

Advanced PWM Controller For Bus Converters

FEATURES

- Programmable, Load Dependent, Off-Time Control
- Frequency Controlled Start Up Allows Small Output Inductor, Low Ripple and Constant Current Start with Large Output Capacitor
- Two 0.2-A Push-Pull Outputs Provide Matched Control Signals D to External Drivers
- Two Additional 1- D Outputs for Optimal Use of Self-Driven or Control Driven Synchronous Rectifiers
- Unregulated, Fixed Volt-Second or Fixed Frequency Modes set by User
- Two, 1.5% Overall Accuracy Reference Voltage Options: 5-V for UCC28230 and 3.3-V for UCC28231
- Resistor Programmable Switching Frequency up to 1 MHz
- Cycle-by-Cycle Current Limit Allows Parallel Operation with Droop Based Current Sharing
- Single External Capacitor sets Soft-Start and Over Current Hiccup Mode Parameters with Restart
- Severe Short Circuit Hiccup with Restart or Latch-Off Protection Option by External Resistor
- Input Under Voltage Lock Out
- Thermal Shutdown
- Thermally Enhanced 3 mm x 2 mm SON-12 and TSSOP-14 Package Options

APPLICATIONS

- Intermediate Bus Isolated Converters
- DC-to-DC Transformers

DESCRIPTION

The UCC28230, UCC28231 PWM bus controllers are optimized for use in high efficiency, high power density, unregulated intermediate bus converters. Topologies include push-pull, half-bridge and full-bridge. External drivers, such as 120-V high-side/low-side driver UCC27200, can be used with this controller.

Low cost, small size and highly efficient solutions are achieved by innovations such as:

- Start-up frequency control circuit allowing small output inductor and start with large intermediate bus capacitance.
- Load dependent off-time control set by user.

Additional 1-D control outputs can be used for primary winding clamping in self-driven output synchronous rectifier applications or as drive signals for the control-driven synchronous rectifier.

Cycle-by-cycle current limit prevents overstresses of converter. If the over current condition causes less than 80% duty cycle at the output, then after programmable time the controller proceeds into periodical shutdown and restart hiccup mode.

The UCC28230 provides 5 V, and the UCC28231 provides 3.3-V precision reference voltages with 1.5% overall accuracy and 10-mA output current. This reference voltage can be used to supply housekeeping circuit and/or microcontroller. The precision reference voltage can also be used for accurate setting of system parameters.

Other features include under-voltage lockout, thermal shutdown, programmable soft-start, over-current hiccup mode and short circuit protection with internal restart (by default) or latch-off mode by using an external resistor.

