FUJITSU SEMICONDUCTOR
DATA SHEET

DS04-27232-3E

ASSP For Power Management Applications (DC/DC Converter for DSC/Camcorder)

4-ch DC/DC Converter IC

MB39A102

■ DESCRIPTION

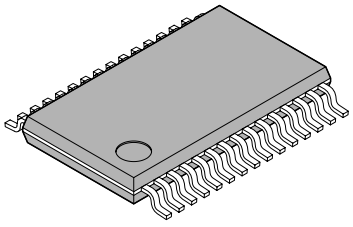
The MB39A102 is a 4-channel DC/DC converter IC using pulse width modulation (PWM). This IC is ideal for up conversion, down conversion, and up/down conversion.
4ch is built in TSSOP-30P/BCC-32P package. Each channel can be controlled, and soft-start.
This is an ideal power supply for high-performance portable devices such as digital still cameras.

■ FEATURES

- Supports for down-conversion and up/down Zeta conversion (CH1 to CH3)
- Supports for up-conversion and up/down Sepic conversion (CH4)
- Power supply voltage range : 2.5 V to 11 V
- Reference voltage : 2.0 V ± 1 %
- Error amplifier threshold voltage : 1.24 V ± 1.5 %
- Built-in totem-pole type output for MOS FET
- Built-in soft-start circuit without load dependence
- High-frequency operation capability : 1.5 MHz (Max)
- External short-circuit detection capability by –INS terminal

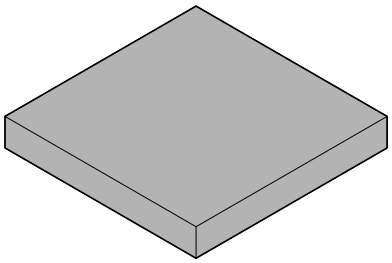
■ PACKAGES

30-pin plastic TSSOP



(FPT-30P-M04)

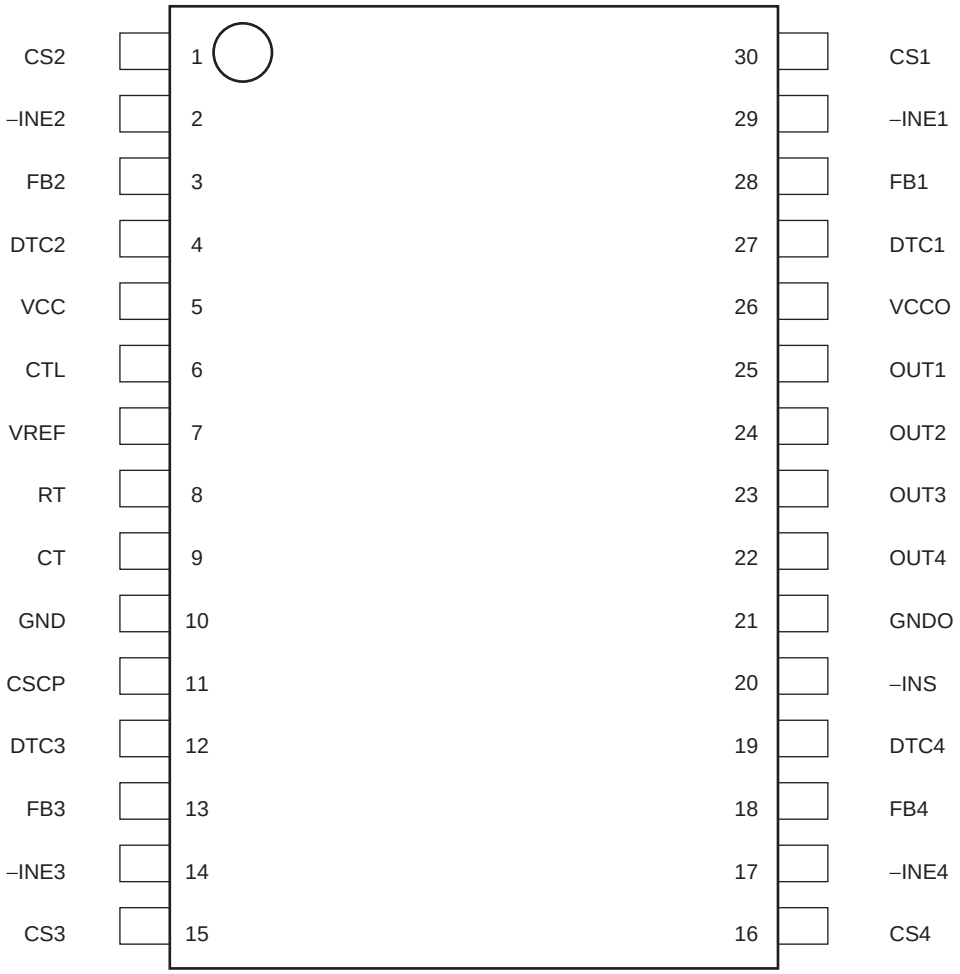
32-pad plastic BCC



(LCC-32P-M15)

■ PIN ASSIGNMENTS

(TOP VIEW)



(FPT-30P-M04)

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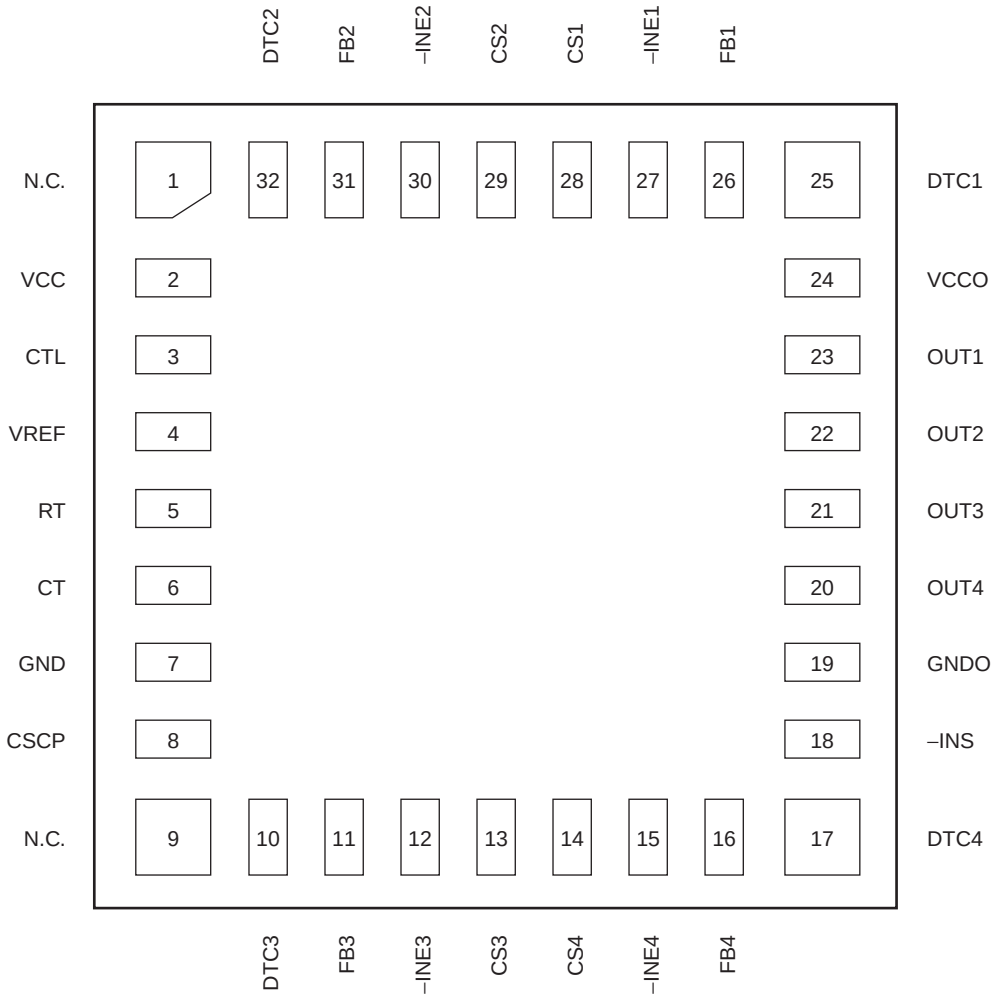
(TOP VIEW)
(Penetration diagram from surface)

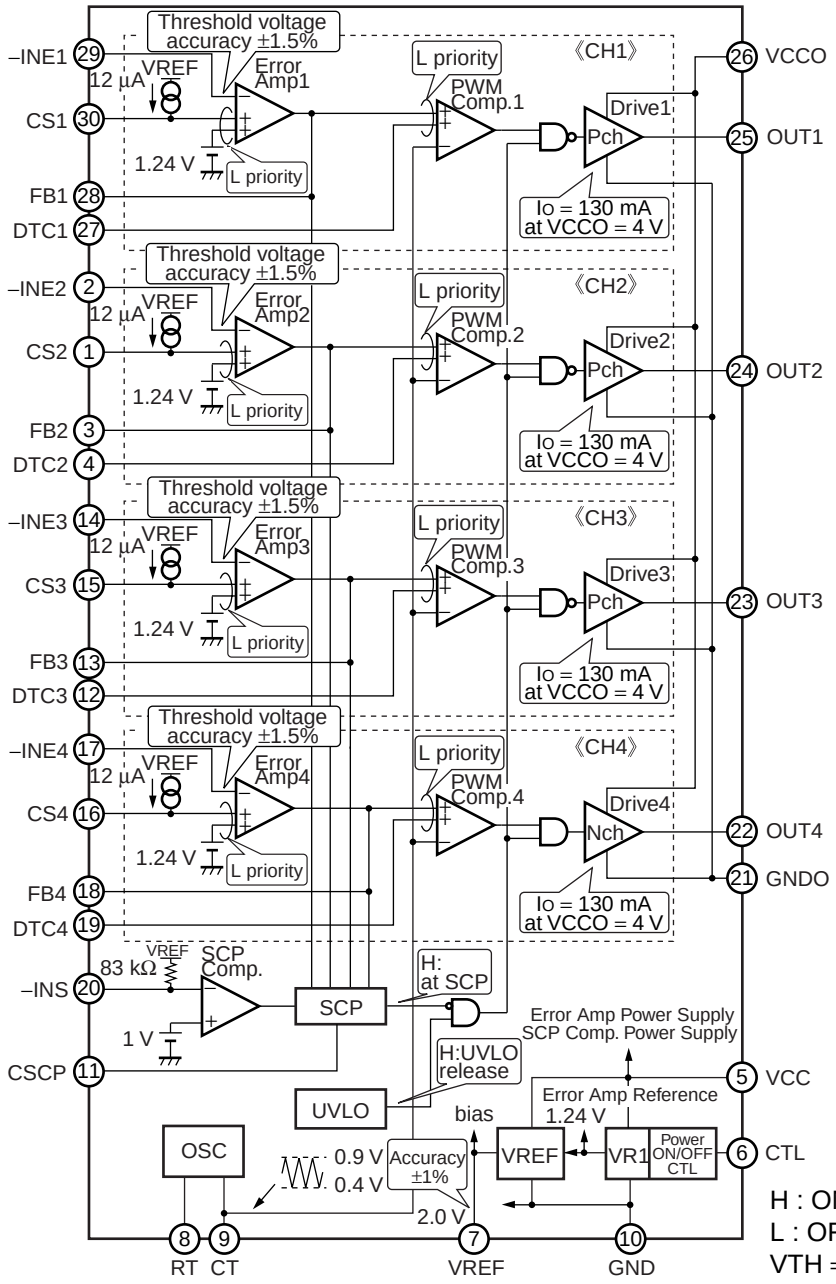


(LCC-32P-M15)

