TOSHIBA Bi-CMOS Digital Integrated Circuit Silicon Monolithic

TB2902H

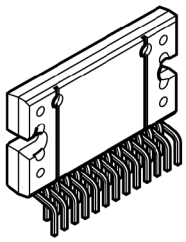
Maximum Power 41 W BTL × 4-ch Audio Power IC

The TB2902H is 4ch audio amplifier for car audio application.

This IC can generate more high power: P_{OUT} MAX = 41 W and high quality sounds as it is included the pure complementary P-ch and N-ch DMOS output stage.

The included self diagnosis function can be controlled via I^2C BUS.

Additionally, stand-by function, mute function and various kind of protector are included.



HZIP25-P-1.00F

Weight: 7.7 g (typ.)

Features

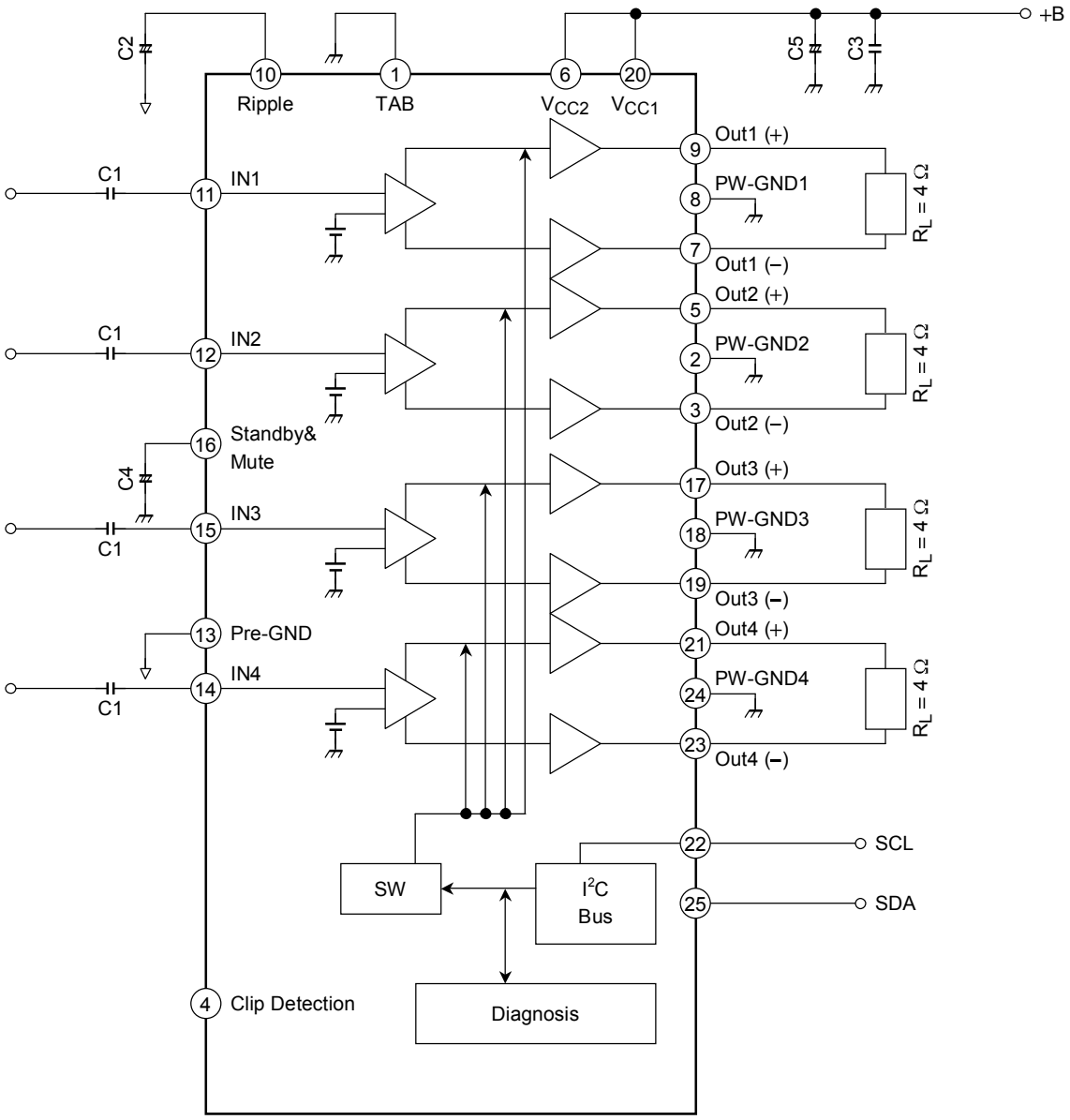
- High power output
  - : P_{OUT} MAX (1) = 41 W (typ.)
    (V_{CC} = 14.4 V, f = 1 kHz, JEITA max, R_L = 4 Ω)
  - : P_{OUT} MAX (2) = 37 W (typ.)
    (V_{CC} = 13.7 V, f = 1 kHz, JEITA max, R_L = 4 Ω)
  - : P_{OUT} MAX (3) = 70 W (typ.)
    (V_{CC} = 14.4 V, f = 1 kHz, JEITA max, R_L = 2 Ω)
  - : P_{OUT} (1) = 27 W (typ.)
    (V_{CC} = 14.4 V, f = 1 kHz, THD = 10%, R_L = 4 Ω)
  - : P_{OUT} (2) = 23 W (typ.)
    (V_{CC} = 13.2 V, f = 1 kHz, THD = 10%, R_L = 4 Ω)
  - : P_{OUT} (3) = 45 W (typ.)
    (V_{CC} = 14.4 V, f = 1 kHz, THD = 10%, R_L = 2 Ω)
- Low distortion ratio: THD = 0.015% (typ.)
  (V_{CC} = 13.2 V, f = 1 kHz, P_{OUT} = 5 W, R_L = 4 Ω)
- Low noise: V_{NO} = 90 μVrms (typ.)
  (V_{CC} = 13.2 V, R_g = 0 Ω, BW = 20 Hz to 20 kHz, R_L = 4 Ω)
- Built in stand by&muting function: controlled via I^2C Bus (pin16)
- Built in clipping detection (pin 4)
- Built in I^2C Bus for stand-by, mute, voltage gain control, self diagnosis: Output short detection, offset detection, tweeter or speaker open detection (pin22 and 25)
- Built-in various protection circuits (Note 1, Note 2)
  Thermal shut down, over-voltage, out to GND, out to V_{CC}, out to out short
- Operating supply voltage: $V_{CC\ (opr)}$ = 9 to 18 V (R_L = 4 Ω)
  $V_{CC\ (opr)}$ = 9 to 16 V (R_L = 2 Ω)

Note 1: Install the product correctly. Otherwise, it may result in break down, damage and/or degradation to the product or equipment.

Note 2: These protection functions are intended to avoid some output short circuits or other abnormal conditions temporarily. These protect functions do not warrant to prevent the IC from being damaged.

- In case of the product would be operated with exceeded guaranteed operating ranges, these protection features may not operate and some output short circuits may result in the IC being damaged.

Block Diagram



Some of the functional blocks, circuits, or constants in the block diagram may be omitted or simplified for explanatory purpose

Caution and Application Method (description is made only on the single channel.)

1. Voltage Gain Adjustment

This IC has no NF (negative feedback) Pins. Therefore, the voltage gain can not be adjusted, but it makes the device a space and total costs saver.

