PRELIMINARY - April 13, 1998

TEL:805-498-2111 FAX:805-498-3804 WEB:http://www.semtech.com

DESCRIPTION

The SC1156 is a low-cost, full featured synchronous, voltage-mode controller designed for use in single ended power supply applications where efficiency is of primary concern. Synchronous operation allows for the elimination of heat sinks in many applications. The SC1156 is ideal for implementing DC/DC converters needed to power advanced microprocessors such as Pentium® II (Klamath), in both single and multiple processor configurations. Internal level-shift, high-side drive circuitry, and preset shoot-thru control, allows for use of inexpensive n-channel power switches.

SC1156 features include an integrated 5-bit V_{ID} DAC, temperature compensated voltage reference, triangle wave oscillator, current limit comparator, frequency shift over-current protection, and an accessible, internally compensated error amplifier. Power good signaling, logic compatible shutdown, and over voltage protection are also provided.

The SC1156 operates at a fixed 200KHz, providing an optimum compromise between efficiency, external component size, and cost.

FEATURES

- Low cost / full featured
- Synchronous operation
- 5 Bit V_{ID} DAC programmable output
- On-chip power good and OVP functions
- Designed to meet Intel VRM8.1 (Klamath)

APPLICATIONS

- Pentium® II (Klamath) Core Supply
- Multiple MicroProcessor Supplies
- Voltage Regulation Modules (VRM)
- Programmable Power Supplies
- High Efficiency DC/DC Conversion

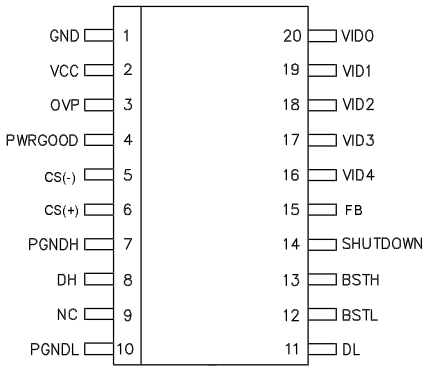
ORDERING INFORMATION

DEVICE (1)	PACKAGE	TEMP. (T_J)
SC1156CSW	SO-20	0 - 125°C

Note:
(1) Add suffix 'TR' for tape and reel.

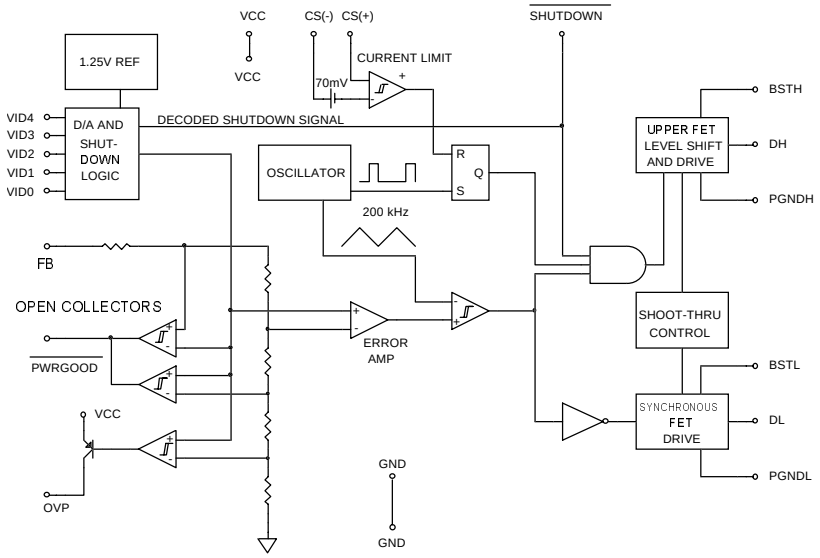
PIN CONFIGURATION

Top View



(20-Pin SOIC)

