

6 channel Composite Power Supply for LCD Panel Monolithic IC MM3206 Series

Outline

This IC is a compound power supply developed for LCD panels and combines a booster + inversion 4-channel switching power supply with a LDO2 channel.

Both the booster and inversion have a built-in switching element to reduce the mounting footprint.

In addition, external component adjustment can be used to set the output voltage, oscillation frequency, soft start time, and protective circuit dead zone time.

It also has such built-in protective functions as overcurrent protection, over voltage protection, and thermal shutdown.

Features

- | | |
|------------------------------------|--|
| 1. Input voltage range | 2.7 to 5.5V |
| 2. Output voltage setting range | Booster: 6.5 to 16V
Inversion: -19 to -6V |
| 3. Built-in switching element | |
| 4. Oscillation frequency | 100 to 500kHz |
| 5. Overcurrent protective circuit | |
| 6. Over voltage protective circuit | |
| 7. Built-in thermal shutdown | |

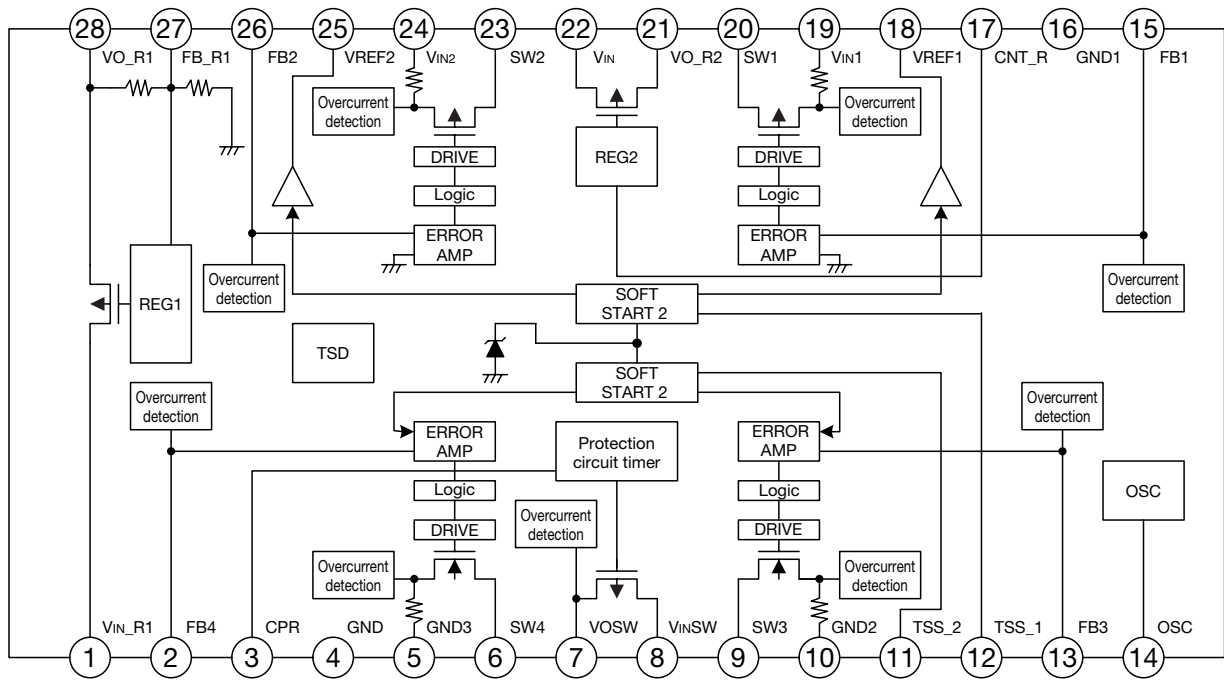
Package

SOP-28B

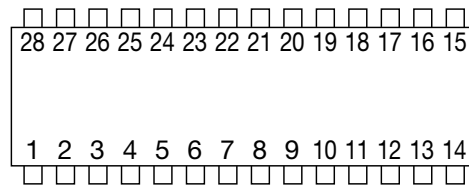
Applications

1. LCD panel
2. CCD

Block Diagram



Pin Assignment



SOP-28B
(TOP VIEW)

1	V _{IN_R1}	8	V _{INSW}	15	FB1	22	V _{IN}
2	FB4	9	SW4	16	GND1	23	SW2
3	CPR	10	GND2	17	CNT_R	24	V _{IN2}
4	GND	11	TSS_2	18	VREF1	25	VREF2
5	GND3	12	TSS_1	19	V _{IN1}	26	FB2
6	SW3	13	FB3	20	SW1	27	FB_R1
7	VOSW	14	OSC	21	VO_R2	28	VO_R1

