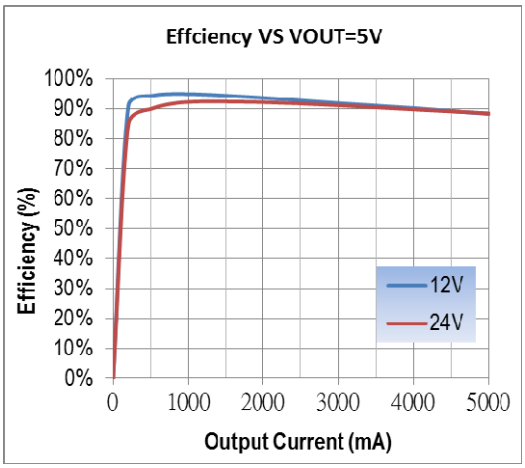
Setting Current : ISEN1=0.1V/0.038R=2600mA , ISEN2=0.1V/0.080R=1250mA,R1=40KΩ

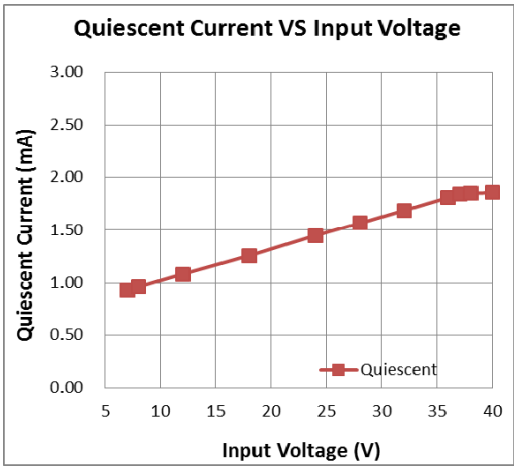
Example1: ISEN1=2600mA , ISEN2=1250mA The cable compensation amount 0.34V

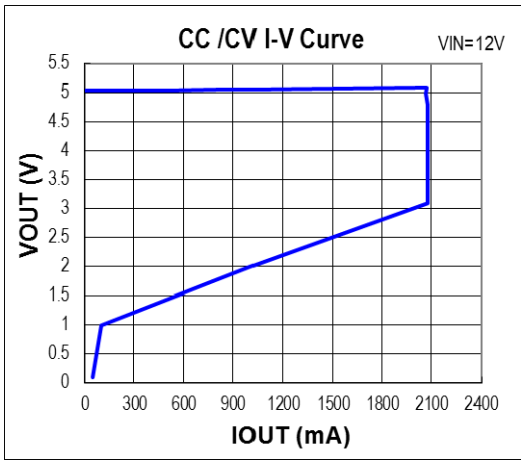
Example2: ISEN1=2600mA , ISEN2=0mA The cable compensation amount 0.17V

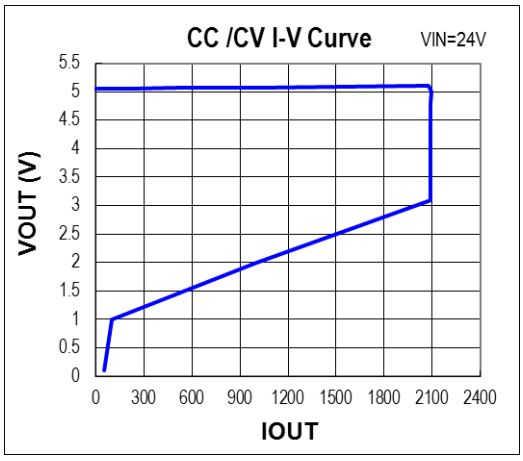
Example3: ISEN1=0mA , ISEN2=1250mA The cable compensation amount 0.17V

