RT9229 Data Sheet

RichTek Technology Corp. RDS-229-013A Rev. 1
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Advanced Dual PWM and Dual Linear Power Controller

General Description

The RT9229 is a 4-in-one power controller optimized for high-performance microprocessor and computer applications. The IC integrates two PWM controllers, a linear regulator and a linear controller as well as monitoring and protection functions into a 28-pin SOP package. The first PWM controller regulates the microprocessor core voltage with a synchronous buck converter, while the second PWM controller supplies the 3.3V power with a standard buck converter. The linear regulator provides power for the clock driver circuit and the linear controller regulates power for the GTL bus.

The RT9229 features an Intel-compatible, TTL 5-bit programmable DAC that adjusts the core voltage from 2.1V to 3.5V in 0.1V increments and from 1.3V to 2.05V in 0.05V steps. The second PWM controller is user-adjustable for output level between 3.0V and 3.5V with ±2.5% accuracy. The 5-bit DAC has a typical ±1% tolerance. The linear regulator uses an internal drive device to provide 2.5V ±2.5% output voltage. The linear controller drives an external N-channel MOSFET or a low cost NPN bipolar transistor to provide 1.5V ±2.5%.

The RT9229 monitors all the output voltages. A Power-good signal is issued when the core voltage is within ±10% of the DAC setting and the other levels are above their under-voltage levels. Additional build-in over-voltage protection for the core output uses the lower MOSFET to prevent output voltage above 115% of the DAC setting. The PWM over-current function monitors the output current using the voltage drop across the upper MOSFET's $R_{DS(ON)}$, which eliminates the need for a current sensing resistor.

Ordering Information

RT9229-□ □

- Package Type
  - S: SOP-28
- Operating Temperature Range
  - C: Commercial standard
  - M: Military standard

Features

- 4-in-one Regulated Voltages for Microprocessor Core, I/O, Clock, and GTL
- Compatible with HIP6019B
- Power-Good Output Voltage Monitor

Switching section

- 5-bit DAC Programmable from 1.3V to 3.5V
- ±1% DAC Accuracy
- Fast Transient Response
- Full 0% to 100% Duty Cycle Driver
- Switching Frequency from 50kHz to 500kHz
- Adaptive Non-overlapping Gate Driver
- Over-current Monitor Uses MOSFET Rds(on)
- Over-voltage Protection Uses Lower MOSFET

Linear Section

- User-adjustable Linear Regulator Output Voltage
- MOSFET or NPN Driving Capability
- Ultra Fast Response Speed
- Under-voltage Protection
- Internal Thermal Shutdown

Applications

- Full Motherboard Power Regulation for Computer
- Low-Voltage Distributed Power Supplies

Pin Configurations

Part Number	Pin Configurations
RT9229CS	(SOP-28, see pin list below)

1	UGATE2	28	VCC
2	PHASE2	27	UGATE1
3	VID4	26	PHASE1
4	VID3	25	LGATE1
5	VID2	24	PGND
6	VID1	23	OCSET1
7	VID0	22	VSEN1
8	PGOOD	21	FB1
9	OCSET2	20	NC1
10	FB2	19	FB3
11	NC2	18	GATE3
12	SS	17	GND
13	FAULT/RT	16	VOUT4
14	FB4	15	VSEN2