Pin Description

Pin No.	Pin name	Functions	Internal equivalent circuit diagram
1	V _{IN_R1}	Power supply pin for regulator 1	
2 13	FB4 FB3	Output voltage detection pin for VH1, 2 (step-up DC-DC converters)	
3	CPR	Pin to connect an external capacitor for setting protection deadtime (Set the time by connecting a capacitor between the pin and GND)	
4	GND	GND pin	
5 10	GND3 GND2	GND pin for switching VH1, 2 (step-up DC-DC converters)	
6 9	SW3 SW4	Switching pin for VH1, 2 (step-up DC-DC converters)	
7	VOSW	Load switch output pin for VH1, 2 (step-up DC-DC converters)	
8	VINSW	Load switch input pin for VH1, 2 (step-up DC-DC converters) (Use at the same potential as that of V _{IN} , V _{IN1} , and V _{IN2})	

Pin No.	Pin name	Functions	Internal equivalent circuit diagram
11	TSS_2	Pin to connect a capacitor for setting soft start time for VH1, 2 (step-up DC-DC converters) (Set the time by connecting a capacitor between the pin and GND)	
12	TSS_1	Pin to connect a capacitor for setting soft start time for VL1, 2 (inverting DC-DC converters) (Set the time by connecting a capacitor between the pin and GND)	
14	OSC	Pin to connect a resistor for setting frequency (Set frequency by connecting a resistor between the pin and GND)	
15 26	FB1 FB2	Output voltage detection pin for VL1, 2 (inverting DC-DC converters)	
16	GND1	GND pin	
17	CNT_R	ON/OFF pin for the outputs of regulator 2	
18 25	VREF1 VREF2	Reference voltage output pin for VL1, 2 (inverting DC-DC converters)	

Pin No.	Pin name	Functions	Internal equivalent circuit diagram
19 24	V _{IN1} V _{IN2}	Power supply pin for switching VL1, 2 (inverting DC-DC converters)	
20 23	SW1 SW2	Switching pin for VL1, 2 (inverting DC-DC converters)	
21	VO_R2	Output pin for regulator 2	
22	V _{IN}	Power supply pin for VL1, 2 (inverting DC-DC converters), and input pin for regulator 2	Refer to pin 21.
27	FB_R1	Reference voltage pin for regulator 1	Refer to pin 1.
28	VO_R1	Output pin for regulator 1	Refer to pin 1.

Absolute Maximum Ratings (Ta=25°C)

Item	Symbol	Ratings	Units
Storage temperature	T _{STG}	-55~+150	°C
Operating temperature	T _{OPR}	-40~+95	°C
Input voltage	V _{IN max.}	6	V
SW1, 2 voltage	V _{SW1, 2 max.}	-22	V
SW3, 4 voltage	V _{SW3, 4 max.}	22	V
FB voltage	V _{FB max.}	6	V
VREF voltage	V _{REF max.}	6	V
V _{IN_R1} voltage	V _{INR1 max.}	12	V
CNTRL voltage	V _{CNTRL max.}	V _{IN} +0.3	V
Allowable loss	P _{d max.}	1.7 *1	W

Note : *1 With PC Board of glass epoxy. (21.3×38.1×1.0^tmm)

Recommended Operating Conditions (Ta=25°C)

Item	Symbol	Ratings	Units
Operating temperature	T _{OPR}	-40~+95 *1	°C
VIN input voltage	V _{IN}	2.7~5.5	V
VH1 output voltage	VH1	6.5~16	V
VH2 output voltage	VH2	6.5~16	V
VL1 output voltage	VL1	-19~-6	V
VL2 output voltage	VL2	-19~-6	V
VO_R1 output current	IOR1	0~85	mA
VO_R2 output current	IOR2	0~85	mA