PRODUCT PREVIEW



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

Symplified Application Diagram

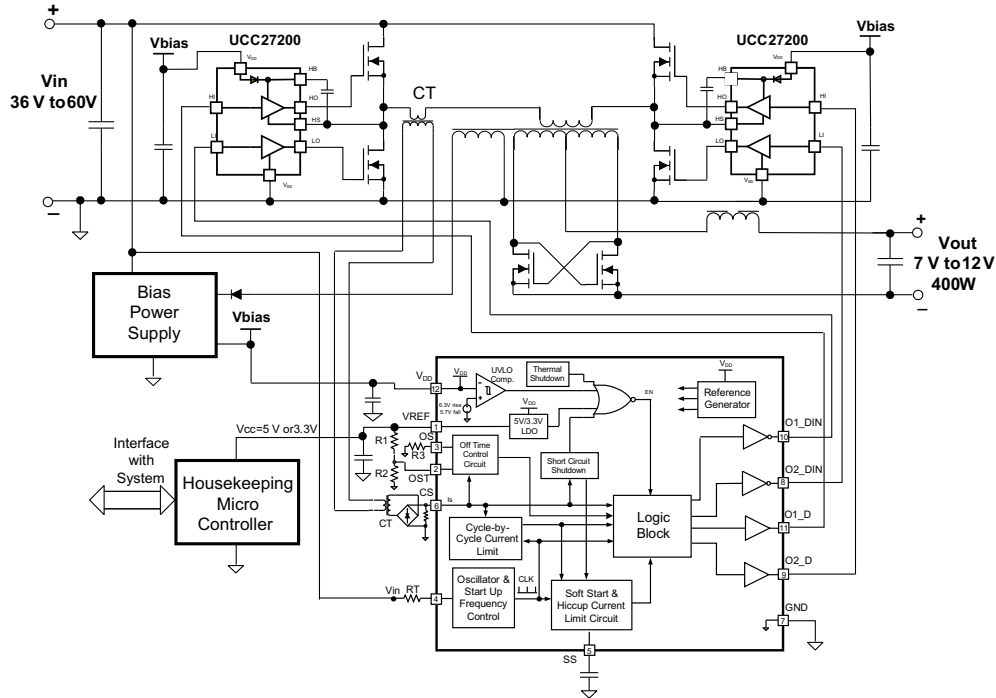


Figure 1. Full-Bridge Converter

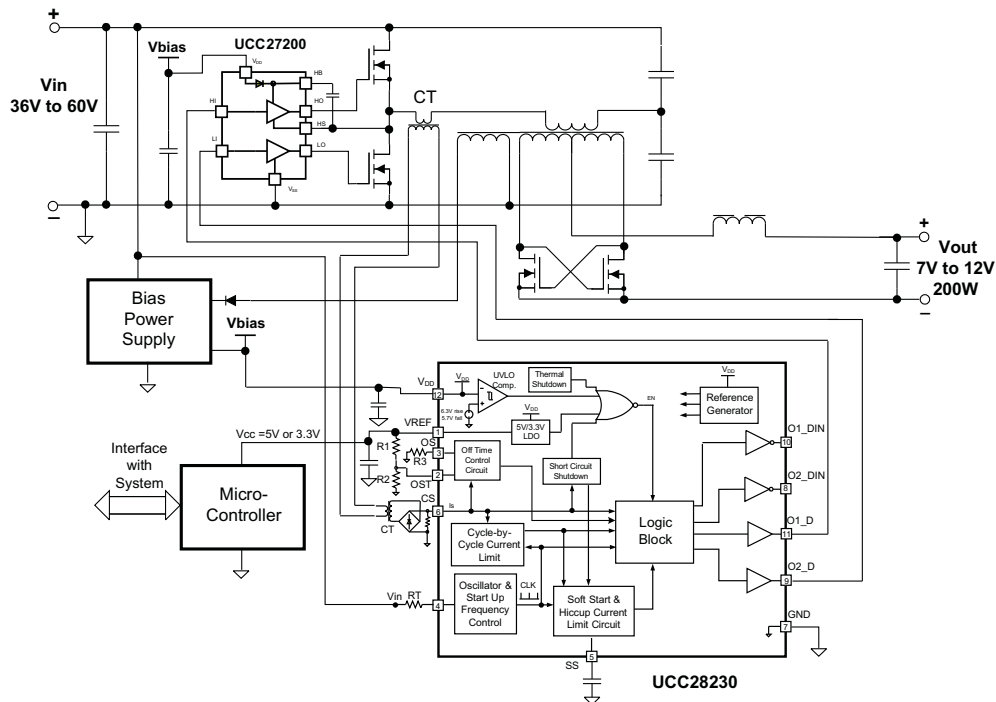


Figure 2. Half-Bridge Converter

ORDERING INFORMATION

TEMPERATURE RANGE, $T_A = T_J$	REFERENCE VOLTAGE	PACKAGE	TAPE AND REEL QTY	PART NUMBER
-40°C to +125°C	5 V	Plastic 12-pin SON (DRN)	250	UCC28230DRNT
	5 V		3000	UCC28230DRNR
	3.3 V		250	UCC28231DRNT
	3.3 V		3000	UCC28231DRNR
	5 V	Plastic 14-pin TSSOP (PW)	250	UCC28230PWT
	5 V		2000	UCC28230PWR
	3.3 V		250	UCC28231PWT
	3.3 V		2000	UCC28231PWR

