HT3328S – High-Efficiency, IoT-Enabled, External MOSFET Dual-Buck DC-DC Controller with Selectable frequency up to 700kHz

APPLICATION

- IoT (Internet of Things) Smart Home Appliance
- Mobile apps controllable DC source
- Automotive ADAS/LED Power Supply
- LCD Monitor Power Supply
- Wireless Router Power Supply
- Remote Power Management
  - Power Scheduler
  - CC-CV
- Low EMI Application (Patent Pending)

GENERAL DESCRIPTION

HT3328S is a high efficiency, dual-channel, Internet of Things (IoT) enabled, synchronous step-down switching controller designed for high-power applications.

HT3328S consists of an I^2C interface to connect with other wireless communication modules (e.g. Bluetooth/Wi-Fi); hence it allows ON/OFF, output voltage and current limit control using mobile apps. As a result, HT3328S enhances productivity and efficiency by enabling remote power management of various IoT devices at homes, office buildings, automobiles, and factories, etc.

HT3328S allows a wide input voltage range from 4.7V to 36V, and provides a wide range of output. The HT3328S enables power delivery of up to 140W or higher by using the appropriate FETs at each channel, while also offering selectable switching frequencies for circuit designs with varying sizes of inductors or capacitors, ensuring high conversion efficiency.

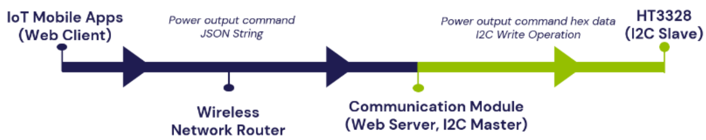
HT3328S has soft start function, which prevents the inrush current at startup from affecting the stability of the input power. On the protection side, it has a variety of protections for both input and output against over voltage, short circuit or under voltage conditions (see Multi-Protection section).

FEATURES

Internet of Things (IoT) Enable function

- ON/OFF control
- Programmable using I^2C serial interface
- Wireless connection with mobile apps

A sample IoT function is illustrated below flowchart:



Multi-Protection

- Input under-voltage lockout (UVLO)
- Output over-voltage protection (OVP)
- Output short-circuit protection (SCP)
- Over-temperature protection (OTP)

Device Information

Part Number	Package	Dimensions (mm)
HT3328S	WQFN32	5.0 x 5.0 x 0.75

See package outline and dimension on page 11.