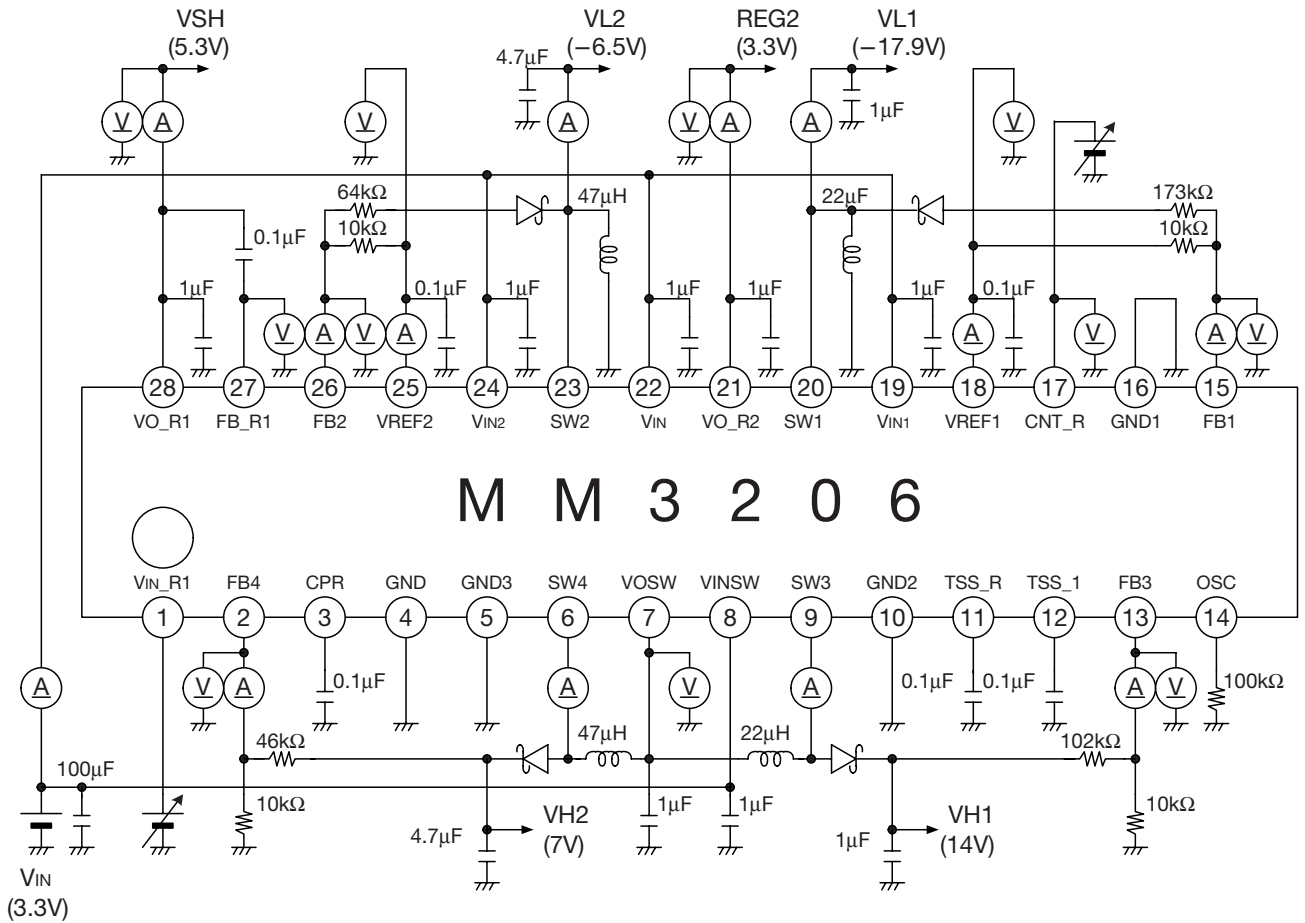
Note : *1 The IC is not tested at high or low temperature. Therefore the operating temperature is guaranteed by design.

Electrical Characteristics (Except where noted otherwise Ta=25°C, V_{IN}=3.3V)