BLOCK DIAGRAM



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ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Maximum	Units
V_{CC} to GND	V_{IN}	-0.3 to +15	V
PGND to GND		± 1	V
BST to GND		-0.3 to +26	V
Operating Temperature Range	T_A	0 to +70	°C
Junction Temperature Range	T_J	0 to +125	°C
Storage Temperature Range	T_{STG}	-65 to +150	°C
Thermal Resistance Junction to Case	θ_{JC}	30	°C/W
Thermal Resistance Junction to Ambient	θ_{JA}	95	°C/W
Lead Temperature (Soldering) 10 sec	T_{LEAD}	300	°C

ELECTRICAL CHARACTERISTICS

(Unless otherwise noted: V_{CC} = 11.4V to 12.6V; GND = PGND = 0V; FB = V_O; 0mV < (CS(+) - CS(-)) < 60mV; T_J = 25°C)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Output Voltage	I_O = 2A(1)	See Output Voltage Table			
Supply Voltage	V_{CC}	4.2		15	V
Supply Current	V_{CC} = 12.0V		5		mA
Load Regulation	I_O = 0.3A to 15A(1)		1		%
Line Regulation	All VID codes(1)		0.5		%
Gain (A_{OL})	V_{OSENSE} to V_O		35		dB
Current Limit Voltage		60	70	80	mV
Oscillator Frequency		180	200	220	kHz
Oscillator Max Duty Cycle		90	95		%
DH Sink/Source Current	BST_H - DH = 4.5V, DH - $PGND_H$ = 2V	1			A
DL Sink/Source Current	BST_L - DL = 4.5V, DL - $PGND_L$ = 2V	1			A
OVP threshold voltage			120		%
OVP source current	V_{OVP} = 3V	10			mA
Power good threshold voltage		90		110	%
Dead time		50	100		ns

NOTE:
(1) Specification refers to Application Circuit (Figure 1).

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PIN DESCRIPTION

Pin #	Pin Name	Pin Function
1	GND	Small Signal Analog and Digital Ground
2	VCC	Chip Supply Voltage
3	OVP	High Signal Out if V_O > Setpoint + 20%
4	PWRGOOD (1)	Open collector logic output, high if V_O within 10% of setpoint
5	CS(-)	Current Sense Input (negative)
6	CS(+)	Current Sense Input (positive)
7	PGNDH	Power Ground for High Side Switch
8	DH	High Side Driver Output
9	NC	Not Connected
10	PGNDL	Power Ground for Low Side Switch
11	DL	Low Side Driver Output
12	BSTL	Vcc for Low Side Driver (Boost)
13	BSTH	Vcc for High Side Driver (Boost)
14	SHUTDOWN(1)	Logic Low Shuts Down The Converter
15	FB	Feedback
16	VID4(1)	Programming Input (MSB)
17	VID3(1)	Programming Input
18	VID2(1)	Programming Input
19	VID1(1)	Programming Input
20	VID0(1)	Programming Input (LSB)

NOTE:

(1) All logic inputs and outputs are open collector TTL compatible.