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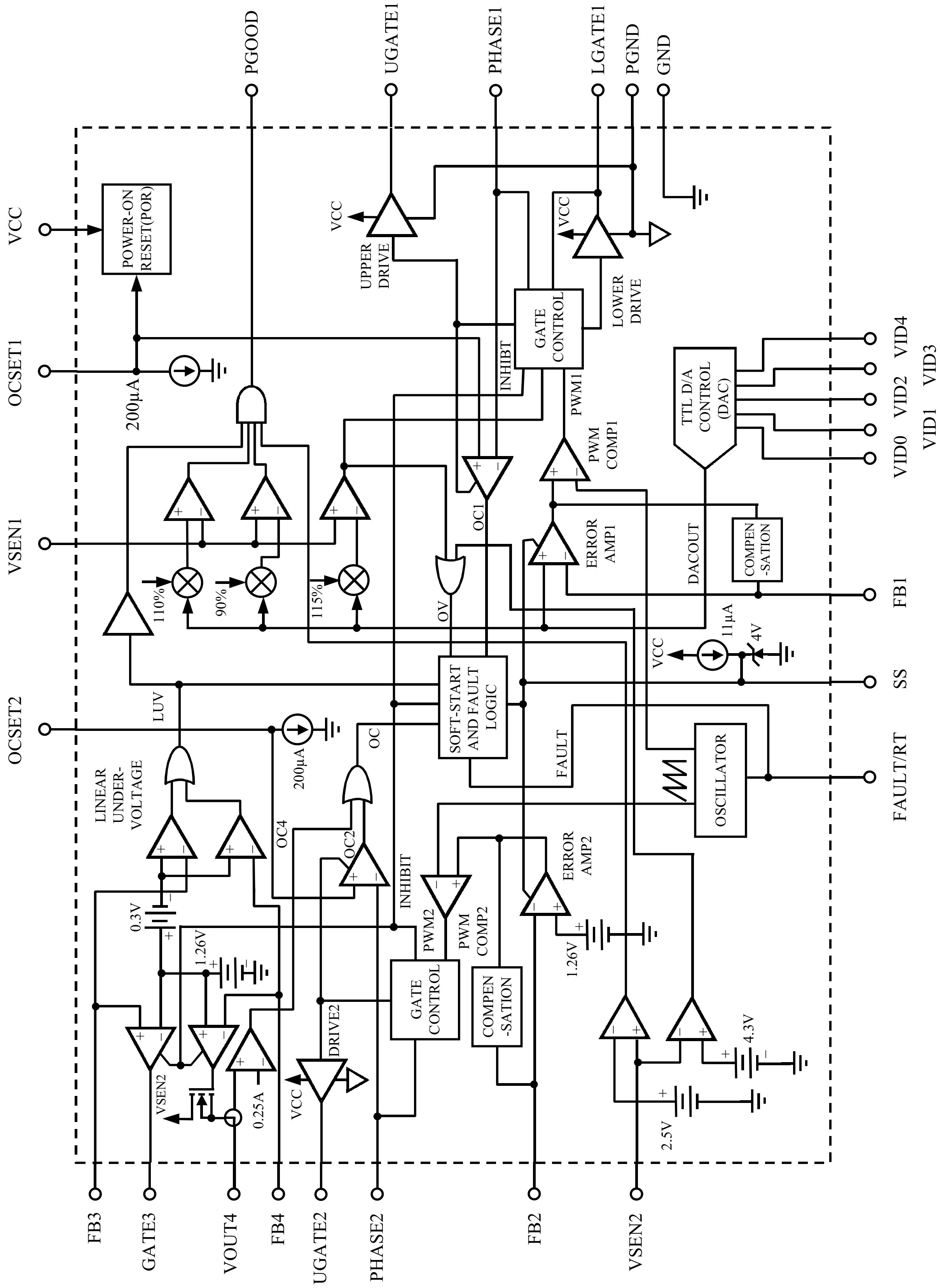
Block Diagram



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Absolute Maximum Ratings

- Supply Voltage, V_{CC} ---------- +15V
- PGOOD, FAULT/RT and GATE Voltage ---------- GND–0.3V to V_{CC}+0.3V
- Input, Output or I/O Voltage ---------- GND–0.3V to 7V
- Ambient Temperature Range (T_A) ---------- 0℃ to +70℃
- Junction Temperature Range (T_J) ---------- 0℃ to +125℃
- Storage Temperature Range (T_{STG}) ---------- –65℃ to +150℃
- Lead Temperature (Soldering) 10 seconds (T_L) ---------- 300℃
- Thermal Impedance Junction to Ambient (θ_{JA}) ---------- 75℃/W
- Thermal Impedance Junction to Case (θ_{JC}) ---------- 25℃/W

Recommended Operating Conditions

- Supply Voltage, V_{CC} ---------- +12V ±10%
- Ambient Temperature Range ---------- 0°C to 70°C
- Junction Temperature Range ---------- 0°C to 125°C

CAUTION:

Stresses beyond the ratings specified in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

Electrical Specifications

V_{CC}=12V, PGND=0V, T_A=25℃, Unless otherwise specified.

