MAX SPEED HT6000 Series – HT6329E (Evaluation Version)

High-Efficiency, External MOSFET Dual-Buck DC-DC Controller with 150kHz/250kHz/350kHz Selectable Frequency

APPLICATION

- Automotive ADAS Power Supply
- Automotive LED Lighting
- CCTV Power Supply
- LCD / TV / Monitor Power
- Wireless Router Power
- USB Type C/A Fast Charging Application
- Low EMI Application *(Patent Pending)*
- Combine-mode, support single-channel, higher power *(Patent Pending)*
- Industrial Applications

GENERAL DESCRIPTION

HT6329E is an easy to use, high efficiency, dual-channel, synchronous step-down switching controller designed for high-power dual buck controller, in single chip.

HT6329E allows a wide input voltage range from 4.7V to 36V, and provides a wide range of output. It can also deliver up to 100W or higher with appropriate FETs at each channel. It also provides selectable switching frequency for circuit design with different size of inductor at high conversion efficiency.

HT6329E has soft start function, which prevent 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).

The external feedback provides the flexibility in interfacing with protocol IC to provide fast battery charging scheme like QC3.0 or PD3.1.

FEATURES

Dual-Channel Synchronous Buck Converter

- Wide input voltage range: 4.7V to 36V
- Dual Channel with independent input voltage
- Independent external feedback for each channel
- Selectable switching frequency at 150kHz, 250kHz and 350kHz
- Support combine mode for high output power applications
- Support CC-CV mode
- Soft start

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)
HT6329E	WQFN32	5.0 x 5.0 x 0.75

See package outline and dimension on page 12.

Typical Application Circuit

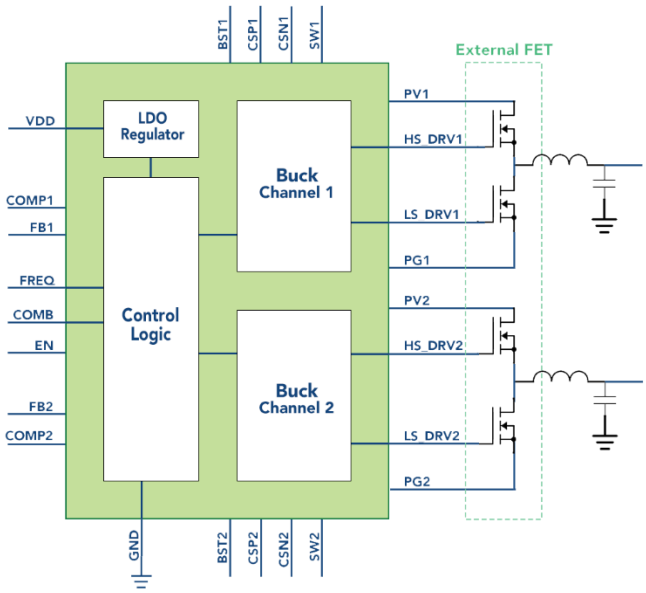


Fig. 1.1 – HT6329E Application Circuit (COMB=0)