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APPLICATION CIRCUIT

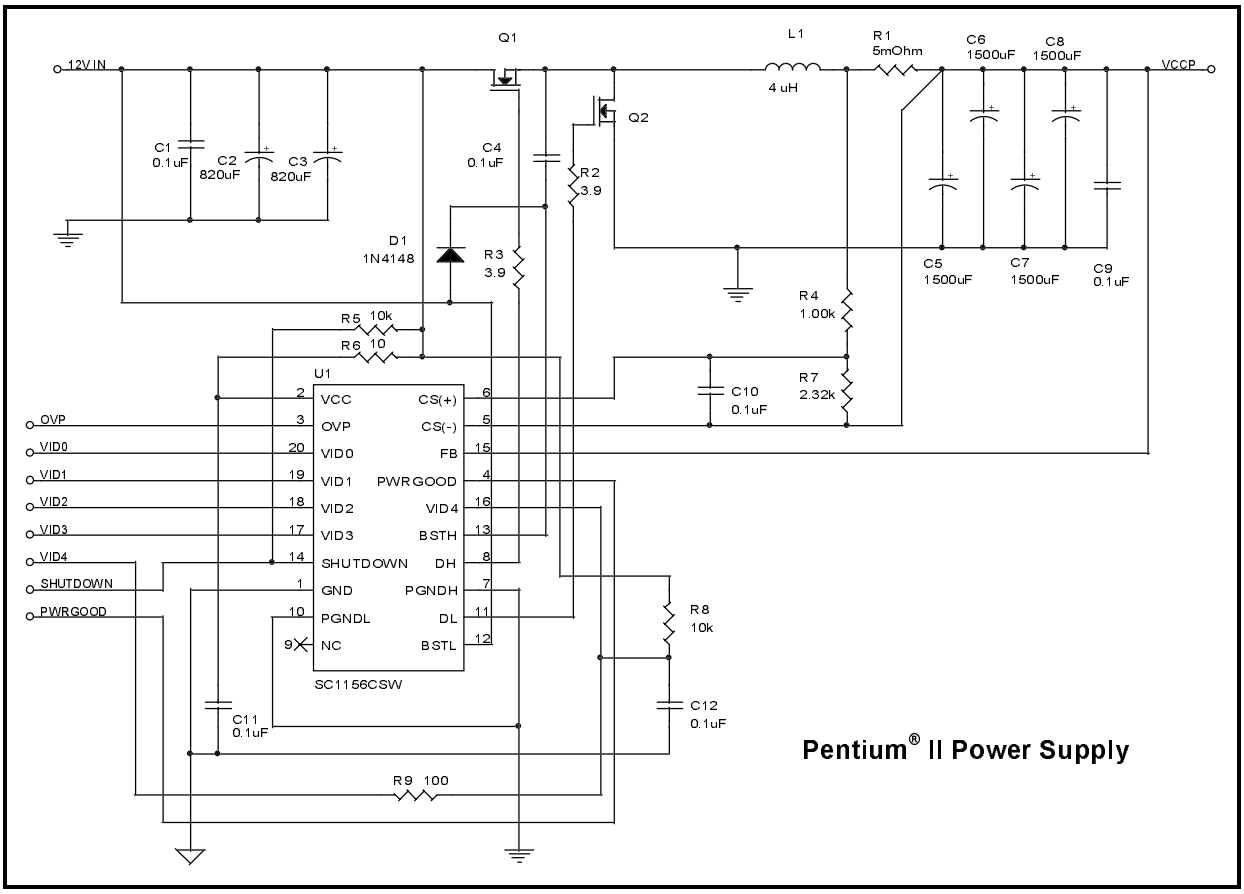

Figure 1.

MATERIALS LIST

Quantity	Reference	Part/Description	Vendor	Notes
6	C1, C4, C9-C12	0.1µF Ceramic	Various	
2	C2, C3	820µF/16V	SANYO	MV-GX or equiv. Low ESR
4	C2-C10	1500µF/6.3V	SANYO	MV-GX or equiv. Low ESR
1	D1	1N4148	Various	
1	L1	4µH		8 Turns 16AWG on MICROMETALS T50-52D core
2	Q1, Q2	See notes	See notes	FET selection requires trade-off between efficiency and cost. Absolute maximum $R_{DS(ON)}$ = 22 mΩ
1	R1	5mΩ	IRC	OAR-1 Series
2	R2, R3	3.9Ω, 5%, 1/8W	Various	
1	R4	1kΩ, 1%, 1/8W	Various	
2	R5, R8	10kΩ, 5%, 1/8W	Various	
1	R6	10Ω, 5%, 1/8W	Various	
1	R7	2.32kΩ, 1%, 1/8W	Various	
1	R9	100Ω, 5%, 1/8W	Various	
1	U1	SC1156CSW	SEMTECH	

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OUTPUT VOLTAGE TABLE

Unless otherwise noted: V_{CC} = 4.75V to 5.25V; GND = PGND = 0V; FB = V_O; 0mV < (CS(+) - CS(-)) < 60mV; T_J = 25°C)