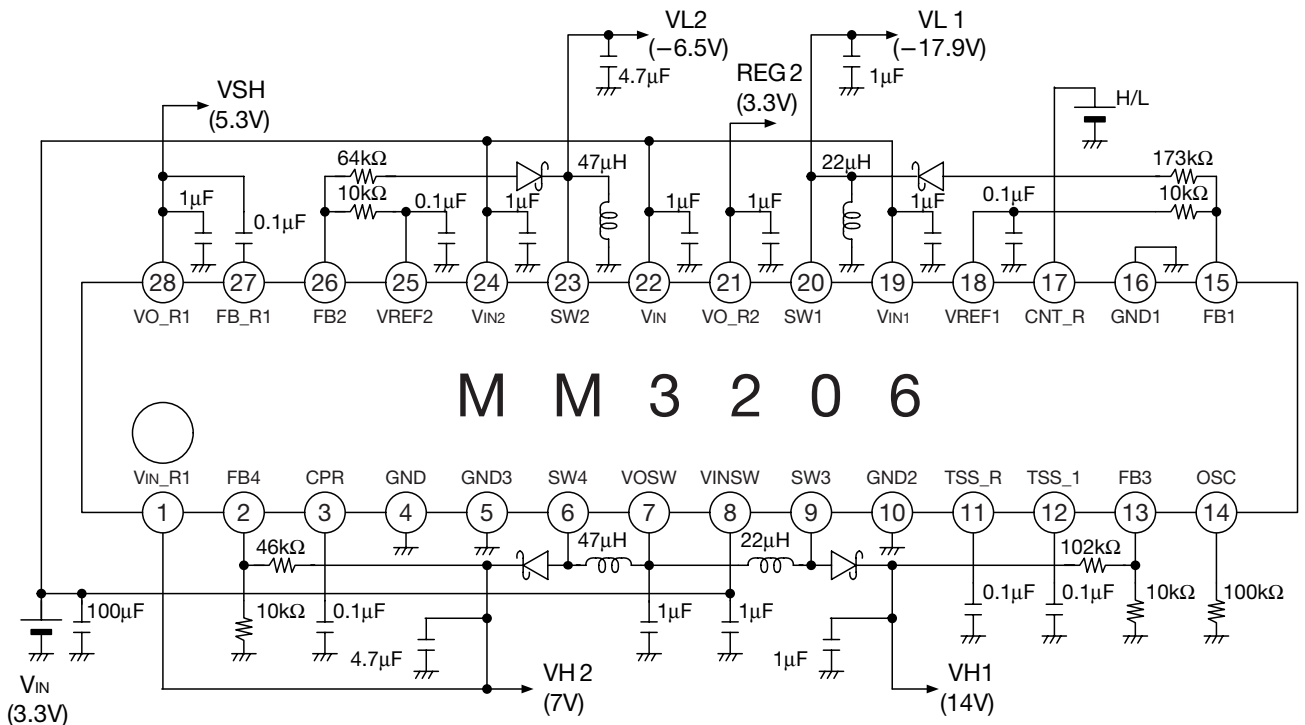
Item	Symbol	Measurement conditions	Min.	Typ.	Max.	Units
GENERAL						
Minimum start-up voltage	V _{IN min.}				2.7	V
Operating supply current	I _{IN}	Non switching		6.0	15	mA
OSCILLATOR						
Oscillator frequency	f _{OSC}	R _{osc} =100kΩ	176	200	224	kHz
Oscillator frequency Range	f _{OSCR}		100		500	kHz
REFERENCE 1						
Reference voltage 1	V _{REF1}	I _{REF1} =10μA	1.237	1.250	1.263	V
Reference line regulation 1	V _{REFLINE 1}	V _{IN} =2.7~5.5V		2		mV
Reference load regulation 1	V _{REFLOAD1}	I _{REF1} =0~100μA		5		mV
Reference voltage current Ability 1	I _{REF1}			1		mA
REFERENCE 2						
Reference voltage 2	V _{REF2}	I _{REF2} =10μA	1.237	1.250	1.263	V
Reference line regulation 2	V _{REFLINE2}	V _{IN} =2.7~5.5V		2		mV
Reference load regulation 2	V _{REFLOAD2}	I _{REF2} =0~100μA		5		mV
Reference voltage current Ability 2	I _{REF2}			1		mA
VL1 (BACK-BOOST DCDC)						
FB1 regulation voltage	V _{FB1}	For start switching	0.195	0.200	0.205	V
FB1 current	I _{FB1}			20	100	nA
Maximum On Duty 1	MAXDUTY1	V _{FB1} =1.25V	90	95		%
Soft start time 1	t _{SS1}	C _{SS1} =0.1μF		5		ms
SW1 ON resistance	RON1	Guaranteed by design		3		Ω
SW1 Leakage current	ILEAK1	V _{SW1} =-22V		0	5	μA
SW1 current Limit	ILIM1			1000		mA
Current Sense resistance 1	RCS1	Guaranteed by design		0.2		Ω
VL2 (BACK-BOOST DC-DC)						
FB2 regulation voltage	V _{FB2}	For start switching	0.195	0.200	0.205	V
FB2 current	I _{FB2}			20	100	nA
Maximum On Duty 2	MAXDUTY2	V _{FB2} =1.25V	90	95		%
Soft start time 2	t _{SS2}	C _{SS2} =0.1μF		5		ms
SW2 ON resistance	RON2	Guaranteed by design		3		Ω
SW2 Leakage current	ILEAK2	V _{SW2} =-22V		0	5	μA
SW2 current Limit	ILIM2			1000		mA
Current Sense resistance 2	RCS2	Guaranteed by design		0.2		Ω

