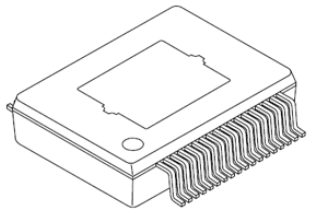
CMOS Linear Integrated Circuit Silicon Monolithic

TCB010FNG

System Regulator IC built in 5 power supply outputs and 2 high side switches, for car audio applications

The TCB010FNG is a system regulator IC for car audio applications.
A power supply for a microcontroller backup, a power supply for a CAN microcontroller backup, one channel of the output voltage fixed power supply, two channels of the output variable power supply, and two high side switches are built-in.
In addition, the TCB010FNG has various functions and detections such as the +B detection, the ACC detection, the thermal shutdown circuit, the over-voltage protection, the reset signal output, and the mute signal output.



P-HSSOP36-1116-0.65-001

Weight: 1.28 g (typ.)

1. Application

System Regulator IC for car audio applications

2. Features

- Five power supply outputs

VDD:	Output voltage 3.3 V	Fixed	Maximum output current 300 mA
CAN:	Output voltage 5 V	Fixed	Maximum output current 200 mA
ILM:	Output voltage 4.5 V to 8.5 V	Variable	Maximum output current 400 mA (at 8.5 V setting)
AUDIO:	Output voltage 3.3 V	Fixed	Maximum output current 1.3 A
DECK:	Output voltage 5 V to 8.5 V	Variable	Maximum output current 2 A (at 7 V setting)

- Two high side switches

  ANT: Maximum output current 500 mA Voltage drop between input and output 1.0 V (maximum)
  AMP: Maximum output current 200 mA Voltage drop between input and output 0.6 V (maximum)

- Built in each part potential detection

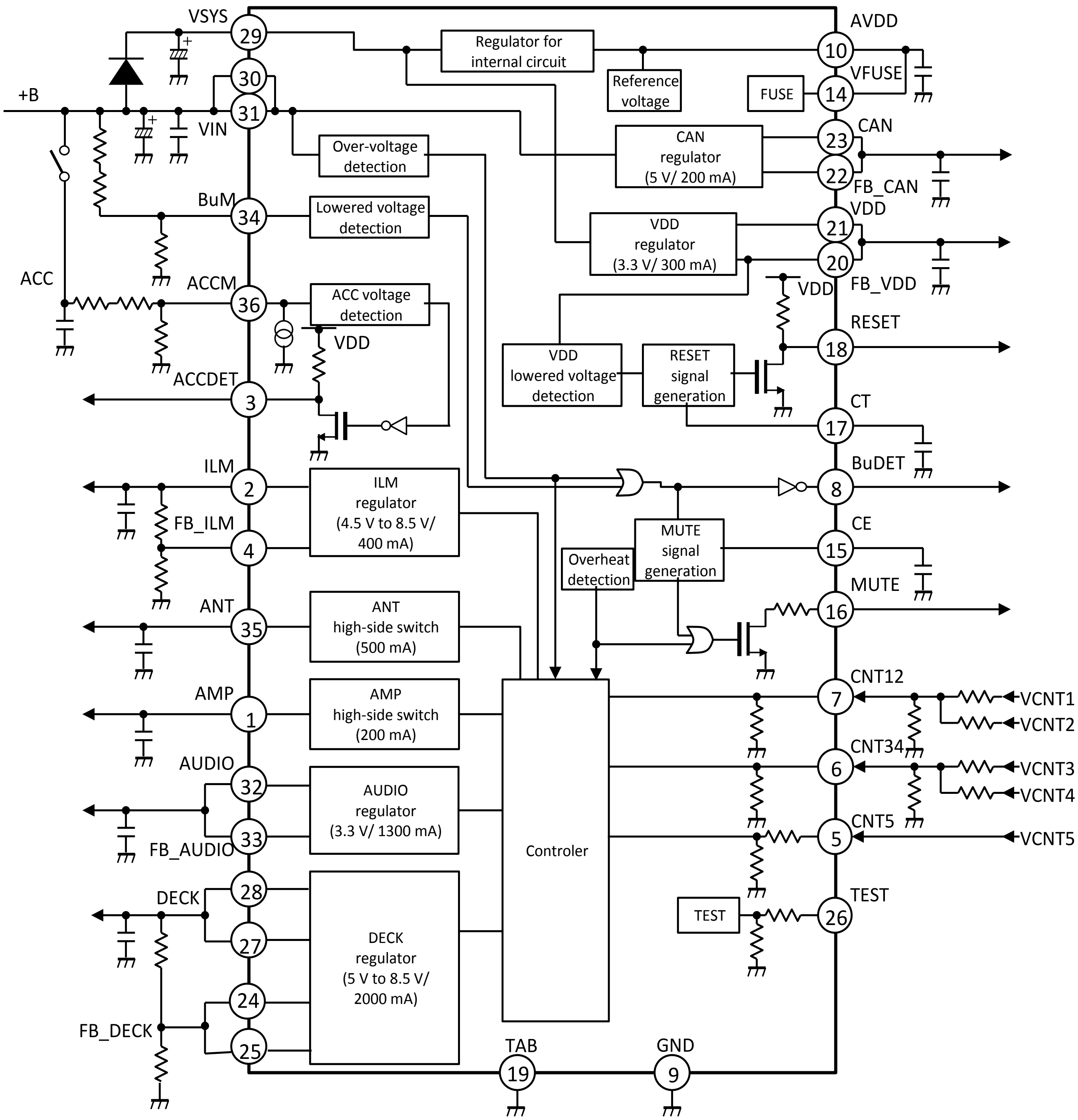
ACCDET:	ACC detection	Rising 8.55 V (typ.), falling 8.25 V (typ.)
BuDET:	+B detection	Rising 8.55 V(typ.), falling 8.25 V (typ.)
RESET:	VDD detection	Detection voltage 2.95 V (typ.)
MUTE:	Output Mute pulses when BuDET is rising or falling	

- Quiescent Current 120 μA (typ.)
  (VIN = VSYS = 13.2V, ACC = 0V. In case that all regulators except VDD, CAN, and the high side switch are off.)
- Built-in various protection circuits: Thermal shut down, over-voltage (except VDD and CAN), and output short (current limitation type)

Typical test condition: Unless otherwise specified, Ta = 25°C

Item	Symbol	Test condition	Min	Typ.	Max	Unit
Operating power voltage	$VSYS_{opr(VDD)}$	VDD	4.9	13.2	18	V
	$VSYS_{opr(CAN)}$	CAN	6.6	13.2	18	
	$VIN_{opr(ILM)}$	ILM	VOUT +1.6 V	13.2	18	
	$VIN_{opr(AUDIO)}$	AUDIO	4.9	13.2	18	
	$VIN_{opr(HSW)}$	AMP, ANT	9.0	13.2	18	
	$VIN_{opr(DECK)}$	DECK	VOUT +1.6 V	13.2	18	
	$VDD_{opr(RESET)}$	RESET	0.9	—	—	
	$VDD_{opr(ACCDET)}$ $VDD_{opr(BuDET)}$ $VDD_{opr(MUTE)}$	ACCDET, BuDET, MUTE	2.95	—	—	

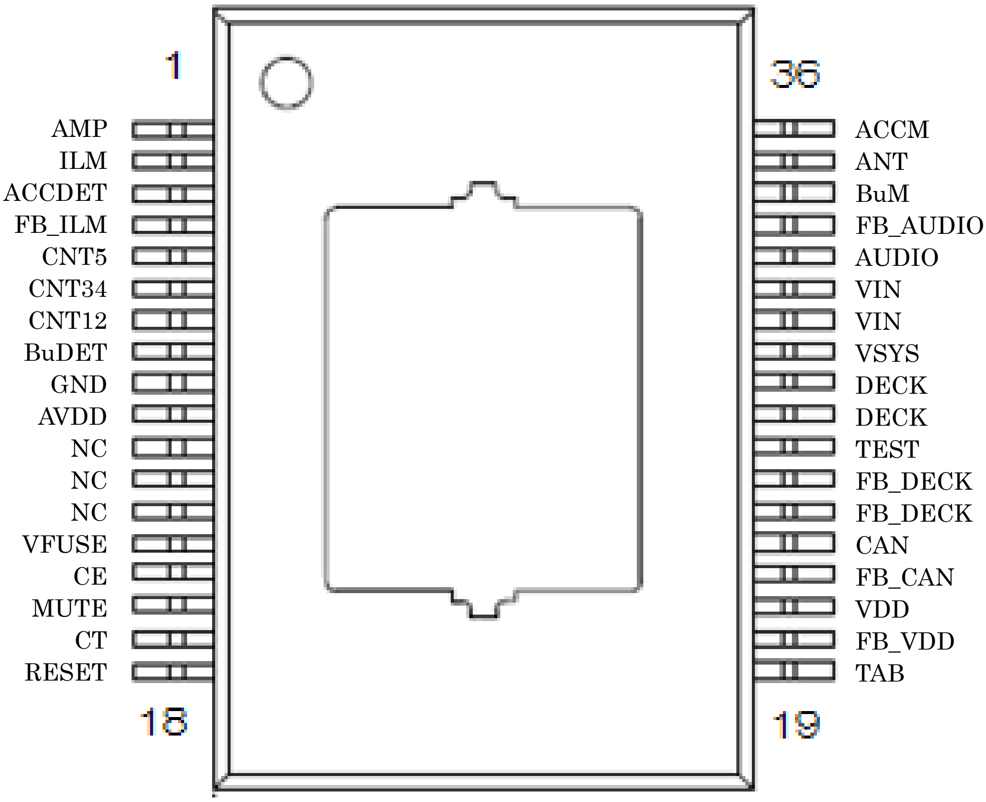
3. Block Diagram



Note: The AVDD for internal circuits is removed from the notation of a regulator.
Some of the functional blocks, circuits, or constants in the block diagram may be omitted or simplified for explanatory purposes.