Typical Application Circuit

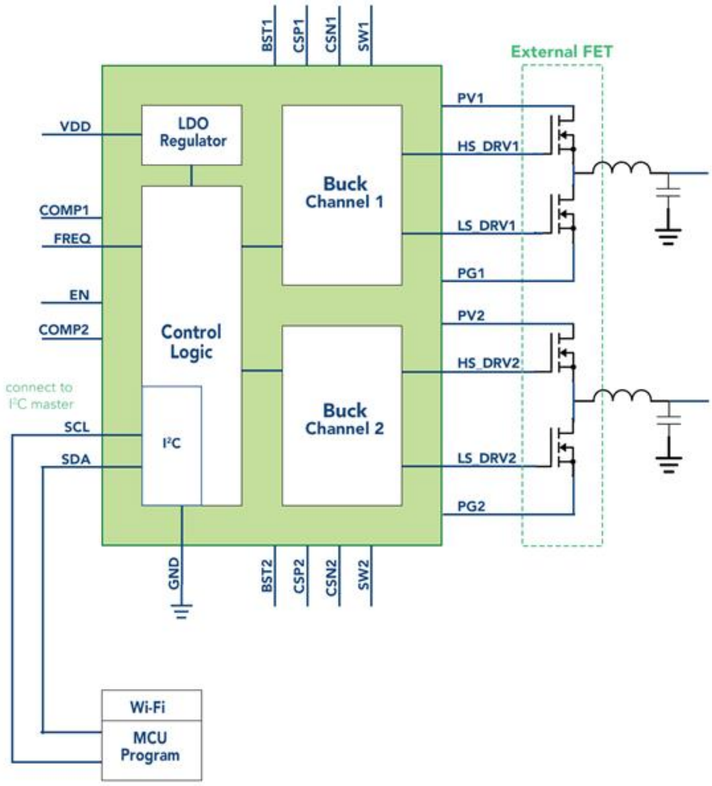


Fig. 1.1 - HT3328S Application Circuit

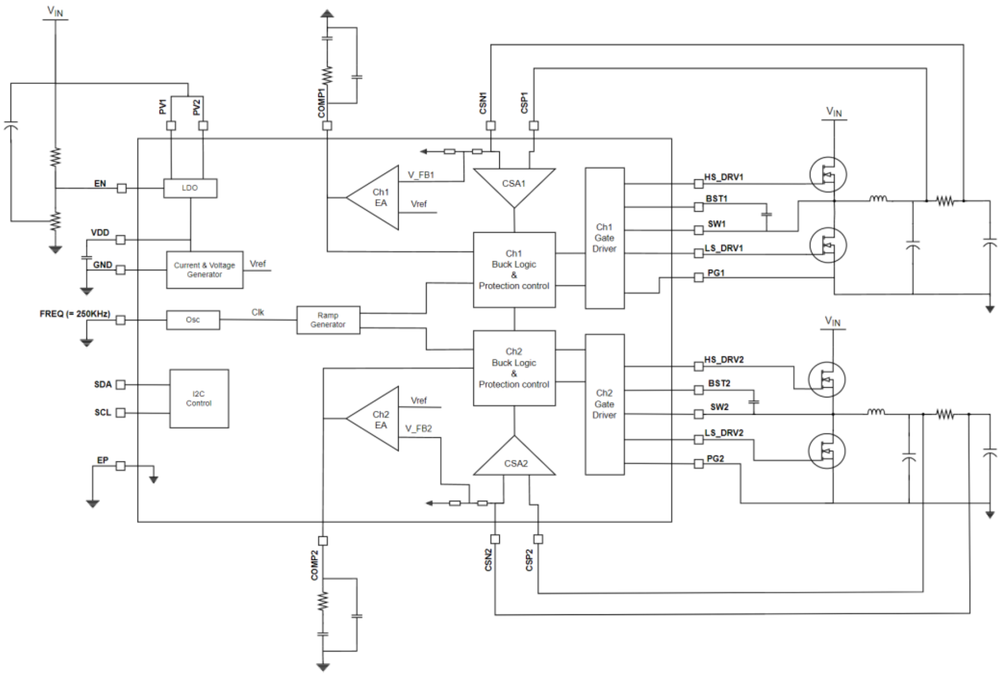


Fig. 1.2 - Detailed HT3328S Application Circuit

Pin Configuration

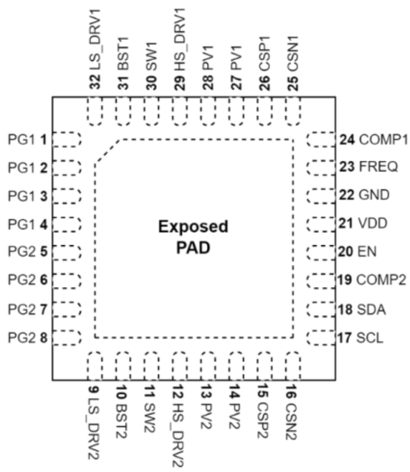


Fig. 2 - 32-pin QFN, 5x5 mm^2, 0.5mm pitch TOP VIEW

Pin Functions

Pin	Name	Description
1,2,3,4	PG1	Power Ground Channel 1
5,6,7,8	PG2	Power Ground Channel 2
9	LS_DRV2	Low Side Gate Drive Channel 2
10	BST2	Bootstrap Channel 2. Connect a capacitor and a resistor to SW2. Recommend 0.1uF and 2Ω.
11	SW2	Inductor Connection Channel 2
12	HS_DRV2	High Side Gate Drive Channel 2
13, 14	PV2	Input Power Channel 2. Connect a capacitor to GND. Recommend 1uF.
15	CSP2	Current Sense Positive Channel 2
16	CSN2	Current Sense Negative Channel 2
17	SCL	I^{2}C Clock
18	SDA	I^{2}C Data
19	COMP2	Compensation Pin 2
20	EN	Chip Enable, 1.35V enables the device
21	VDD	VDD Regulator, connect a decoupling capacitor to GND. Recommended 2.2uF.
22	GND	Signal Ground
23	FREQ	Frequency Selection, See the Application Information Section for details.
24	COMP1	Compensation Pin 1
25	CSN1	Current Sense Negative Channel 1
26	CSP1	Current Sense Positive Channel 1
27, 28	PV1	Input Power Channel 1. Connect a capacitor to GND. Recommend 1uF.
29	HS_DRV1	High Side Gate Drive Channel 1
30	SW1	Inductor Connection Channel 1
31	BST1	Bootstrap Channel 1. Connect a capacitor and a resistor to SW1. Recommend 0.1uF and 2Ω.

32	LS_DRV1	Low Side Gate Drive Channel 1
33	EPAD	Signal Ground & Thermal Dissipation Pad

Absolute Maximum Rating

PV1, PV2, SW1, SW2, EN	-0.3V to 40V
HS_DRV1, HS_DRV2, BST1, BST2	-0.3V to 36V
LS_DRV1, LS_DRV2	-0.3V to 6V
CSP1, CSN1, CSP2, CSN2	-0.3V to 22V
VDD, COMP1, COMP2, SCL, SDA, FREQ	-0.3V to 6V