PARAMETER	CONDITIONS	VID 43210	MIN	TYP	MAX	UNITS
Output Voltage(1)	I_O = 2A in Application Circuit (Figure 1)	00101	1.782	1.800	1.818	V
		00100	1.832	1.850	1.868	V
		00011	1.881	1.900	1.919	V
		00010	1.931	1.950	1.969	V
		00001	1.980	2.000	2.020	V
		00000	2.030	2.050	2.070	V
		11111	1.980	2.000	2.020	V
		11110	2.079	2.100	2.121	V
		11101	2.178	2.200	2.222	V
		11100	2.277	2.300	2.323	V
		11011	2.376	2.400	2.424	V
		11010	2.475	2.500	2.525	V
		11001	2.574	2.600	2.626	V
		11000	2.673	2.700	2.727	V
		10111	2.772	2.800	2.828	V
		10110	2.871	2.900	2.929	V
		10101	2.970	3.000	3.030	V
		10100	3.069	3.100	3.131	V
		10011	3.168	3.200	3.232	V
		10010	3.267	3.300	3.333	V
		10001	3.366	3.400	3.434	V
		10000	3.465	3.500	3.535	V

NOTE:
(1) All VID codes not specifically listed are invalid and cause shutdown exactly as if the shutdown pin had been asserted.

THEORY OF OPERATION

The output voltage of the DAC sets the reference voltage at the non-inverting input of the error amplifier which in turn determines the output voltage of the buck converter. The specification lists all available output voltage settings and the corresponding input codes at VID0 through VID4 control pins. These voltages are derived from an internal trimmed bandgap voltage reference. The inverting input of the error amplifier receives its voltage from the VO_{SENSE} pin via a precision resistor divider. The error amplifier itself is transconductance amplifier with an internal load resistor. Loop compensation is provided by the output filter capacitor of the buck converter. The open loop gain is internally set to approximately 40 dB.

The internal oscillator uses on-chip capacitor and trimmed precision current sources to set the frequency of oscillation to 200 kHz. The triangular output of the oscillator sets the reference voltage of a comparator at its inverting input. The non-inverting input of the same comparator receives its input voltage from the error amplifier. The timing diagram is shown in Figure 1. When the oscillator output voltage reaches the mosfet driver DRIVEH, which controls the gate drive of an external MOS power device, serving as the switch connected in series with the main inductor. At the same time DRIVEH receives a low to high output voltage change which turns on DRIVEL as soon as the SHOOT-THROUGH CONTROL circuit permits it. As VO_{SENSE} voltage increases, the output voltage of the error amplifier decreases, causing a reduction of the on-time of the external MOSFET transistor connected to DRIVEH.

When the triangular wave of the oscillator output voltage reaches its positive peak value, another event takes place: a one-shot circuit is triggered in order to generate the required pulse to reset the current limit latch, in case it has been triggered by current limit condition.

When the triangular oscillator output voltage decreases to the point of equivalence with the reference voltage of the error amplifier, the comparator with hysteresis changes state and DRIVEH turns on the external mosfet, while turning off the DRIVEL stage with some delay determined by the shoot-through control.