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
VCC SUPPLY CURRENT						
Nominal Supply Current	I_{CC}	UGATE1, GATE2, GATE3, LGATE1, and VOUT4 Open	-	10	-	mA
POWER-ON RESET						
Rising VCC Threshold		V_{OCSET} = 4.5V	7.5	-	9.5	V
Falling VCC Threshold		V_{OCSET} = 4.5V	7	-	9	V
Rising $V_{OCSET1\ (and\ 2)}$ Threshold			-	1.25	-	V

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OSCILLATOR						
Free Running Frequency		RT = Ooen	180	200	225	kHz
Ramp Amplitude	ΔV_{OSC}	RT = Open	-	1.9	-	Vp-p
REFERNECE and DAC						
DAC(VID0-VID4)Input Low Voltage			-	-	0.8	V
DAC(VID0-VID4)Input High Voltage			2.0	-	-	V
DACOUT Voltage Accuracy		DACOUT= 2.05~3.50V	−1	-	1	%
DACOUT Voltage Accuracy		DACOUT =1.30~2.00V	−1%	-	20mV	-
Reference Voltage (Pin FB2 and FB3)			1.240	1.265	1.290	V
LINEAR REGULATOR						
Regulation		10mA<I_{VOUT2}<150mA	−2.5	-	2.5	%
Under-Voltage Level	$FB4_{UV}$	FB4 Rising	-	75	87	%
Under-Voltage Hysteresis			-	100	-	mV
Over-Current Protection			180	230	-	mA
Over-Current Protection During Start-Up			-	700	-	mA
LINEAR CONTROLLER						
Regulation		VSEN3= GATE3, 0<I_{GATE3}<20mA	−2.5	-	2.5	%
Under-Voltage Level	$FB3_{UV}$	FB3 Rising	-	75	87	%
Under-Voltage Hysteresis			-	100	-	mV
Output Drive Current	I_{GATE3}	VIN2-VOUT3>1.5V	20	40	-	mA
PWM CONTROLLER ERROR AMPLIFIER						
DC Gain			-	65	-	dB
PWN CONTROLLER GATE DRIVER						
Upper Drive1 (and 2) Source	R_{UGATE}	VCC=12V, VCC−V_{UGATE} =1V	-	3	7	Ω
Upper Drive1 (and 2) Sink	R_{UGATE}	V_{UGATE}=1V	-	3	7	Ω
Lower Drive Source	I_{LGATE1}	VCC=12V, V_{LGATE1}=2V	-	1	-	A
Lower Drive Sink	R_{LGATE1}	V_{LGATE1}=1V	-	2	6	Ω
PROTECTION						
V_{OUT1} Over-voltage Trip		VSEN1 Rising	112	115	118	%
V_{OUT2} Over-voltage Trip		VSEN2 Rising	4.1	4.3	4.5	V
FAULT Souring Current	I_{OVP}	V_{FAULT}=8V	10	14	-	mA
OCSET1 (and 2) Current Source	I_{OCSET}	V_{OCSET}=4.5V_{DC}	170	200	230	μA
Soft-Start Current	I_{SS}	Vss=1V	-	11	-	μA
POWER GOOD						
V_{OUT1} Upper Threshold		VSEN1 Rising	108	-	112	%
V_{OUT1} Under Voltage		VSEN1 Rising	90	-	94	%
V_{OUT1} Hysteresis(VSEN1/DACOUT)		Upper/Lower Threshold	-	2	-	%
PGOOD Voltage Low	V_{PGOOD}	I_{PGOOD}=-4mA	-	-	0.5	V

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Functional Pin Description

VSEN1, VSEN2 (Pins 22 and 15)

These pins are connected to the PWM converters' output voltage. The PGOOD and OVP comparator circuits use these signals to report output voltage status and for over-voltage protection. VSEN2 provides the input power to the integrated linear regulator.