ABSOLUTE MAXIMUM RATINGS⁽¹⁾⁽²⁾

over operating free-air temperature range (unless otherwise noted)

	VALUE	UNIT
VDD Input supply voltage range, ⁽³⁾	-0.3 to 20.0	V
O1_D, O2_D, O1_DIN, O2_DIN	-0.3 to VDD +0.3	
Inputs voltages on OS, CS, SS, RT, OST	-0.3 to 6.3	
Output voltage on VREF	-0.3 to 5.6	
HBM ESD rating,	2k	
CDM ESD rating	500	°C
Continuous total power dissipation	NoLabel	
T _J Operating virtual junction temperature range,	-40 to +150	
T _A Operating ambient temperature range,	-40 to +125	
T _{stg} Storage temperature,	-65 to +150	
Lead temperature (Soldering, 10 sec.)	+300	

- (1) Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) These devices are sensitive to electrostatic discharge; follow proper device handling procedures.
- (3) All voltages are with respect to GND unless otherwise noted. Currents are positive into, negative out of the specified terminal. See Packaging Section of the datasheet for thermal limitations and considerations of packages.

DISSIPATION RATINGS⁽¹⁾

BOARD	PACKAGE	R _{θJC}	R _{θJA}	DERATING FACTOR ABOVE T _A = 25°C	T _A <25°C POWER RATING	T _A = 70°C POWER RATING	T _A = 85°C POWER RATING
High-K(2) ⁽²⁾	DRN						
	PW		110°C	9.07mW/ °C	907 mW		

- (1) These thermal data are taken at standard JEDEC test conditions and are useful for the thermal performance comparison of different packages. The cooling condition and thermal impedance R_{θJA} of practical design is specific.
- (2) The JEDEC test board JESD51-5 with direct thermal pad attach, 3-inch x 3-inch, 4-layer with 1-oz internal power and ground planes and 2-oz top and bottom trace layers (preliminary data based on modeling)

RECOMMENDED OPERATING CONDITIONS

over operating free-air temperature range (unless otherwise noted)

	MIN	NOM	MAX	UNIT
VDD Supply voltage range	7	12	17	V
T _J Operating junction temperature range	-40		125	°C

ELECTRICAL CHARACTERISTICS⁽¹⁾

over operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITION	MIN	TYP	MAX	UNITS
Bias Currents						
I _{DD(off)}	Startup current	V _{DD} is 200 mV below UVLO falling threshold		150	238	μA
I _{DD}	Operating supply current			1.5	4	mA
Under Voltage Lockout						
	Start threshold		5.9	6.3	6.8	V
	Minimum operating voltage after start		5.3	5.7	6.1	
	Hysteresis		0.55	0.6	0.75	
Soft Start (SS Pin)						
I _{SS}	Charge current	V _{SS} = 0 V	20	25	30	μA
V _{SS_STD}	Shutdown/restart/reset threshold		0.3	0.55	0.8	V
V _{SS_FP}	Soft-start first pulse threshold			0.85		
V _{SS_PU}	Pull up threshold		3.3	3.5	3.7	
V _{SS_CL}	Clamp voltage		4.2	4.5	4.7	
OFF Time Programming						
T _{OFF}	Off time between O1_D and O2_D	OS = 12.7 kΩ, CS = 0.3 V, OST = 1 V	33	40	47	ns
T _{DT}	Dead time between O1_D and O1_DIN, O2_D and O2_DIN		10			
T _{OFFR}	Off time between O1_D and O2_D	OS = 12.7 kΩ, CS = 0 V, OST = VREF	33	40	47	
T _{DTF}	Dead time between O1_D and O1_DIN, O2_D and O2_DIN		10			
ΔT _{OFFR}	Off time matching			2		
I _{HYST}	Hysteresis current source			10		μA
V _{CS(off)}	Off time control threshold	OS = 12.7 kΩ, OST = 1 V, CS rising		0.1		V
T _{OFF(max)}	Maximum off time at low CS	OS = 12.7 kΩ, OST = 1 V, CS = 0 V	165		235	ns
Switching Frequency at O1_D and O2_D Outputs						
	Starting frequency	V _{SS} = V _{SS(FP)} + 100 mV	92	100	108	kHz
F _{SW(nom)}	Nominal frequency	V _{SS} = V _{SS(PU)} + 100 mV	92	100	108	
F _{SW(max)}	Maximum frequency	V _{SS} = 1.8 V	450	500	550	
VREF Output Voltage						
V _{REF5}	Output voltage (UCC28230)	0 ≤ IR ≤ 10 mA, 7 V ≤ V _{DD} ≤ 17 V, -40°C ≤ T _J ≤ 125°C	4.925	5	5.075	V
V _{REF3}	Output voltage (UCC28231)	0 ≤ IR ≤ 10 mA, 7 V ≤ V _{DD} ≤ 17 V, -40°C ≤ T _J ≤ 125°C	3.25	3.3	3.35	
ΔV _{REF} /ΔV _{DD}	Line regulation	7 V ≤ V _{DD} ≤ 17 V, IR = 1 mA		0.3	1	mV/V
ΔV _{REF} /ΔI _{REF}	Load regulation	0 ≤ IR ≤ 10 mA		1.3	3	mV/mA
I _{SCC}	Short circuit current	VREF = 0 V	-35	-25	-15	mA