■ PIN DESCRIPTION

Block	Pin No.		Symbol	I/O	Descriptions
	TSSOP	BCC			
CH1	27	25	DTC1	I	Dead time control terminal
	28	26	FB1	O	Error amplifier output terminal
	29	27	–INE1	I	Error amplifier inverted input terminal
	30	28	CS1	—	Soft-start capacitor connection terminal
	25	23	OUT1	O	Output terminal
CH2	4	32	DTC2	I	Dead time control terminal
	3	31	FB2	O	Error amplifier output terminal
	2	30	–INE2	I	Error amplifier inverted input terminal
	1	29	CS2	—	Soft-start capacitor connection terminal
	24	22	OUT2	O	Output terminal
CH3	12	10	DTC3	I	Dead time control terminal
	13	11	FB3	O	Error amplifier output terminal
	14	12	–INE3	I	Error amplifier inverted input terminal
	15	13	CS3	—	Soft-start capacitor connection terminal
	23	21	OUT3	O	Output terminal
CH4	19	17	DTC4	I	Dead time control terminal
	18	16	FB4	O	Error amplifier output terminal
	17	15	–INE4	I	Error amplifier inverted input terminal
	16	14	CS4	—	Soft-start capacitor connection terminal
	22	20	OUT4	O	Output terminal
OSC	9	6	CT	—	Triangular wave frequency setting capacitor connection terminal
	8	5	RT	—	Triangular wave frequency setting resistor connection terminal
Control	6	3	CTL	I	Power supply and control terminal
	11	8	CSCP	—	Short-circuit detection circuit capacitor connection terminal
	20	18	–INS	I	Short-circuit detection comparator inverted input terminal
Power	26	24	VCCO	—	Output block power supply terminal
	5	2	VCC	—	Power supply terminal
	7	4	VREF	O	Reference voltage output terminal
	21	19	GNDO	—	Output block ground terminal
	10	7	GND	—	Ground terminal

■ BLOCK DIAGRAM



■ ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Condition	Rating		Unit
			Min	Max	
Power supply voltage	V_{CC}	VCC, VCCO terminals	—	12	V
Output current	I_O	OUT1 to OUT4 terminals	—	20	mA
Output peak current	I_{OP}	OUT1 to OUT4 terminals Duty ≤ 5% (t = 1/f_{OSC}×Duty)	—	400	mA
Power dissipation	P_D	Ta ≤ +25 °C (TSSOP-30P)	—	1390*	mW
		Ta ≤ +25 °C (BCC-32P)	—	980*	mW
Storage temperature	T_{STG}	—	−55	+125	°C

* : The packages are mounted on the epoxy board (10 cm × 10 cm).

WARNING: Semiconductor devices can be permanently damaged by application of stress (voltage, current, temperature, etc.) in excess of absolute maximum ratings. Do not exceed these ratings.

■ RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Condition	Value			Unit
			Min	Typ	Max	
Power supply voltage	V_{CC}	VCC, VCCO terminals	2.5	4	11	V
Reference voltage output current	I_{REF}	VREF terminal	−1	—	0	mA
Input voltage	V_{INE}	−INE1 to −INE4 terminals	0	—	V_{CC} − 0.9	V
		−INS terminal	0	—	V_{REF}	V
	V_{DTC}	DTC1 to DTC4 terminals	0	—	V_{REF}	V
Control input voltage	V_{CTL}	CTL terminal	0	—	11	V
Output current	I_O	OUT1 to OUT4 terminals	−15	—	+15	mA
Oscillation frequency	f_{OSC}	*	100	500	1500	kHz
Timing capacitor	C_T	—	39	100	560	pF
Timing resistor	R_T	—	11	24	130	kΩ
Soft-start capacitor	C_S	CS1 to CS4 terminals	—	0.1	1.0	µF
Short detection capacitor	C_{SCP}	—	—	0.1	1.0	µF
Reference voltage output capacitor	C_{REF}	—	—	0.1	1.0	µF
Operating ambient temperature	Ta	—	−30	+25	+85	°C

* : See “■ SETTING THE TRIANGULAR OSCILLATION FREQUENCY”.

Note : Pin numbers referred after this part are present on TSSOP-30P PKG.

WARNING: The recommended operating conditions are required in order to ensure the normal operation of the semiconductor device. All of the device’s electrical characteristics are warranted when the device is operated within these ranges.

Always use semiconductor devices within their recommended operating condition ranges. Operation outside these ranges may adversely affect reliability and could result in device failure.

No warranty is made with respect to uses, operating conditions, or combinations not represented on the data sheet. Users considering application outside the listed conditions are advised to contact their FUJITSU representatives beforehand.

■ ELECTRICAL CHARACTERISTICS

(VCC = VCCO = 4 V, Ta = +25 °C)

Parameter		Symbol	Pin No	Conditions	Value			Unit
					Min	Typ	Max	
Reference voltage block [Ref]	Output voltage	V_{REF}	7	—	1.98	2.00	2.02	V
	Output voltage temperature variation	$\Delta V_{REF}/V_{REF}$	7	Ta = –30 °C to +85 °C	—	0.5*	—	%
	Input stability	Line	7	VCC = 2.5 V to 11 V	–10	—	+10	mV
	Load stability	Load	7	VREF = 0 mA to –1 mA	–10	—	+10	mV
Under voltage lockout protection circuit block [UVLO]	Threshold voltage	V_{TH}	25	VCC = ↓	1.7	1.8	1.95	V
	Hysteresis width	V_H	25	—	0.05	0.1	0.2	V
Short comparator detection block [SCP]	Threshold voltage	V_{TH}	11	—	0.65	0.70	0.75	V
	Input source current	I_{CSCP}	11	—	–1.4	–1.0	–0.6	µA
	Reset voltage	V_{RST}	25	VREF = ↓	1.5	1.7	1.9	V
Triangular wave oscillator block [OSC]	Oscillation frequency	f_{OSC}	22, 23, 24, 25	CT = 100 pF, RT = 24 kΩ	450	500	550	kHz
	Frequency temperature variation	$\Delta f_{OSC}/f_{OSC}$	22, 23, 24, 25	Ta = –30 °C to +85 °C	—	1*	—	%
Soft-start block [CS]	Charge current	I_{CS}	1, 15, 16, 30	CS1 to CS4 = 0 V	–16	–12	–8	µA
Error amplifier block [Error Amp1 to Error Amp4]	Threshold voltage	V_{TH}	3, 13, 18, 28	FB1 to FB4 = 0.65 V	1.222	1.240	1.258	V
	Input bias current	I_B	2, 14, 17, 29	–INE1 to –INE4 = 0 V	–120	–30	—	nA
	Voltage gain	A_V	3, 13, 18, 28	DC	—	100*	—	dB
	Frequency bandwidth	BW	3, 13, 18, 28	A_V = 0 dB	—	1.6*	—	MHz
	Output voltage	V_{OH}	3, 13, 18, 28	—	1.7	1.9	—	V
		V_{OL}	3, 13, 18, 28	—	—	40	200	mV
	Output source current	I_{SOURCE}	3, 13, 18, 28	FB1 to FB4 = 0.65 V	—	–2	–1	mA
	Output sink current	I_{SINK}	3, 13, 18, 28	FB1 to FB4 = 0.65 V	150	200	—	µA

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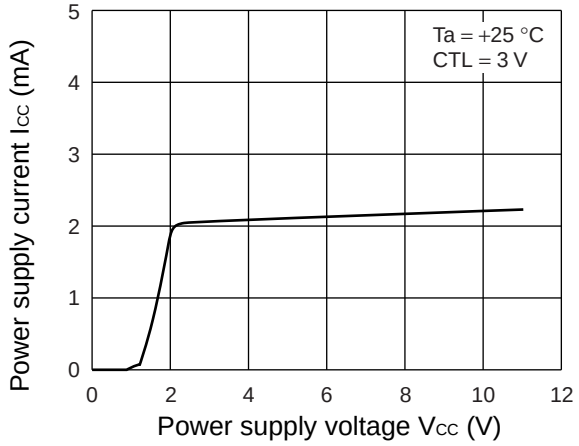
(VCC = VCCO = 4 V, Ta = +25 °C)

Parameter		Symbol	Pin No.	Conditions	Value			Unit
					Min	Typ	Max	
PWM comparator block [PWM Comp.1 to PWM Comp.4]	Threshold voltage	V_{T0}	22, 23, 24, 25	Duty cycle = 0 %	0.3	0.4	—	V
		V_{T100}	22, 23, 24, 25	Duty cycle = 100 %	—	0.9	1.0	V
	Input current	I_{DTC}	4, 12, 19, 27	DTC1 to DTC4 = 0.4 V	–2.0	–0.6	—	µA
Output block [Drive1 to Drive4]	Output source current	I_{SOURCE}	22, 23, 24, 25	Duty ≤ 5 % (t = 1/fosc×Duty) OUT1 to OUT4 = 0 V	—	–130	–75	mA
	Output sink current	I_{SINK}	22, 23, 24, 25	Duty ≤ 5 % (t = 1/fosc×Duty) OUT1 to OUT4 = 4 V	75	120	—	mA
	Output ON resistance	R_{OH}	22, 23, 24, 25	OUT1 to OUT4 = –15 mA	—	18	27	Ω
		R_{OL}	22, 23, 24, 25	OUT1 to OUT4 = 15 mA	—	18	27	Ω
Short detection comparator block [SCP Comp.]	Threshold voltage	V_{TH}	25	—	0.97	1.00	1.03	V
	Input bias current	I_B	20	–INS = 0 V	–29	–24	–21	µA
Control block [CTL]	CTL input voltage	V_{IH}	6	IC Active mode	1.7	—	11	V
		V_{IL}	6	IC Standby mode	0	—	0.8	V
	Input current	I_{CTLH}	6	CTL = 3 V	5	30	60	µA
		I_{CTLL}	6	CTL = 0 V	—	—	1	µA
General	Standby current	I_{CCS}	5	CTL = 0 V	—	0	2	µA
		I_{CCSO}	26	CTL = 0 V	—	0	2	µA
	Power supply current	I_{CC}	5	CTL = 3 V	—	2.1	4.5	mA

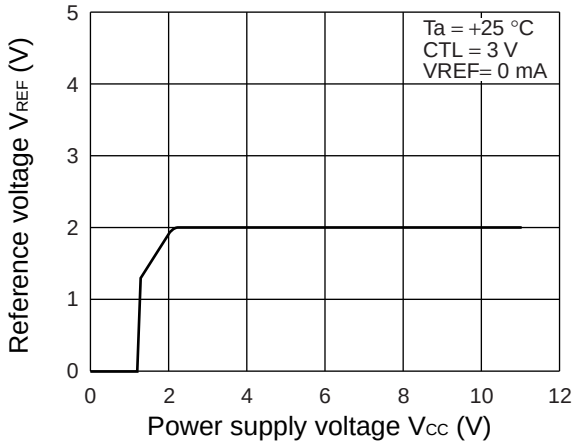
*: Standard design value.