Operating Temperature Range	-40°C to 85°C
Maximum Junction Temperature	125°C
Storage Temperature Range	-65°C to 125°C
Soldering Temperature	300°C

Electrical Characteristics

Limits apply over the operating temperature range, unless else specified. Max and Min limits are provided through design, test or statistical dependence. Typical values are the most likely parametric norm at room temperature, and are stated for reference only. Unless specified the following conditions apply: V_{IN} = 12V, T_A=25°C.

Parameters	Symbol	Test Conditions	Rating			Unit
			MIN	TYP	MAX	
Input Characteristics						
Operating Input Supply Voltage	V_{IN}		4.7		36	V
EN Threshold	V_{EN}			1.35		V
EN Hysteresis	V_{ENHYS}			110		mV
Quiescent Current	I_Q	Output at no load		1.5		mA
Shutdown Current	I_{stb}	V_{EN} = 0V		20		µA
Output Characteristics						
Output Voltage Range	V_{OUT}	V_{IN} = 36V	3.3		20	V
Output Current Limit	I_{Limit_FB}	R_{SENSE} = 10mΩ		3.6		A
Reference Voltage						
Output Voltage Reference	V_{FB}	Measured at FB1, FB2		1		V
Regulator Reference	V_{DD}	Measured at VDD		5.4		V
Switching Characteristics						
Switching Frequency	f_{sw}	FREQ=Z		300		kHz
		FREQ=L		500		kHz
		FREQ=H		700		kHz
Minimum On-Time	$t_{ON, Min}$			80		ns
Dither Generator						
Dither Modulation Frequency	f_{DITH}	FREQ=H		1560		Hz
Maximum Switching Frequency	f_{OSCMAX}	FREQ=H		850		kHz
Minimum Switching Frequency	f_{OSCMIN}	FREQ=H		700		kHz

Electrical Characteristics

Limits apply over the operating temperature range, unless else specified. Max and Min limits are provided through design, test or statistical dependence. Typical values are the most likely parametric norm at room temperature, and are stated for reference only. Unless specified the following conditions apply: V_{IN} = 12V, T_A=25°C.