4. Pin Layout

4.1 Pin Layout (top view)



5. Pin Description

Pin Number	Name	I/O	Description
1	AMP	OUT	AMP output pin
2	ILM	OUT	Power output pin for general purposes such as back light and tuners
3	ACCDET	OUT	Output pin for ACC detection signals
4	FB_ILM	IN	Voltage setting pin for ILM
5	CNT5	IN	DECK ON-OFF control pin
6	CNT34	IN	ILM, ANT ON-OFF control pin
7	CNT12	IN	AUDIO, AMP ON-OFF control pin
8	BuDET	OUT	Output pin for +B detection signals
9	GND	GND	GND pin
10	AVDD	OUT	Capacitor connection pin for smoothing 4V power supply for internal circuits
11	NC	NC	—
12	NC	NC	—
13	NC	NC	—
14	VFUSE	IN	Voltage applying pin of FUSE circuit
15	CE	IO	Capacitor connection pin for setting MUTE pulse time
16	MUTE	OUT	MUTE output pin
17	CT	IO	Capacitor connection pin for setting power-on-reset time
18	RESET	OUT	RESET output pin
19	TAB	GND	GND pin
20	FB_VDD	IN	Reference power supply pin for microcontroller backup
21	VDD	OUT	Power output pin for microcontroller backup
22	FB_CAN	IN	Reference voltage pin for CAN
23	CAN	OUT	Power output pin for CAN microcontroller
24 25	FB_DECK	IN	Voltage setting pin for DECK
26	TEST	IN	Test pin
27 28	DECK	OUT	Power output pin for general purposes such as CD mechanics, back view camera etc.
29	VSYS	Power	Capacitor connection pin for power supply of backup
30 31	VIN	Power	Battery power (13.2 V) connection pin
32	AUDIO	OUT	Output pin of (3.3 V) power supply such as audio microcontrollers and DSP
33	FB_AUDIO	IN	Reference power supply pin for AUDIO
34	BuM	IN	Input pin for +B voltage monitor
35	ANT	OUT	ANT output pin
36	ACCM	IN	Input pin for ACC voltage monitor

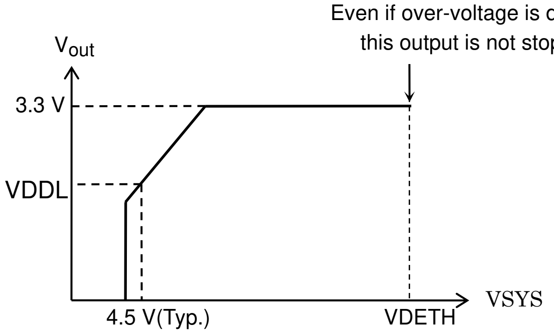
Note 1: AVDD pin is used as a power supply for internal circuits. Therefore do not use to supply to external IC.
Note 2: Do not use TEST pin.

6. Operation Description

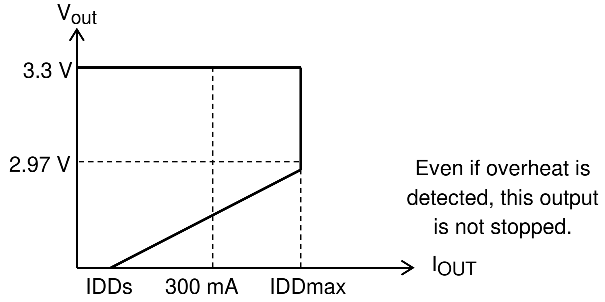
6.1 Power Supply Circuit for Microcontroller Backup (VDD)

For the VDD output, although 10 μF ceramic capacitor is required, select constants with an enough confirmation and consideration on influences of print patterns, routing of wiring, and positions of components such as capacitors.

VDD I/O characteristics



VDD output voltage - Load characteristics

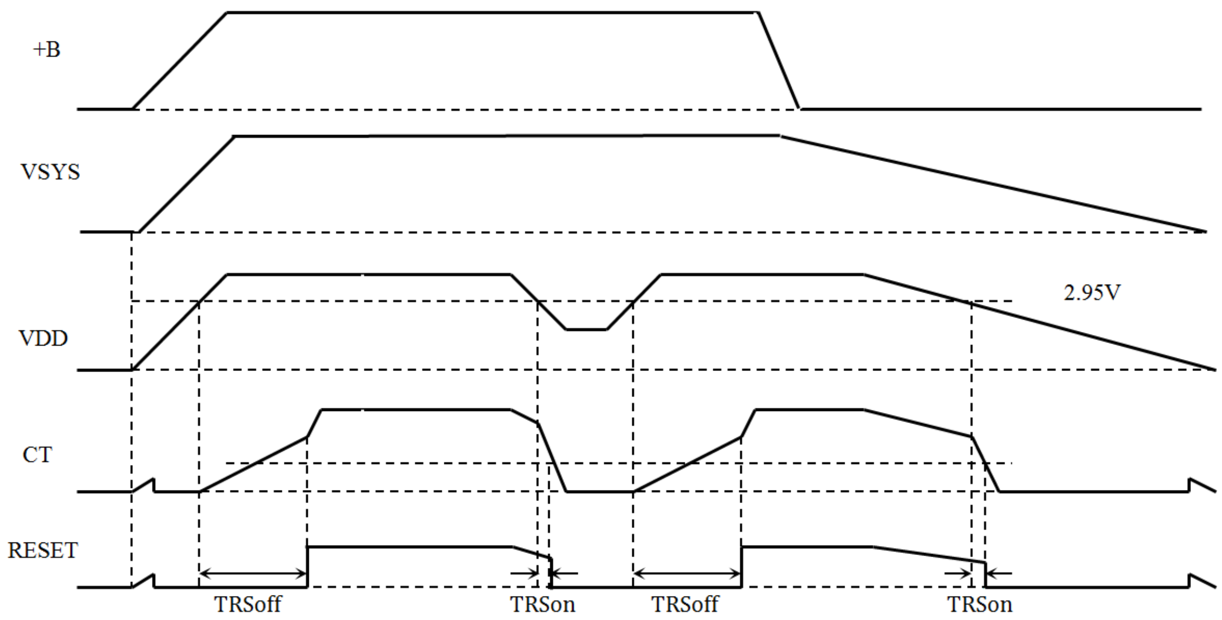


6.2 VDD Lowered Voltage Detection Circuit (RESET)

When the VDD output voltage becomes under 2.95 V, the RESET pin outputs Low, and hold it if the VDD voltage is more than 0.9 V.
When the power supply is turned on or the VDD output voltage becomes under 2.95 V, the RESET pin outputs Low.
The RESET pin is set to High after passing the power-on-reset time when the voltage is returned again.

Note: To prevent wrong operations by momentary disconnection of power in extremely short time, the under voltage detection is performed by disconnection at 190 μs or more.

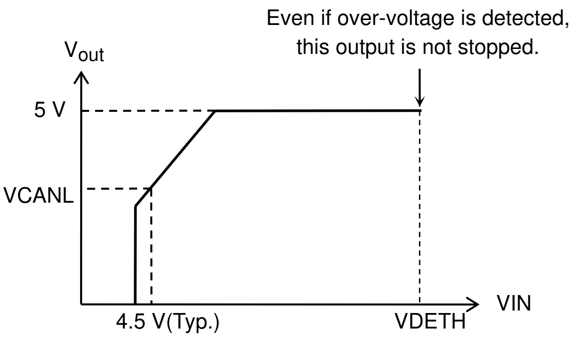
Timing chart of RESET output



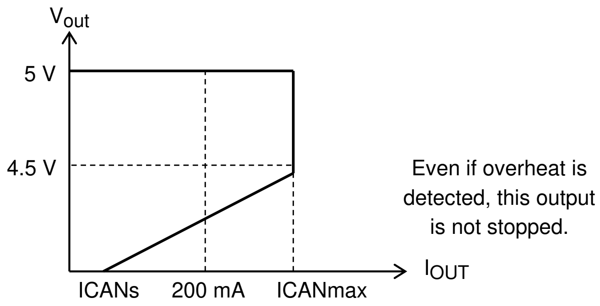
6.3 Power Supply Circuit for CAN Microcontroller Backup (CAN)

For the CAN output, although 10 μF ceramic capacitor is required, select constants with an enough confirmation and consideration on influences of print patterns, routing of wiring, and positions of components such as capacitors.

CAN I/O characteristics



CAN output voltage - Load characteristics



6.4 +B Voltage Detection Circuit (BuDET and BuM)

The BuDET pin outputs High in the case of +B voltage drop and the over-voltage detection.
The thresholds of +B voltage drop are 8.25 V (typ.) at falling, and 8.55 V (typ.) at rising.
It is a circuit configuration of which the current does not flow backward from BuDET to +B.

VTHBu ≈ (VTHBuM/R6) × (R4+ R5) + VTHBuM,
VTLBu ≈ (VTLBuM/R6) × (R4 + R5) + VTLBuM

6.5 MUTE Pulse Generator (MUTE and CE)

The MUTE pin outputs MUTE pulses (TM), when the BuDET is rising and falling.
It outputs Low at an overheat detection.
The MUTE pulse time is 1 s (typ.) when the capacitance value of the capacitor between CE pin and GND pin is 1 μF the change of this capacitance value allows a change of the setting time.