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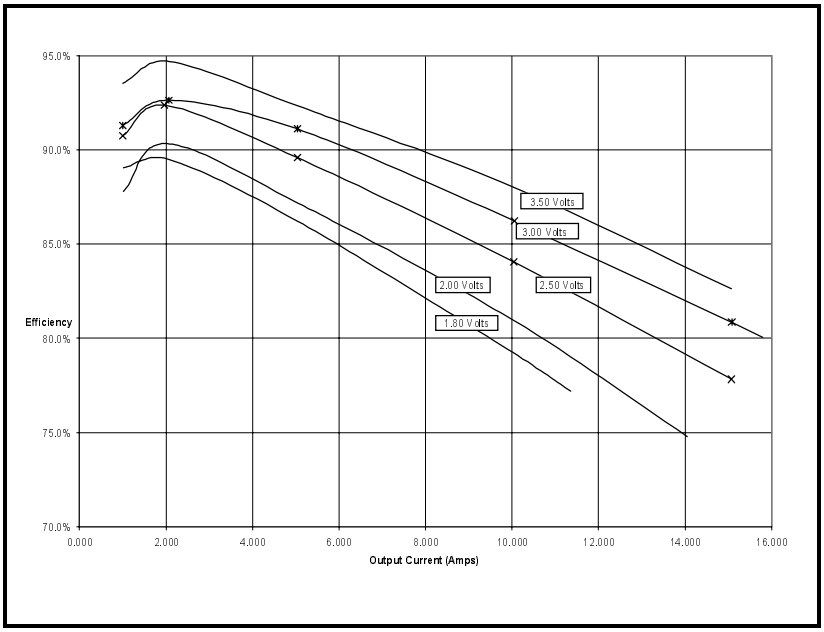
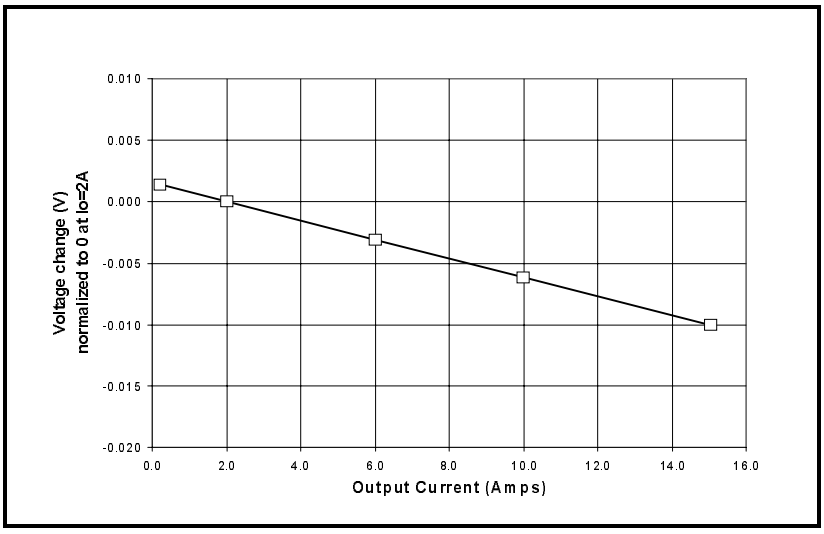
CHARACTERISTIC CURVES

SC1156 Efficiency in Application Circuit (Figure 1)



SC1156 Regulation in Application Circuit (Figure 1)



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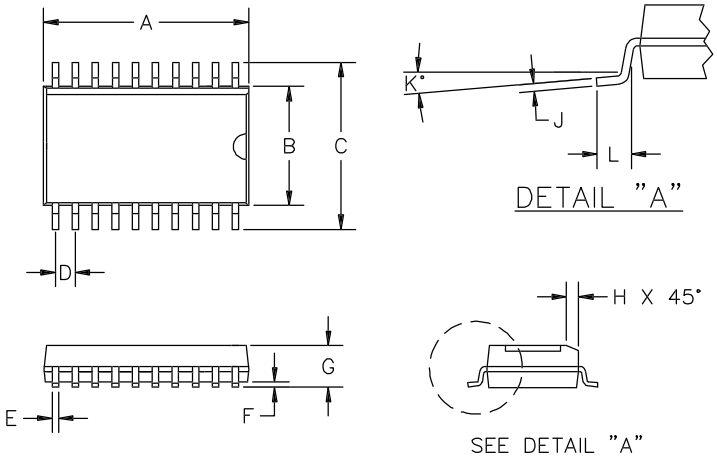
OUTLINE DRAWING SO-20



DIMENSIONS [1]					
DIM N	INCHES		MM		NOTE
	MIN	MAX	MIN	MAX	
A	.496	.512	12.6	13.0	[2]
B	.291	.299	7.40	7.60	[2]
C	.394	.419	10.0	10.65	–
D	.050	BSC	1.27	BSC	–
E	.013	.020	0.33	0.51	–
F	.004	.012	.10	.30	–
G	.092	.104	2.35	2.65	–
H	.010	.030	.25	.75	–
J	.009	.013	.23	.32	–
K	0°	8°	0°	8°	–
L	.016	.050	.40	1.27	–

[2] DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTUSIONS
[1] CONTROLLING DIMENSION : MILLIMETERS.

Ref. MS-013AC