Item	Symbol	Measurement conditions	Min.	Typ.	Max.	Units
VH1 (BOOST DC-DC)						
FB3 regulation voltage	V _{FB3}	For start switching	1.237	1.250	1.263	V
FB3 current	I _{FB3}			20	100	nA
Maximum On Duty 3	MAXDUTY3	VFB3=0V	90	95		%
Soft start time 3	t _{SS3}	CSS3=0.1μF		5		ms
SW3 ON resistance	RON3	Guaranteed by design		2		Ω
SW3 Leakage current	ILEAK3	VSW3=22V		0	5	μA
SW3 current limit	ILIM3			1000		mA
Current Sense resistance 3	RCS3	Guaranteed by design		0.2		Ω
VH2 (BOOST DC-DC)						
FB4 regulation voltage	V _{FB4}	For start switching	1.237	1.250	1.263	V
FB4 current	I _{FB4}			20	100	nA
Maximum On Duty 4	MAXDUTY4	VFB4=0V	90	95		%
Soft start time 4	t _{SS4}	CSS4=0.1μF		5		ms
SW4 ON resistance	RON4	Guaranteed by design		2		Ω
SW4 Leakage current	ILEAK4	VSW4=22V		0	5	μA
SW4 current Limit	ILIM4			1000		mA
Current Sense resistance 4	RCS4	Guaranteed by design		0.2		Ω
REGULATOR 1						
R1 output voltage	VO_R1	IOR1=1mA	5.2	5.3	5.4	V
R1 FB voltage	V _{FB1}			1.25		V
R1 dropout voltage	V _{DROPR1}	IOR1=85mA, VIN1=5.1V		0.20	0.32	V
R1 Feed Back resistance	R _{FB1}	Guaranteed by design		500		kΩ
R1 line regulation	V _{LINER1}	VIN1=5.8~12V		0.2		%/V
R1 load regulation	V _{LOADR1}	IOR1=1~85mA		22		mV
REGULATOR 2						
R2 output voltage	VO_R2	IOR2=1mA, VIN=5V	3.2	3.3	3.4	V
R2 dropout voltage	V _{DROPR2}	IOR2=85mA, VIN=3.1V		0.10	0.16	V
R2 line regulation	V _{LINER2}	VIN=3.8~5.5V		0.2		%/V
R2 load regulation	V _{LOADR2}	IOR2=1~85mA, VIN=5V		22		mV
CNT pin threshold voltage H	VCNTH	VIN=5V	1.5			V
CNT pin threshold voltage L	VCNTL	VIN=5V			0.4	V
CNT pin bias current	ICNT	VIN=5V		6		μA
PROTECTION CIRCUIT						
V _{IN} start voltage	V _{INST}	V _{IN} =L→H	2.3	2.4	2.5	V
V _{IN} stop voltage	V _{INSP}	V _{IN} =H→L	2.2	2.3	2.4	V
FB1 over voltage detection	V _{OVFB1}		0.00	0.06	0.12	V
FB2 over voltage detection	V _{OVFB2}		0.00	0.06	0.12	V
FB3 over voltage detection	V _{OVFB3}		1.40	1.50	1.60	V
FB4 over voltage detection	V _{OVFB4}		1.40	1.50	1.60	V
Input SW ON resistance	RONSW	Guaranteed by design		0.3		Ω
VINSW over current detection	IOCSW	Guaranteed by design	1.9	2.0	2.1	A
Protecton circuit dead time	tPDT	CPDT=0.1μF		100		ms
Protecton circuit dead time	tPDTR		50		500	ms
Protecton circuit reset voltage	VR		0		1.0	V

Measuring Circuit



Application Circuit



Note

■ How to calculate Pd.

Power loss calculation

$$VGH \text{ power loss : } PLGH = VGH \times IOGH \times (100 / \eta_{GH} - 1) \dots(1)$$

$$VS+ \text{ power loss : } PLS+ = VS+ \times (IOS++ + IOR1) \times (100 / \eta_{S+} - 1) \dots(2)$$

$$VGL \text{ power loss : } PLGL = VGL \times (IOGL) \times (100 / \eta_{GL} - 1) \dots(3)$$

$$VS- \text{ power loss : } PLS- = VS- \times (IOS--) \times (100 / \eta_{S-} - 1) \dots(4)$$

$$REG1 (VSH) \text{ power loss : } PLR1 = (VS+ - VR1) \times IOR1 \dots(5)$$

$$REG2 \text{ power loss : } PLR2 = (VIN - VR2) \times IOR2 \dots(6)$$

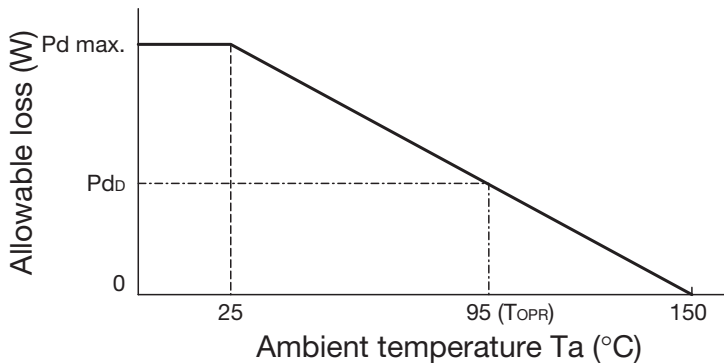
$$VINSW \text{ power loss : } PLSW = [\{ VGH \times IOGH \times 100 / \eta_{GH} + VS+ \times (IOS++ + IOR1) \times 100 / \eta_{S+} \} / (VIN)] 2 \times RONSW \dots(7)$$