TM ≈ RCE1 × CE   RCE1 = 1 MΩ, CE = Capacitance value

Note: The CE pin should be open when the MUTE circuit is not used.

6.6 ACC Voltage Detection Circuit (ACCDET and ACCM)

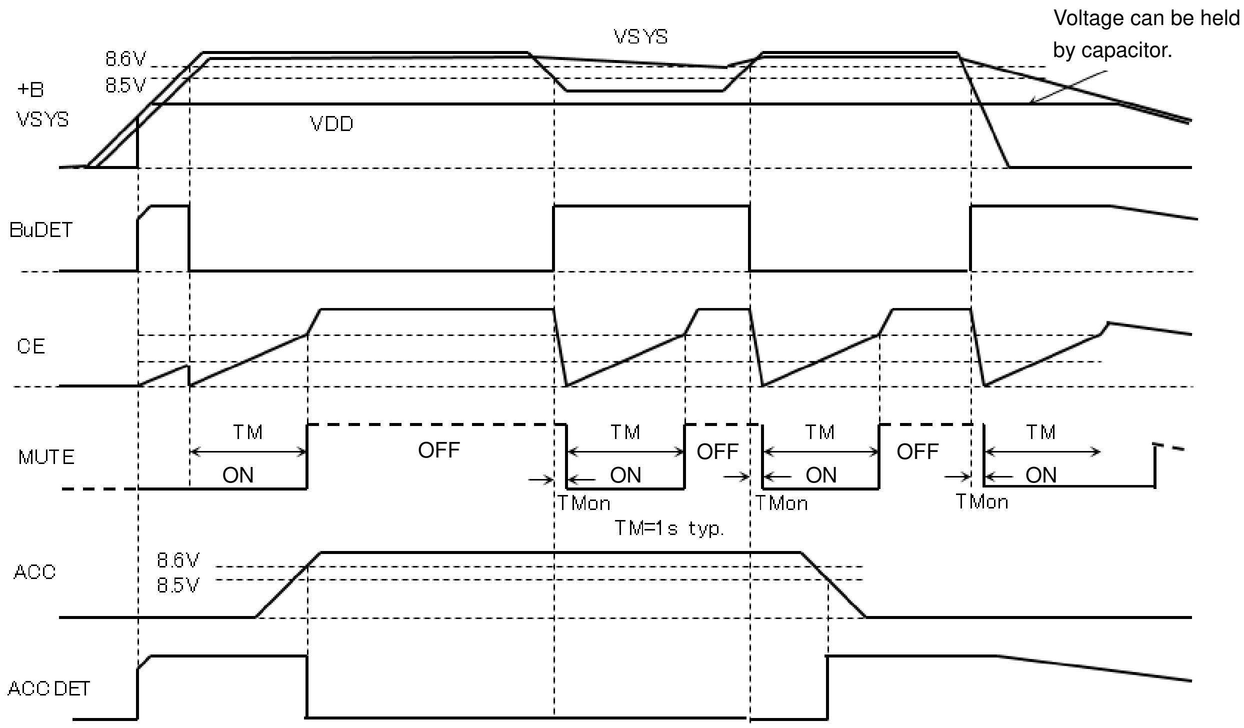
The ACCDET pin outputs Low when the ACCM pin voltage is more than the detection voltage.
The thresholds of the ACCM voltage drop are defined by VTHACCM and VTLACCM in each cases of rising or falling.
The ACCM pin is pulled-down with a constant current circuit of 1 μA.
The ACCDET pin output is set to "High" when ACCM pin is open.

VTHACC ≈ {(VTHACCM/R3) +1 μ} × (R1 + R2) + VTHACCM,
VTLACC ≈ {(VTLACCM/R3) + 1 μ} × (R1 + R2) + VTLACCM

For VTHACCM and VTLACCM, refer to the Electric Characteristics (3). For R1 to R3, refer to section 13 Test Circuit.

Note: When the ACC voltage detection circuit is unused, the ACCM pin can be used as open (external components can be reduced).

Timing chart



6.7 Power Supply Circuit for Audio (AUDIO) and High Side Switch Circuit (AMP and ANT)

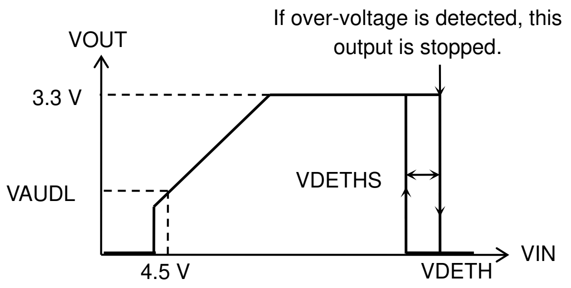
The AUDIO is a power supply output pin for an audio of which output voltage is 3.3 V (typ.) and output current is 1.3 A.
The ANT is an output pin for high side switch of which output current is 500 mA, and I/O Drop out voltage 1.0 V (maximum).
The AMP is an output pin for high side switch of which output current is 200 mA, and I/O Drop out voltage 0.6 V (maximum).

The over-current protection circuit is built in each power supply circuit and high side switch, and the output current is limited in the case of over-load.
Moreover when an over-voltage and overheat are detected, the output is turned OFF.

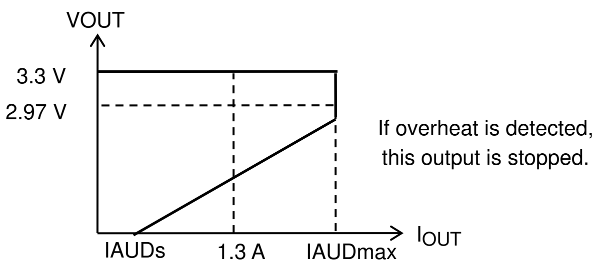
Note1: Do not use with over-load because each regulator may oscillate in the over-current detection area. In the case of oscillating, pay attention because an oscillation waveform is superimposed to other regulator output.

Note2: It is confirmed that the regulator does not oscillate if the values of capacitors (C5/C6) to be connected to the AMP and ANT output pins are made small until 1 μF. However, confirm the final constants using actual application circuit and wiring board since the surge resistance is changed.

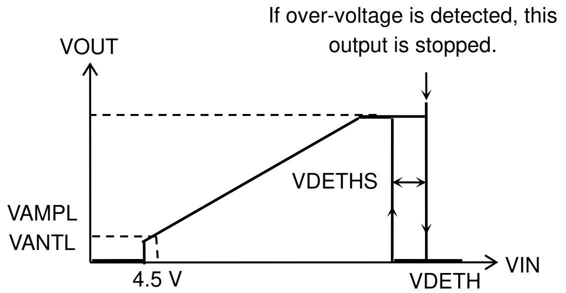
AUDIO 3.3 V I/O characteristics



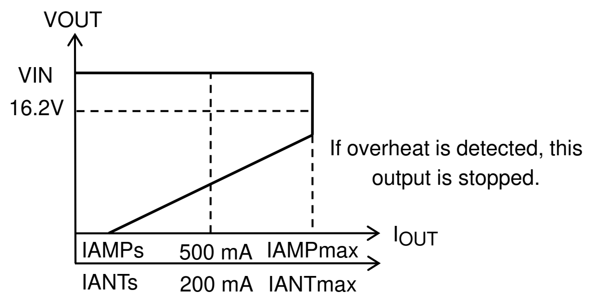
AUDIO 3.3 V load characteristics



AMP, ANT I/O characteristics



AMP, ANT load characteristics

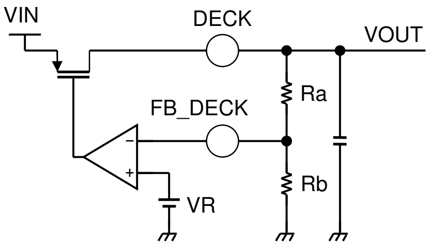


6.8 Power Supply Circuit for DECK (DECK) and for ILM (ILM)

The DECK is a general-purpose power supply output pin of which output voltage is from 5 to 8.5 V (variable) and output current is from 1.3 A (at 5 V) to 2 A (at 7 V).
ON or OFF can be switched by the CNT5 pin.
The over-current protection circuit is built in each power supply circuit, and the output current is limited in the case of over-load.
Moreover when an over-voltage and overheat are detected, the output is turned OFF.
The output voltage is set by external resistances.

Example of DECK usage

(1) Constant voltage regulator

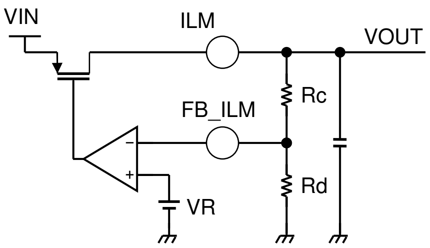


VOUT = VR × (Ra + Rb)/Rb VR = 0.8 V (Typ.)

The ILM is a general-purpose power supply output pin of which output voltage is from 4.5 to 8.5 V (variable) and output current is from 250 mA (at 5 V) to 400 mA (at 8.5 V).
ON or OFF can be switched by the CNT34 pin.
The over-current protection circuit is built in each power supply circuit, and the output current is limited in the case of over-load.
Moreover when an over-voltage and overheat are detected, the output is made OFF.
The output voltage is set by external resistances.