■ TYPICAL CHARACTERISTICS

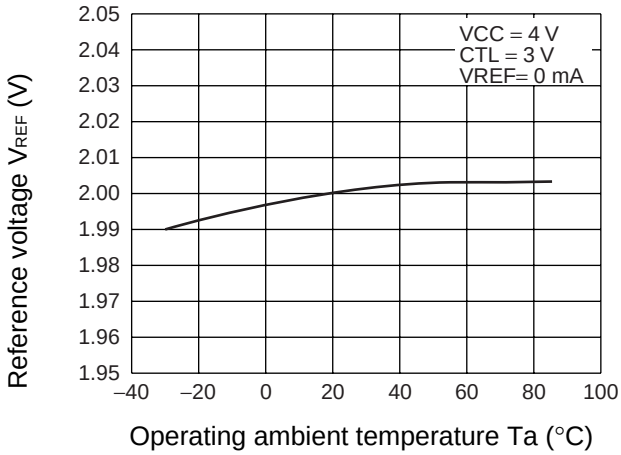
Power Supply Current vs. Power Supply Voltage



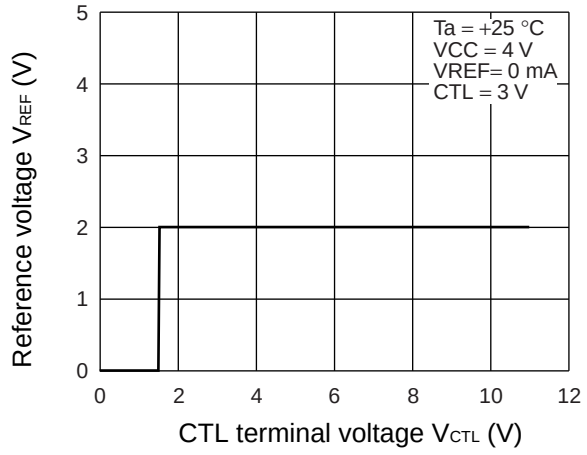
Reference Voltage vs. Power Supply Voltage



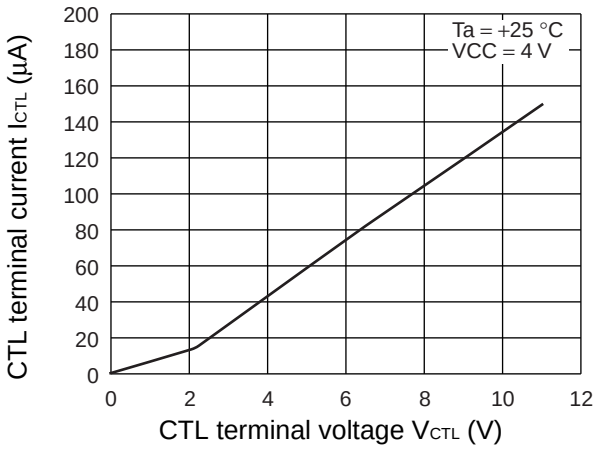
Reference Voltage vs. Operating Ambient Temperature



Reference Voltage vs. CTL terminal Voltage



CTL terminal Current vs. CTL terminal Voltage



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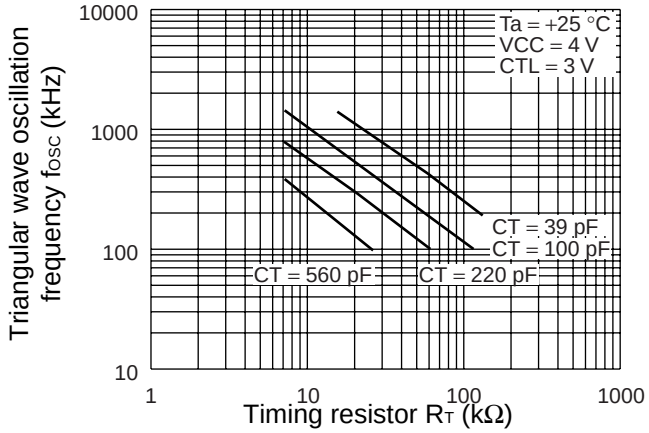
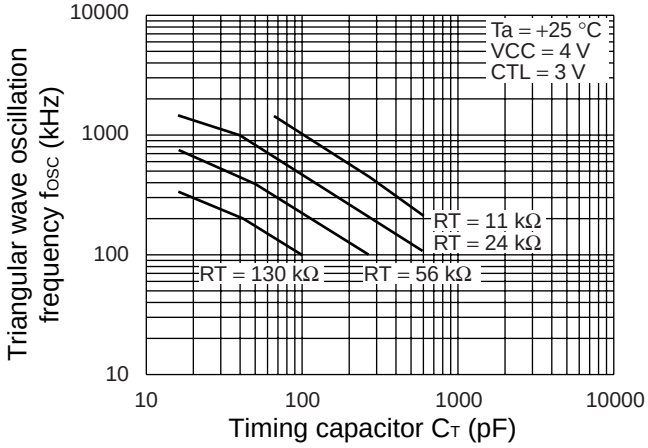
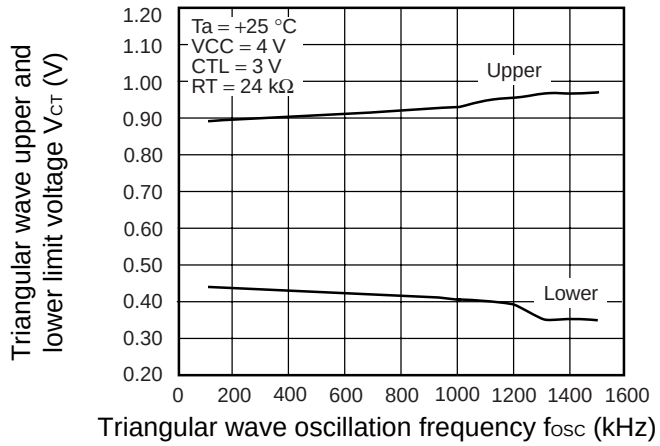
Triangular Wave Oscillation Frequency vs. Timing Resistor



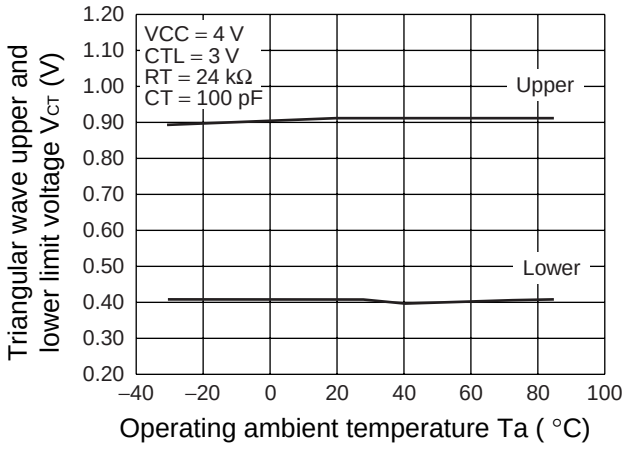
Triangular Wave Oscillation Frequency vs. Timing Capacitor



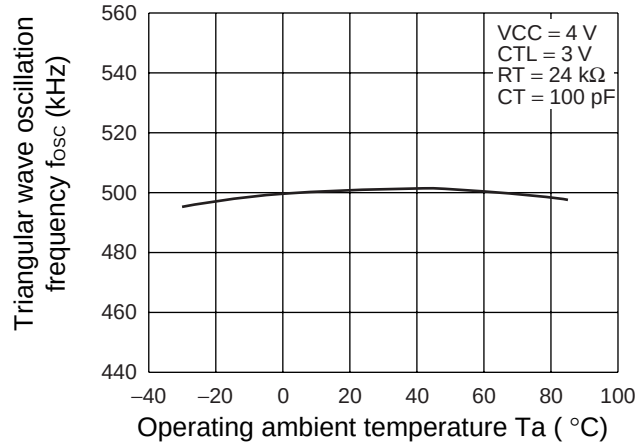
Triangular Wave Upper and Lower Limit Voltage vs. Triangular Wave Oscillation Frequency



Triangular Wave Upper and Lower Limit Voltage vs. Operating Ambient Temperature



Triangular Wave Oscillation Frequency vs. Operating ambient Temperature



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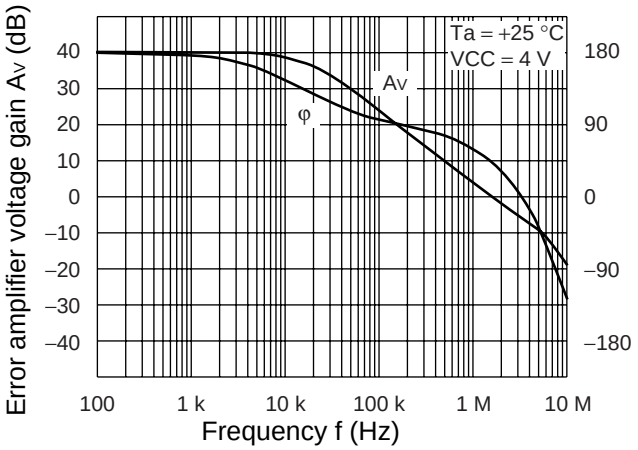
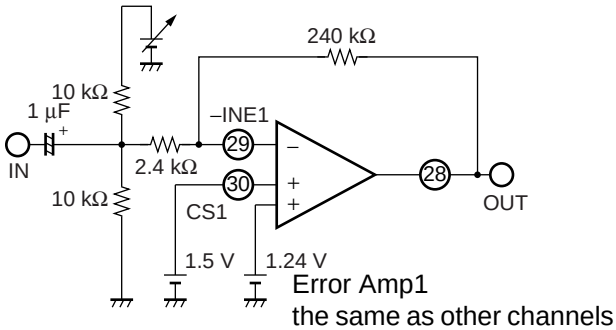
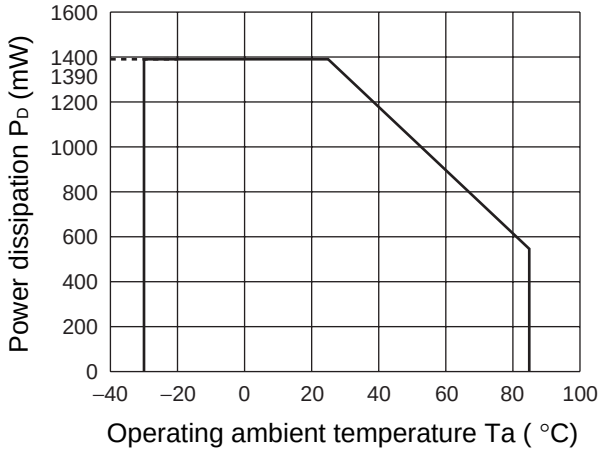
Error Amplifier Voltage Gain, Phase vs. Frequency



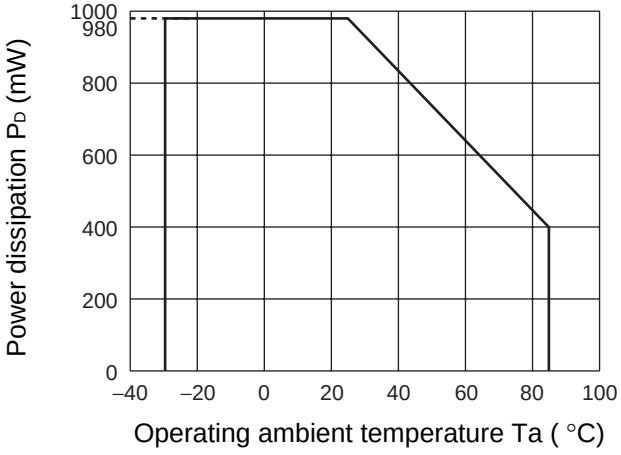


Error Amp1
the same as other channels

Power Dissipation vs.
Operating Ambient Temperature
(TSSOP-30P)



Power Dissipation vs.
Operating Ambient Temperature
(BCC-32P)



■ FUNCTIONS

1. DC/DC Converter Functions

(1) Reference voltage block (Ref)

The reference voltage circuit generates a temperature-compensated reference voltage (2.0 V Typ) from the voltage supplied from the VCC terminal (pin 5). The voltage is used as the reference voltage for the IC's internal circuitry.
The reference voltage can supply a load current of up to 1 mA to an external device through the VREF terminal (pin 7).

(2) Triangular-wave oscillator block (OSC)

The triangular wave oscillator incorporates a timing capacitor and a timing resistor connected respectively to the CT terminal (pin 9) and RT terminal (pin 8) to generate triangular oscillation waveform amplitude of 0.4 V to 0.9 V.
The triangular waveforms are input to the PWM comparator in the IC.