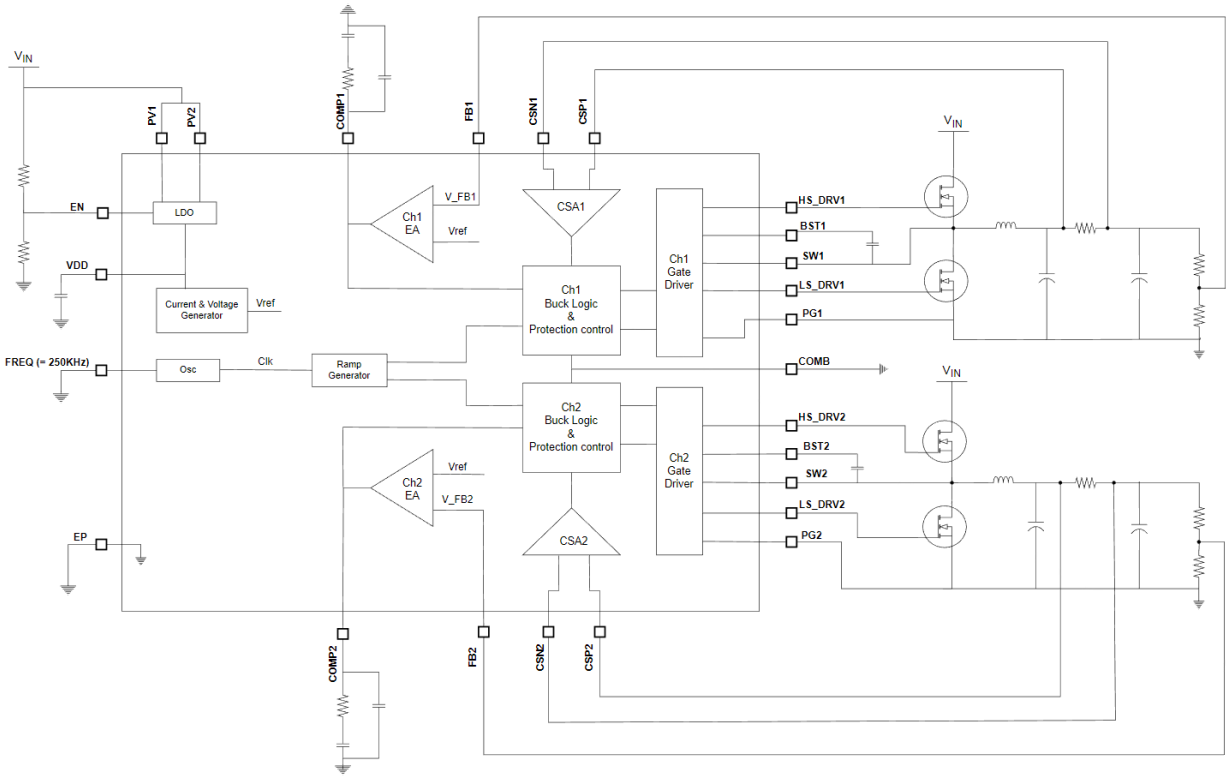


Fig. 1.2 – Detailed HT6329E Application Circuit (COMB=0)

Typical Application Circuit (Cont.)

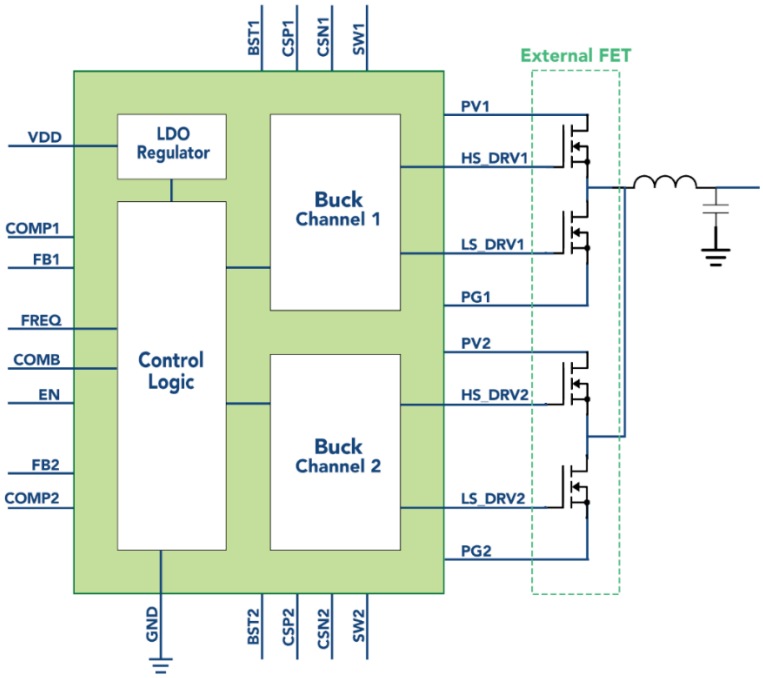


Fig. 2.1 – HT6329E Application Circuit (COMB=1)