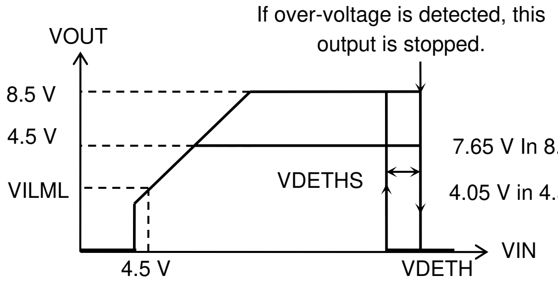
Example of ILM usage

(1) Constant voltage regulator

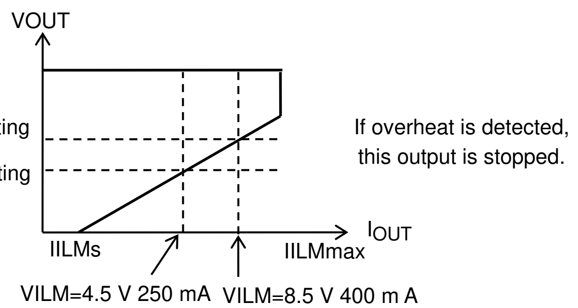


VOUT = VR × (Rc + Rd)/Rd VR = 0.8 V (Typ.)

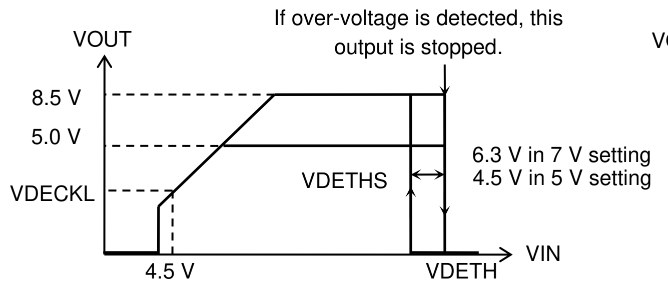
I/O characteristics in ILM4.5 V / 8.5 V setting



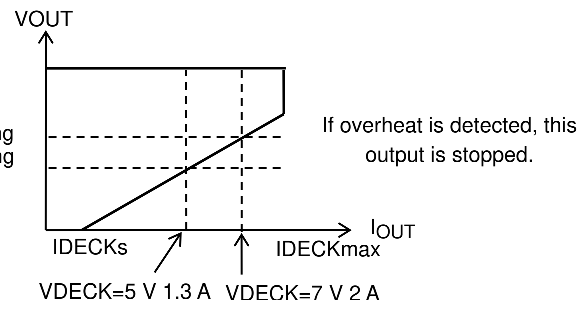
Load characteristics in ILM 4.5 V / 8.5 V setting



I/O characteristics in DECK 8.5 V setting



Load characteristics in DECK 7.0 V / 5.0 V setting



6.9 CNT12 pin and CNT34 pin

When the input voltage of the CNT * pin changes from VTL to VTH, it becomes transiently the potential of VTM1 and VTM2, so each regulator may be turned ON momentarily.
Therefore for preventing the wrong operation, pay attention to the following.

- A capacitor should not be attached to CNT* pin as much as possible.
- The CNT* pin should be turned on after the +B is turned on and 20 ms or more elapses.
- The capacitance value of each regulator-output load should be the value not to be influenced on the voltage change by momentary ON-OFF switching.

Note: CNT*= CNT12, CNT34

Truth value table of CNT pin

CNT12	AUDIO	AMP
VTL	OFF	OFF
VTM1	OFF	ON
VTM2	ON	OFF
VTH	ON	ON

CNT34	ILM	ANT
VTL	OFF	OFF
VTM1	OFF	ON
VTM2	ON	OFF
VTH	ON	ON

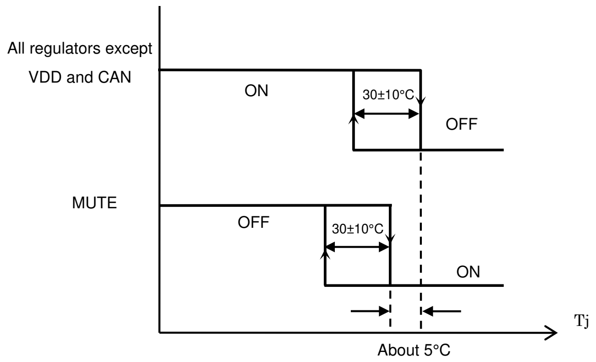
7. Thermal Shut Down (TSD) function

The MUTE pin outputs Low when Tj becomes 165±20°C. After the MUTE pin outputs Low once, the MUTE pin outputs High again when the temperature is lowered to 30±10°C. The heat value of this IC is not changed by Low of the MUTE pin.

The TSD function with the MUTE pin assume that the power amplifier outputs are attenuated and the temperature is controlled by micro controller as the car audio system.

All regulators except VDD and CAN are stopped if the MUTE pin outputs Low and the temperature further rises about 5°C.

Additionally the hysteresis is prepared for the detection threshold. Each regulator is returned by the reset of TSD when the temperature is lowered to 30±10°C after the detection.



8. Heat Sink Design

The heat resistance θHS of the heat sink to be attached is determined by the following formula.

$\theta HS = (Tjmax - Ta)/PDmax - \theta j\text{-}T$

* Package heat resistance of this IC: θj-T = 1.8°C/W

* PDmax means the maximum power consumption of the internal IC.

* Tjmax = 150°C

PDmax can be calculated by the following formula.

PDmax = PD1 + PD2

PD1: Maximum power to be consumed in each regulator and power transistor at the output stage of the high side switch

PD2: Maximum power to be consumed in the internal circuit (Iint) of the IC.

PD1 should be calculated with the use condition of maximum power consumption. PD2 should be also calculated as the current consumption Iint = 30 mA.

Furthermore, the heat sink should be designed with enough size because the heat conduction gets worse by the contact thermal resistance on the contact surface.

9. Absolute Maximum Ratings

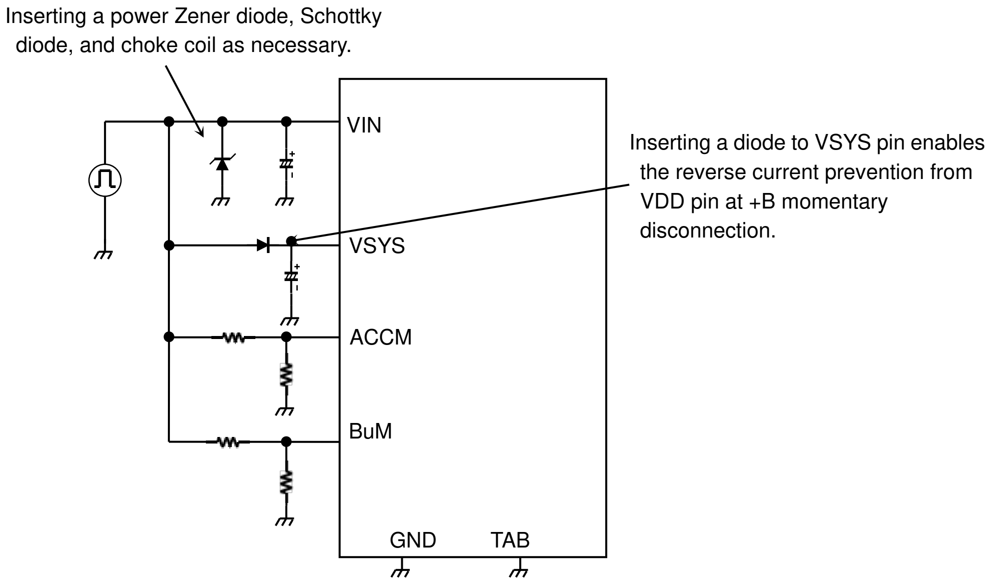
Item	Symbol	Condition	Rating	Unit
Static power voltage	VIN (DC)	—	30	V
	BuM (DC)	—	30	V
	ACCM (DC)	—	30	V
	VSYS (DC)	—	30	V
Operating power voltage	Vopr	—	-0.3 to 18	V
Applied voltage of CNT12 and CNT34 pin	ViCNT1234	—	-0.3 to VDD	V
Applied voltage of CNT5 pin	ViCNT5	—	-0.3 to VDD	V
Instantaneous power voltage	VIN (surge)	t = 200 ms	+50	V
	VSYS (surge)	t = 200 ms	+50	V
	VIN (impulse)	t = 100 ms	+35	V
	VSYS (impulse)	t = 100 ms	+35	V
Operating temperature	Topr	—	-40 to 85	°C
Storage temperature	Tstg	—	-55 to 150	°C
Junction temperature	Tj (max)	—	150	°C
Power dissipation	PDvdd	VDD power supply	9.1	W
	PDcan	CAN power supply	8.1	W
	PDilm	Power supply for ILM	13	W
	PDaud	Power supply for AUDIO	32	W
	PDant	High side switch for ANT	11	W
	PDamp	High side switch for AMP	7.5	W
	PDdeck	Power supply for DECK	44	W
Power dissipation	PD	Total dissipation of each regulator + IC operating power	69.5	W

Note 1: The absolute maximum ratings of a semiconductor device are a set of ratings that must not be exceeded, even for a moment. Do not exceed any of these absolute maximum ratings.
Exceeding the absolute maximum rating(s) may cause the device breakdown, damage or deterioration, and may result injury by explosion or combustion.
Please use the IC within the specified operating ranges.

Note 2: Package thermal resistance (θ_j-T = 1.8°C/W) in the case of Ta = 25°C, and using an infinite heat sink.

Note 3: When the surge over the absolute maximum ratings is applied to the power supply (VIN) line, it should be supported with external circuit such as inserting a power Zener diode or choke coil.