(1) Typical values for $T_A + 25^\circ C$.

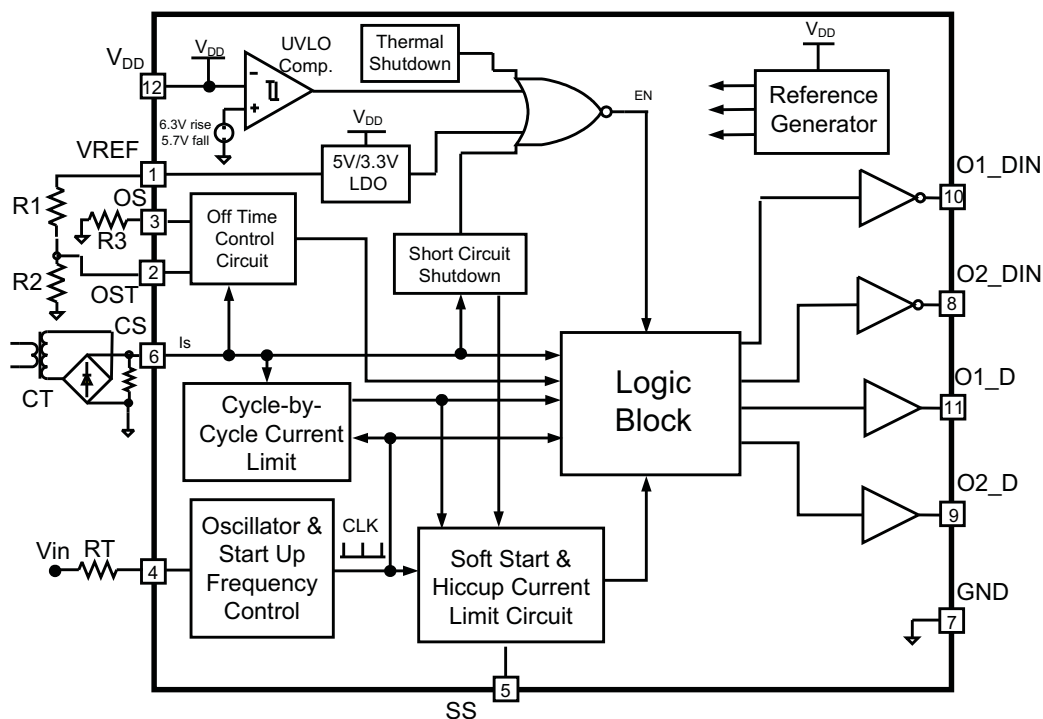
ELECTRICAL CHARACTERISTICS (continued)

over operating free-air temperature range (unless otherwise noted)