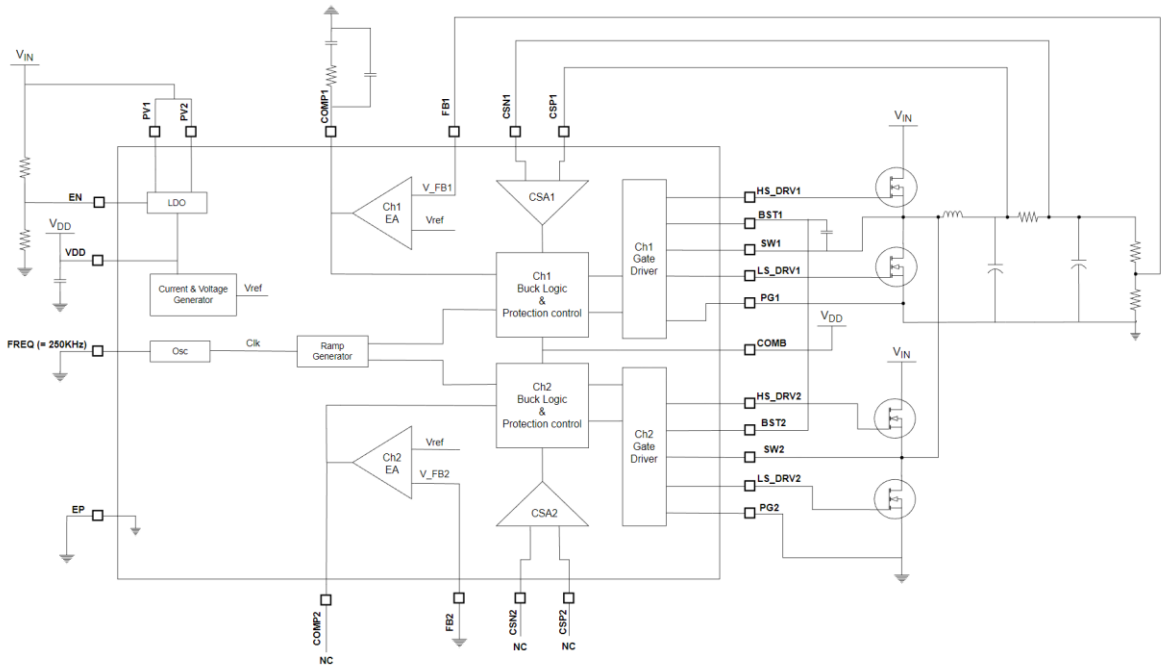


Fig. 2.2 – Detailed HT6329E Application Circuit (COMB=1)

Pin Configuration

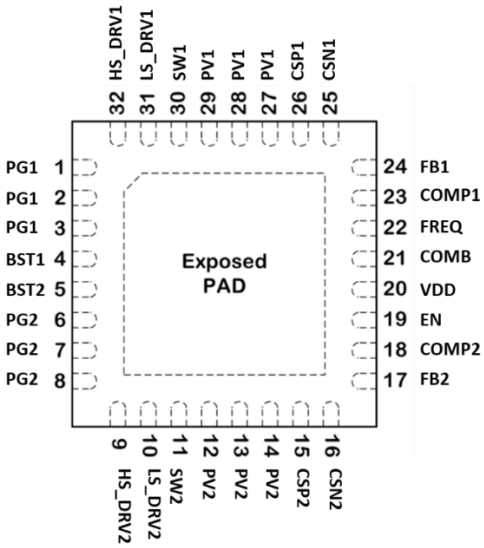


Fig. 3 - 32-pin QFN, 5x5 mm^2, 0.5mm pitch TOP VIEW

Pin Functions

Pin	Name	Description	Pin	Name	Description
1	PG1	Power Ground Channel 1	**17**	FB2	Feedback Channel 2
2	PG1		**18**	COMP2	Compensation Channel 2
3	PG1		**19**	EN	Chip Enable, 1.35V enables the device
4	BST1	Bootstrap Channel 1, Connect a capacitor (recommended 0.1uF) to SW1.	**20**	VDD	VDD Regulator, Connect a decoupling capacitor to GND. Recommended 2.2uF.
5	BST2	Bootstrap Channel 2, Connect a capacitor (recommended 0.1uF) to SW2.	**21**	COMB	Combine Mode Input, Logic High enables combine mode; Logic Low disables combine mode.
6	PG2	Power Ground Channel 2	**22**	FREQ	Frequency Selection, See Application Information Section for detail
7	PG2		**23**	COMP1	Compensation Channel 1
8	PG2		**24**	FB1	Feedback Channel 1
9	HS_DRV2	High Side Gate Drive Channel 2	**25**	CSN1	Current Sense Negative Channel 1
10	LS_DRV2	Low Side Gate Drive Channel 2	**26**	CSP1	Current Sense Positive Channel 1
11	SW2	Inductor Connection Channel 2	**27**	PV1	Input Power Channel 1, Connect a capacitor (recommended 1uF) to PV1.
12	PV2	Input Power Channel 2, Connect a capacitor (recommended 1uF) to PV2.	**28**	PV1	
13	PV2		**29**	PV1	
14	PV2		**30**	SW1	Inductor Connection Channel 1
15	CSP2	Current Sense Positive Channel 2	**31**	LS_DRV1	Low Side Gate Drive Channel 1
16	CSN2	Current Sense Negative Channel 2	**32**	HS_DRV1	High Side Gate Drive Channel 1
33	EPAD	Signal Ground & Thermal Dissipation Pad			