(3) Error amplifier block (Error Amp1 to Error Amp4)

The error amplifier detects the DC/DC converter output voltage and outputs PWM control signals. In addition, an arbitrary loop gain can be set by connecting a feedback resistor and capacitor from the output terminal to inverted input terminal of the error amplifier, enabling stable phase compensation to the system.
Also, it is possible to prevent rush current at power supply start-up by connecting a soft-start capacitor with the CS1 terminal (pin 30) to CS4 terminal (pin 16) while are the non-inverted input terminal for Error Amp. The use of Error Amp for soft-start detection makes it possible for a system to operate on a fixed soft-start time that is independent of the output load on the DC/DC converter.

(4) PWM comparator block (PWM Comp.1 to PWM Comp.4)

The PWM comparator is a voltage-to-pulse width modulator that controls the output duty depending on the input/output voltage.
The output transistor turns on while the error amplifier output voltage and DTC voltage remain higher than the triangular wave voltage.

(5) Output block (Drive1 to Drive4)

The output block is in the totem pole configuration, capable of driving an external P-channel MOS FET (channels 1 to 3), and N-channel MOS FET (channel 4).

2. Channel Control Function

The main or each channel is turned on and off depending on the voltage levels at the CTL terminal (pin 6), CS1 terminal (pin 30), CS2 terminal (pin 1), CS3 terminal (pin 15), and CS4 terminal (pin 16).

Channel On/Off Setting Conditions

CTL	CS1	CS2	CS3	CS4	Power	CH1	CH2	CH3	CH4
L	—*	—*	—*	—*	OFF	OFF	OFF	OFF	OFF
H	GND	GND	GND	GND	ON	OFF	OFF	OFF	OFF
H	High-Z	GND	GND	GND	ON	ON	OFF	OFF	OFF
H	GND	High-Z	GND	GND	ON	OFF	ON	OFF	OFF
H	GND	GND	High-Z	GND	ON	OFF	OFF	ON	OFF
H	GND	GND	GND	High-Z	ON	OFF	OFF	OFF	ON
H	High-Z	High-Z	High-Z	High-Z	ON	ON	ON	ON	ON

*: Undefined

3. Protective Functions

(1) Timer-latch short-circuit protection circuit (SCP, SCP Comp.)

The short-circuit detection comparator in each channel detects the output voltage level of Error Amp, and if any channel output voltage of Error Amp reaches the short-circuit detection voltage, the timer circuits are actuated to start charging the external capacitor C_{SCP} connected to the CSCP terminal (pin 11).
When the capacitor (C_{SCP}) voltage reaches about 0.7 V, the circuit is turned off the output transistor and sets the dead time to 100 %.
In addition, the short-circuit detection from external input is capable by using –INS terminal (pin 20) on short-circuit detection comparator (SCP Comp.) .
To release the actuated protection circuit, either the power supply turn off and on again or set the CTL terminal (pin 6) to the “L” level to lower the VREF terminal (pin 7) voltage to 1.5 V (Min) or less. (See “■SETTING TIME CONSTANT FOR TIMER-LATCH SHORT-CIRCUIT PROTECTION CIRCUIT”.)

(2) Under voltage lockout protection circuit (UVLO)

The transient state or a momentary decrease in supply voltage, which occurs when the power supply is turned on, may cause the IC to malfunction, resulting in breakdown or degradation of the system. To prevent such malfunctions, under voltage lockout protection circuit detects a decrease in internal reference voltage with respect to the power supply voltage, turns off the output transistor, and sets the dead time to 100% while holding the CSCP terminal (pin 11) at the “L” level.
The circuit restores the output transistor to normal when the supply voltage reaches the threshold voltage of the under voltage lockout protection circuit.

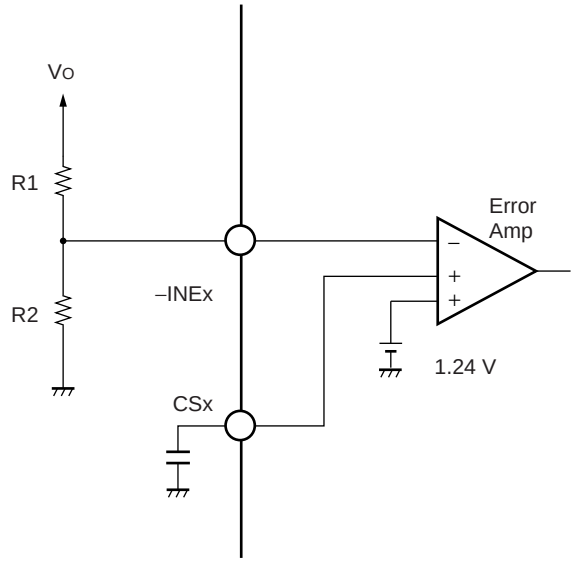
■ PROTECTION CIRCUIT OPERATING FUNCTION TABLE

This table refers to output condition when protection circuit is operating.

Operating circuit	OUT1	OUT2	OUT3	OUT4
Short-circuit protection circuit	H	H	H	L
Under voltage lockout protection circuit	H	H	H	L

■ SETTING THE OUTPUT VOLTAGE

• CH1 to CH4



$$V_O\,(V) = \frac{1.24}{R2}\,(R1 + R2)$$

x : Each channel No.

■ SETTING THE TRIANGULAR OSCILLATION FREQUENCY

The triangular oscillation frequency is determined by the timing capacitor (C_T) connected to the CT terminal (pin 9), and the timing resistor (R_T) connected to the RT terminal (pin 8).
Moreover, it shifts more greatly than the calculated values according to the constant of timing resistor (R_T) when the triangular wave oscillation frequency exceeds 1 MHz. Therefore, set it referring to “Triangular Wave Oscillation Frequency vs. Timing Resistor” and “Triangular Wave Oscillation Frequency vs. Timing Capacitor” in “■ TYPICAL CHARACTERISTICS”.

Triangular oscillation frequency : f_{OSC}

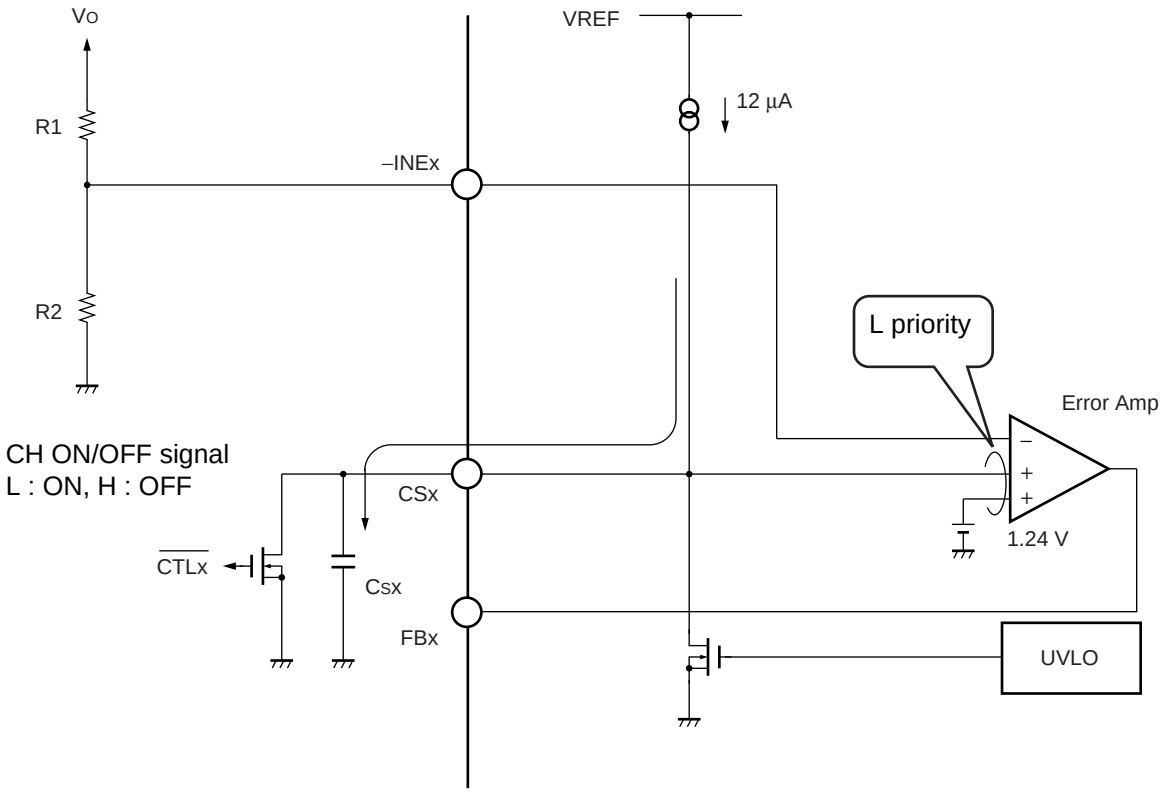
$$f_{OSC}\,(kHz) \fallingdotseq \frac{1200000}{C_T\,(pF) \times R_T\,(k\Omega)}$$

■ SETTING THE SOFT-START TIME

To prevent rush currents when the IC is turned on, you can set a soft-start by connecting soft-start capacitors (C_{S1} to C_{S4}) to the CS1 terminal (pin 30) to the CS4 terminal (pin 16), respectively.
Setting each $\overline{CTLx}$ from “H” to “L” switches to charge the external soft-start capacitors (C_{S1} to C_{S4}) connected to the CS1 terminal (pin 30) to CS4 terminal (pin 16) at 12 µA.
The error amplifier output (FB1 to FB4) is determined by comparison between the lower one of the potentials at two non-inverted input terminals (1.24 V, CS terminal voltages) and the inverted input terminal voltage (–INE1 to–INE4).
The FB terminal voltage during the soft-start period (CS terminal voltage < 1.24 V) is therefore determined by comparison between the –INE terminal and CS terminal voltages. The DC/DC converter output voltage rises in proportion to the CS terminal voltage as the soft-start capacitor connected to the CS terminal is charged.
The soft-start time is obtained from the following formula:

Soft-start time: ts (time to output 100%)
ts (s) ≒ 0.103 × C_{SX} (µF)

• Soft-Start Circuit

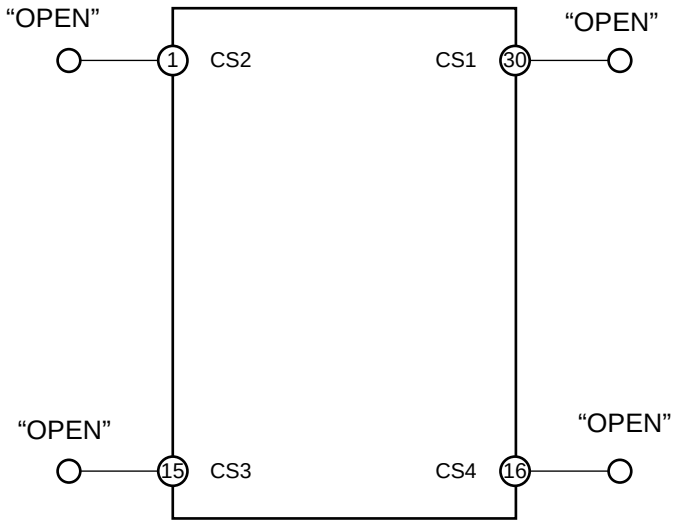


x : Each channel No.

■ TREATMENT WITHOUT USING CS TERMINAL

When not using the soft-start function, open the CS1 terminal (pin 30) , the CS2 terminal (pin 1) , the CS3 terminal (pin 15) , the CS4 terminal (pin 16) .