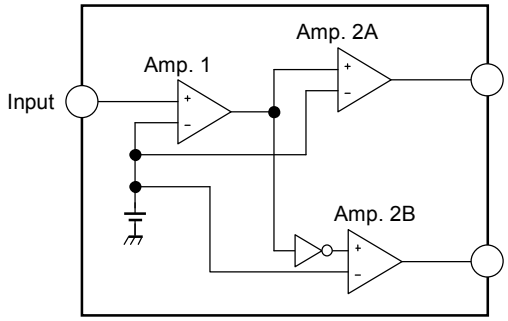


Figure 1 Block Diagram

In case of G_V = 26dB, it is calculated by below expression:
The voltage gain of amp.1: G_{V1} = 0dB
The voltage gain of amp.2A, B: G_{V2} = 20dB
The voltage gain of BTL connection: $G_{V\,(BTL)}$ = 6dB
Therefore, the total voltage gain is decided by expression below.
$G_V = G_{V1} + G_{V2} + G_{V\,(BTL)} = 0 + 20 + 6 = 26dB$

While, in case of G_V = 12dB selected via I^2C, G_{V1} change from 0dB to −14dB so that the output dynamic range becomes lower as the output of Amp.1 is suppressed.

2. Muting Time Constant and Pop Noise Suppression at V_{CC} Rapidly Falling (pin 16)

The capacitor C_4 at pin 16 is for muting time constant to suppress the pop noise. The larger value capacitor is used, the lower pop noise becomes but the longer the muting time from the mute ON command sent to muting an output sound actually.

As the V_{CC} is rapidly falling, the IC internal low voltage muting operates to eliminate the large pop noise basically.
If the effect of the internal low voltage muting is not enough in such a case, make this pin 16 set at low: 5 V and less by external circuit for more effective to suppress the pop noise.
In this case, this pin 16 has to be released from setting at low before going back to play mode.

Additionally, the initial condition after turning on or stand by off by setting of I^2C Bus is in muting condition so that it is necessary to send the mute off command to change from this condition to play mode.

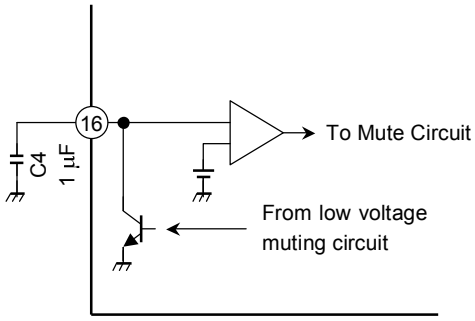


Figure 2 Pin 16 Muting Circuit

Caution for the muting operation and the application.

Audio muting function is enabled when pin 16 is not set at Low. When the time constant of the muting function is determined by C4, it should take into account the pop noise. The pop noise which is generated when the power or muting function is turned ON/OFF will vary according to the time constant.
In case of the longer time constant using, set the C4 become larger value.
The effective time constant to suppress the pop noise is during the pin 16 voltage falling. Therefore, the pop noise may become a peaky sound if the mute ON or OFF command is sent from µController during the pin 16 voltage rising.

3. Clip Detection

The output clip detection terminal of pin 4 has the open collector output structure on chip as shown in Figure 3. In case that the output waveform is clipping, the clip detection circuit is operated and NPN Tr. Is turned on.

It is possible to improve the audio quality with controlling the volume, tone control circuit through L.P.F. smoothing circuit as shown in Figure 3.

The sensitivity of clipping level can be selected T.H.D. = 1 % or 10% via I²C bus.

In case of being unused this function, use this IC as open connection on pin4.

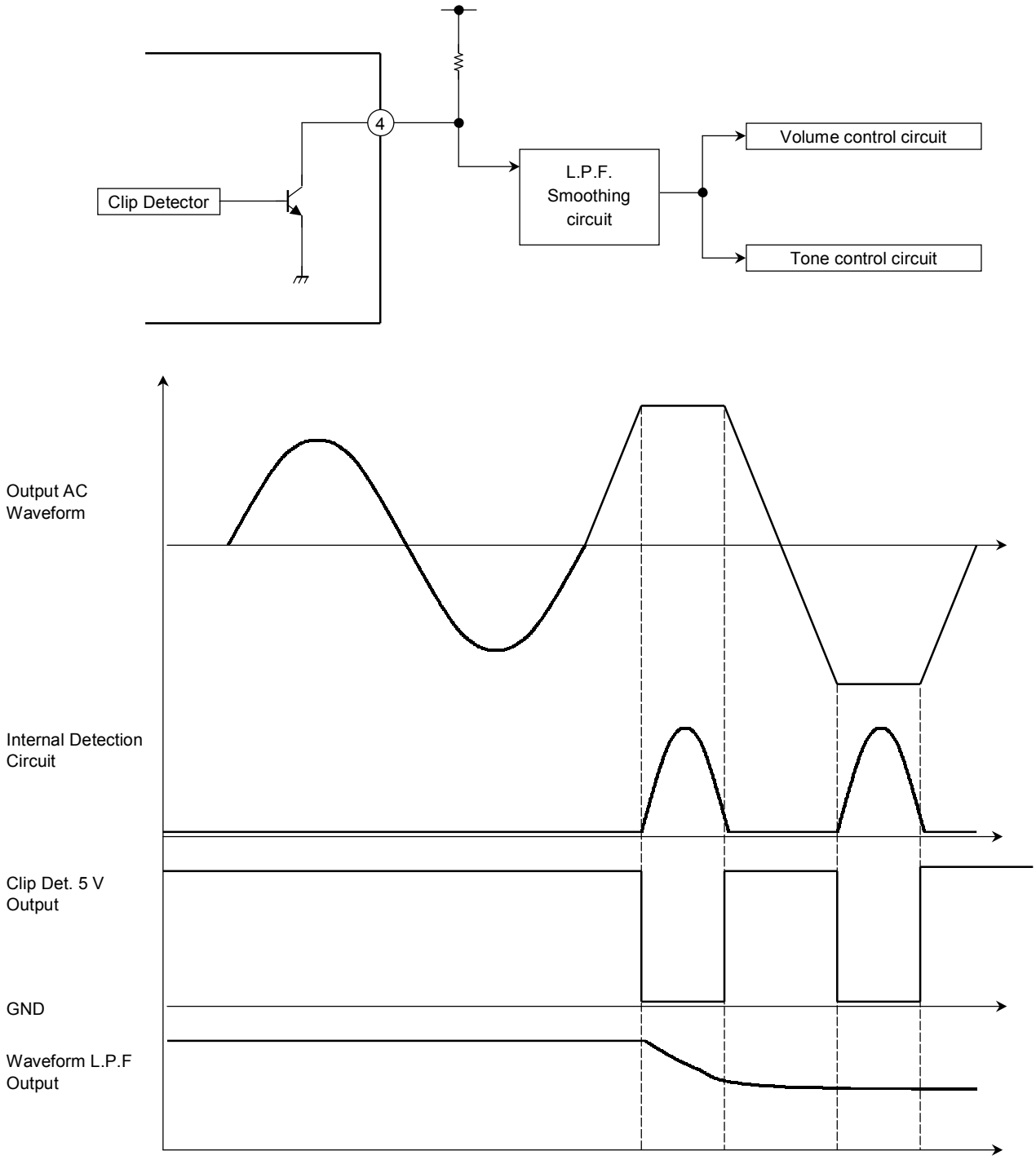


Figure 3 Clip Detection

4. External Component Constants

Component Name	Recommended Value	Purpose	Effect		Notes
			Lower than Recommended Value	Higher than Recommended Value	
C1	0.22 μF	To eliminate DC	Cut-off frequency becomes higher	Cut-off frequency becomes lower	Pop noise is concerned with this capacitor.
C2	10 μF	To reduce ripple To determine the time of turn on diag	Power ON/OFF time and turn ON diag cycle shorter	Power ON/OFF time and turn ON diag cycle longer	
C3	0.1 μF	To provide sufficient oscillation margin	Reduces noise and provides sufficient oscillation margin		
C4	1 μF	To reduce pop noise	Pop noise becomes larger Muting ON/OFF time is shorter	Pop noise becomes smaller Muting ON/OFF time is longer	
C5	3900 μF	Ripple filter	Power supply ripple filtering		

Note 3: In case of the recommended value not used.