9.1 Example of Application Circuit



10. Operating Range

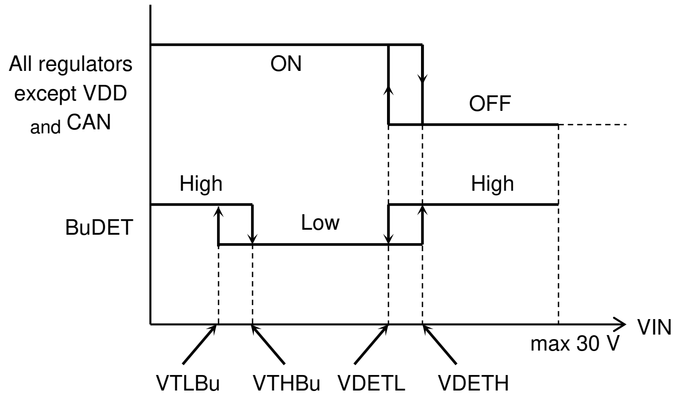
Item	Symbol	Test condition	Min	Typ.	Max	Unit
Operating power supply voltage	$VIN_{opr(VDD)}$	VDD	4.9	13.2	18	V
	$VIN_{opr(CAN)}$	CAN	6.6	13.2	18	
	$VIN_{opr(ILM)}$	ILM	VOUT +1.6 V	13.2	18	
	$VIN_{opr(AUDIO)}$	AUDIO	4.9	13.2	18	
	$VIN_{opr(HSW)}$	AMP, ANT	9.0	13.2	18	
	$VIN_{opr(DECK)}$	DECK	VOUT +1.6 V	13.2	18	
	$VDD_{opr(RESET)}$	RESET	0.9	—	—	
	$VDD_{opr(ACCDET)}$ $VDD_{opr(BuDET)}$ $VDD_{opr(MUTE)}$	ACCDET, BuDET, MUTE	2.95	—	—	

11. Electric Characteristics

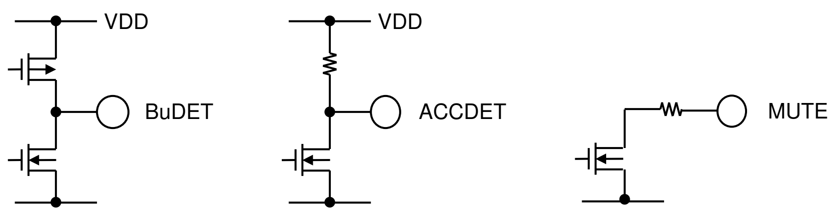
11.1 Electric Characteristics (1) Quiescent Current and Over-Voltage Detection

Item	Symbol	Test condition	Min	Typ.	Max	Unit
Unless otherwise specified, Ta = 25°C, VIN = VSYS = 13.2 V, Using Test Circuit of section 13, SW = OFF						
Quiescent Current	IB	ACCM = 0 V, SW1, SW2, SW3, SW4, and SW5 = OFF	—	120	145	µA
VIN over-voltage detection voltage	VDETH	All regulators outputs except VDD and CAN are forced to be OFF.	26	27.2	28.4	V
	VDETL	All regulators outputs are recovered.	25.3	26.5	27.7	V
Hysteresis width of over-voltage detection	VDETHS	VDETH - VDETL	0.4	0.7	1.2	V

Over-voltage detection characteristics



BuDET　ACCDET MUTE Output circuit



11.2 Electric Characteristics (2) Power Supply (VDD) for Microcontroller Backup, Reset Circuit, and CAN Power Supply for CAN (CAN)

Item	Symbol	Test condition	Min	Typ.	Max	Unit
Power supply for microcontroller backup (VDD)		Unless otherwise specified, Ta = 25°C, VSYS = 13.2 V				
Output voltage	VDD	I_{OUT} = 0 to 300 mA	3.138	3.3	3.462	V
Output minimum	VDDL	VSYS= 4.5 V, I_{OUT} = 0 to 100 mA	3	—	—	V
I/O Drop out voltage	VDDsat	VSYS= 3.3 V, I_{OUT} = 1 mA	—	—	0.15	V
Line Regulation	ΔVDDI	VSYS= 4.9 to 18 V	-50	5	50	mV
Load Regulation	ΔVDDL	I_{OUT} = 0.1 to 300 mA	-100	10	100	mV
Fold back protection tip current	IDDmax	VDD = 2.97 V	300	480	600	mA
Current Limit	IDDs	VDD = 0 V	45	100	155	mA
Ratio of power supply ripple rejection	RRvdd	I_{OUT} = 300 mA, fr=100 Hz, Vrip=-10 dBV, Sin wave	50	60	—	dB
Output noise and ripple voltage	VNvdd	BW = 20 Hz to 20 MHz	—	—	0.7	mVrms
Reset circuit (RESET)		Unless otherwise specified, Ta = 25°C, VIN = 13.2 V				
Voltage to detect low voltage	VTHRST	VDD voltage to switch RESET	2.85	2.95	3.05	V
Power-on-reset time	TRSoff	CT=0.1 μF	80	100	140	ms
Reset on delay time	TRSon	CT=0.1 μF	70	140	190	μs
Saturation voltage of RESET output 1	VRSTsat1	VDD = 3.3 V, I_{souce}=1 mA	—	—	0.3	V
Saturation voltage of RESET output 2	VRSTsat2	VDD = 1.2 V, I_{sink} = 0.1 mA	—	—	0.3	V
RESET pull-up resistor	RRESET	—	17	22	27	kΩ
Power supply for CAN microcontroller backup (CAN)		Unless otherwise specified, Ta = 25°C, VSYS = 13.2 V				
Output voltage	VCAN	I_{OUT} = 0 to 200 mA	4.755	5.0	5.245	V
Output minimum	VCANL	VSYS = 4.5 V, I_{OUT} = 0 to 100 mA	3.0	—	—	V
I/O Drop out voltage	VCANsat	VSYS = 5.0 V, I_{OUT} = 200 mA	—	0.5	1.0	V
Line Regulation	ΔVCANI	VSYS = 6.6 to 18 V	-50	5	50	mV
Load Regulation	ΔVCANL	I_{OUT} = 0.1 to 200 mA	-100	10	100	mV
Fold back protection tip current	ICANmax	VCAN = 4.5 V	200	480	620	mA
Output short circuit current	ICANs	VCAN = 0 V	45	100	155	mA
Ratio of power supply ripple rejection	RRcan	I_{OUT} = 200 mA, fr= 100 Hz, Vrip = -10 dBV, Sin wave	50	60	—	dB
Output noise and ripple voltage	VNcan	BW = 20 Hz to 20 MHz	—	—	0.7	mVrms

11.3 Electric Characteristics (3) ACC voltage detection circuit, +B Voltage Detection Circuit, and MUTE Pulse Generator

Item	Symbol	Test condition	Min	Typ.	Max	Unit
ACC voltage detection circuit (ACCDET)	Unless otherwise specified, Ta = 25°C, VIN = 13.2 V, Using Test Circuit of section 13					
ACC detection voltage	VTHACC	It is set with the input division resistor (precision ±1% product). This is the point of which the ACCDET becomes Low by raising ACC voltage.	8.1	8.55	9.0	V
	VTLACC	It is set with the input division resistor (precision ±1% product). After detecting the ACC voltage, this is the point of which the ACCDET becomes High by lowering that voltage.	7.8	8.25	8.7	
ACCM detection voltage	VTHACCM	This is the point of which the ACCDET becomes Low by raising ACCM voltage.	1.163	1.204	1.243	V
	VTLACCM	After detecting the ACCM voltage, this is the point of which the ACCDET becomes High by lowering that voltage.	1.123	1.163	1.201	
ACC hysteresis width	VHSACC	It is set with the input division resistor (precision ±1% product). VTHACC - VTLACC	200	300	400	mV
Saturation voltage of ACCDET output	VACCDETL	Isink=1 mA	—	—	0.3	V
ACCDET output voltage	VACCDETH	ACCM=0 V	VDD -0.3	—	VDD	V
ACCDET pull-up resistor	RACCDET	—	—	10	—	kΩ
ACCM input current	IACCM	VACCM = 1.2 V	0.5	1	2	μA
+B voltage detection circuit (BuDET)	Unless otherwise specified, Ta = 25°C, VIN = 13.2 V, Using Test Circuit of section 13					
+B detection voltage	VTHBu	It is set with the input division resistor (precision ±1% product). This is the point of which the BuDET becomes Low by raising Bu voltage.	8.1	8.55	9.0	V
	VTLBu	It is set with the input division resistor (precision ±1% product). After detecting the Bu voltage, this is the point of which the BuDET becomes High by lowering that voltage.	7.8	8.25	8.7	
BuM detection voltage	VTHBuM	This is the point of which the BuDET becomes Low by raising BuM voltage.	1.163	1.204	1.243	
	VTLBuM	After detecting the BuM voltage, this is the point of which the BuDET becomes High by lowering that voltage.	1.123	1.163	1.201	
+B hysteresis width	VHSBu	VTHBu - VTLBu	200	300	400	mV
Saturation voltage of BuDET output	V+BDETL	Isink=1 mA	—	—	0.3	V
BuDET outuput voltage	V+BDETH	BuM=0 V	VDD -0.3	—	VDD	
MUTE pulse generator	Unless otherwise specified, Ta = 25°C, VIN = 13.2 V					
MUTE pulse width	TM	CE = 1 μF	0.7	1.0	1.5	s
MUTE on delay time	TMon	CE = 1 μF	—	16	—	μs
Saturation voltage of MUTE output	VOL	I_{OUT} = 1 mA	—	—	0.3	V
Leak current when MUTE is OFF	Ileak	VOUT = VDD	-1	—	1	μA