Absolute Maximum Ratings

PV1, PV2, SW1, SW2, EN	-0.3V to 36V
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, FB1, FB2, FREQ, COMB	-0.3V to 6V
Operating Temperature Range	-40°C to 85°C
Maximum Junction Temperature	-40°C to 125°C
Storage Temperature Range	-65°C to 125°C
Soldering Temperature	300°C

Electrical Characteristics (T_A=25°C unless specified)

Parameters	Symbol	Test Conditions	Rating			Unit
			MIN	TYP	MAX	
Input Characteristics						
Input 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		10		μA
COMB Input						
Input Threshold High	$V_{COMB\_TH\_H}$			3.5		V
Input Threshold Low	$V_{COMB\_TH\_L}$			1		V
Output Characteristics						
Output Voltage Range	V_{OUT}		3		V_{IN} *95%	V
Output Current Limit	I_{Limit_FB}	R_{SENSE} = 10mΩ		3.3		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		150		kHz
		FREQ=L		250		kHz
		FREQ=H		350		kHz
Minimum On-Time	$t_{ON, Min}$			80		ns
Dither Generator						
Dither Modulation Frequency	f_{DITH}			TBD		kHz
Maximum Switching Frequency	f_{OSCMAX}			TBD		kHz
Minimum Switching Frequency	f_{OSCMIN}			TBD		kHz

Electrical Characteristics (T_A=25°C unless specified)

Parameters	Symbol	Test Conditions	Rating			Unit
			MIN	TYP	MAX	
Input Under-voltage Lockout						
Input Under-Voltage Lockout Threshold	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_{UVLO}			V_{OUT}*60%		V
Output Over-voltage Protection						
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