5. Fast Mute Mode

This mode will mainly use a occur by pop sound on V_{CC} cranking condition.
A Fast mute mode can be used to send a command via I^2C bus.
Using the IB2 register and set one the bit D6, it is possible to get a fast I^2C mute command.
If a fast mute command is received, this IC will operate and make to discharge a capacitor of pin16.
Therefore the Pop sound will reduce of not using this mode on V_{CC} cranking condition.

6. Explanation for Self Diagnosis Via I^2C

(1) Bus map

【Slave Address】

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Details	Hex
							0	Write Mode	
							1	Read Mode	
1	1	0	1	1	0	0	—		D8H

【WRITE】

- Sub address

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Details	Hex
0								Page Mode (auto increment) OFF	
1								Page Mode (auto increment) ON	
—	0	0	0	0	0	0	1	Control Byte1	01H
—	0	0	0	0	0	1	0	Control Byte2	02H

- Control byte1 (01H)

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Function
0	0	0	0	0	0	0	1	Clip Det 1% to 10% change
0	0	0	0	0	0	1	0	R-ch Muting off (play)
0	0	0	0	0	1	0	0	Fch Muting off (play)
0	0	0	0	1	0	0	0	R-ch Gain 26dB to 12dB
0	0	0	1	0	0	0	0	Fch Gain 26dB to 12dB
0	0	1	0	0	0	0	0	Offset Det Enable
0	1	0	0	0	0	0	0	Diag Cycle Enable
1	—	—	—	—	—	—	—	Turn-on Select (normal/repeatedly)

- Control byte2 (02H)

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Function
0	0	0	0	0	0	0	1	R-ch Iccq become Lower
0	0	0	0	0	0	1	0	Fch Iccq become Lower
0	0	0	0	0	1	0	0	Current Detection Enable
0	0	0	0	1	0	0	0	Line Drive Diag
0	0	0	1	0	0	0	0	Stand By OFF (play)
0	0	1	0	0	0	0	0	Clip Det Pin change to Offset Det
—	1	—	—	—	—	—	—	Fast mute ON/OFF
1	0	0	0	0	0	0	0	Current Detection. Level change from 500 mA (max) to 300 mA (max)

Note4: Self mute circuit is included on chip in independent from I^2C bus stage.
Self mute operating voltage is V_{CC} = 7.8 V

Note5: Auto Increment is available.
If it is chosen the control byte 1 by sub address, it is not necessary to send byte 2 in case of writing both byte 1 and 2.

Ex) In case of sub address = byte1 chosen:
Sub address byte 1 → byte 1 writing → Sub address byte 2 → byte 2 writing: available
Sub address byte 1 → byte 1 writing ---------- → byte 2 writing: available

【READ】

Byte 1

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	At "Bit = 1" Condition
0	0	0	0	0	0	0	1	Ch1 Short to GND
0	0	0	0	0	0	1	0	Ch1 Short to V_{CC}
0	0	0	0	0	1	0	0	Ch1 Open load or Offset Detected
0	0	0	0	1	0	0	0	Ch1 Short load
0	0	0	1	0	0	0	0	Ch1 Diagnosis condition (bit = 1: permanent, 0: turn-on)
0	0	1	0	0	0	0	0	Ch1 Current Detection (at IB2 D2 = 1 = enable only) (IB2 – D7 = 0: bit = 1: <250 mA, 0: >500 mA) (IB2 – D7 = 1: bit = 1: <100 mA, 0: >300 mA)
0	1	0	0	0	0	0	0	Bit = 1: Diag. Cycle terminated, 0: Not terminated
1	0	0	0	0	0	0	0	TSDMute ON (thermal warning)

Byte 2

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	At "Bit = 1" Condition
0	0	0	0	0	0	0	1	Ch2 Short to GND
0	0	0	0	0	0	1	0	Ch2 Short to V_{CC}
0	0	0	0	0	1	0	0	Ch2 Open load or Offset Detected
0	0	0	0	1	0	0	0	Ch2 Short load
0	0	0	1	0	0	0	0	Ch2 Diagnosis condition (bit = 1: permanent, 0: turn-on)
0	0	1	0	0	0	0	0	Ch2 Current Detection (at IB2 D2 = 1 = enable only) (IB2 – D7 = 0: bit = 1: <250 mA, 0: >500 mA) (IB2 – D7 = 1: bit = 1: <100 mA, 0: >300 mA)
0	1	0	0	0	0	0	0	Current sensor activated (D6 = 1)
1	0	0	0	0	0	0	—	Offset detection activated (D7 = 1)

Byte 3

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	At "Bit = 1" Condition
0	0	0	0	0	0	0	1	Ch3 Short to GND
0	0	0	0	0	0	1	0	Ch3 Short to V_{CC}
0	0	0	0	0	1	0	0	Ch3 Open load or Offset Detected
0	0	0	0	1	0	0	0	Ch3 Short load
0	0	0	1	0	0	0	0	Ch3 Diagnosis condition (bit = 1: permanent, 0: turn-on)
0	0	1	0	0	0	0	0	Ch3 Current Detection (at IB2 D2 = 1 = enable only) (IB2 – D7 = 0: bit = 1: <250 mA, 0: >500 mA) (IB2 – D7 = 1: bit = 1: <100 mA, 0: >300 mA)
—	1	—	—	—	—	—	—	Diagnotic status (= IB1 – D6 bit = 1: diag enable)
1	—	—	—	—	—	—	—	Stand-by status (= IB2 – D4 bit = 1: play)

Byte 4

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	At "Bit = 1" Condition
0	0	0	0	0	0	0	1	Ch4 Short to GND
0	0	0	0	0	0	1	0	Ch4 2Short to V_{CC}
0	0	0	0	0	1	0	0	Ch4 Open load or Offset Detected
0	0	0	0	1	0	0	0	Ch4 Short load
0	0	0	1	0	0	0	0	Ch4 Diagnosis condition (bit = 1: permanent, 0: turn-on)
0	0	1	0	0	0	0	0	Ch4 Current Detection (at IB2 D2 = 1 = enable only) (IB2 – D7 = 0: bit = 1: <250 mA, 0: >500 mA) (IB2 – D7 = 1: bit = 1: <100 mA, 0: >300 mA)
—	—	—	—	—	—	—	—	x
—	—	—	—	—	—	—	—	x

Note 6: Short protection can be operated in channel by channel.

(EX) If channel 1 is shorted, ch 1 is protected but other channels are available.

(2) Description for turn on diagnosis

This IC can diagnose whether the below condition occurs or not at turning ON:

-Short to GND
-Short to V_{CC}
-Output to output short
-Speaker open

As firstly, the write data is sent to turning ON, and then this IC will become turning ON.

If this turning on diagnosis become activate at the time, the write data, that the diagnostic cycle byte: IB1 D6 set at 1, is sent at the same time

The result of self diagnosis can be obtained by the read data sent after the turn on diagnostic data permitted time, as below Figure:

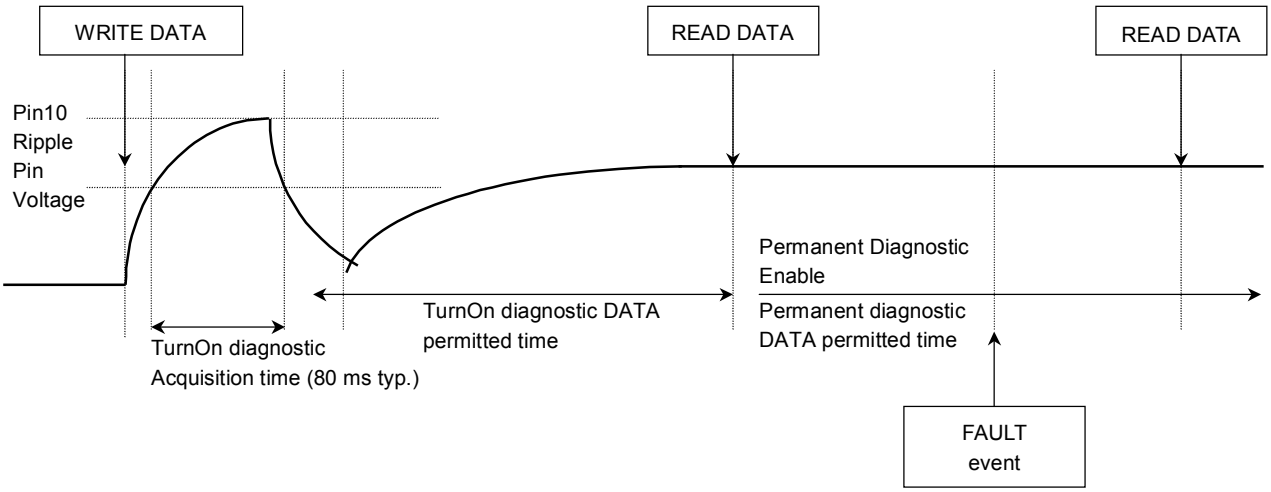


Figure 4 Diagnosis Timing Chart

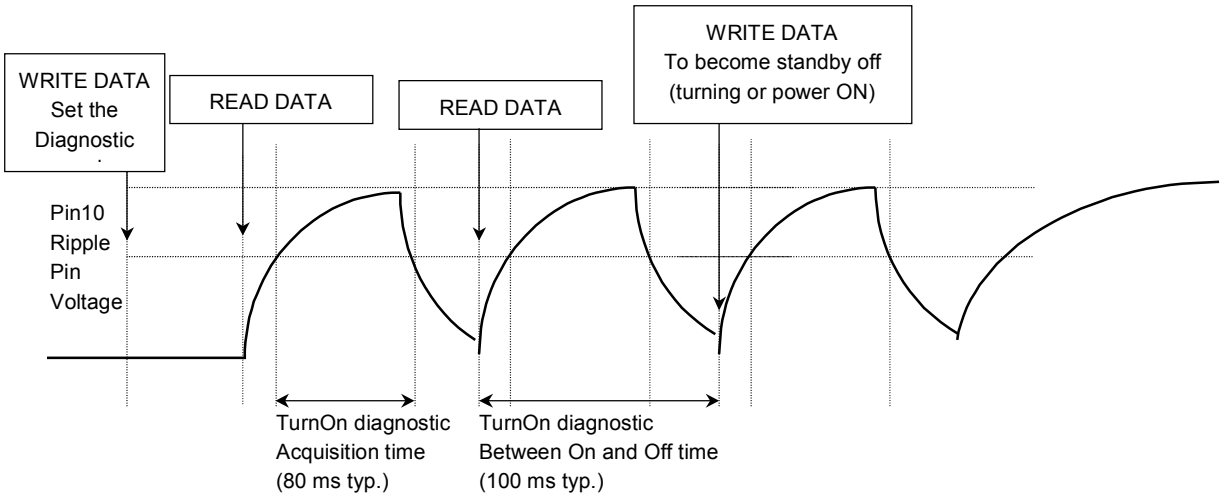


Figure 5 Number of Times Turn ON Diagnosis Timing Chart

As firstly, the write data is set at the on diagnostic cycle enable (IB1 D6 = 1), the turn on diagnosis can be available for repeated by sent the read command repetition after above set up as shown as Figure 5.

Therefore, it is useful to check number of times from Power ON to the output appearance.

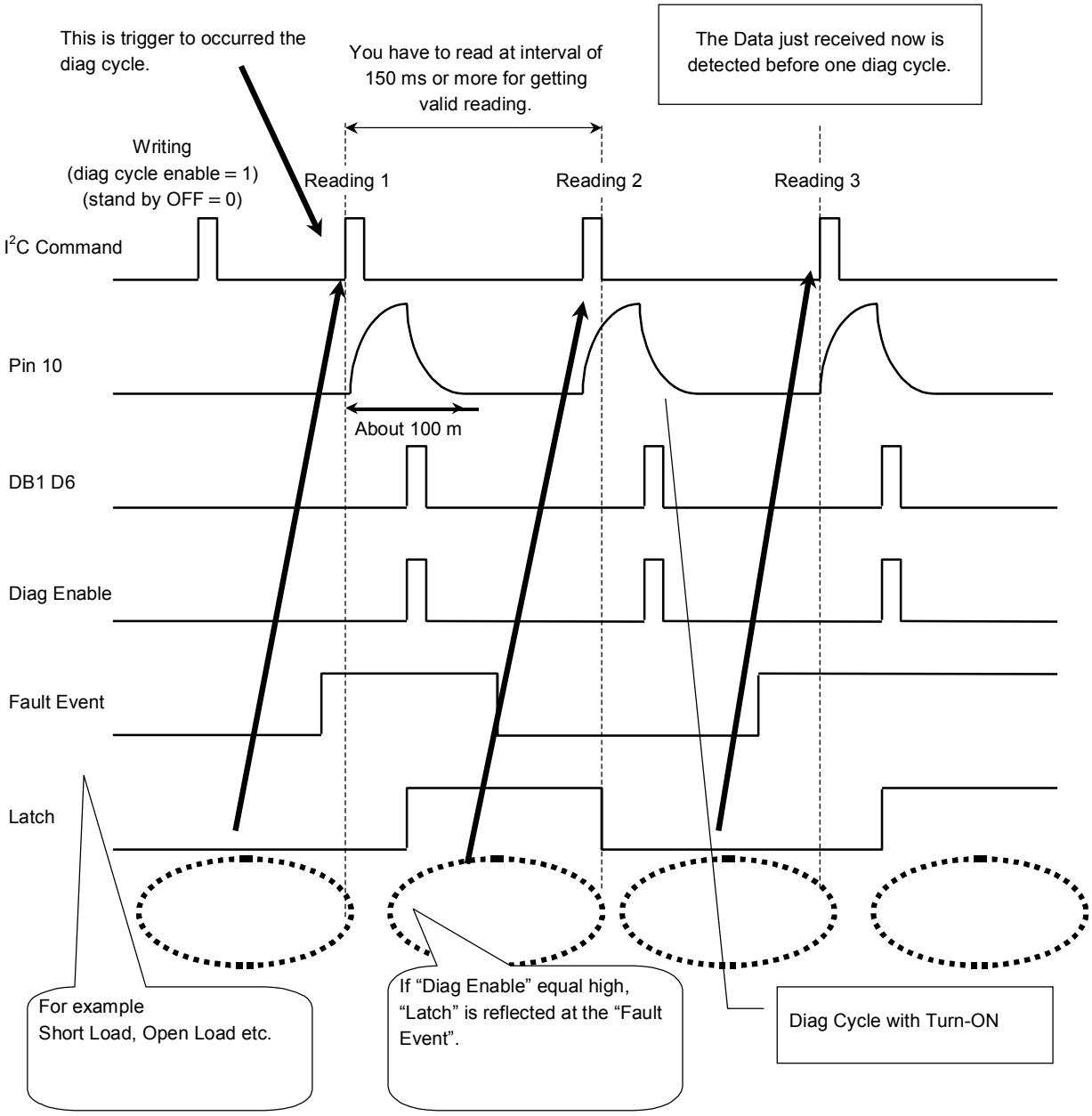
This IC has built-in a two mode diagnostics on the Turn-on timing.