Parameters	Symbol	Test Conditions	Rating			Unit
			MIN	TYP	MAX	
Output control by PROG (For both channel1 and channel2)						
Single Channel Output Voltage (PROG)	V_{OUT_PROG}	V_{IN}=24V, DAC_CV = 0.5V		5		V
		V_{IN}=24V, DAC_CV = 0.9V		9		V
		V_{IN}=24V, DAC_CV = 1.2V		12		V
		V_{IN}=24V, DAC_CV = 2V		20		V
	V_{STEP_PROG}	DAC_CV step		100		mV
Single Channel Output Current (PROG)	I_{OUT_PROG}	R_{SENSE} =10mΩ, DAC_CC = 1.2V		3		A
		R_{SENSE} =10mΩ, DAC_CC = 0.8V		2		A
		R_{SENSE} =10mΩ, DAC_CC = 0.6V		1.5		A
		R_{SENSE} =10mΩ, DAC_CC = 0.4V		1		A
Input Under-voltage Lockout Protection						
Input Under-Voltage Lockout Threshold High	V_{UVLO}			4.7		V
Input Under-Voltage Lockout Hysteresis	V_{UVHYS}		0.53	0.64	0.71	V
Output Under-voltage Lockout						
Output Under-voltage Protection	V_{UVP}			V_{OUT}*60%		V
Output Over-voltage Protection						
Output Over-Voltage Protection	V_{OVP}			V_{OUT}*120%		V
Over-Temperature Protection						
Thermal Shutdown	T_{SD}	Increasing Temperature		140		°C
Thermal Shutdown Hysteresis	T_{SD_HYS}	Decreasing temperature		30		°C
Digital Output Pins						
Digital Output High Voltage	V_{OH}	Maximum Sink Current = 12mA	0.8 × V_{DD}			V
Digital Output Low Voltage	V_{OL}	Maximum Sink Current = 12mA			0.1 × V_{DD}	V