Functional Block Diagram

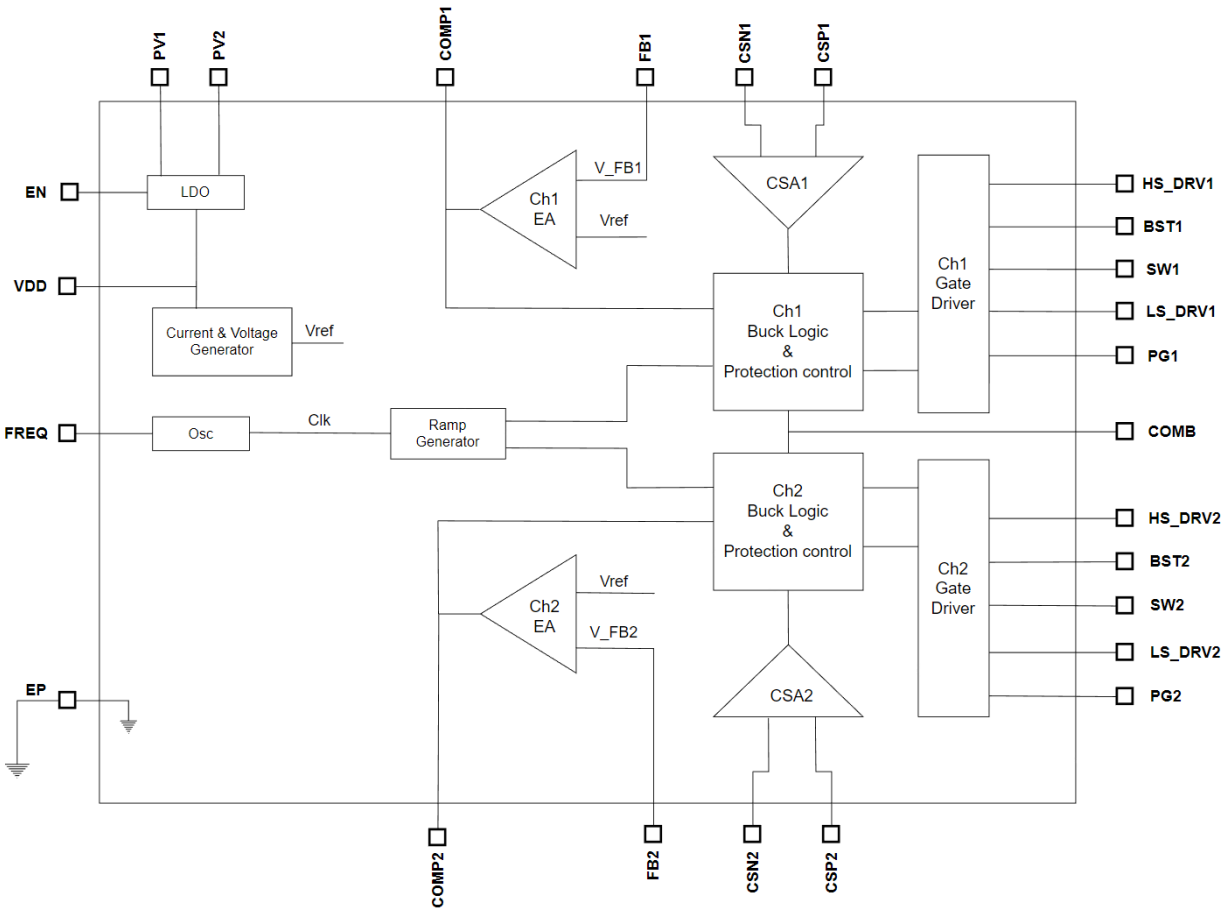


Fig. 4 – Functional Block Diagram

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

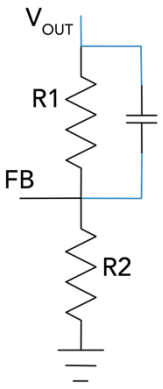
The Output Under-voltage Lockout threshold and the Output Over-voltage Protection are set at V_{OUT}*60% and V_{OUT}*120%. Once Output UVLO or OVP is triggered, the specific channel stops the gate driver, reset and enters hiccup mode.

Soft Start

HT6000 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.

Feedback and Output Voltage

HT6329E provides an external FB for setting the output voltage. The feedback resistor divider tap is connected and V_{FB} is regulated at 1V. The relationship between the V_{OUT} and the resistor divider tap is as follows:



$$V_{OUT} = V_{FB}\left(1 + \frac{R1}{R2}\right)$$

Fig. 5 – Feedback Resistor Network Design

Frequency Selection

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

FREQ state	f_{sw} (kHz)
Z	150
L	250
H (Tied to VDD)	350

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

Combine Mode

The Combine Mode can be enabled by setting COMB = VDD. In Combine Mode, channel 1 takes up the output current from channel 2. Once the Combine Mode is active, the control over channel 2 is disable. Short COMB to GND when unused.

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.

Constant Voltage / Constant Current Mode

HT6329E 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.6). When in CV mode, it regulates the output voltage. Once the output current limit threshold is reached, HT6329E 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.