A) Normal mode (one shot) of Turn-on diagnostics (data of IB1, D7 = 1)
B) Repeatability mode of Turn-on diagnostics (data of IB1, D7 = 0)

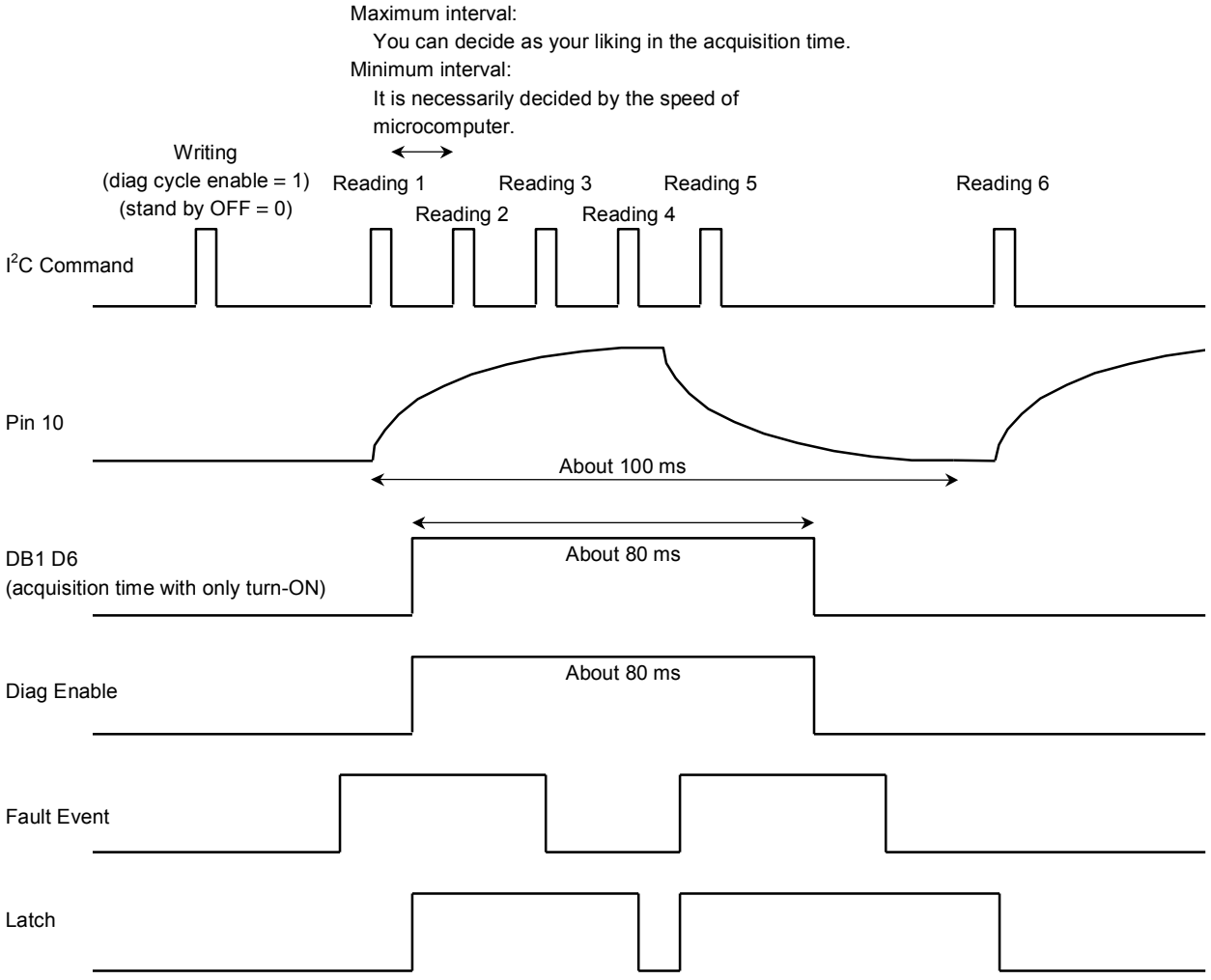
A) Normal mode (one shot diag.)

For example, if you want to get two valid readings, you have to send the command to read three times.

True data are second data and third data.



B) Repeatable mode



The turn ON diagnostic acquisition time is determined by the ripple filter capacitance C2 and the equivalent internal resistance Rr as below expression.

Acquisition time = 2 × C2 × Rr = 4400 × C2 (typ.)

Rr is fixed in internal circuit and it is not varied by the fluctuation of power supply V_{CC} voltage.

The C2 determines the time from power ON (standby off) to the appearance of sound signal from output and the characteristic for ripple rejection ratio, too. Therefore, take care of the value decision.

If the turn ON diagnosis is not used, in other words sent the diagnostic cycle defeat command, the waveform of ripple terminal voltage will change but the time from turning on to the output signal appearance will not change as below Figure 6.

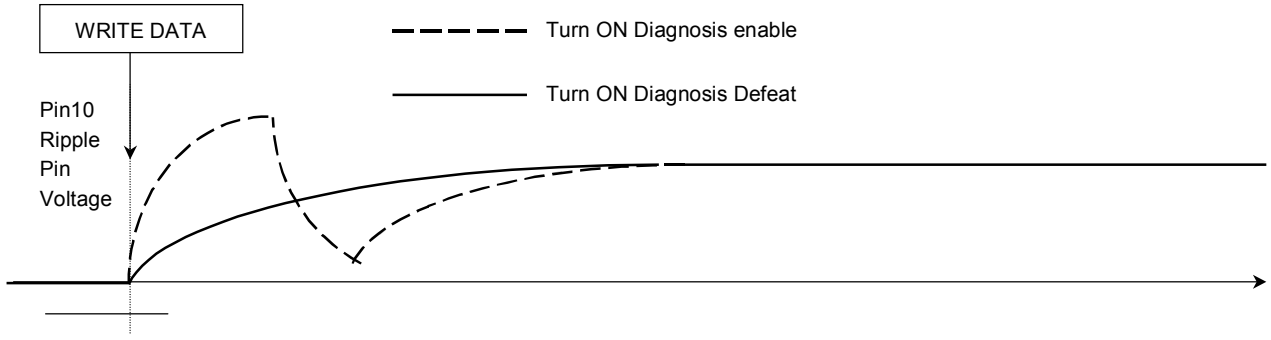


Figure 6 Not Used the Turn on Diagnosis Timing Chart

(3) Description for permanent diagnosis

This IC can provide the permanent diagnosis whether the below condition occurs or not after turning ON:

-Short to GND
-Short to V_{CC}
-Output to output short
-Output offset detection
-Current detection for tweeter open

This permanent diagnosis is available not only the diagnostic cycle byte: IB1 D6 set at 1 but also set at 0.

Additionally, the result of it can obtain by the just read command sent only, not necessary the write data.

In this time, concerning with each short detection, the first read data after the fault removed is shown “the Faulty”. Therefore, it is necessary to obtain the 3 times and more faulty result to prevent the misjudgment as for example the speaker sometimes makes a large counter electro motive and then this IC recognize it is fault event.

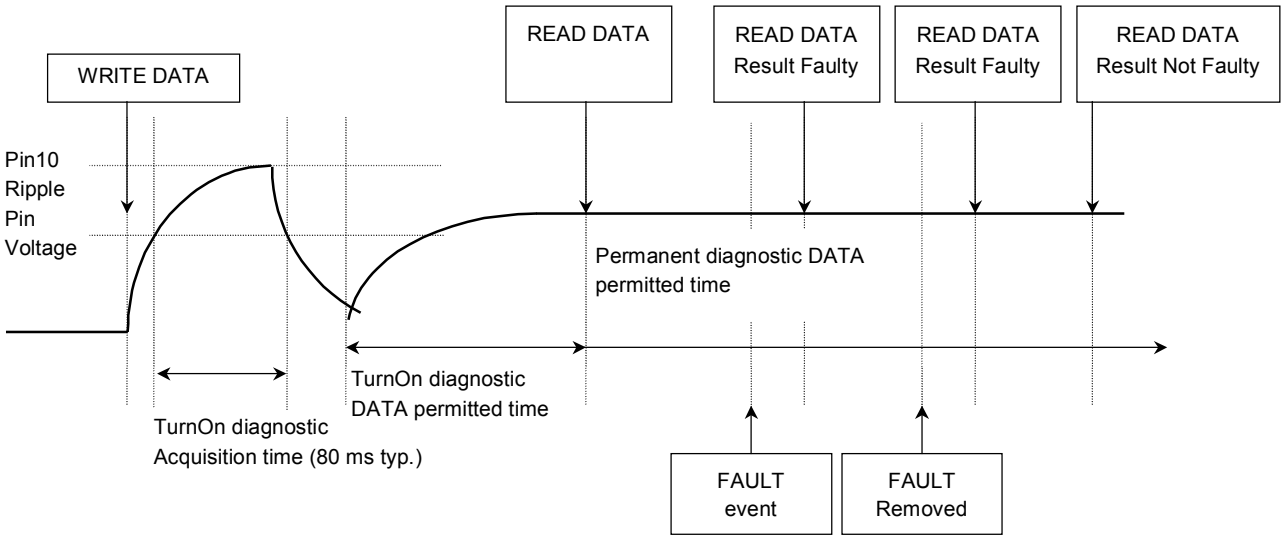


Figure 7 Permanent Diagnosis Timing Chart for Each Short Detection

Regarding output offset detection, it always detects the output offset and the result is not latched internal as shown as below Figure:

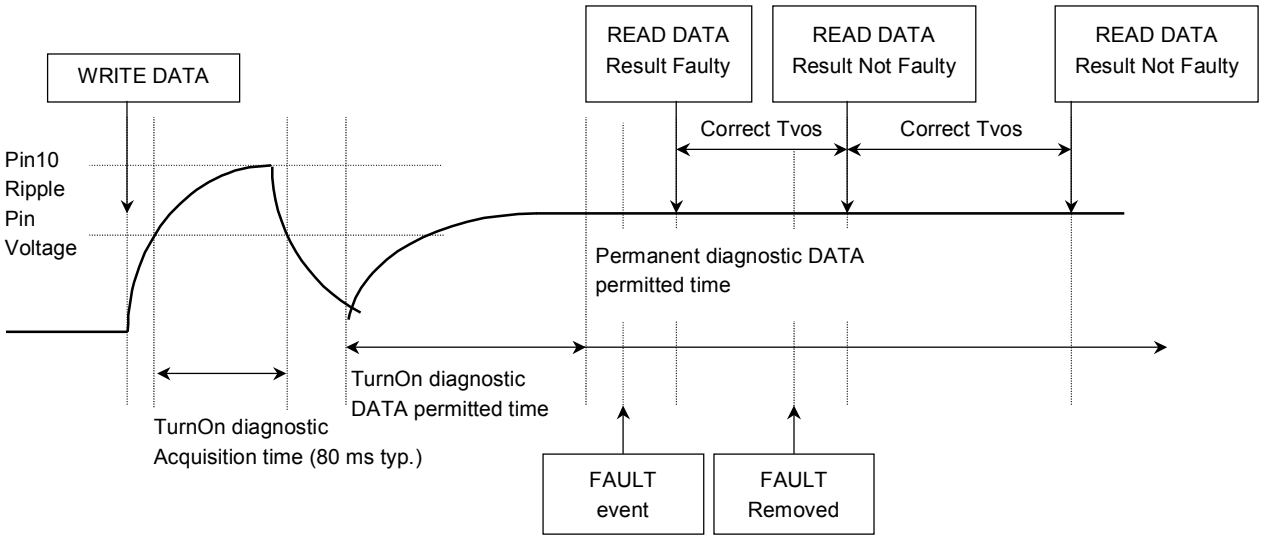


Figure 8 Software Output Offset Detection Timing Chart

However, this detection has to be performed with the time: Tvos between read and next read is set at Tvos = 1/the lowest signal frequency and more for instance Tvos > 50 ms if the lowest output signal frequency is 20 Hz, and to obtain the 2 times and more faulty result to prevent the misjudgment

Additionaly, the threshold level is designed at +/−2 V.

While, the terminal of pin 4 can be changed from clip detector to offset detector output by sending the write command via I²C.

If the L.P.F output voltage has become a half of pull up voltage for a while, firstly the signal output volume goes down. After that, it can be judged that the abnormal output offset occures if the L.P.F. output voltage will not go back to a half of pull up voltage.

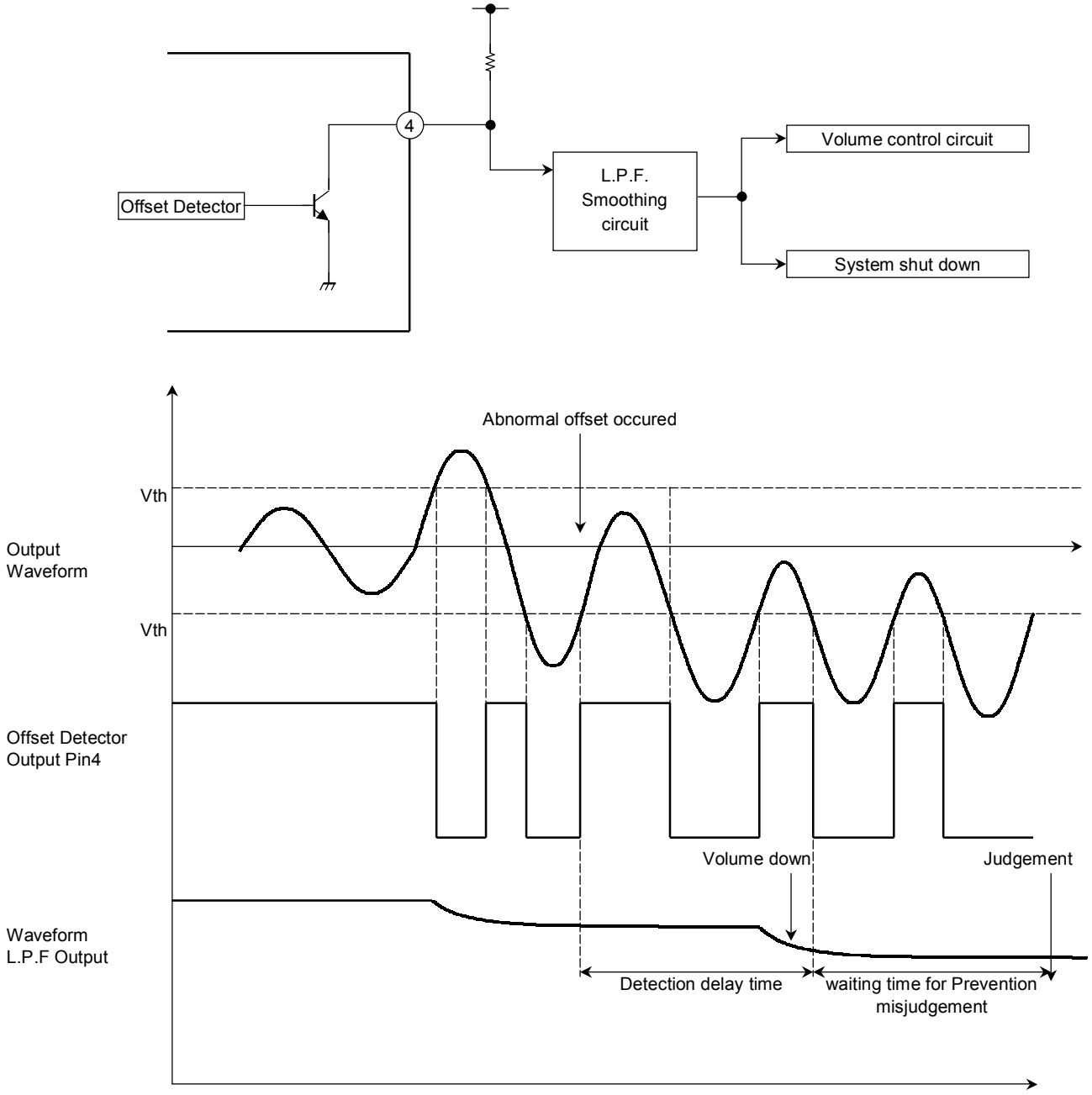


Figure 9 Hardware Output Offset Detection

When the current detector for Tweeter open check is used, it is neccesary to take care as below:

- Need to input the pulse or signal which is the higher out of audience frequency for example f = 20 kHz
- The pulse or signal input timing has to be after mute off (play mode)
- At least, the read timing has to be after 1 cycle of input pulse or signal and more, the recommadation cycles are 3 cycle and more if can.
- The level of input pulse or signal is more than the detection threshold level 300 mA or 500 mA. For instance, if the tweeter impedance is 20 Ω at f = 20 kHz which is same as input signal frequency, the output minimum voltage is: Vout = 500 mA × 20 Ω = 10 V and more.