11.4 Electric Characteristics (4) CNT Pin, AMP or ANT High Side Switch

Item	Symbol	Test condition	Min	Typ.	Max	Unit
CNT input circuit		Unless otherwise specified, Ta = 25°C, VIN = 13.2 V				
Input thresholds of CNT12 and CNT34	VTL	Refer to the CNT pin truth value table	0	—	0.5	V
	VTM1		0.85	—	1.4	V
	VTM2		1.8	—	2.2	V
	VTH		2.8	—	VDD	V
Pull-down resistor of CNT12 and CNT34	RCNT	VCNT12 =VCNT34= VDD	—	220	—	kΩ
CNT5 input threshold	VTL5	DECK output OFF	—	—	0.4	V
	VTH5	DECK output ON	2.0	—	VDD	
CNT5 input resistor	RCNT5	VCNT5 = VDD	—	200	—	kΩ
ANT high side switch Unless otherwise specified, Ta = 25°C, VIN = 13.2 V, Using Test Circuit of section 13, SW4=ON, Other SW=OFF						
I/O Drop out voltage	VANTsat	I_{OUT} = 500 mA	—	0.65	1	V
Output minimum	VANTL	VIN = 4.5 V, I_{OUT} = 0 to 100 mA	3.0	—	—	V
Fold back protection tip current	IANTmax	VIN = 18 V, VOUT = 16 .2 V	500	900	1400	mA
Output short circuit current	IANTs	VOUT = 0 V	75	150	250	mA
AMP high side switch Unless otherwise specified, Ta = 25°C, VIN = 13.2 V, Using Test Circuit of section 13, SW2=ON, Other SW=OFF						
I/O Drop out voltage	VAMPsat	I_{OUT} = 200 mA	—	0.4	0.8	V
Output minimum	VAMPL	VIN = 4.5 V, I_{OUT} = 0 to 100 mA	3.0	—	—	V
Fold back protection tip current	IAMPmax	VIN = 18 V, VOUT = 16.2 V	200	600	1000	mA
Output short circuit current	IAMPs	VOUT = 0 V	50	110	180	mA

11.5 Electric Characteristics (5) Power Supply for ILM

Item	Symbol	Test condition	Min	Typ.	Max	Unit
Power supply for ILM Unless otherwise specified, Ta = 25°C, VIN = 13.2 V, Using Test Circuit of section 13, SW3= ON, Other SW=OFF						
Range of output voltage setting	VILM	—	4.5	—	8.5	V
Precision of reference voltage	VFBilm	I_{OUT} = 0 to 400 mA	0.775	0.8	0.824	V
Output minimum	VILML	VIN = 4.5 V, I_{OUT} = 0 to 100 mA	3.0	—	—	V
I/O Drop out voltage	VILMsat1	I_{OUT} =400 mA, VILM= VIN =8.5 V	—	0.5	0.9	V
	VILMsat2	I_{OUT} =250 mA, VILM= VIN =4.5 V	—	0.3	0.6	V
Line regulation	ΔVILMI	VIN = 5.1 to 18 V, I_{OUT} = 250 mA	-100	5	100	mV
Load regulation	ΔVILML1	I_{OUT} = 10 mA to 400 mA	-200	25	200	mV
	ΔVILML2	I_{OUT} = 10 mA to 250 mA	-125	16	125	mV
Fold back protection tip current	IILMmaxH	VILM = 8.5 V, VOUT =7.65 V	400	750	1000	mA
	IILMmaxL	VILM = 4.5 V, VOUT = 4.05 V	250	600	900	mA
Output short circuit current	IILMs	VOUT = 0 V	50	90	140	mA
Ratio of power supply ripple rejection	RRILM	I_{OUT} = 400 mA, fr = 100 Hz, Vr = -10 dBV, Sin wave	44	50	—	dB
Output noise and ripple voltage	VNILM	BW = 20 Hz to 20 MHz	—	—	1.0	mVrms

11.6 Electric Characteristics (6) Power Supply for AUDIO

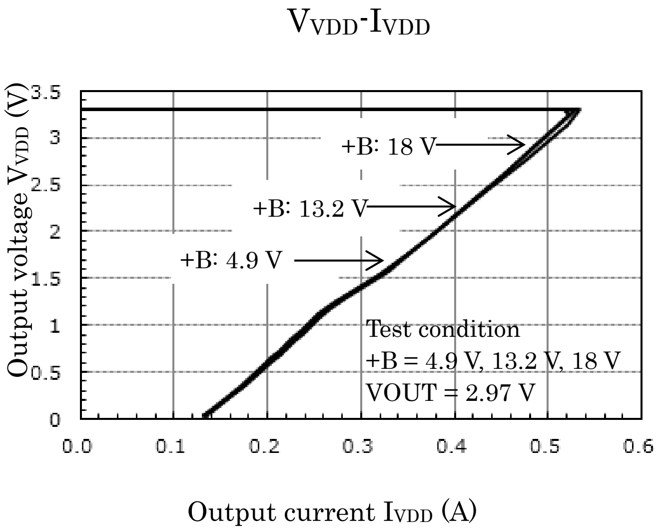
Item	Symbol	Test condition	Min	Typ.	Max	Unit
Power supply for AUDIO Unless otherwise specified, Ta = 25°C, VIN = 13.2 V, Using Test Circuit of section 13, SW1 = ON, Other SW=OFF						
Output voltage	VAUD	—	3.138	3.3	3.462	V
Output minimum	VAUDL	VIN = 4.5 V, I_{OUT} = 0 to 100 mA	3.0	—	—	V
Line regulation	ΔVAUDI	VIN = 4.9 to 18 V, I_{OUT} = 500 mA	-100	5	100	mV
Load regulation	ΔVAUDL	I_{OUT} = 10 to 1300 mA	-300	20	300	mV
Fold back protection tip current	IAUDmax	VOUT = 2.97 V	1300	1600	2160	mA
Output short circuit current	IAUDs	VOUT = 0 V	80	390	540	mA
Ratio of power supply ripple rejection	RRaud	I_{OUT} = 500 mA fr = 100 Hz, Vr = -10 dBV, Sin wave	45	50	—	dB
Output noise and ripple voltage	VNAUD	BW = 20 Hz to 20 MHz	—	—	0.7	mVrms

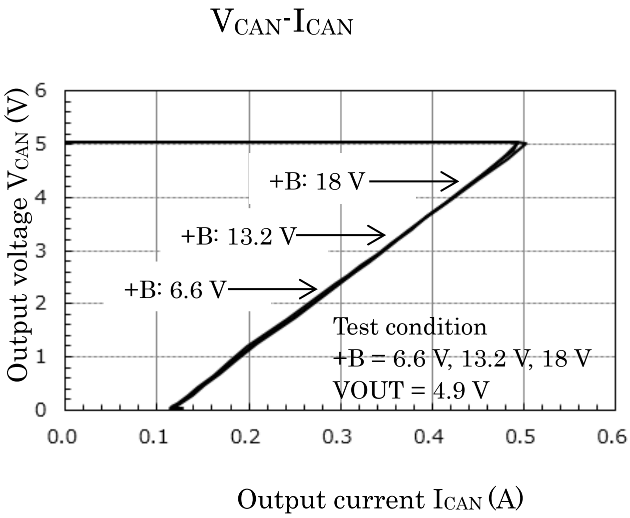
11.7 Electric Characteristics (7) Power Supply for DECK

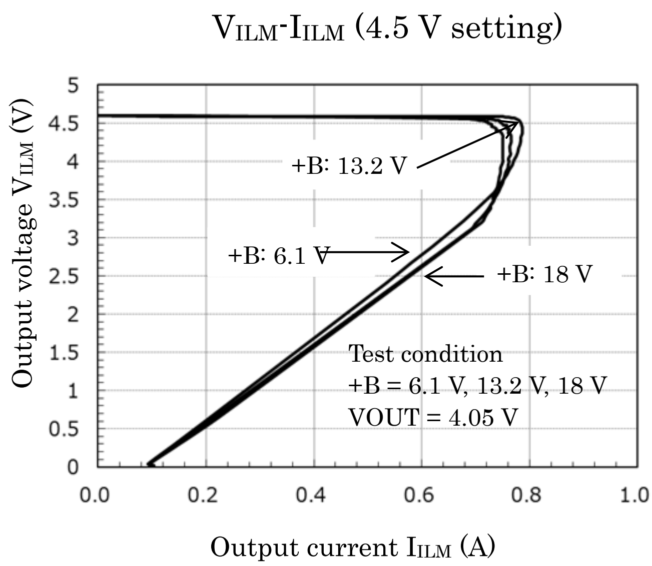
Item	Symbol	Test condition	Min	Typ.	Max	Unit
Power supply for DECK Unless otherwise specified, Ta = 25°C, VIN = 13.2 V, Using Test Circuit of section 13, SW5 = ON, Other SW=OFF						
Range of output voltage setting	VDECK	—	5.0	—	8.5	V
Precision of reference voltage	VFB	I_{OUT} = 0 to 2 A	0.775	0.8	0.824	V
Output minimum	VDECKL	VIN = 4.5 V, I_{OUT} = 0 to 100 mA	3.0	—	—	V
I/O Drop out voltage	VDECKsat1	I_{OUT} =2 A, VDECK= VIN =8.5 V	—	0.9	1.8	V
	VDECKsat2	I_{OUT} =1.3 A, VDECK= VIN =5 V	—	0.5	1.0	V
Line regulation	ΔVDECKI	VIN = 6.6 to 18 V, I_{OUT} = 500 mA	-100	10	100	mV
Load regulation	ΔVDECKL	I_{OUT} = 10 mA to 2 A	-200	20	200	mV
Fold back protection tip current	IDECKmaxH	VDECK=7 V, VOUT = 6.3 V	2.0	2.8	3.5	A
	IDECKmaxL	VDECK= 5 V, VOUT = 4.5 V	1.3	2.6	3.2	A
Output short circuit current	IDECKs	VOUT = 0 V	70	160	340	mA
Ratio of power supply ripple rejection	RRdeck	I_{OUT} = 500 mA, fr = 100 Hz, Vr = -10 dBV, Sin wave	44	50	—	dB
Output noise and ripple voltage	VNDECK	BW = 20 Hz to 20 MHz	—	—	1.0	mVrms