- Without Setting Soft-Start Time



■ SETTING TIME CONSTANT FOR TIMER-LATCH SHORT-CIRCUIT PROTECTION CIRCUIT

Each channel uses the short-circuit detection comparator (SCP) to always compare the error amplifier's output level to the reference voltage.

While DC/DC converter load conditions are stable on all channels, the short-circuit detection comparator output remains at "L" level, and the CSCP terminal (pin 11) is held at "L" level.

If the load condition on a channel changes rapidly due to a short-circuit of the load, causing the output voltage to drop, the output of the short-circuit detection comparator on that channel goes to "H" level. This causes the external short-circuit protection capacitor C_{SCP} connected to the CSCP terminal (pin 11) to be charged at 1 µA.

Short-circuit detection time (t_{CSCP})

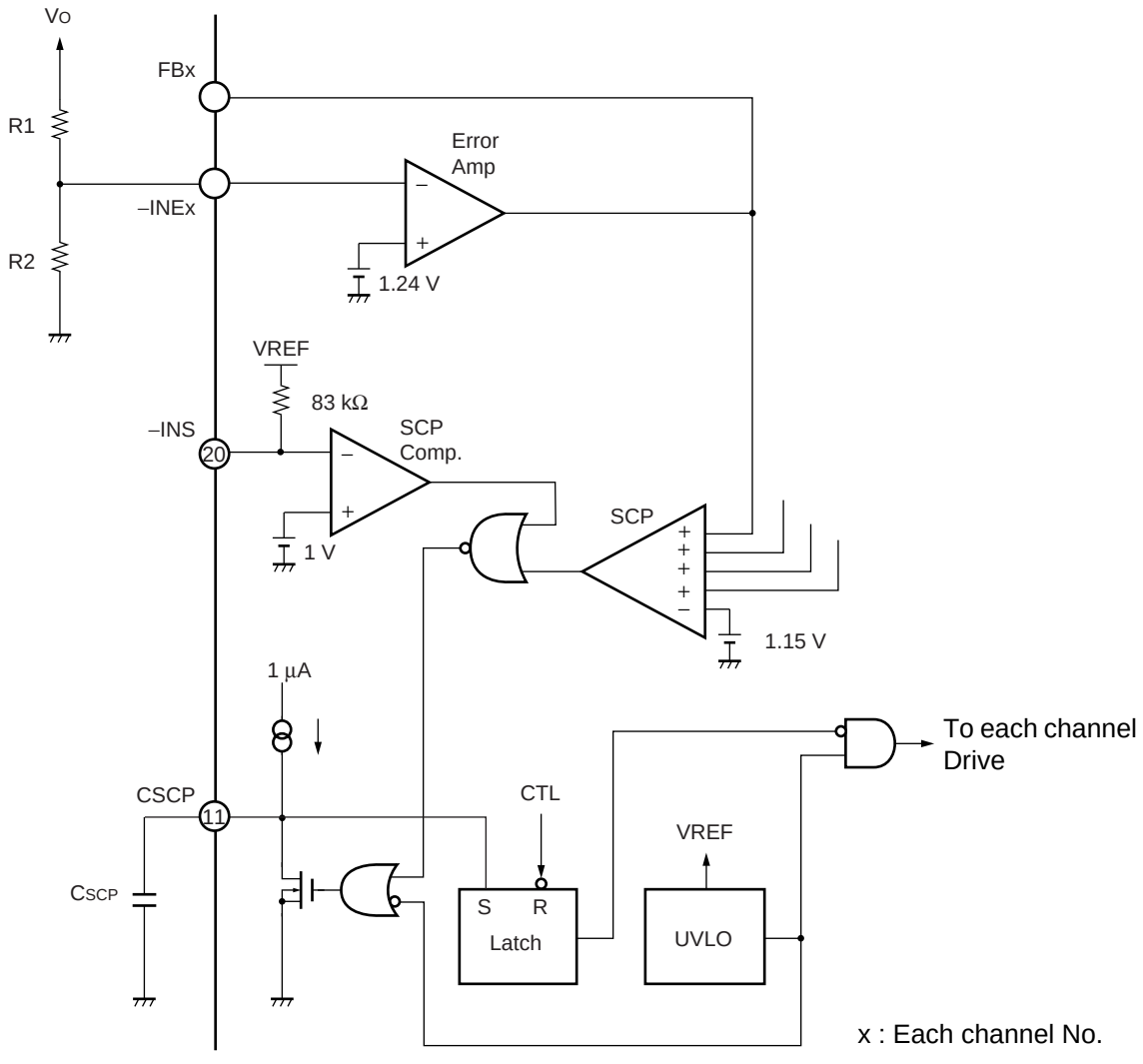
t_{CSCP} (s) ≒ 0.70 × C_{SCP} (µF)

When the capacitor C_{SCP} is charged to the threshold voltage (VTH ≒ 0.70 V), the latch is set and the external FET is turned off (dead time is set to 100%). At this point, the latch input is closed and the CSCP terminal (pin 11) is held at "L" level.

In addition, the short-circuit detection from external input is capable by using –INS terminal (pin 20) on the short-circuit detection comparator (SCP Comp.) . The short-circuit detection operation starts when –INS terminal voltage is less than threshold voltage (VTH≒ 1 V) .

When the power supply is turn on back or VREF terminal (pin 7) voltage is less than 1.5 V (Min) by setting CTL terminal (pin 6) to "L" level, the latch is released.

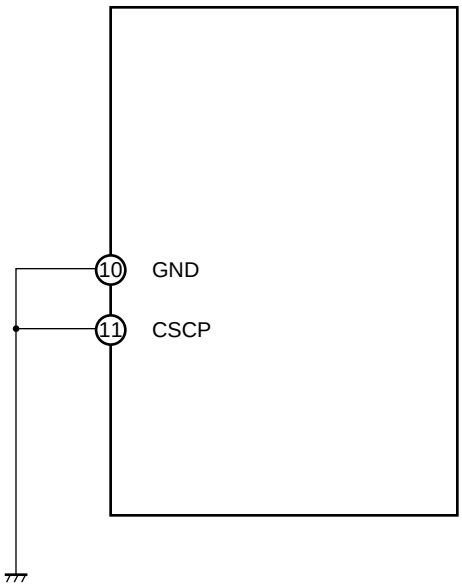
• Timer-latch short-circuit protection circuit



■ TREATMENT WITHOUT USING CSCP TERMINAL

When not using the timer-latch short-circuit protection circuit, connect the CSCP terminal (pin 11) to GND (pin 10) with the shortest distance.

- Treatment without using CSCP



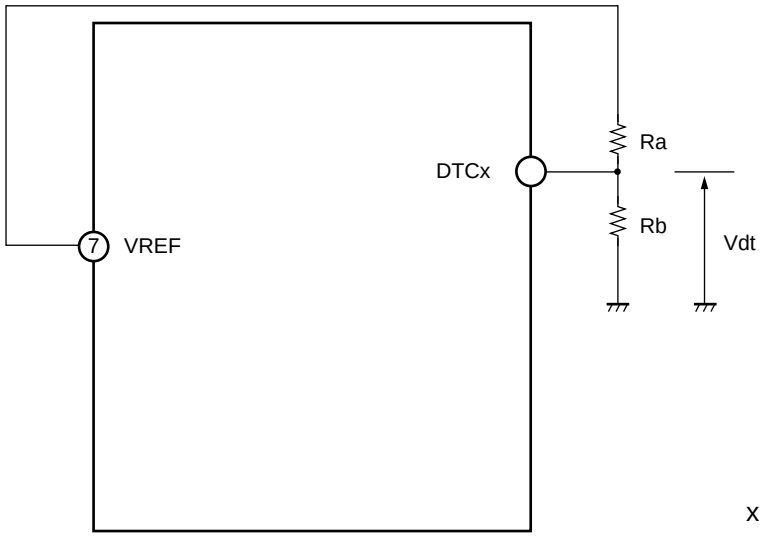
■ SETTING THE DEAD TIME

When the device is set for step-up inverted output based on the step-up or step-up/down Zeta conversion, step-up/down Sepic conversion or flyback conversion, the FB terminal voltage may reach and exceed the triangular wave voltage due to load fluctuation. If this is the case, the output transistor is fixed to a full-ON state (ON duty = 100 %). To prevent this, set the maximum duty of the output transistor. To set it, set the voltage at the DTC terminal by applying a resistive voltage divider to the VREF voltage as shown below.
When the DTC terminal voltage is higher than the triangular wave voltage, the output transistor is turned on. The maximum duty calculation formula assuming that triangular wave amplitude ≒ 0.5 V and triangular wave lower voltage ≒ 0.4 V is given below.

$$\text{DUTY (ON) Max} \fallingdotseq \frac{\text{Vdt} - 0.4\ \text{V}}{0.5\ \text{V}} \times 100\,(\%)\ ,\ \text{Vdt} = \frac{\text{Rb}}{\text{Ra} + \text{Rb}} \times \text{VREF}$$

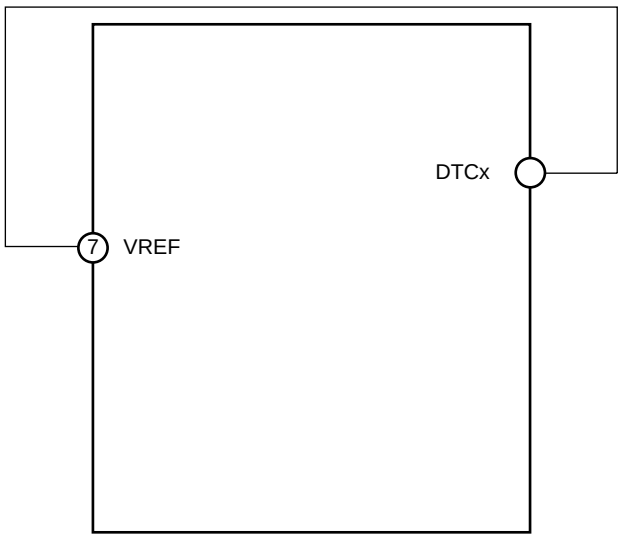
When the DTC terminal is not used, connect it directly to the VREF terminal (pin 7) as shown below (when no dead time is set).

- When using DTC to set dead time



x : Each channel No.

- When no dead time is set



x : Each channel No.

