STRUCTURE Silicon Monolithic Integrated Circuit
TYPE Multiple Voltage Regulator For Car Audio
PRODUCT SERIES **BD9401FM**
FEATURES Built in Switching Regulator Controller, 1A Linear Regulator, and 500mA High-side Switch.

• ABSOLUTE MAXIMUM RATINGS (T_A=25℃)

PARAMETER	SYMBOL	LIMIT	UNIT
Supply Voltage	VCC	36	V
Supply Voltage 2	VLDOIN	12*1	V
Supply Voltage 3 (VREG, VREF)	VREG, VREF	7	V
PWM Output Current	IOMAX	100	mA
Power Dissipation 1	P_{D1}	1.8*2	W
Power Dissipation 2	P_{D2}	2.2*3	W
Operation Temperature Range	T_{OPR}	-40～+85	℃
Storage Temperature Range	T_{STG}	+150	℃
Junction temperature range	T_{JMAX}	+150	℃

*1 Do not exceed P_D.

*2 P_D decreased at 14.4mW/℃ for temperatures above T_A=25℃ without a heat sink.

*3 P_D decreased at 17.6mW/℃ for temperatures above T_A=25℃ with PCB (70×70×1.6mm^3).

• OPERATING CONDITIONS (T_A=-40～+85℃, Do not exceed P_D)

PARAMETER	SYMBOL	MIN.	MAX.	UNIT
Supply Voltage 1	VCC	8	26	V
Supply Voltage 2	VLDOIN	3	11	V
Maximum Frequency (PWM Controller)	VCC	30	500	KHz

NOTE : This product is not designed for protection against radioactive rays.

NOTE : The product described in this specification is a strategic product (and/or service) subject to COCOM regulations. It should not be exported without authorization from the appropriate government.

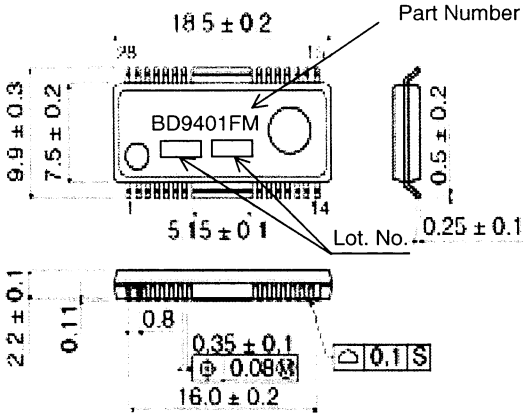
Status of this document
The English version of this document is the formal specification.
A customer may use this translation version only for a reference to help reading the formal version.
If there are any differences in translation version of this document, formal version takes priority.

· ELECTRICAL CHARACTERISTIC 1

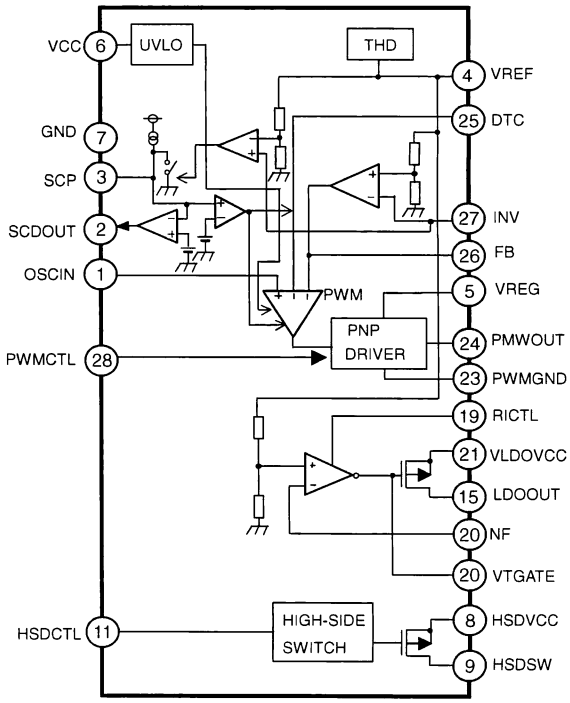
(T_A=25℃, VCC=13.5V, VDOVCC=5V, HSOCTL=PWMCTL=3V unless otherwise specified.)