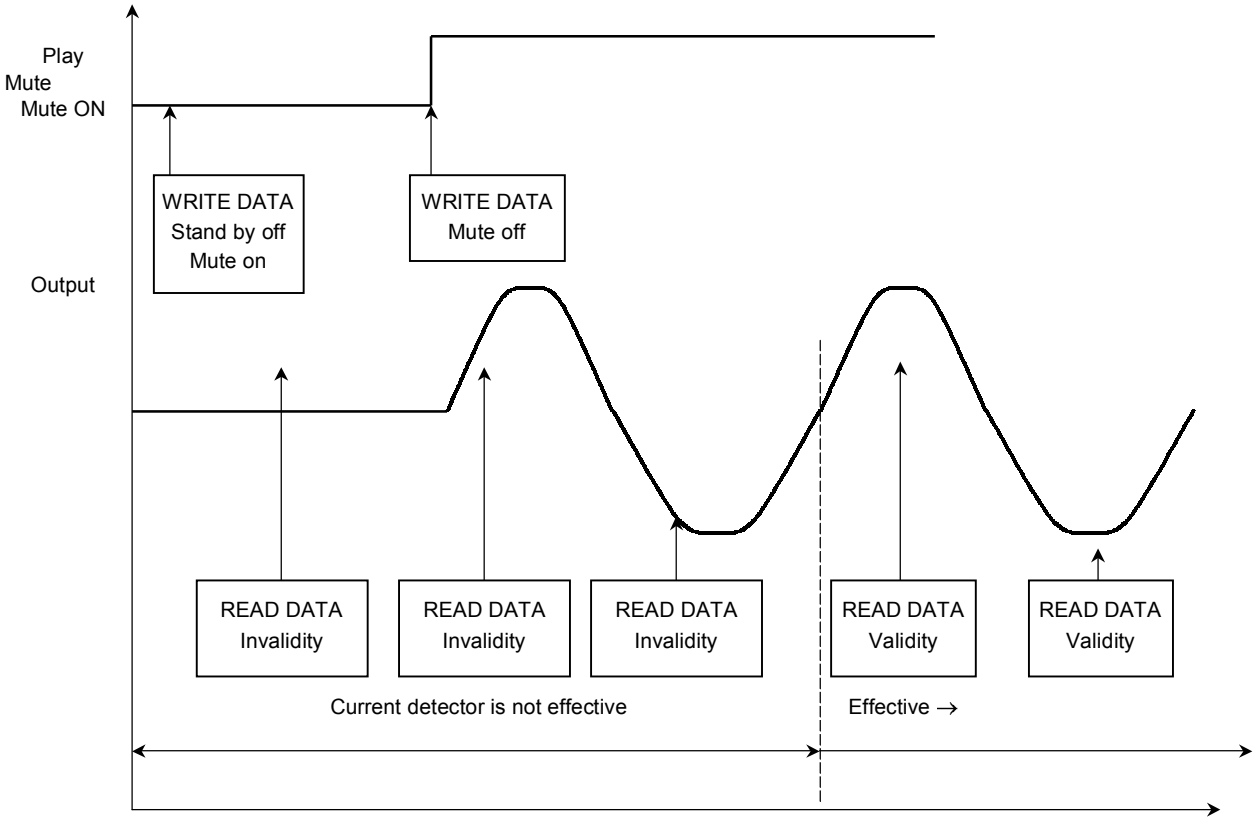


Figure 10 Tweeter Open Detection Timing Chart

At last, if DB1 D7 = 1 then the temperature of IC chip is closer to the temperature of thermal protector operation. This warning bit becomes high, before about 10 degrees of temperature at the protector operation.

Note 7: Timing charts may be simplified for explanatory purpose.

Note 8: Please read all self-diagnosis twice or more and judge them.

(4) Multiple faults

The self diagnosis shows as below tables when there are multi fault connection for the audio outputs.

At Turning ON:

	S.GND (out +)	S.GND (out –)	S.V_{CC}	Out to Out. S	Open L
S.GND (out +)	S.GND	S.GND	S.Load	S.GND	S.GND
S.GND (out –)		S.GND	S.Load	S.GND	S.GND
S.V_{CC}			S.V_{CC}	S.V_{CC}	S.V_{CC} + S.Load + open
Out to Out .S				S.Load	N/A
Open L					Open

At Permanent:

	S.GND (out +)	S.GND (out –)	S.V_{CC}	Out to Out. S	Open L
S.GND (out +)	S.GND	S.GND	S.GND or S.V_{CC} (Note 10)	S.GND	S.GND (Note 9)
S.GND (out –)		S.GND	S.GND or S.V_{CC} (Note 10)	S.GND	S.GND (Note 9)
S.V_{CC}			S.V_{CC}	S.V_{CC}	S.V_{CC} (Note 9)
Out to Out .S				S.Load + S.GND	N/A
Open L					Normal

Note 9: If the DC offset detection mode is ON, the information which the DC offset is appeared is added.

Note10: The chance which they can read this exact information is only one time although in case of other diagnosis, the more times sending read command, the higher the confidence of the result.

For example,

a) ch1+ is connected to GND

b) ch1- is connected to Vcc

c) They can read or get the "Short to GND" information when the uP send the Read command.

d) Next, however, they can not get the " Short to GND" or "Short to Vcc" information when the uP send the Read command again.

(5) Explanation of I^2C bus commands

Below the “ADDRESS BYTE”, presently the address byte is fixed at 216 dec = D8hex = 1101100xbin.

- ADDRESS SELECTION is D8hexa:

A7	Address bit	1
A6	Address bit	1
A5	Address bit	0
A4	Address bit	1
A3	Address bit	1
A2	Address bit	0
A1	Address bit	0
A0 (R/W)	Read/Write bit	X

X: 0 = Write instruction to device; 1 = Read instruction to device

- If R/W = 0, the Up Sends Two Instruction Bytes, IB1 and IB2:

IB1 Instruction Byte:

Bit	
D7	Turn-on diag timing Normal (D7 = 1) repeat (D7 = 0)
D6	Diagnostic cycle enable (D6 = 1) Diagnostic cycle defeat (D6 = 0)
D5	Offset Detection enable (D5 = 1) Offset Detection defeat (D5 = 0)
D4	Front Channel Gain = 26dB (D4 = 0) Gain = 12dB (D4 = 1)
D3	Rear Channel Gain = 26dB (D3 = 0) Gain = 12dB (D3 = 1)
D2	Mute front channels (D2 = 0) Unmute front channels (D2 = 1)
D1	Mute rear channels (D1 = 0) Unmute rear channels (D1 = 1)
D0	CD 1% (D0 = 0) CD 10% (D0 = 1)

IB2 Instruction Byte:

Bit	
D7	Current Det 500 mA (max) (D7 = 0) Current Det 300 mA (max) (D7 = 1)
D6	Fast mute on (D6 = 1) off (D6 = 0)
D5	Pin4 Clip Detection (D5 = 0) Pin4 Offset Detection (D5 = 1)
D4	Std-by on-PA not working (D4 = 0) Std-by off-PA working (D4 = 1)
D3	Amplifier mode diagnostic (D3 = 0) Line driver mode diagnostic (D3 = 1)
D2	Current Det. diag enabled (D2 = 1) Current Det. diag defeat (D2 = 0)
D1	Front Channels Work standard mode (D1 = 0) Work Low Iccq mode (D1 = 1)
D0	Rear Channels Work standard mode (D1 = 0) Work Low Iccq mode (D1 = 1)