Functional Block Diagram

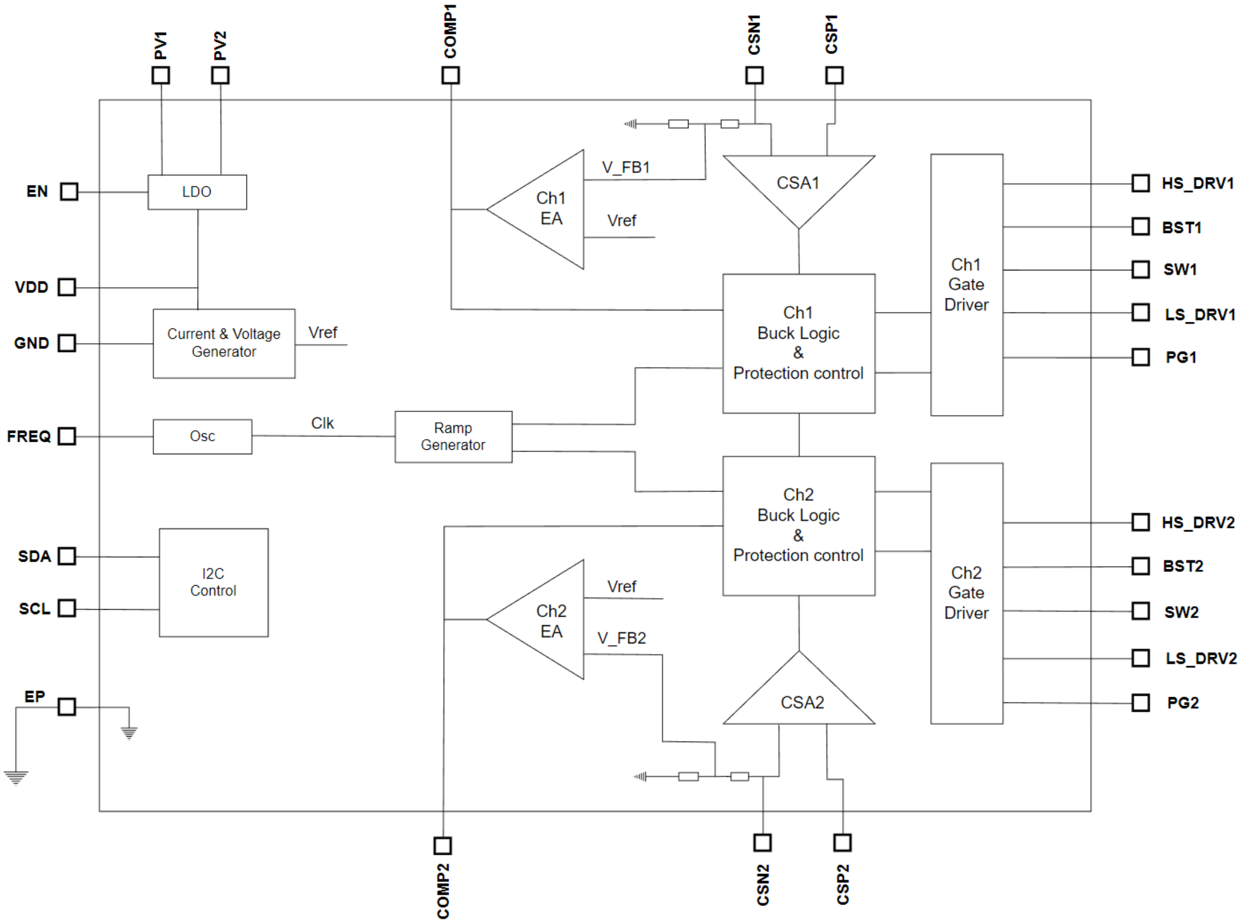


Fig. 3 - Functional Block Diagram

Application Information

Input Protection

If the input voltage is smaller than Input UVLO, both buck channels stop the gate driver, reset and enter hiccup mode. It returns to Normal when the faults are cleared.

Output Protection

The Output Under-voltage Lockout threshold and the Output Over-voltage Protection are set at V_{OUT}*60% and V_{OUT}*120%. Once Output UVLO or OVP is triggered, the specific channel stops the gate driver, reset and enters hiccup mode.

Soft Start

HT3000 series employs an internal soft start in the buck converter to prevent large inrush current and overshoots of V_{OUT}. The soft start time is 20ms in the design.

Frequency Selection

The switching frequency can be selected by applying different condition to the pin FREQ.

FREQ state	f_{sw} (kHz)
Z	300
L	500
H (Tied to VDD)	700

The efficiency of the conversion depends on the switching FET. Usually, the efficiency is higher at lower frequency because of lower switching loss.

Efficiency and External FET R_{dson}

The accuracy of the output voltage and the conversion efficiency is highly affected by the R_{dson} of the external FET. The lower the R_{dson} the higher the efficiency and voltage accuracy.

Programmable Output by I²C Serial Interface

A wireless communication module such as ESP8266 (master) can access HT3328 (slave) internal registers through the SCL and SDA pins. The master can program HT3328S power output by writing hex data to the registers.

Constant Voltage / Constant Current Mode

HT3328S has the capability to operate in either CV (constant voltage) mode or CC (constant current) mode, with a smooth transition from CV to CC (See Fig.4). When in CV mode, it regulates the output voltage. Once the output current limit threshold is reached, HT3328S switches to CC mode. In CC mode, the output voltage decreases while the output current remains clamped at the predefined values. The current limit can be determined using the following equation.