■ OPERATION EXPLANATION WHEN CTL TURNING ON AND OFF

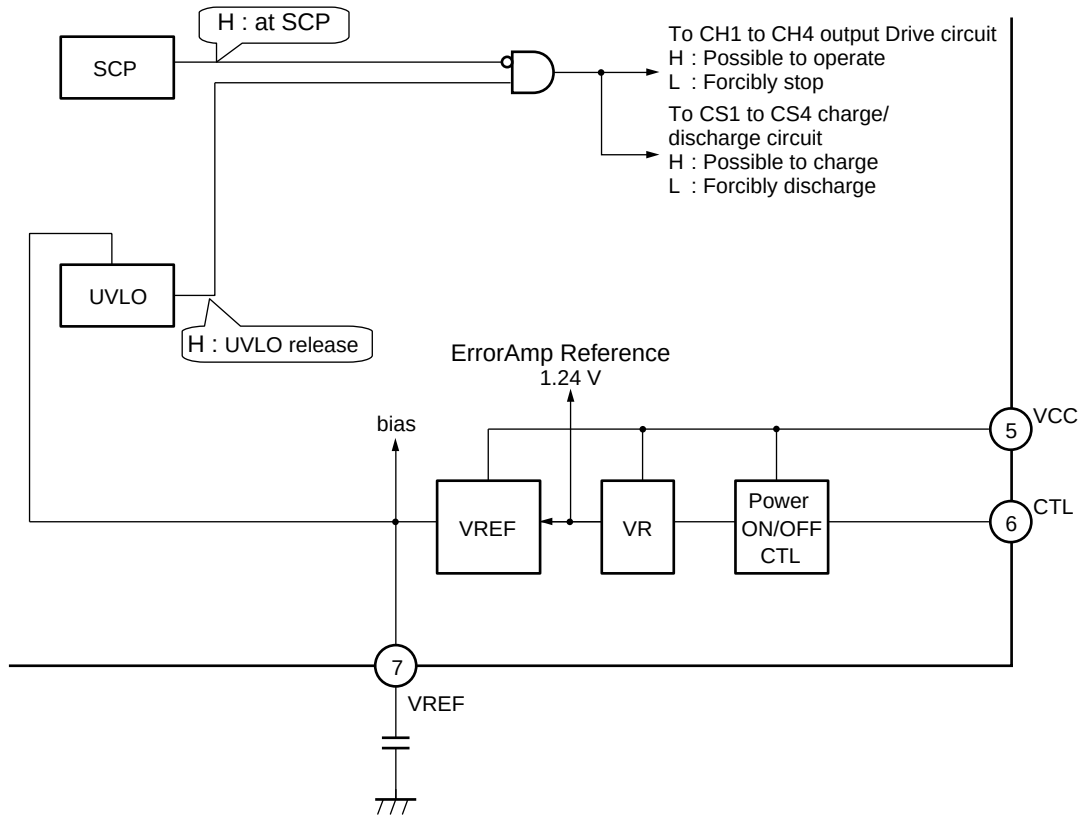
When CTL is turned on, internal reference voltage VR and VREF generate. When VREF exceeds threshold voltage (VTH) of UVLO (under voltage lockout protection circuit), UVLO are released, and the operation of output Drive circuit of each channel becomes possible.

When CTL is off, VR and VREF fall. When VREF decreases and UVLO fall below each reset voltage (VRST), UVLO operates and output Drive circuit of each channel is forcibly done the operation stop, and makes the output off state.

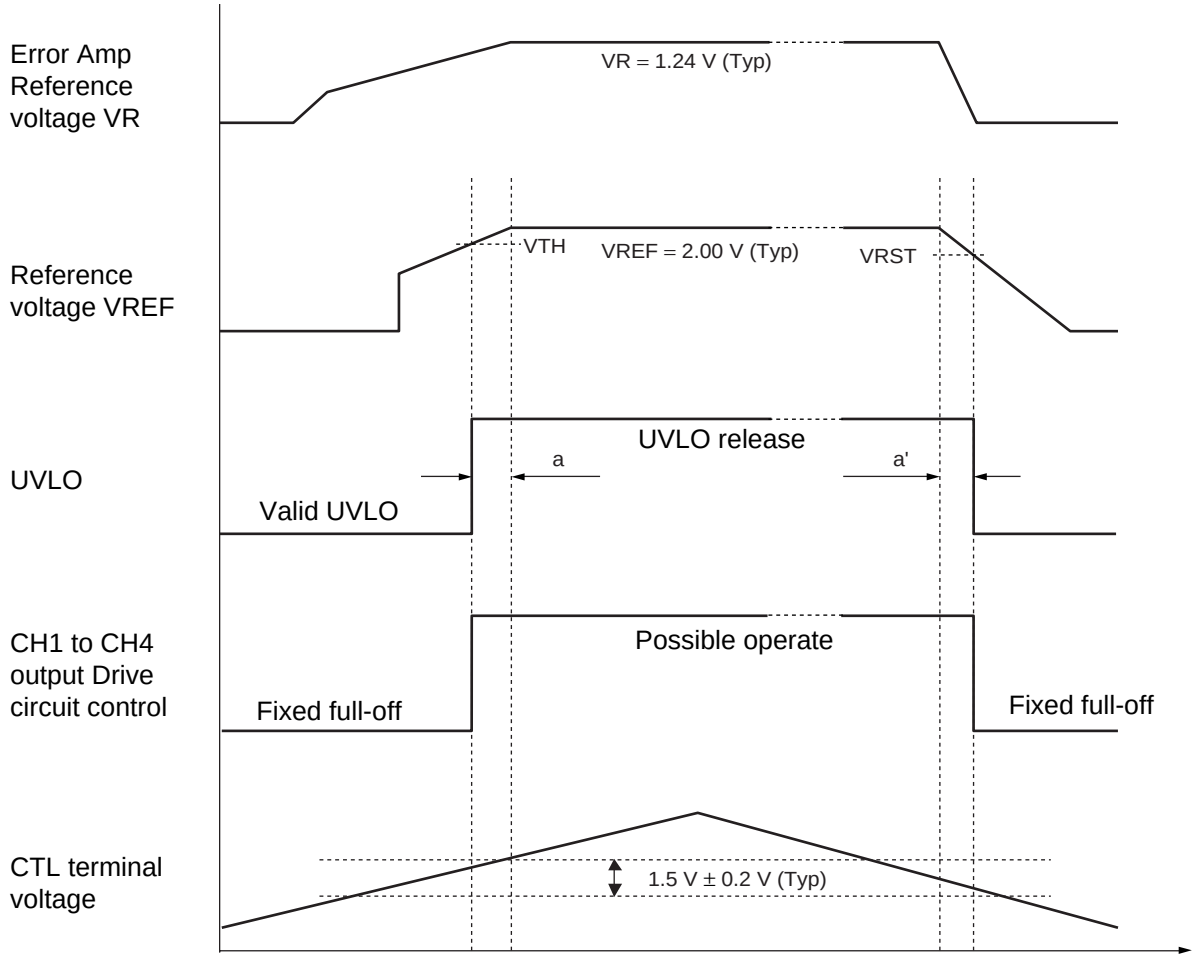
When period to reaching to 2.0 V by VREF voltage after UVLO are released by turning on CTL (refer to a in "• Timing Chart"), and VREF decreases from 2.0 V after turning off CTL and the period until do the operation of UVLO (refer to a' in "• Timing Chart"), the bias voltage and the bias current in IC do not reach a prescribed value because VREF which is the reference voltage does not reach 2.0 V, and the speed of response for IC has decreased.

Note : Moreover, when it does the turning on and off of the input sudden change, the load sudden change, IC cannot conform and the output might overshoot.
Therefore, impress the voltage to CTL terminal by which the VREF terminal voltage never stays in the above-mentioned period.

• CTL Block Equivalent Circuit

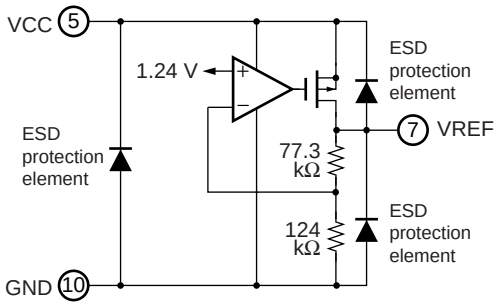


- Timing Chart

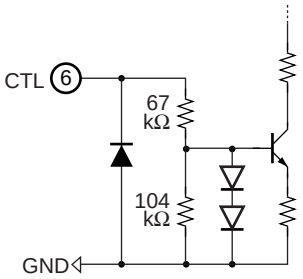


■ I/O EQUIVALENT CIRCUIT

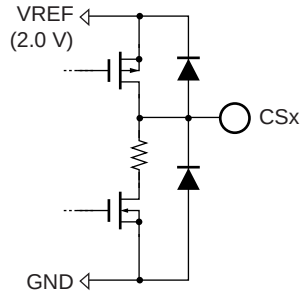
⟨⟨Reference voltage block⟩⟩



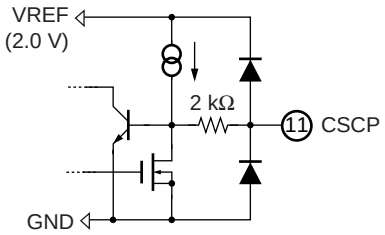
⟨⟨Control block⟩⟩



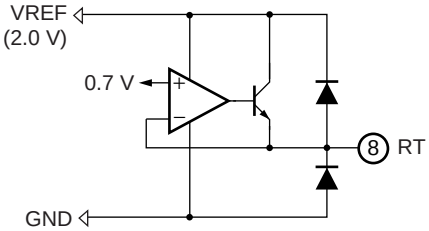
⟨⟨Soft-start block⟩⟩



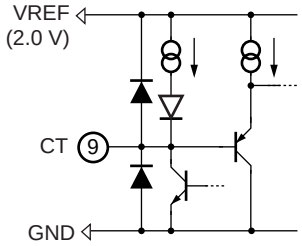
⟨⟨Short detection block⟩⟩



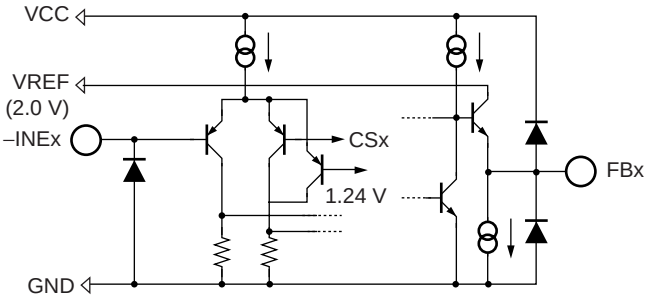
⟨⟨Triangular wave oscillator block (RT) ⟩⟩



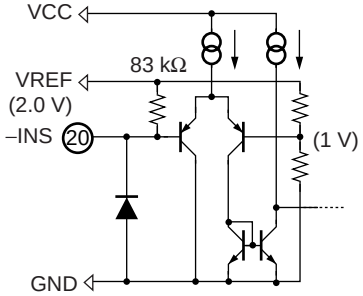
⟨⟨Triangular wave oscillator block (CT) ⟩⟩