OCSET1, OCSET2 (Pins 23 and 9)

Connect a resistor (R_{OCSET}) from this pin to the drain of the upper MOSFET. R_{OCSET}, an internal 200μA current source (I_{OCSET}), and the upper MOSFET on-resistance ($r_{DS(ON)}$) set the converter over-current (OC) trip point according to the following equation:

$$I_{PEAK} = \frac{I_{OCSET} \times R_{OCSET}}{r_{DS(ON)}}$$

An over-current trip cycles the soft-start function. Sustaining an over-current for 2 soft-start intervals shuts down the controller.

SS (Pin 12)

Connect a capacitor from this pin to ground. This capacitor, along with an internal 11μA (Vss>1V) current source, sets the soft-start interval of the converter.
Pulling this pin low with an open drain signal will shut down the IC.

VID0, VID1, VID2, VID3, VID4 (Pin 7, 6, 5, 4, and 3)

VID0~4 are the input pins to the 5-bit DAC. The states of these five pins program the internal voltage reference, DACOUT. The level of DACOUT sets the core converter output voltage (V_{OUT1}). It also sets the core PGOOD and OVP thresholds. Table 1 specifies the DACOUT voltage of 32 combinations of VID levels.

FB1, FB2 (21 and 10)

FB1, 2 are the available external pins of the PWM error amplifiers. Both the FB pins are the inverting input of the error amplifiers.

PGOOD (Pin 8)

PGOOD is an open collector output used to indicate the status of the PWM converter output voltage. This pin is pulled low when the core output is not within ±10% of the DACOUT reference voltage, or when any of the other outputs are below their under-voltage thresholds. The PGOOD output is open for '11111'VID code. See table 1.

PHASE1, PHASE2 (Pins 26 and 2)

Connect the PHASE pins to the PWM converter's upper MOSFET source. These pins are used to monitor the voltage drop across the upper MOSFETs for over-current protection.

UGATE1, UGATE2 (Pins 27 and 1)

Connect UGATE pins to the respective PWM converter's upper MOSFET gate. This pin provides the gate drive for the upper MOSFETs.

PGND (Pin 24)

This is the power ground of UGATE1, LGATE1, and UGATE2. Tie the synchronous PWM converter's lower MOSFET source to this pin.

LGATE1 (Pin 25)

Connect LGATE1 to the synchronous PWM converter's lower MOSFET gate. This pin provides the gate drive for the lower MOSFET.

VCC (Pin 28)

Provide a 12V bias supply for the IC to this pin. This pin also provides the gate bias charge for all the MOSFETs controlled by the IC.

FAULT/RT (Pin 13)

This pin provides oscillator switching frequency adjustment. By placing a resistor (R_T) form this pin to GND, the nominal 200kHz switching frequency is increased according to the following equation:

$$Fs = 200\text{kHz} + \frac{3.5\times 10^6}{R_T(k\Omega)} (R_T \text{ to GND})$$

Conversely, connecting a pull-up resistor (R_T) from this pin to VCC reduces the switching frequency according to the following equation:

$$Fs = 200\text{kHz} - \frac{2.8\times 10^7}{R_T(k\Omega)} (R_T \text{ to 12V})$$

Nominally, this pin voltage is 1.26V, but is pulled to VCC in the event of an over-voltage or over-current condition.

GATE3 (Pin 18)

Connect this pin to the gate of an external MOSFET or the base of a NPN. This pin provides the drive for the linear controller's pass transistor.

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FB3 (Pin 19)
Connect this pin to a resistor divider to set the linear controller output voltage.

VOUT4 (Pin 16)
Output of the linear regulator. Supplies current up to 230mA.