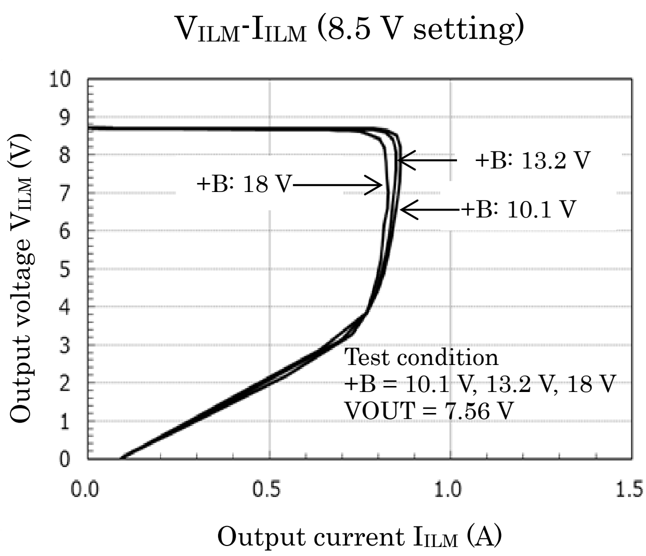
12. Characteristic Diagram

12.1 Output Characteristics of Each Regulator

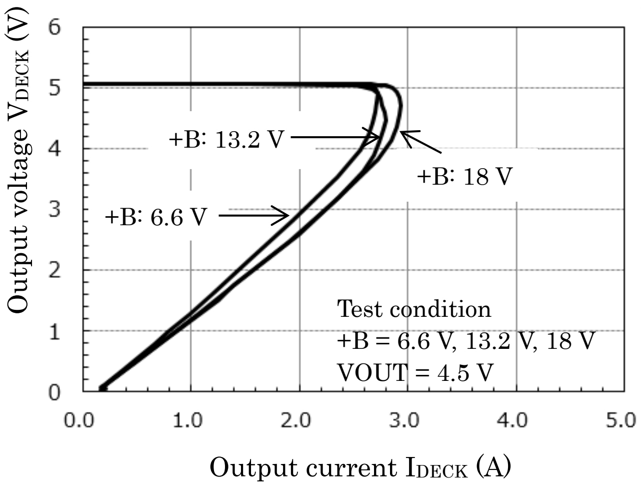




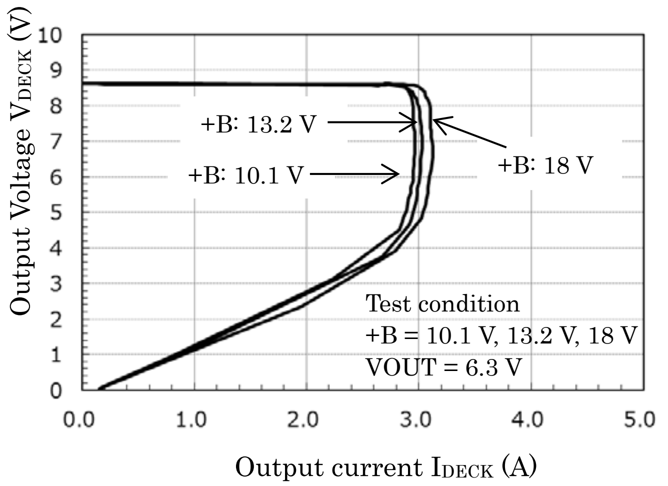




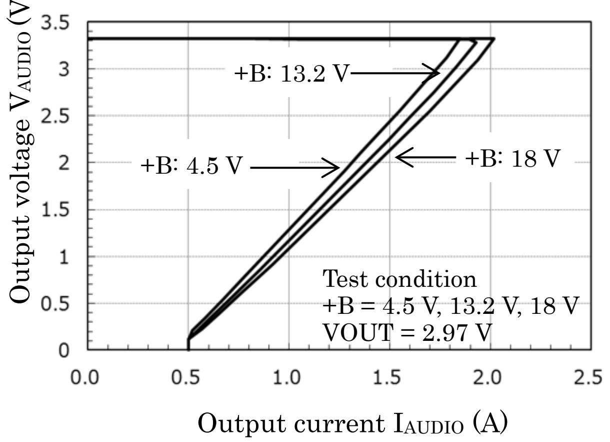
V_{DECK}-I_{DECK} (5 V setting)



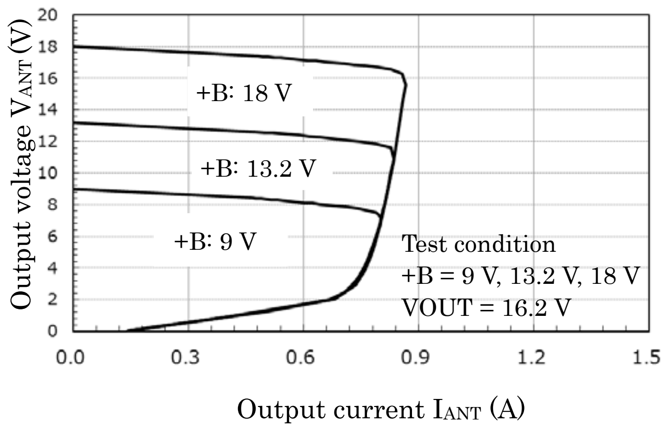
V_{DECK}-I_{DECK} (8.5 V setting)