$$I_{out(\max)} = \frac{36mV}{R_{sense}}$$

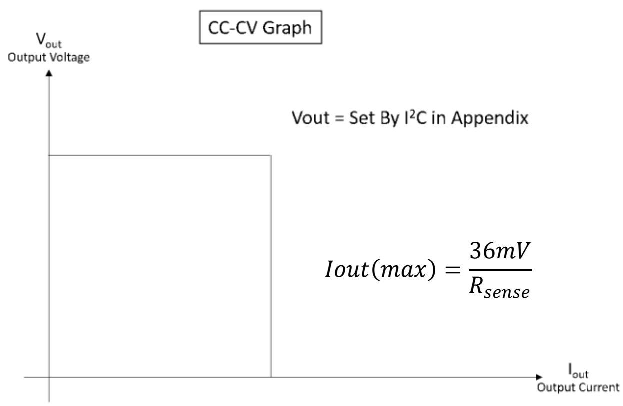


Fig.4 - CC-CV graph

Typical Application Schematic

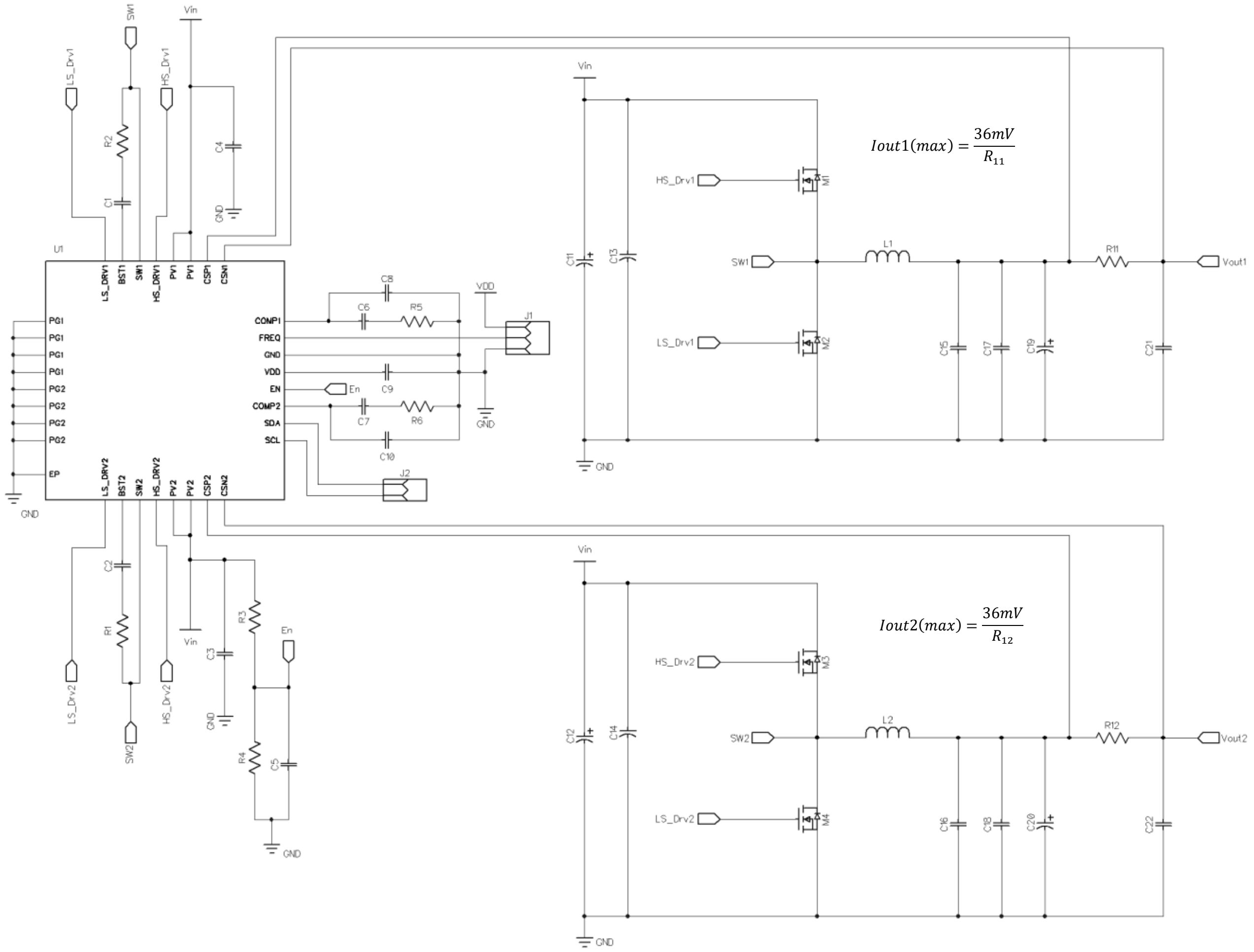
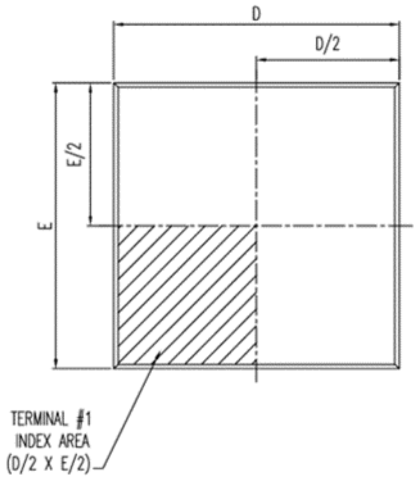