$$I_{out(\max)} = \frac{33mV}{R_{sense}}$$

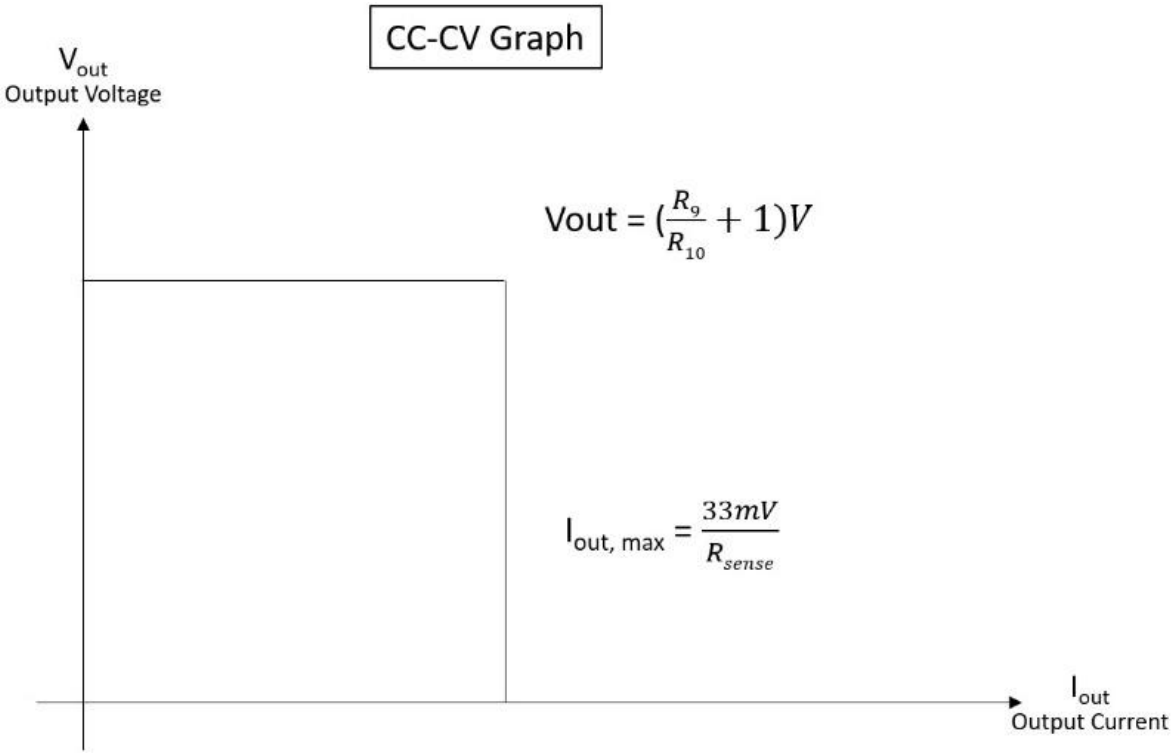


Fig. 6 - CC-CV Graph

Typical Application Schematic

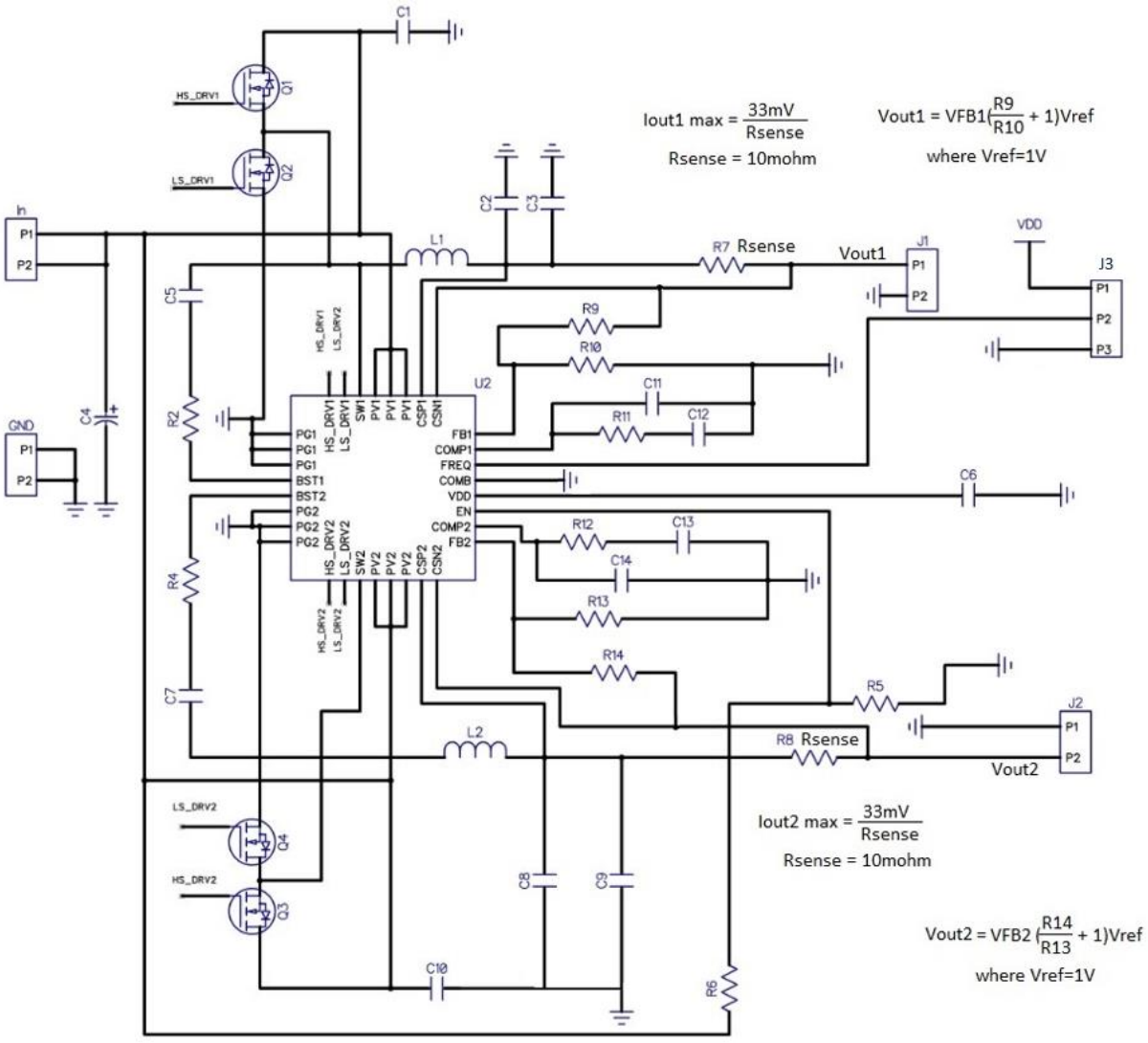