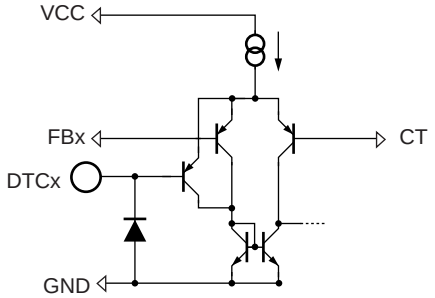
⟨⟨Error amplifier block (CH1 to CH4) ⟩⟩



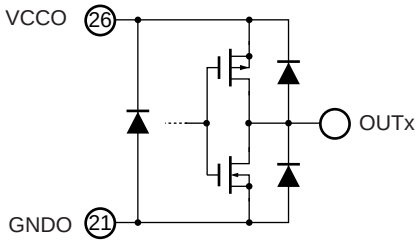
⟨⟨Short detection comparator block⟩⟩



⟨⟨PWM comparator block (CH1 to CH4) ⟩⟩

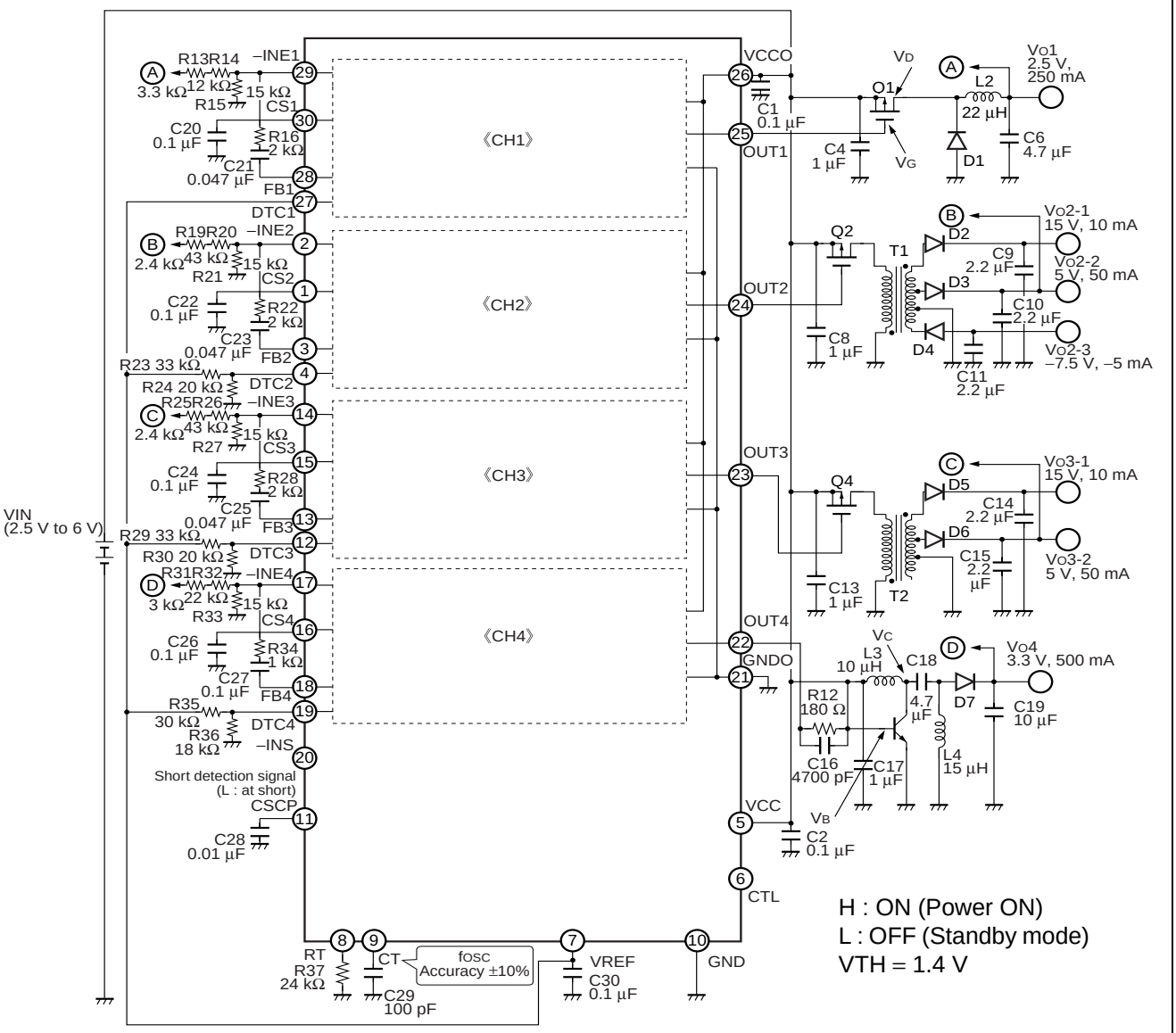


⟨⟨Output block (CH1 to CH4) ⟩⟩



x : Each channel No.

■ APPLICATION EXAMPLE



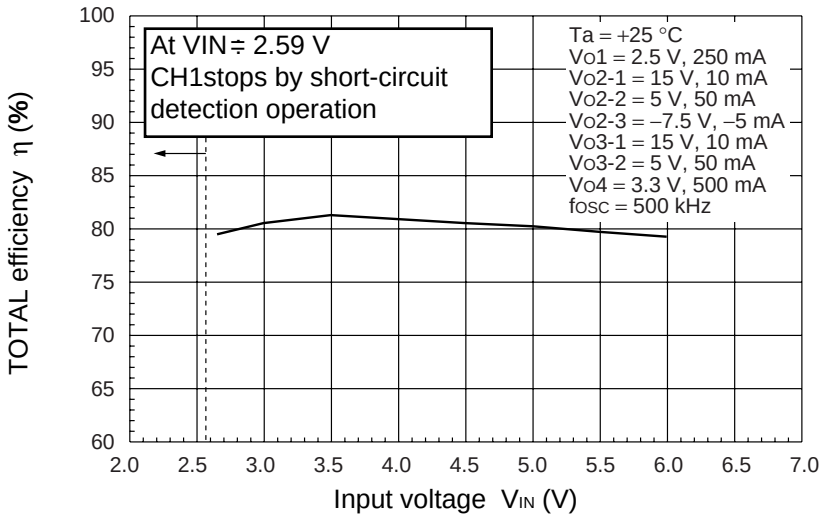
■ PARTS LIST

COMPONENT	ITEM	SPECIFICATION		VENDOR	PARTS NO.
Q1, Q2, Q4	Pch FET	VDS = –20 V, ID = –1.5 A		SANYO	MCH3309
Q5	NPN Tr	VCEO = 15 V, IC = 3 A		SANYO	CPH3206
D1, D7	Diode	VF = 0.4 V (Max) , at IF = 1 A		SANYO	SBS004
D2 to D6	Diode	VF = 0.55 V (Max) , at IF = 0.5 A		SANYO	SB05-05CP
L2	Inductor	22 µH	0.63 A, 160 mΩ	TDK	RLF5018T-220MR63
L3	Inductor	10 µH	0.94 A, 67 mΩ	TDK	RLF5018T-100MR94
L4	Inductor	15 µH	0.76 A, 120 mΩ	TDK	RLF5018T-150MR76
T1, T2	Transformer	—	—	SUMIDA	CLQ52 5388-T095
C1, C2	Ceramics Condenser	0.1 µF	50 V	TDK	C1608JB1H104K
C4, C8, C13	Ceramics Condenser	1 µF	25 V	TDK	C3216JB1E105K
C6	Ceramics Condenser	4.7 µF	10 V	TDK	C3216JB1A475M
C9 to C11	Ceramics Condenser	2.2 µF	16 V	TDK	C3216JB1C225K
C14, C15	Ceramics Condenser	2.2 µF	16 V	TDK	C3216JB1C225K
C16	Ceramics Condenser	4700 pF	50 V	TDK	C1608JB1H472K
C17	Ceramics Condenser	1 µF	25 V	TDK	C3216JB1E105K
C18	Ceramics Condenser	4.7 µF	10 V	TDK	3216JB1A475M
C19	Ceramics Condenser	10 µF	6.3 V	TDK	C3216JB0J106M
C20, C22, C24	Ceramics Condenser	0.1 µF	50 V	TDK	C1608JB1H104K
C21, C23, C25	Ceramics Condenser	0.047 µF	50 V	TDK	C1608JB1H473K
C26, C27, C30	Ceramics Condenser	0.1 µF	50 V	TDK	C1608JB1H104K
C28	Ceramics Condenser	0.01 µF	50 V	TDK	C1608JB1H103K
C29	Ceramics Condenser	100 pF	50 V	TDK	C1608CH1H101J
R12	Resistor	180 Ω	0.5 %	ssm	RR0816P-181-D
R13	Resistor	3.3 kΩ	0.5 %	ssm	RR0816P-332-D
R14	Resistor	12 kΩ	0.5 %	ssm	RR0816P-123-D
R15, R21, R27	Resistor	15 kΩ	0.5 %	ssm	RR0816P-153-D
R16, R22, R28	Resistor	2 kΩ	0.5 %	ssm	RR0816P-202-D
R19, R25	Resistor	2.4 kΩ	0.5 %	ssm	RR0816P-242-D
R20, R26	Resistor	43 kΩ	0.5 %	ssm	RR0816P-433-D
R23, R29	Resistor	33 kΩ	0.5 %	ssm	RR0816P-333-D
R24, R30	Resistor	20 kΩ	0.5 %	ssm	RR0816P-203-D
R31	Resistor	3 kΩ	0.5 %	ssm	RR0816P-302-D
R32	Resistor	22 kΩ	0.5 %	ssm	RR0816P-223-D
R33	Resistor	15 kΩ	0.5 %	ssm	RR0816P-153-D
R34	Resistor	1 kΩ	0.5 %	ssm	RR0816P-102-D
R35	Resistor	30 kΩ	0.5 %	ssm	RR0816P-303-D
R36	Resistor	18 kΩ	0.5 %	ssm	RR0816P-183-D
R37	Resistor	24 kΩ	0.5 %	ssm	RR0816P-243-D

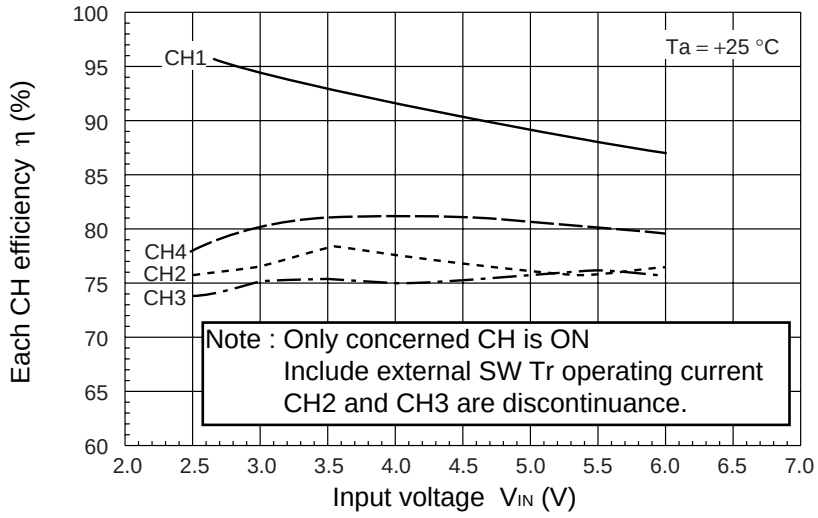
Note : SANYO : SANYO Electric Co., Ltd.
TDK : TDK Corporation
SUMIDA : SUMIDA Electric Co., Ltd.
ssm : SUSUMU Co., Ltd.

■ REFERENCE DATA

TOTAL Efficiency vs. Input Voltage



Each CH Efficiency vs. Input Voltage



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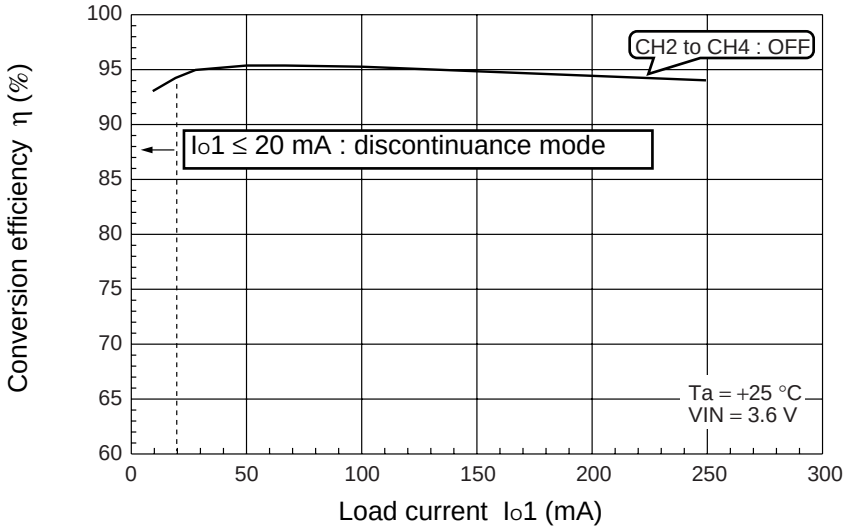
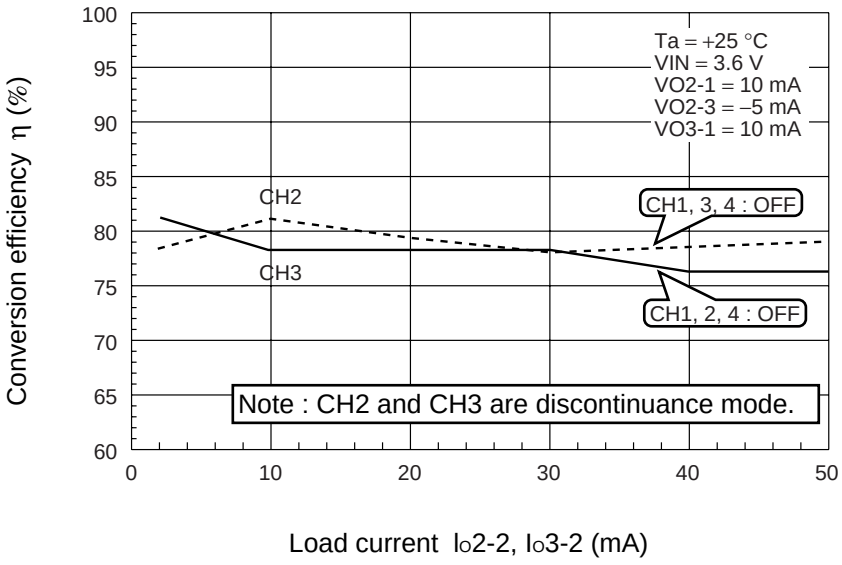
Conversion Efficiency vs. Load Current (CH1)