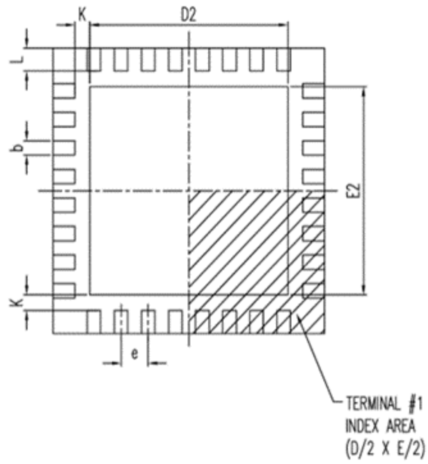
Fig. 5 - HT3328S Simplified Schematic

Package Outline and Dimensions

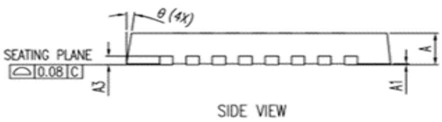
32-pin QFN (5mm x 5mm, 0.5mm pitch)



Top View



Bottom



Side View

SYMBOL	DIMENSION IN MM		
	MIN.	NOM.	MAX.
A	0.70	0.75	0.80
A1	0	0.02	0.05
A3	0.20 REF.		
D	5.00 BASIC		
D2	3.50	3.65	3.80
E	5.00 BASIC		
E2	3.50	3.65	3.80
e	0.50 BASIC		
b	0.18	0.25	0.30
L	0.35	0.40	0.45
K	0.20		
θ	0°		14°
JEDEC	MO-220 (Variation WHHD-4)		

NOTES :
1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSION b APPLIES TO METALLIZED TERMINAL AND IS MEASURED BETWEEN 0.15mm AND 0.30mm FROM THE TERMINAL TIP. IF THE TERMINAL HAS THE OPTIONAL RADIUS ON THE OTHER END OF THE TERMINAL, THE DIMENSION b SHOULD NOT BE MEASURED IN THAT RADIUS AREA.
3. BILATERAL COPLANARITY ZONE APPLIES TO THE EXPOSED HEAT SINK SLUG AS WELL AS THE TERMINALS.

Appendix

The hex data values for programmable constant voltage (CV). The lowest value of CV (output voltage) may go down to 1.2V, depending on applications. The step size is 100mV.