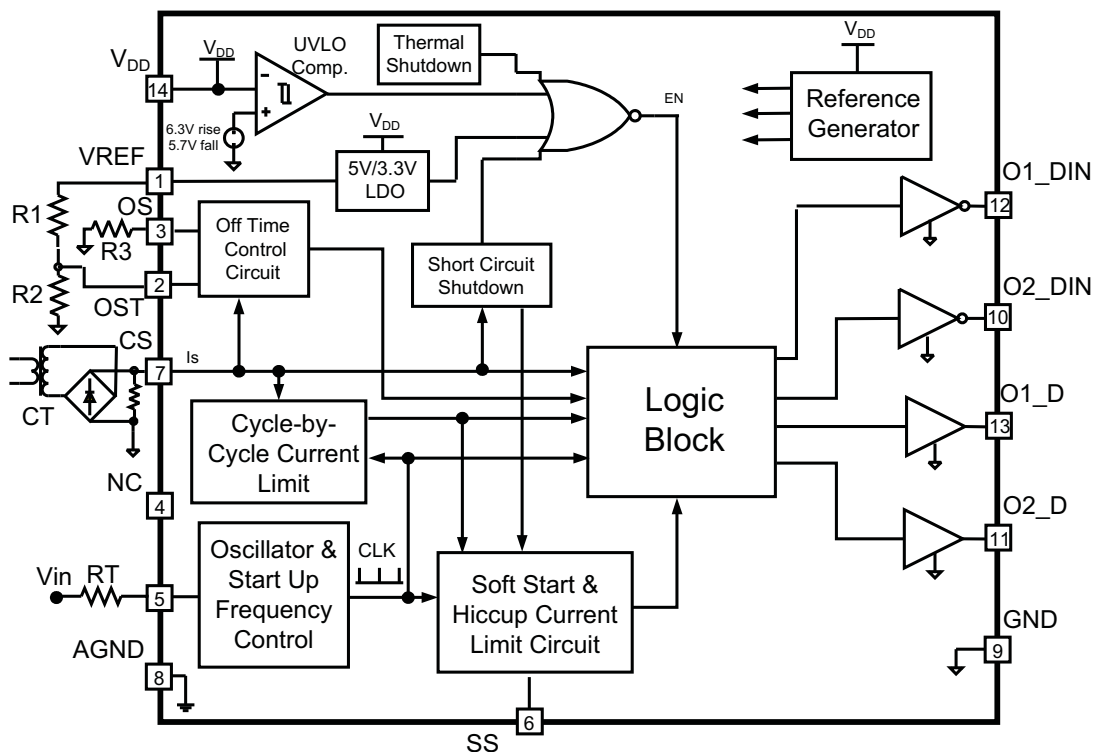
PARAMETER		TEST CONDITION	MIN	TYP	MAX	UNITS
Current Sense, Cycle-by-Cycle Current Limit With Hiccup, Short Circuit Protection With Latch OFF						
V _{CS_LIM}	CS pin cycle-by-cycle threshold		0.485	0.5	0.515	V
T _{CS}	Propagation delay from CS to O1_D and O2_D outputs	Input pulse at CS from zero to 0.6 V		25		ns
I _{DS}	Discharge current to set cycle-by-cycle current limit duration	CS = 0.6 V, V _{SS} = 4 V	15	20	25	μA
	Hiccup OFF time threshold		3.1	3.4	3.7	V
I _{HCC}	Discharge current to set hiccup mode OFF time		1.9	2.5	3.1	μA
V _{CS_SC}	CS pin short circuit protection threshold		0.65	0.7	0.75	V
Outputs O1_D, O2_D, O1_DIN, O2_DIN						
	Sink/source peak current			0.2		A
	Rise time	C _{LOAD} = 100 pF		8	20	ns
	Fall time	C _{LOAD} = 100 pF		4	20	
R _{SRC}	Output source resistance	I _{OUT} = 20 mA	15	20	30	Ω
R _{SINK}	Output sink resistance	I _{OUT} = 20 mA	5	10	25	
	Duty cycle matching	Pins 7 and 9 pulses matching at F _{SW} = 100 kHz		35		ns
Thermal Shutdown						
	Rising threshold		150	160	170	°C
	Falling threshold		130	140	150	
	Hysteresis			20		