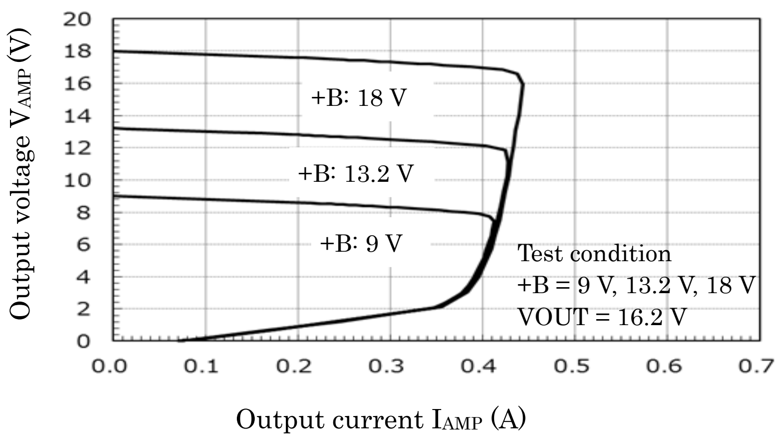
V_{AUDIO}-I_{AUDIO}



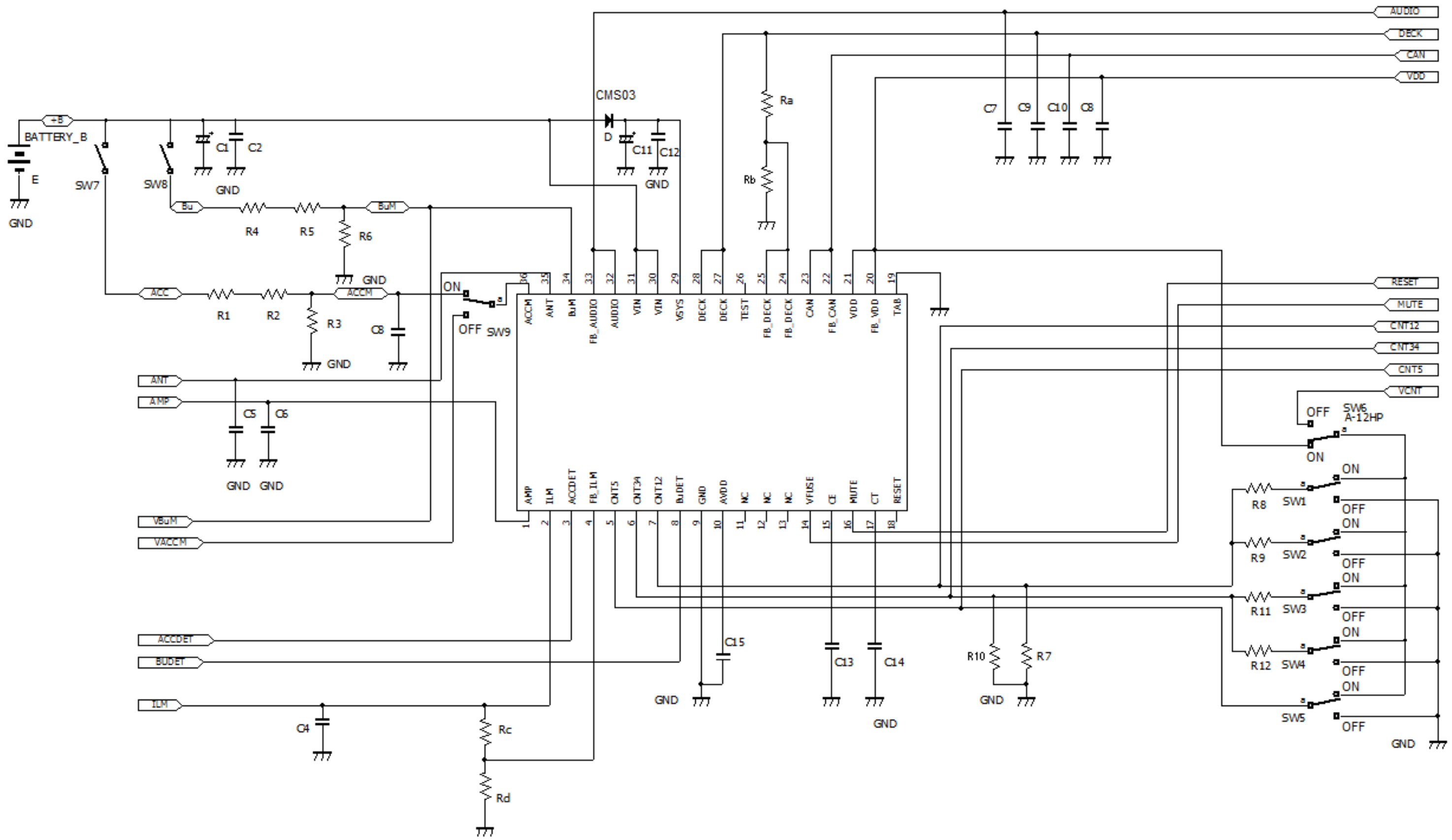
V_{ANT}-I_{ANT}



V_{AMP}-I_{AMP}



13. Test Circuit



Note: Components in the test circuits are used only to obtain and confirm the device characteristics. These components and circuits are not guaranteed to prevent malfunction or failure from occurring in the application equipment.

Note: The VFUSE pin should be connected surely to the AVDD pin.

Note: The dispersion of thresholds of each detecting function, the output voltage value of regulators, and over-current protection circuit can be adjusted by connecting the VFUSE pin and the AVDD pin. Thereby, the electric characteristics are satisfied in the shipment test.

Note: Constants should be determined by evaluating the board to be used because oscillating may occur depending on capacitors to be used and the inserting position of capacitors.

14. List of the external parts for the TCB010FNG

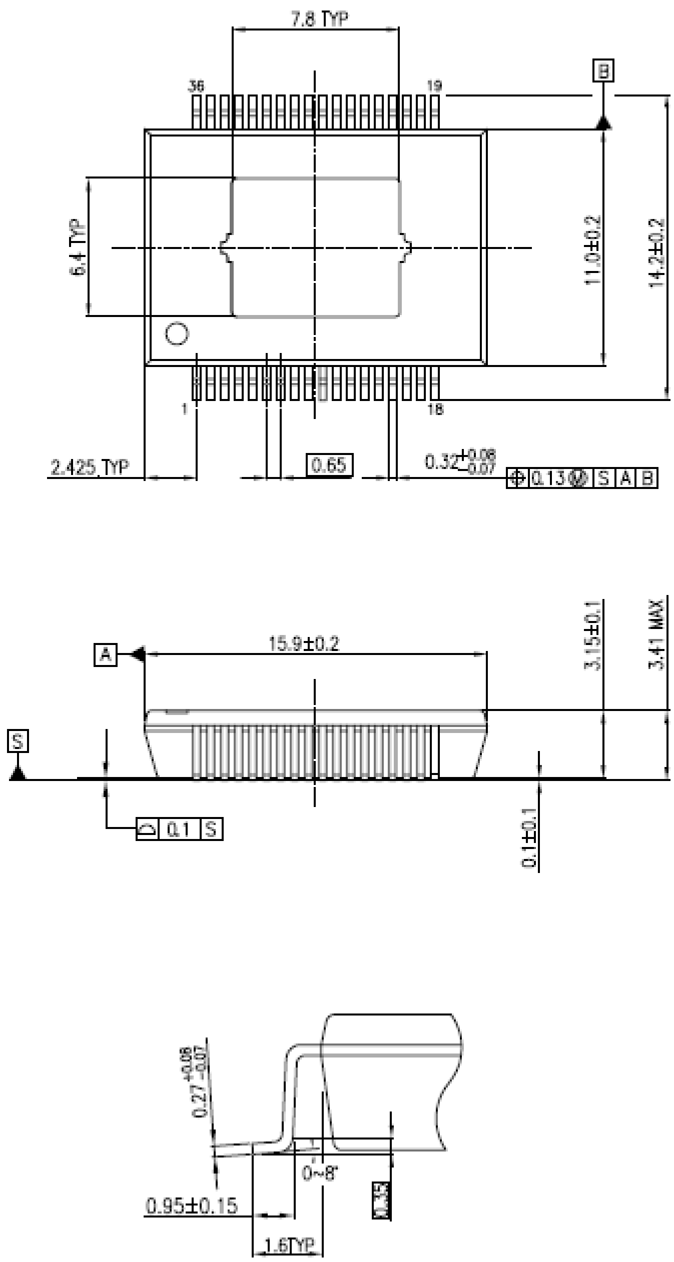
Part name	Recommendation value	Connect pin	Description
C1	1000 μF	VIN	Power hum, filter for ripple
C2	0.1 μF	VIN	Noise reduction, improvement of oscillating allowance
C3	0.1 μF	ACCM	Oscillation prevention
C4	10 μF	ILM	Oscillation prevention
C5	1 μF	ANT	Oscillation prevention
C6	1 μF	AMP	Oscillation prevention
C7	10 μF	AUDIO	Oscillation prevention
C8	10 μF	VDD	Oscillation prevention
C9	10 μF	DECK	Oscillation prevention
C10	10 μF	CAN	Oscillation prevention
C11	470 μF	VSYS	Holding VDD output in lowering VIN
C12	10 μF	VSYS	Oscillation prevention
C13	1 μF	CE	Setting time constant for MUTE pulse
C14	0.1 μF	CT	Setting time constant in RESET
C15	4.7 μF	AVDD	Oscillation prevention
R1	8.2 kΩ	ACCM	Resistance for adjusting threshold for ACCDET
R2	100 kΩ	ACCM	Resistance for adjusting threshold for ACCDET
R3	18 kΩ	ACCM	Resistance for adjusting threshold for ACCDET
R4	2 MΩ	BuM	Resistance for adjusting threshold for BuDET
R5	390 kΩ	BuM	Resistance for adjusting threshold for BuDET
R6	390 kΩ	BuM	Resistance for adjusting threshold for BuDET
R7	220 kΩ	CNT12	Resistance for controlling voltage of CNT pin
R8	33 kΩ	CNT12	Resistance for controlling voltage of CNT pin
R9	15 kΩ	CNT12	Resistance for controlling voltage of CNT pin
R10	220 kΩ	CNT34	Resistance for controlling voltage of CNT pin
R11	33 kΩ	CNT34	Resistance for controlling voltage of CNT pin
R12	15 kΩ	CNT34	Resistance for controlling voltage of CNT pin
Ra	—	FB_DECK	Resistance for setting output voltage of DECK
Rb	—	FB_DECK	Resistance for setting output voltage of DECK
Rc	—	FB_ILM	Resistance for setting output voltage of ILM
Rd	—	FB_ILM	Resistance for setting output voltage of ILM
D	—	VSYS	Backflow prevention Diode Recommendation Diode: (part number: CMS03, maker: Toshiba Electronic Devices & Storage Corporation)

Note: Components in the test circuits are only used to obtain and confirm the device characteristics.
These components and circuits do not warrant preventing the application from malfunction or failure.

15. Package Dimensions

P-HSSOP36-1116-0.65-001

Unit: mm

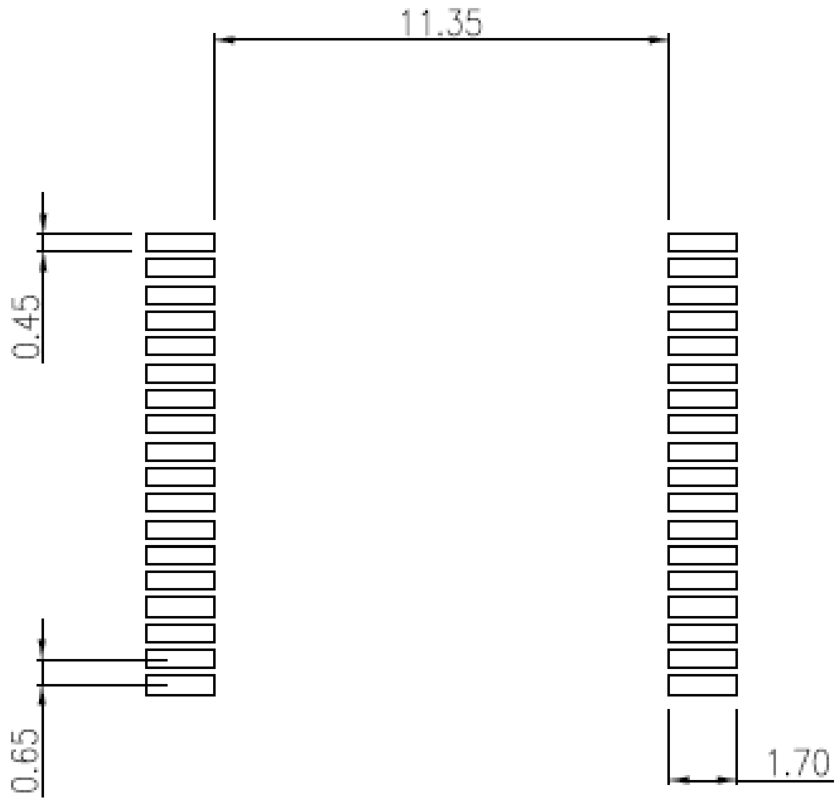


Weight: 1.28 g (typ.)

16. Land Pattern Size for Reference

P-HSSOP36-1116-0.65-001

Unit: mm



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