❖ TYPICAL CHARACTERISTICS

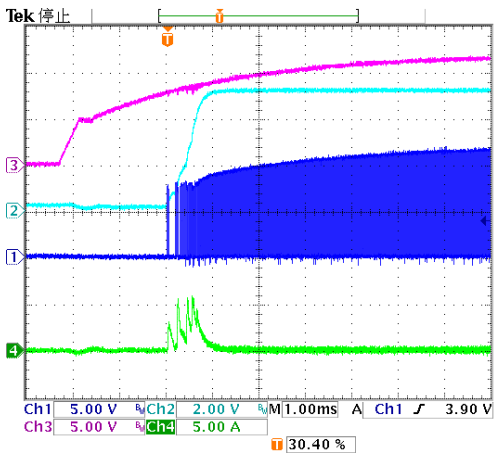






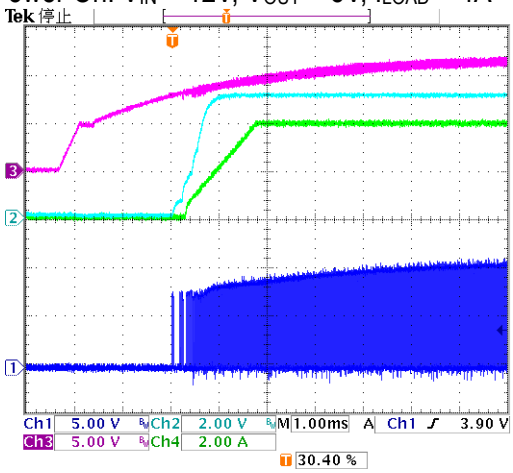


Power On: V_{IN} = 12V, V_{OUT} = 5V, I_{LOAD} = 0A



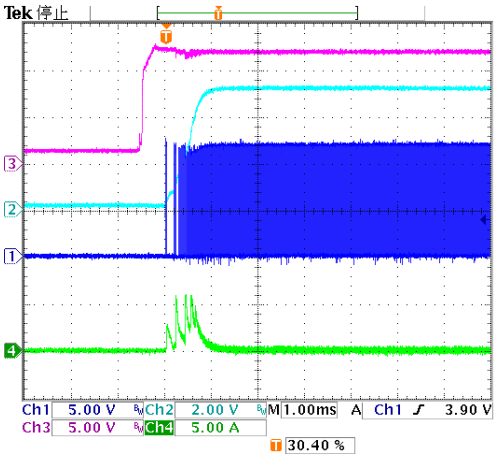
Ch1=SW , Ch2=V_{OUT} ,Ch3=V_{IN} , Ch4=I_{SW}

Power On: V_{IN} = 12V, V_{OUT} = 5V, I_{LOAD} = 4A



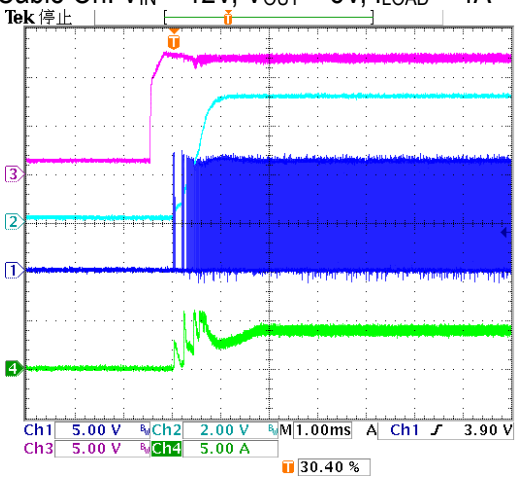
Ch1=SW , Ch2=V_{OUT} ,Ch3=V_{IN} , Ch4=I_{OUT}

Cable On: V_{IN} = 12V, V_{OUT} = 5V, I_{LOAD} = 0A



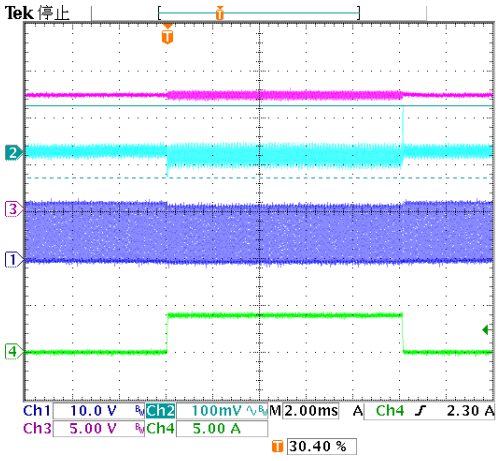
Ch1=SW , Ch2=V_{OUT} ,Ch3=V_{IN} , Ch4=I_{SW}

Cable On: V_{IN} = 12V, V_{OUT} = 5V, I_{LOAD} = 4A



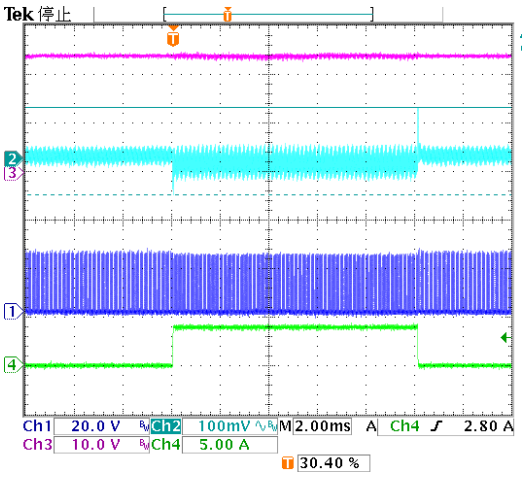
Ch1=SW , Ch2=V_{OUT} ,Ch3=V_{IN} , Ch4=I_{SW}

12VIN Load Transient: ILOAD = 0A to 4A



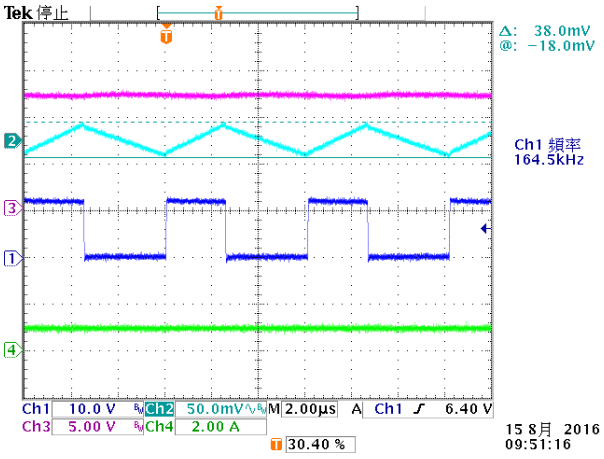
Ch1=SW , Ch2= V_{RIPPLE} ,Ch3=V_{IN} , Ch4=I_{SW}