PARAMETER	SYMBOL	STANDARD VALUE			UNIT	CONDITIONS
		MIN.	TYP.	MAX.		
[Linear Regulator Adjustable 1.0A]						
Output Voltage	V_O	-	3.3	-	V	Io=10mA
NF Voltage	VNF	1.225	1.250	1.275	V	
Output Peak Current	I_{PEAKL}	1.0	-	-	A	without an external FET
Line regulation	ΔV_{OLI}	-	10	20	mV	VCC=9～26V
Load regulation	ΔV_{OLO}	-	50	100	mV	Io=800mA
Dropout Voltage	ΔV_{DLDO}	-	0.5	1.0	V	Io=800mA
Ripple Rejection	RR	50	60	-	dB	Io=10mA,VIN=0.1Vp_p
[High-side Switch 500mA]						
Dropout Voltage	V_{DH}	—	0.5	0.8	V	Io=500mA
Output Peak Current	I_{PEAKH}	0.5	-	-	A	
[Error Amplification]						
INV Threshold Voltage	V_{INV}	1.225	1.250	1.275	V	VREF=3.0V
INPUT Bias Current	I_{BIAS}	-1	-	1	uA	VINV=0V
Voltage Gain	A_V	-	60	-	dB	DC Gain
Maximum Output Voltage	V_{FBM}	2.0	2.4	2.8	V	VINV=0V
Minimum Output Voltage	V_{FBL}	-	-	0.1	V	VINV=2.0V
Output Sink Current	I_{FBSI}	1	2.5	4	mA	VFB=3V,VINV=0V
Output Source Current	I_{FBSO}	50	100	200	uA	VFB=0V,VINV=2V
[PWM Comparator]						
0% Duty Cycle	V_{TH0}	0.90	1.00	1.10	V	FB Voltage, OSCIN=1.0V
100% Duty Cycle	V_{TH100}	1.80	2.00	2.20	V	FB Voltage, OSCIN=2.0V
[Protection Circuit]						
Timer Start Voltage	V_{SINV}	0.8	0.9	1.0	V	INV Voltage
Stand-by Voltage	V_{SSCP}	-	50	100	mV	SCP Voltage
Threshold Voltage 1	V_{T1SCP}	0.90	1.00	1.10	V	SCP Voltage, SCD_OUT: High
Threshold Voltage 2	V_{T2SCP}	1.80	2.00	2.20	V	SCP Voltage, PWM: OFF
Source Current	I_{SOSCP}	1.5	2.5	4.0	uA	VSCP=0V
[Under Voltage Lockout]						
Threshold Voltage	V_{UVLO}	-	5.70	-	V	PWM:OFF, VCC=13.5→4V
Hysteresis Voltage	V_{HYS}	-	0.07	-	V	VCC=4V→13.5V
[PNP DRIVER]						
Saturation Voltage	V_{SAT}	-	0.8	1.2	V	Io=75mA
Output Current	V_{DET1}	-	-	5	uA	Vo=30V
[Control Input]						
PWM Off Input Range	V_{PWMOFF}	0.0	-	2.0	V	
PWM On Input Range	V_{PWMON}	3.0	-	VREG	V	
HSDSW Off Input Range	V_{HSDOFF}	0.0	-	2.0	V	
HSDSW On Input Range	V_{HSDON}	3.0	-	VREG	V	
[SCD OUTPUT]						
SCD Low Voltage Range	V_{SCDL}	0.0	-	1.0	V	
SCD High Voltage Range	V_{SCDH}	3.0	-	VREG	V	
[All Devices]						
Consumption Current VCC	I_{CC}	-	1.65	3.2	mA	D_CTL=H_CTL=3V,Io=0mA
Consumption Current VREG	I_{VREG}	-	1.30	-	mA	VREG=5.0V
Consumption Current VREF	I_{VREF}	-	0.65	-	mA	VREF=3.0V
Stand-by Current	I_{STBY}	-	1	10	μA	D_CTL=H_CTL=0V

○Physical Dimensions



○Block Diagram



• PIN FUNCTION

No.	PIN NAME	FUNCTION	No.	PIN NAME	FUNCTION
1	OSCIN	Triangle oscillator input from BD9400BFP	16	N.C.	Non connection
2	SCDOUT	DC/DC short circuit detection signal output to BD9400BFP	17	N.C.	Non connection
3	SCP	Adjustment of short circuit protection and detection with capacitor	18	VTGATE	Be connected GATE of external FET
4	VREF	Reference voltage (3V) from BD9400BFP	19	RICTL	Adjustment of current limit for LDO
5	VREG	Reference voltage (5V) from BD9400BFP	20	NF	Negative feedback input pin of LDO
6	VCC	Main power supply pin	21	LDOVCC	Power supply pin for LDO
7	GND	Low-noise ground	22	N.C.	Non connection
8	HSDVCC	Power supply pin for High-side switch	23	PWMGND	PWM ground
9	HSDSW	High-side switch output	24	PWMCOUT	PWM Output terminal
10	N.C	Non connection	25	DTC	Dead Time Control PIN with resistor (adjustment of Soft Start)
11	HSDCTL	High-side switch enable/disable control input from BD9401FM	26	FB	Output terminal of err amplifier
12	N.C.	Non connection	27	INV	Inverting input terminal of err amplifier
13	N.C.	Non connection	28	PWMCTL	DC/DC converter enable/disable control input from BD9400BFP
14	N.C.	Non connection	FIN	FIN	It should be connected ground
15	LDOOUT	LDO output			

※ Please refer to technical note concerning application circuit and etc.