Conversion Efficiency vs. Load Current (CH2, CH3)



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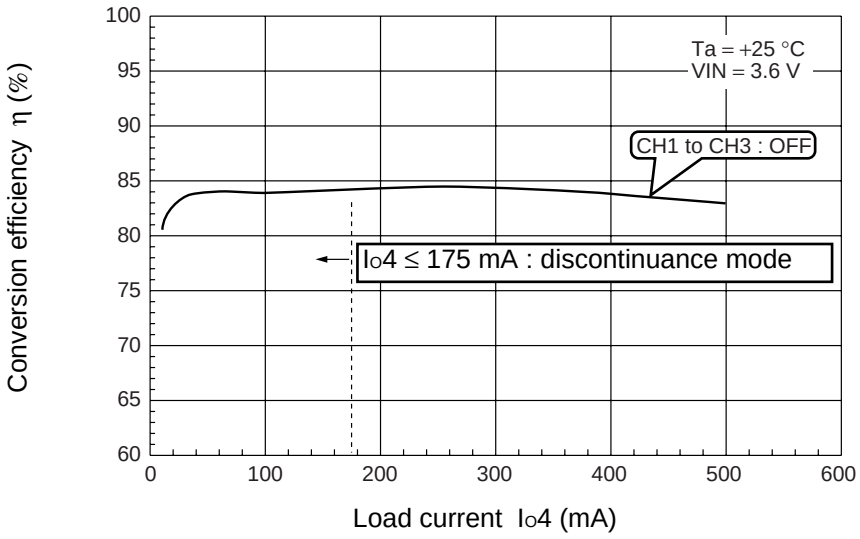
Conversion Efficiency vs. Load Current (CH4)



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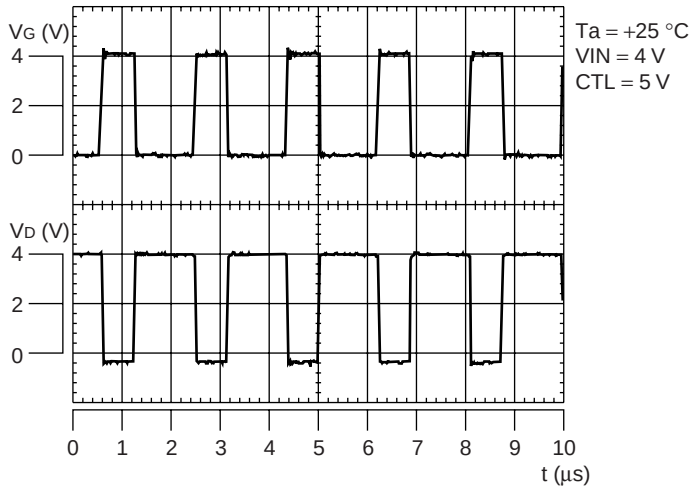
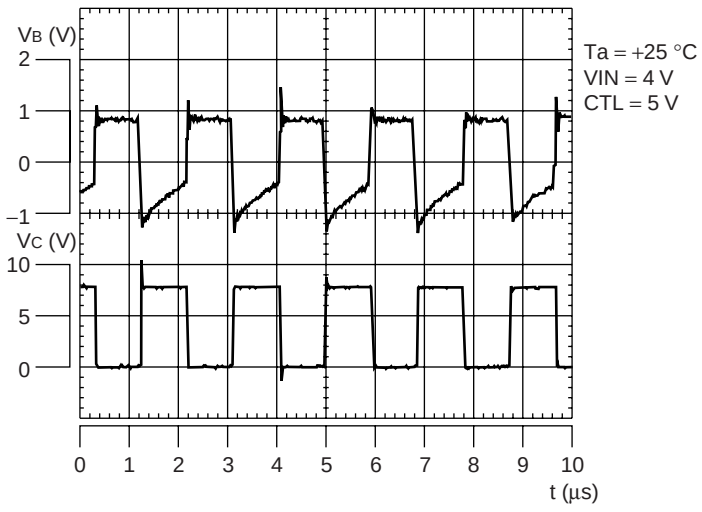
Switching Wave Form (CH1)



Switching Wave Form (CH4)



■ USAGE PRECAUTION

- **Printed circuit board ground lines should be set up with consideration for common impedance.**

- **Take appropriate static electricity measures.**
  - Containers for semiconductor materials should have anti-static protection or be made of conductive material.
  - After mounting, printed circuit boards should be stored and shipped in conductive bags or containers.
  - Work platforms, tools, and instruments should be properly grounded.
  - Working personnel should be grounded with resistance of 250 kΩ to 1 MΩ between body and ground.

- **Do not apply negative voltages.**

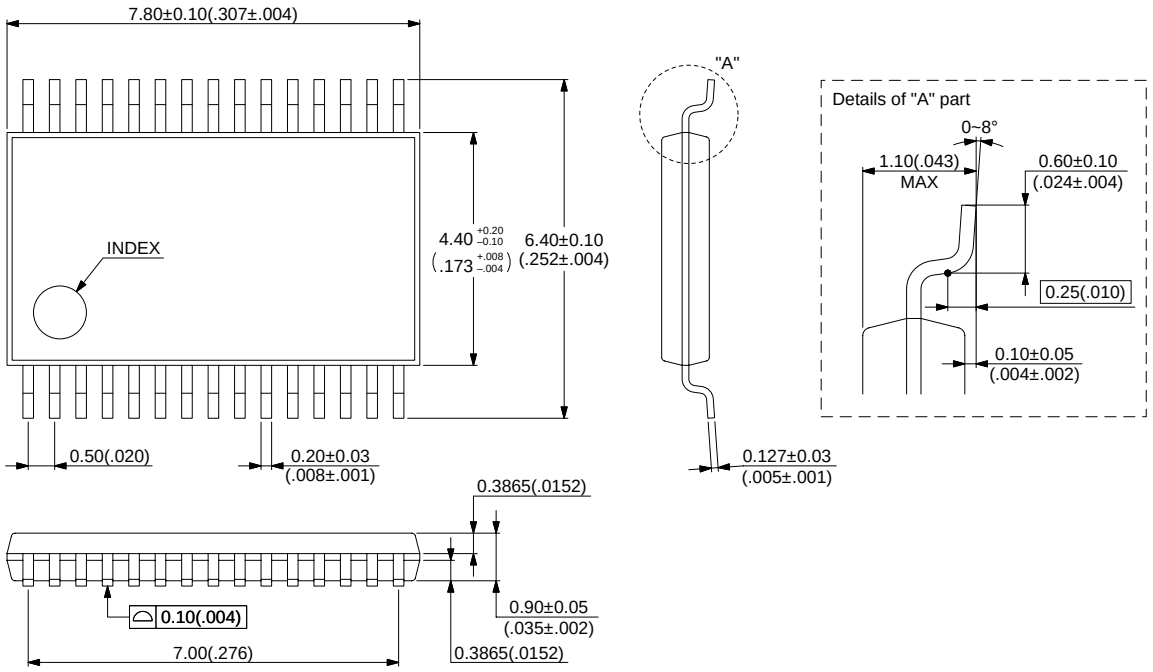
  The use of negative voltages below –0.3 V may create parasitic transistors on LSI lines, which can cause abnormal operation.

■ ORDERING INFORMATION

Part number	Package	Remarks
MB39A102PFT	30-pin plastic TSSOP (FPT-30P-M04)	
MB39A102PV3	32-pad plastic BCC (LCC-32P-M15)	

■ PACKAGE DIMENSIONS

30-pin plastic TSSOP
(FPT-30P-M04)



Dimensions in mm (inches).
Note: The values in parentheses are reference values.

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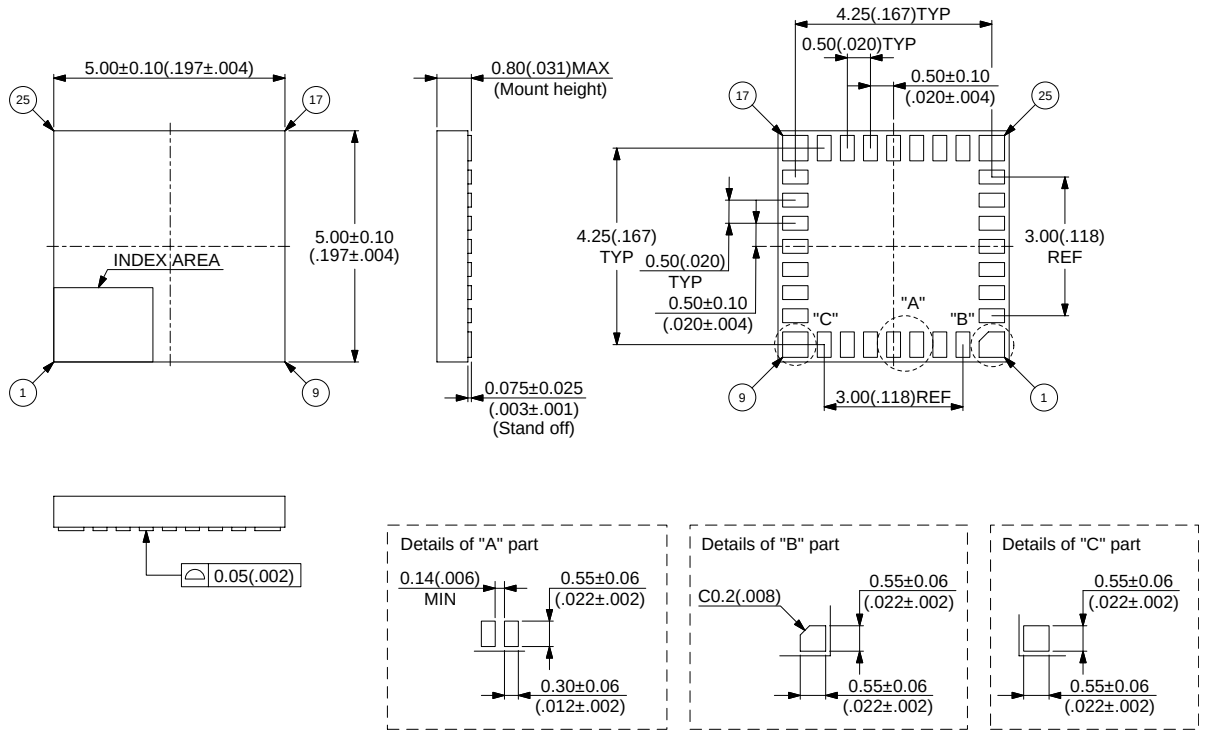
32-pad plastic BCC
(LCC-32P-M15)



Dimensions in mm (inches).
Note: The values in parentheses are reference values.

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