24VIN Load Transient: ILOAD = 0A to 4A



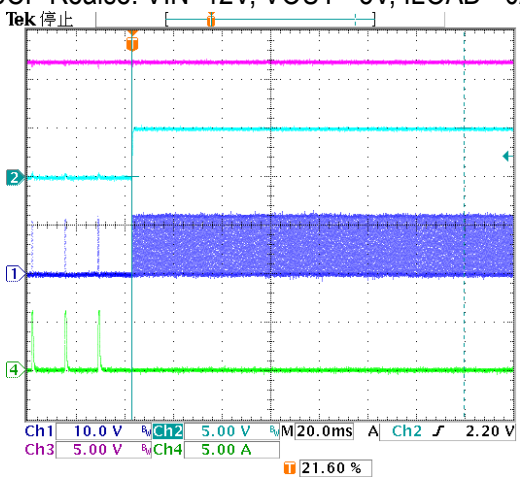
Ch1=SW , Ch2= V_{RIPPLE} ,Ch3=V_{IN} , Ch4=I_{OUT}

SW: VIN =12V, VOUT=5V, ILOAD = 0A



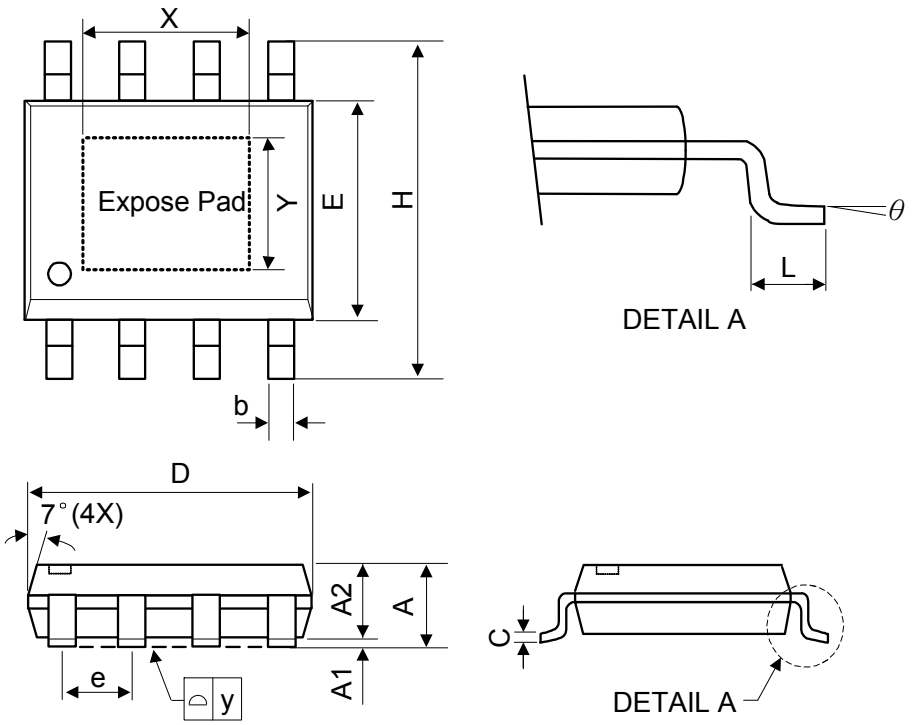
Ch1=SW , Ch2=V_{RIPPLE} ,Ch3=V_{IN} , Ch4=I_{OUT}

SCP Realse: VIN=12V, VOUT= 5V, ILOAD= 0A



Ch1=SW , Ch2=V_{OUT} ,Ch3=V_{IN} , Ch4=I_{SW}

❖ PACKAGE OUTLINES



Symbol	Dimensions in Millimeters			Dimensions in Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	-	-	1.75	-	-	0.069
A1	0	-	0.15	0	-	0.06
A2	1.25	-	-	0.049	-	-
C	0.1	0.2	0.25	0.0075	0.008	0.01
D	4.7	4.9	5.1	0.185	0.193	0.2
E	3.7	3.9	4.1	0.146	0.154	0.161
H	5.8	6	6.2	0.228	0.236	0.244
L	0.4	-	1.27	0.015	-	0.05
b	0.31	0.41	0.51	0.012	0.016	0.02
e	1.27 BSC			0.050 BSC		
y	-	-	0.1	-	-	0.004
X	-	2.34	3.43	-	0.092	0.135
Y	-	2.34	2.54	-	0.092	0.10
θ	0°	-	8°	0°	-	8°

❖ Mold flash shall not exceed 0.25mm per side
❖ JEDEC outline: MS-012 BA