$$\text{Total power loss: } PLTTL = (1) + (2) + (3) + (4) + (5) + (6) + (7)$$

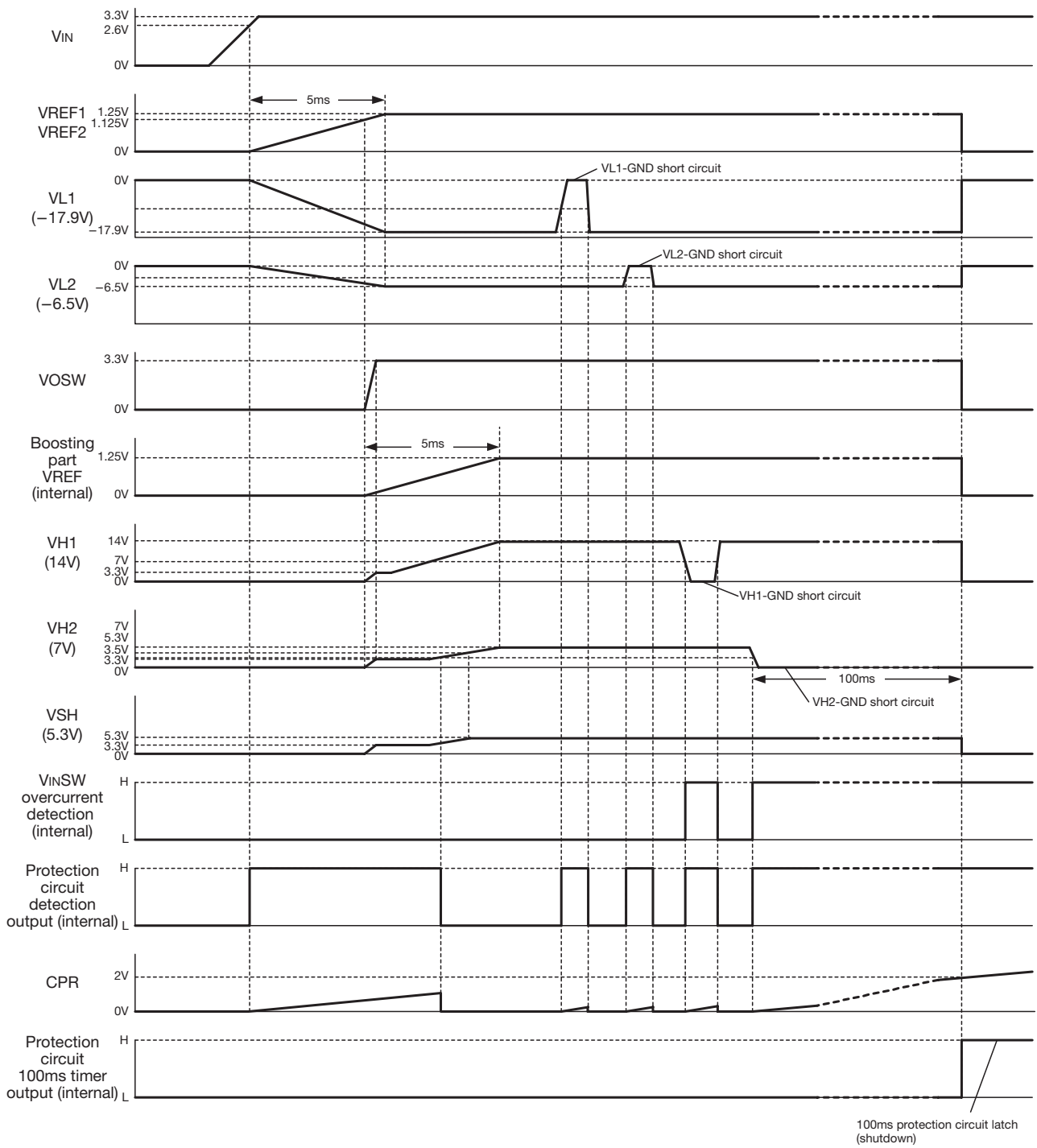
Derating power dissipation

$$PdD = PdMAX \times [1 - \{ (T_{opr} - 25^\circ C) / (T_{jMAX} - 25^\circ C) \}] = PdMAX \times [1 - \{ (95^\circ C - 25^\circ C) / (150^\circ C - 25^\circ C) \}]$$

Pd should be determined for recommended temperature as follow. PdD > PLTTL.