FB4 (Pin 14)
Connect this pin to a resistor divider to set the linear regulator output.

Table 1. VOUT1 Voltage Program

Pin Name					Normal OUT1 Voltage DACOUT
VID4	**VID3**	**VID2**	**VID1**	**VID0**	
0	1	1	1	1	1.30
0	1	1	1	0	1.35
0	1	1	0	1	1.40
0	1	1	0	0	1.45
0	1	0	1	1	1.50
0	1	0	1	0	1.55
0	1	0	0	1	1.60
0	1	0	0	0	1.65
0	0	1	1	1	1.70
0	0	1	1	0	1.75
0	0	1	0	1	1.80
0	0	1	0	0	1.85
0	0	0	1	1	1.90
0	0	0	1	0	1.95
0	0	0	0	1	2.00
0	0	0	0	0	2.05
1	1	1	1	1	INHIBIT
1	1	1	1	0	2.10
1	1	1	0	1	2.20
1	1	1	0	0	2.30
1	1	0	1	1	2.40
1	1	0	1	0	2.50
1	1	0	0	1	2.60
1	1	0	0	0	2.70
1	0	1	1	1	2.80
1	0	1	1	0	2.90
1	0	1	0	1	3.00
1	0	1	0	0	3.10
1	0	0	1	1	3.30
1	0	0	1	0	3.30
1	0	0	0	1	3.40
1	0	0	0	0	3.50

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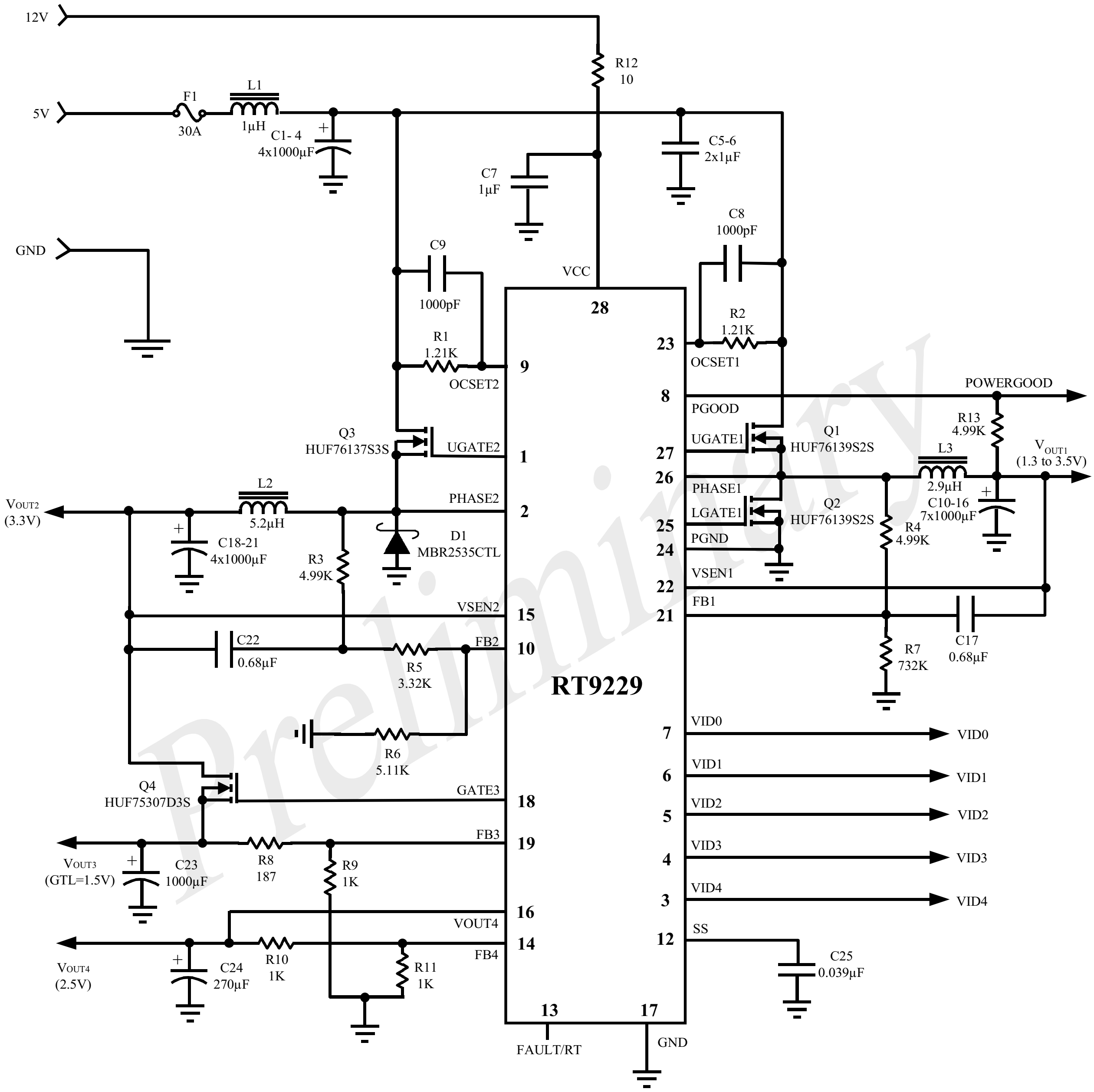
Typical Application Circuit