○ NOTE FOR USE

1. Absolute Maximum Range
   Absolute Maximum Ratings are values stated values, when any values in excess stated values may cause the deuce to be destroyed.
   We cannot be defined the failure mode, such as short mode or open mode.
   Therefore, physical devices for protection, such as fuses to be provided when a specific mode exceeds the Absolute.

2. Operating Supply Voltage Range
   Functional circuit operation is guaranteed within operation ambient temperature, as long as it is within operating supply voltage range. The electrical characteristics standard value can not be guaranteed. However, there is no drastic variation in these values, as long as it is within operating supply voltage range.

3. Grounding
   Connection of GND indicated in application circuit should be as short as possible to avoid electrical interference.

4. Power dissipation
   If IC is used on condition that the power loss is over the power dissipation, the reliability will become worse by heat up, such as reduced output current capability.
   Also, be sure to use this IC within a power dissipation range allowing enough of margin.

5. Oscillation Stopper of Output and Bypass Capacitor
   Please put capacitor of 10 μF on LDOOUT respectively to stop oscillation. It has a possibility of oscillation if capacitor value is changed due to temperature change. And it is recommended to use tantalum or electrolytic capacitor with low internal serial resistor (ESR). If extremely big capacitor (over 1000 μF) is used, it may have a case to occur oscillation of low frequency. And it is recommended to put bypass capacitor 1 μF into the nearest position between Input pin and GND.

6. Electrical characteristics described in these specifications may vary, depending on temperature, supply voltage, external circuits and other conditions. Therefore, be sure to check all relevant factors, including transient characteristics.

7. Overcurrent protection circuit
   The built-in overcurrent protection circuit is designed to respond to the output current and prevent destruction of the IC from load short circuits; however, it is only effective in protecting the IC from destruction in sudden overcurrent accidents. The protection circuit is not to be used continuously, or for transitions. In executing thermal design, bear in mind that overcurrent protection has negative characteristic according with the temperature.

8. Thermal shutdown circuit
   A built-in internal shutdown (TSD) circuit is provided to protect the IC from heat destruction. Operation has to be done within the allowable loss range, but in continuous use beyond the range, chip temperature Tj will increase to the threshold, activating the TSD circuit and turning the output power Tr OFF. Once the chip temperature Tj returns to the normal range, the circuit is automatically restored. Note that the TSD circuit is designed to operate over the maximum absolute rating. Therefore, make absolutely certain not to use the TSD function in set design.

9. Mounting Failures
   Mounting failure, such as misdirection or mismount, may cause a malfunction in the device.

10. Internal circuits or elements may be damaged when Vcc and pin voltage are reversed. For example, Vcc short circuit to GND while a external capacitor is charged. Output pin capacitor is recommended no larger than 1000μF. In addition, inserting a Vcc series countercurrent prevention diode, or a bypass diode between the various pins and the vcc, is recommended.

11. Electric Magnetic Field
    Mal-function may happen when the device is used in the strong electromagnetic field.

12. We recommend to put diode for protection purpose in case of output pin connected with large load of impedance or reverse current occurred during start up or output off timing.

13. Precautions for board inspection
    Connecting low-impedance capacitors to run inspections with the board may produce stress on the IC. Therefore, be certain to use proper discharge procedure before each process of the test operation. To prevent electrostatic accumulation and discharge in the assembly process, thoroughly ground yourself and any equipment that could sustain ESD damage, and continue observing ESD-prevention procedures in all handling, transfer and storage operations. Before attempting to connect components to the test setup, make certain that the power supply is OFF. Likewise, be sure the power supply is OFF before removing any component connected to the test setup.

14. GND pattern
    When both a small-signal GND and high current GND are present, single-point grounding (at the set standard point) is recommended, in order to separate the small-signal and high current patterns, and to be sure the voltage change stemming from the wiring resistance and high current does not cause any voltage change in the small-signal GND. In the same way, care must be taken to avoid voltage fluctuations in any connected external component GND.

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