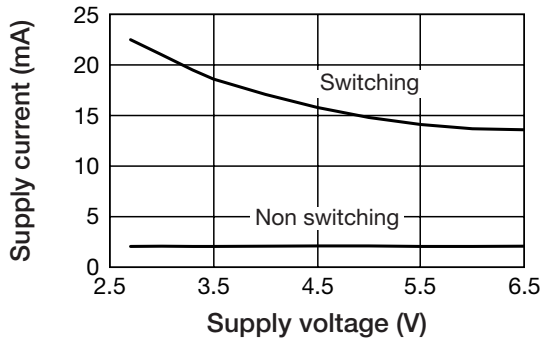


Timing Chart

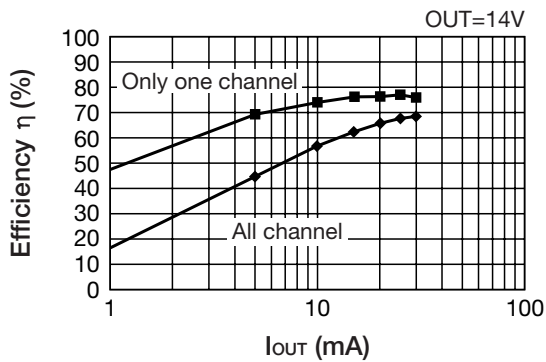


Characteristics (Except where noted otherwise $T_a=25^{\circ}\text{C}$, $V_{IN}=3.3\text{V}$, $V_{H1}=14\text{V}$, $V_{H2}=7\text{V}$, $V_{L1}=-17.9\text{V}$, $V_{L2}=-6.5\text{V}$)