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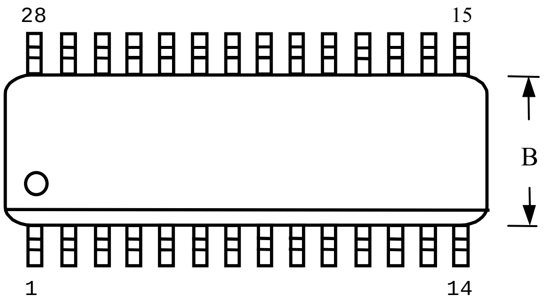

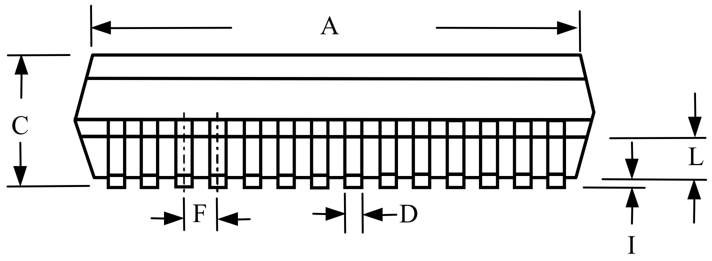

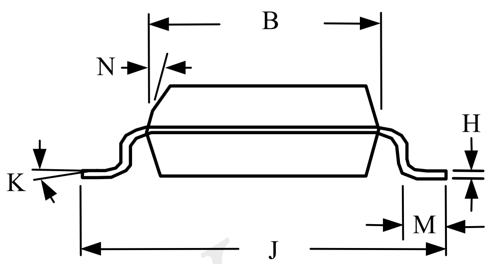

Symbols	Dimensions In Inches			Dimensions In Millimeter		
	Min	Norm	Max	Min	Norm	Max
A	0.701	0.705	0.709	17.800	17.900	18.000
B	0.291	0.295	0.299	7.400	7.500	7.600
C	0.090	0.092	0.094	2.280	2.330	2.380
D	0.015	0.016	0.017	0.390	0.400	0.410
F	-	0.050	-	-	1.270	-
H	0.008	0.009	0.010	0.200	0.230	0.260
I	0.003	0.006	0.009	0.080	0.160	0.240
J	0.405	0.409	0.413	10.300	10.400	10.500
K	-	5°	-	-	5°	-
L	0.035	0.039	0.043	0.900	1.000	1.100
M	0.020	0.028	0.035	0.500	0.700	0.900
N	--	7°	--	--	7°	--

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