Fig. 7 - HT6329E simplified schematic (COMB = 0)

Typical Application Schematic (Cont.)

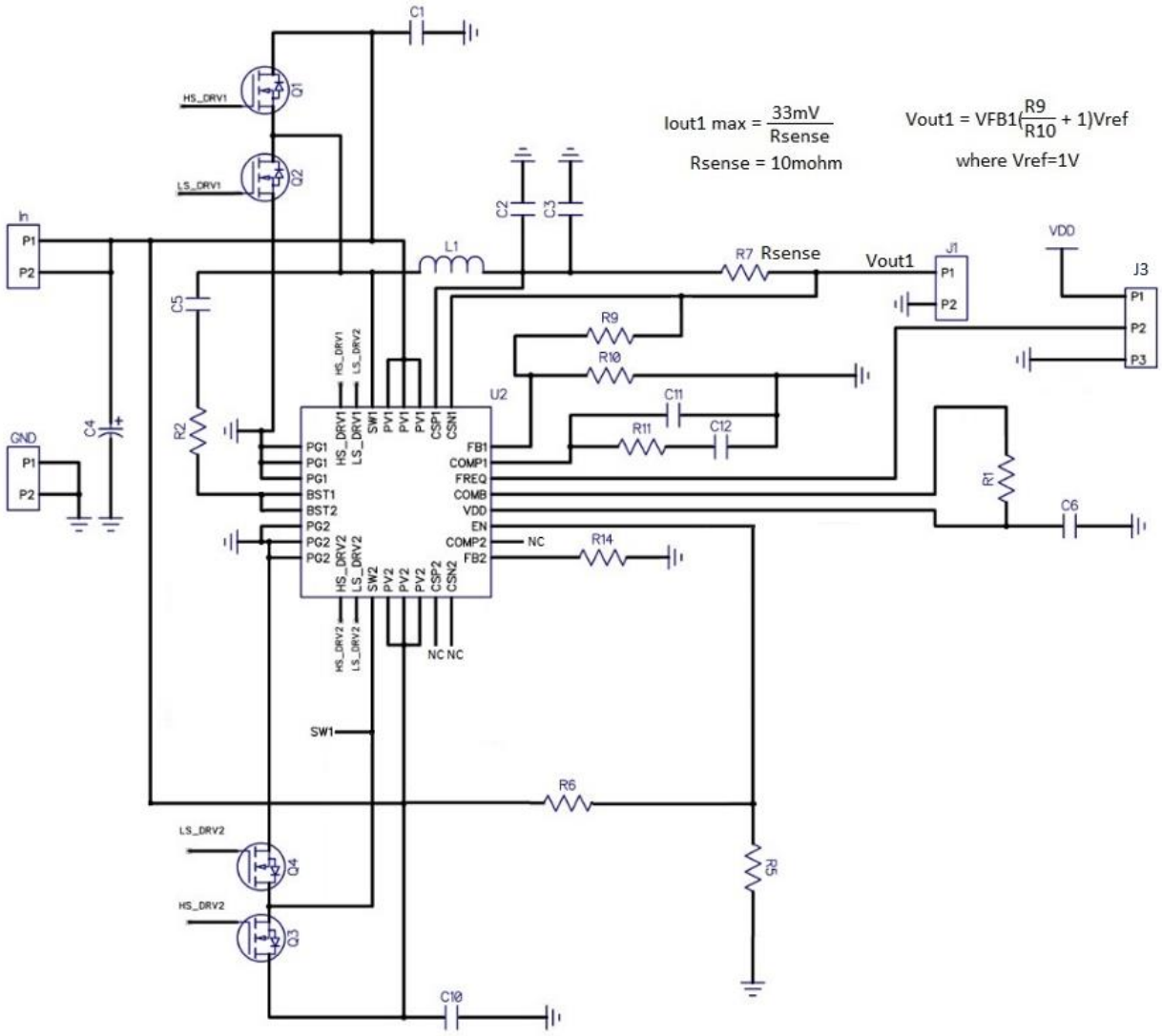
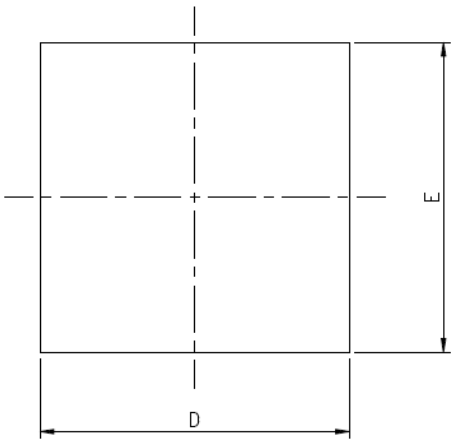