DEVICE INFORMATION

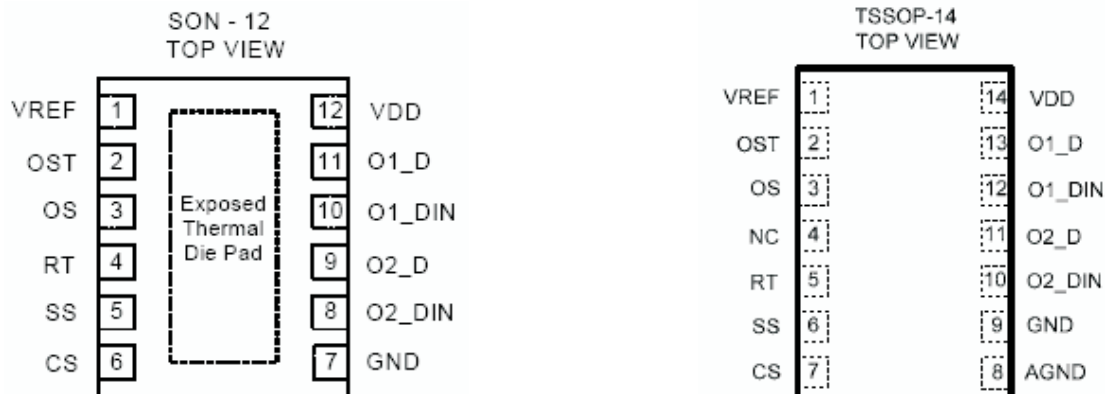
SON-12 Package



TSSOP-14 Package



PINOUT DIAGRAMS



TERMINAL FUNCTIONS

DFN-12	TSSOP-14	NAME	I/O	FUNCTION
PIN #				
1	1	VREF	O	VREF is a 10-mA output reference, 1.5% accurate 5 V for UCC28230 and 3.3 V for UCC28231. The reference voltage has short circuit protection that can be used for fixed switching frequency setting and/or for housekeeping microcontroller. Place decoupling capacitor in the range of 1 μ F to 2.2 μ F from this pin to GND.
2	2	OST	I	The off-time control threshold pin uses a resistor divider to set current level as percentage of current limit threshold below which T _{OFF} starts increasing and reaches its maximum value at no load condition.
3	3	OS	I	Nominal off time, T _{OFF} , set pin.
	4	NC		No connection pin, TSSOP-14 only.
4	5	RT	I	Oscillator timing input pin. The external resistor which is connected between this pin and VIN sets the oscillator frequency which varies with VIN. Tying the external resistor to VREF sets fixed frequency operation independent of VIN.
5	6	SS	I/O	Input for setting the adjustable soft-start and hiccup mode. Place the soft-start capacitor from this pin to GND. The internal charge/discharge current I _{SS} and an external capacitor value set the soft-start timing, duration of cycle-by-cycle current limit and OFF time for hiccup mode operation.
6	7	CS		Current sensing pin used for cycle-by-cycle current limit, short circuit protection and off time control.
	8	AGND		Analog ground, TSSOP-14 only.
7	9	GND		Ground pin connected to thermal pad. All signals are referenced to this node.
8	10	O2_DIN	O	0.2-A sink/source switching output pin. Connect this pin to an external driver that provides 1-D pulse.
9	11	O2_D	O	0.2-A sink/source switching output pin. Connect this pin to an external driver that provides D pulse.
10	12	O1_DIN	O	0.2-A sink/source switching output pin. Connect this pin to an external driver that provides 1-D pulse.
11	13	O1_D	O	0.2-A sink/source switching output pin. Connect this pin to an external driver that provides D pulse.
12	14	VDD	I	Connect this pin to a 7-V to 17-V bias supply. Place a high quality at least 1- μ F ceramic bypass capacitor from this pin to GND.