I2C Data (Hex)	CV (V)	I2C Data (Hex)	CV (V)	I2C Data (Hex)	CV (V)	I2C Data (Hex)	CV (V)	I2C Data (Hex)	CV (V)	I2C Data (Hex)	CV (V)
20	3.2	40	6.4	60	9.6	80	12.8	A0	16.0	C0	19.2
21	3.3	41	6.5	61	9.7	81	12.9	A1	16.1	C1	19.3
22	3.4	42	6.6	62	9.8	82	13.0	A2	16.2	C2	19.4
23	3.5	43	6.7	63	9.9	83	13.1	A3	16.3	C3	19.5
24	3.6	44	6.8	64	10.0	84	13.2	A4	16.4	C4	19.6
25	3.7	45	6.9	65	10.1	85	13.3	A5	16.5	C5	19.7
26	3.8	46	7.0	66	10.2	86	13.4	A6	16.6	C6	19.8
27	3.9	47	7.1	67	10.3	87	13.5	A7	16.7	C7	19.9
28	4.0	48	7.2	68	10.4	88	13.6	A8	16.8	C8	20.0
29	4.1	49	7.3	69	10.5	89	13.7	A9	16.9	C9	20.1
2A	4.2	4A	7.4	6A	10.6	8A	13.8	AA	17.0	CA	20.2
2B	4.3	4B	7.5	6B	10.7	8B	13.9	AB	17.1	CB	20.3
2C	4.4	4C	7.6	6C	10.8	8C	14.0	AC	17.2	CC	20.4
2D	4.5	4D	7.7	6D	10.9	8D	14.1	AD	17.3	CD	20.5
2E	4.6	4E	7.8	6E	11.0	8E	14.2	AE	17.4	CE	20.6
2F	4.7	4F	7.9	6F	11.1	8F	14.3	AF	17.5	CF	20.7
30	4.8	50	8.0	70	11.2	90	14.4	B0	17.6	D0	20.8
31	4.9	51	8.1	71	11.3	91	14.5	B1	17.7	D1	20.9
32	5.0	52	8.2	72	11.4	92	14.6	B2	17.8	D2	21.0
33	5.1	53	8.3	73	11.5	93	14.7	B3	17.9		
34	5.2	54	8.4	74	11.6	94	14.8	B4	18.0		
35	5.3	55	8.5	75	11.7	95	14.9	B5	18.1		
36	5.4	56	8.6	76	11.8	96	15.0	B6	18.2		
37	5.5	57	8.7	77	11.9	97	15.1	B7	18.3		
38	5.6	58	8.8	78	12.0	98	15.2	B8	18.4		
39	5.7	59	8.9	79	12.1	99	15.3	B9	18.5		
3A	5.8	5A	9.0	7A	12.2	9A	15.4	BA	18.6		
3B	5.9	5B	9.1	7B	12.3	9B	15.5	BB	18.7		
3C	6.0	5C	9.2	7C	12.4	9C	15.6	BC	18.8		
3D	6.1	5D	9.3	7D	12.5	9D	15.7	BD	18.9		
3E	6.2	5E	9.4	7E	12.6	9E	15.8	BE	19.0		
3F	6.3	5F	9.5	7F	12.7	9F	15.9	BF	19.1		

The hex data values for programmable current limit (CC). The step size is 100mA. R_{sense}=10mΩ

I2C Data (Hex)	CC (A)	I2C Data (Hex)	CC (A)	I2C Data (Hex)	CC (A)	I2C Data (Hex)	CC (A)	I2C Data (Hex)	CC (A)	I2C Data (Hex)	CC (A)
0	-	7	0.7	E	1.4	15	2.1	1C	2.8	23	3.5
1	0.1	8	0.8	F	1.5	16	2.2	1D	2.9	24	3.6
2	0.2	9	0.9	10	1.6	17	2.3	1E	3.0	25	3.7
3	0.3	A	1.0	11	1.7	18	2.4	1F	3.1	26	3.8
4	0.4	B	1.1	12	1.8	19	2.5	20	3.2	27	3.9
5	0.5	C	1.2	13	1.9	1A	2.6	21	3.3	28	4.0
6	0.6	D	1.3	14	2.0	1B	2.7	22	3.4		

IOT POWER

HT3000 Series

Smart Home Connection
At Your Fingertips

Hong Kong Office
Tel: (852) 36195375
Email: sales@hightt.com
URL: https://hightt.com
Address:
Unit 713, 7/F, 12W, 12 Science Park West Avenue,
Hong Kong Science Park, Shatin, Hong Kong

微信 WeChat