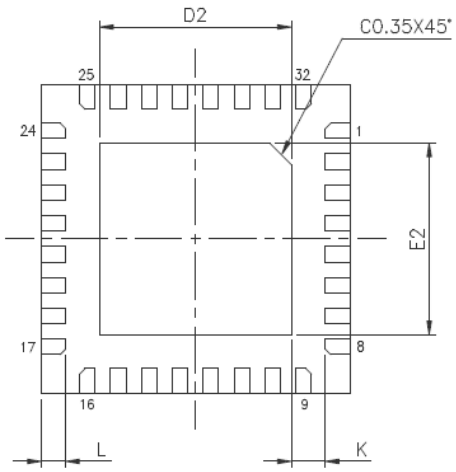
Fig. 8 - HT6329E simplified schematic (COMB = 1)

Package Outline and Dimensions

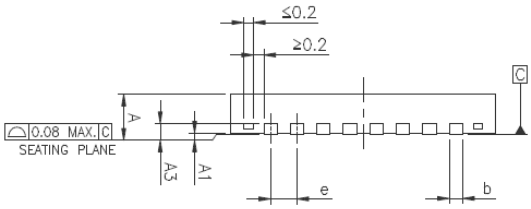
32-pin QFN (5mm x 5mm, 0.5mm pitch)



Top View



Bottom



Side View

	PACKAGE TYPE					
JEDEC OUTLINE	MO-220			MO-220		
PKG CODE	WQFN(X532)			VQFN(Y532)		
SYMBOLS	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	0.70	0.75	0.80	0.80	0.85	0.90
A1	0.00	0.02	0.05	0.00	0.02	0.05
A3	0.203 REF.			0.203 REF.		
b	0.18	0.25	0.30	0.18	0.25	0.30
D	5.00 BSC			5.00 BSC		
E	5.00 BSC			5.00 BSC		
e	0.50 BSC			0.50 BSC		
L	0.35	0.40	0.45	0.35	0.40	0.45
K	0.20	—	—	0.20	—	—

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.

Dual Ports MAX SPEED

HT6000 Series

Fast Charging is just a Breeze

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