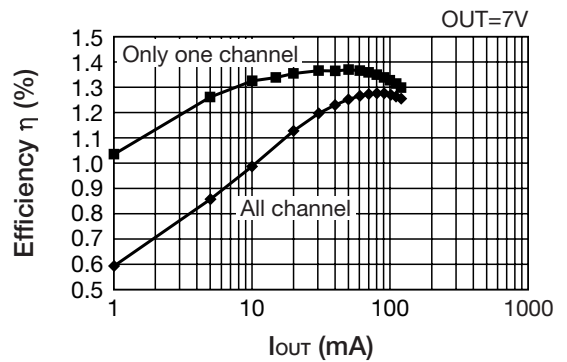
■ Supply current – Supply voltage



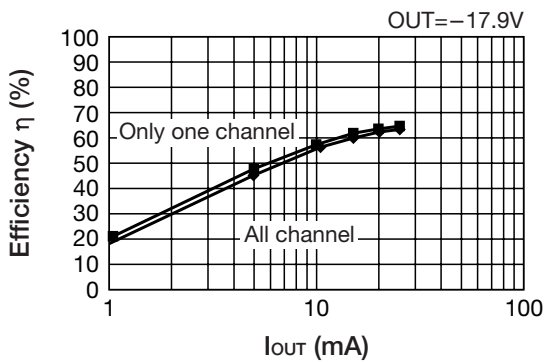
■ VH1_Efficiency – Load current



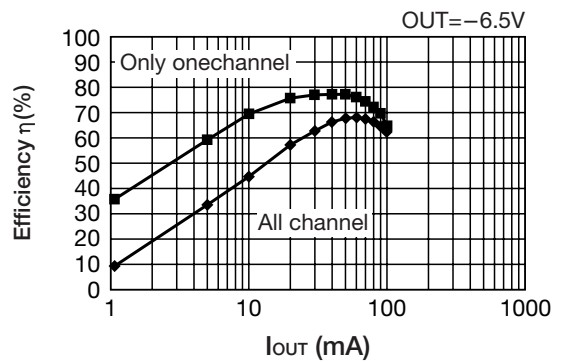
■ VH2_Efficiency – Load current



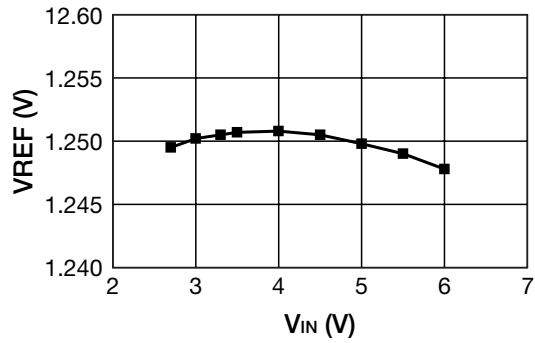
■ VL1_Efficiency – Load current



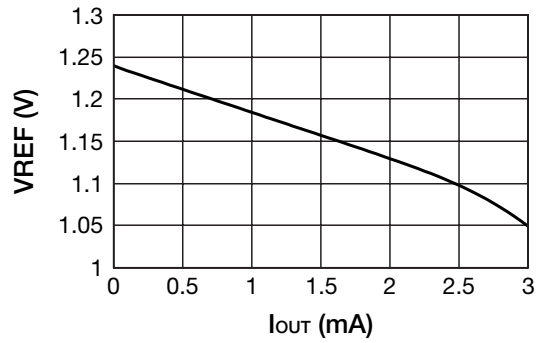
■ VL2_Efficiency – Load current



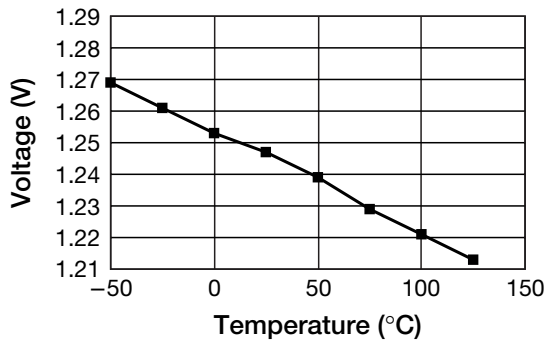
■ VREF output voltage – Input voltage



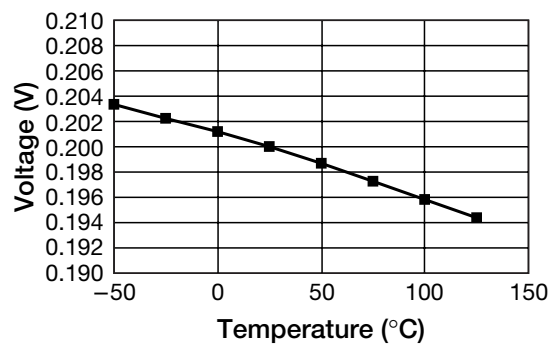
■ VREF output voltage – Input voltage



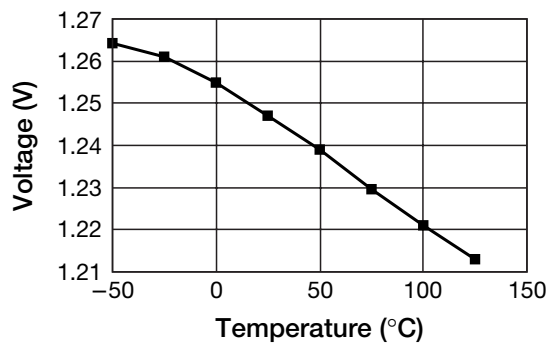
■ VREF output voltage – Temperature



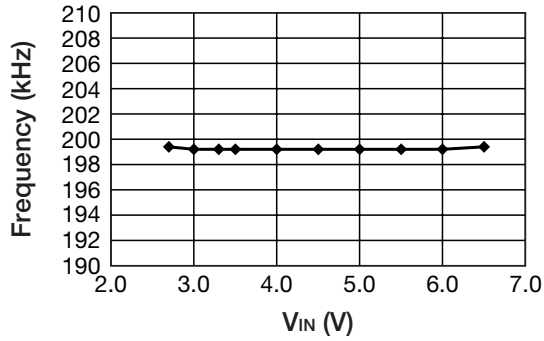
■ FB1, 2 output voltage – Temperature



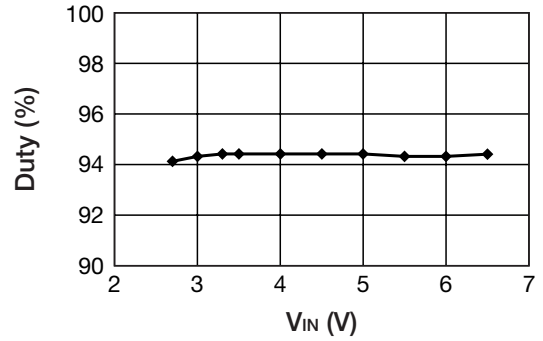
■ FB3, 4 output voltage – Temperature



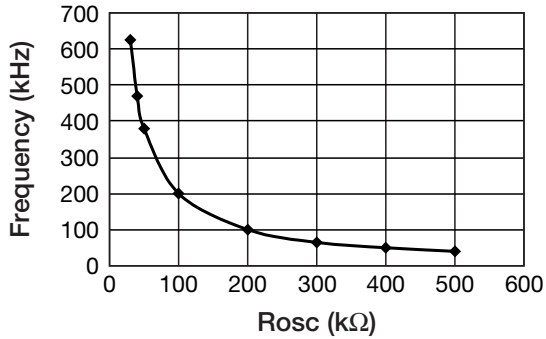
■ Switching frequency – Input voltage



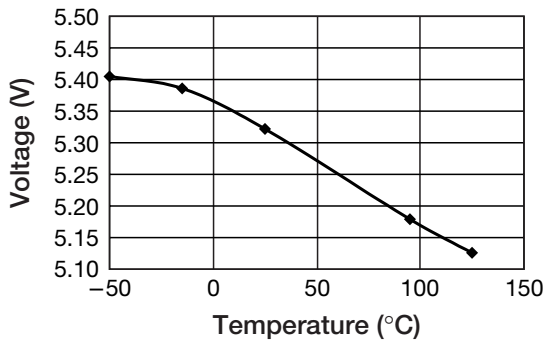
■ PWM MAX Duty – Input voltage



■ Rosc – Frequency



■ REG1 output current – Temperature



■ REG2 output current – Temperature