- If R/W = 1, the Power Amplifier Sends Four Diagnostics Bytes, DB1, DB2, DB3 and DB4:

DB1 Diagnostic Byte:

Bit	
D7	Thermal warning active (D7 = 1)
D6	Diag not actived or not terminated (D6 = 0) Diag terminated (D6 = 1)
D5	Channel 1 current detection Output peak current < 250 mA (IB2 – D7 = 0) – open load (D5 = 1) Output peak current < 100 mA (IB2 – D7 = 1) – open load (D5 = 1) Output peak current > 500 mA (IB2 – D7 = 0) – normal load (D5 = 0) Output peak current > 300 mA (IB2 – D7 = 1) – normal load (D5 = 0)
D4	Channel 1 Turn-on diagnostic (D4 = 0) Permanent diagnostic (D4 = 1)
D3	Channel 1 Normal load (D3 = 0) Short load (D3 = 1)
D2	Channel 1 Turn-on diag: No open load (D2 = 0) Open load detected (D2 = 1) Offset diag: No output offset (D2 = 0) Output offset detected (D2 = 1)
D1	Channel 1 No short to V_{CC} (D1 = 0) Short to V_{CC} (D1 = 1)
D0	Channel 1 No short to Gnd (D0 = 0) Short to Gnd (D0 = 1)

DB2 Diagnostic Byte:

Bit	
D7	Offset detection not activated (D7 = 0) Offset detection activated (D7 = 1)
D6	Current sensor not activated (D6 = 0) Current sensor activated (D6 = 1)
D5	Channel 2 current detection Output peak current < 250 mA (IB2 – D7 = 0) – open load (D5 = 1) Output peak current < 100 mA (IB2 – D7 = 1) – open load (D5 = 1) Output peak current > 500 mA (IB2 – D7 = 0) – normal load (D5 = 0) Output peak current > 300 mA (IB2 – D7 = 1) – normal load (D5 = 0)
D4	Channel 2 Turn-on diagnostic (D4 = 0) Permanent diagnostic (D4 = 1)
D3	Channel 2 Normal load (D3 = 0) Short load (D3 = 1)
D2	Channel 2 Turn-on diag: No open load (D2 = 0) Open load detected (D2 = 1) Offset diag: No output offset (D2 = 0) Output offset detected (D2 = 1)
D1	Channel 2 No short to V_{CC} (D1 = 0) Short to V_{CC} (D1 = 1)
D0	Channel 2 No short to Gnd (D0 = 0) Short to Gnd (D0 = 1)

Note 11: DBx (D5) is effective only at the time of “Current detection enable”.

DB3 Diagnostic Byte:

Bit	
D7	Stand-by status (= IB2 – D4)
D6	Diagnostic status (= IB1 – D6)
D5	Channel 3 current detection Output peak current < 250 mA (IB2 – D7 = 0) – open load (D5 = 1) Output peak current < 100 mA (IB2 – D7 = 1) – open load (D5 = 1) Output peak current > 500 mA (IB2 – D7 = 0) – normal load (D5 = 0) Output peak current > 300 mA (IB2 – D7 = 1) – normal load (D5 = 0)
D4	Channel 3 Turn-on diagnostic (D4 = 0) Permanent diagnostic (D4 = 1)
D3	Channel 3 Normal load (D3 = 0) Short load (D3 = 1)
D2	Channel 3 Turn-on diag: No open load (D2 = 0) Open load detected (D2 = 1) Offset diag: No output offset (D2 = 0) Output offset detected (D2 = 1)
D1	Channel 3 No short to V_{CC} (D1 = 0) Short to V_{CC} (D1 = 1)
D0	Channel 3 No short to Gnd (D0 = 0) Short to Gnd (D0 = 1)

DB4 Diagnostic Byte:

Bit	
D7	X
D6	X
D5	Channel 4 current detection Output peak current < 250 mA (IB2 – D7 = 0) – open load (D5 = 1) Output peak current < 100 mA (IB2 – D7 = 1) – open load (D5 = 1) Output peak current > 500 mA (IB2 – D7 = 0) – normal load (D5 = 0) Output peak current > 300 mA (IB2 – D7 = 1) – normal load (D5 = 0)
D4	Channel 4 Turn-on diagnostic (D4 = 0) Permanent diagnostic (D4 = 1)
D3	Channel 4 Normal load (D3 = 0) Short load (D3 = 1)
D2	Channel 4 Turn-on diag: No open load (D2 = 0) Open load detected (D2 = 1) Offset diag.: No output offset (D2 = 0) Output offset detected (D2 = 1)
D1	Channel 4 No short to V_{CC} (D1 = 0) Short to V_{CC} (D1 = 1)
D0	Channel 4 No short to Gnd (D0 = 0) Short to Gnd (D0 = 1)

Note 12: DBx (D5) is effective only at the time of “Current detection enable”.

Examples of Bytes Sequence

1 - Turn-On Diagnostic - Write Operation

Start	Address byte with D0 = 0	ACK	Sub-address D0 = 1	ACK	IB with D6 = 1	ACK	IB2	ACK	STOP

Note 13: Auto increment

2 - Turn-On Diagnostic - Read Operation

Start	Address byte with D0 = 1	ACK	DB1	ACK	DB2	ACK	DB3	ACK	DB4	ACK	STOP

3a - Turn-On of the Power Amplifier with 26dB Gain, Mute On, Diagnostic Defeat.

Start	Address byte with D0 = 0	ACK	Sub-address D0 = 1	ACK	IB 1	ACK	IB2	ACK	STOP
					X0X0000X		XXX1X0XX		

Note 14: Auto increment

3b - Turn-Off of the Power Amplifier

Start	Address byte with D0 = 0	ACK	Sub-address D0 = 1	ACK	IB 1	ACK	IB2	ACK	STOP
					X0XXXXXX		XXX0XXXX		

Note 15: Auto increment

4 - Offset Detection Procedure Enable

Start	Address byte with D0 = 0	ACK	Sub-address D0 = 1	ACK	IB 1	ACK	IB2	ACK	STOP
					XX1XX11X		XXX1X0XX		

Note 16: Auto increment

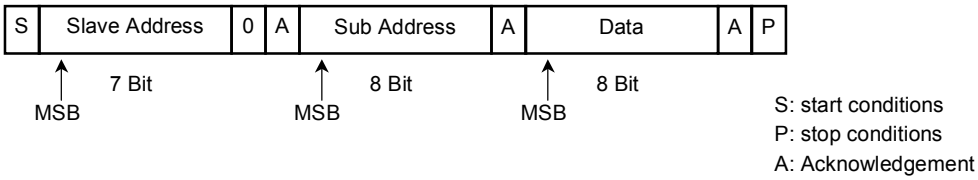
5 - Offset detection procedure stop and reading operation (the results are valid only for the offset detection bits (D2 of the bytes DB1, DB2, DB3, DB4)).

Start	Address byte with D0 = 1	ACK	DB1	ACK	DB2	ACK	DB3	ACK	DB4	ACK	STOP

(6) I²C Bus control format outline

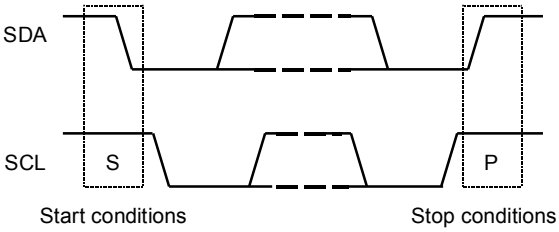
The BUS control format of TB2902H is based on the PHILIPS I²C BUS control format.

Data Transmission Format

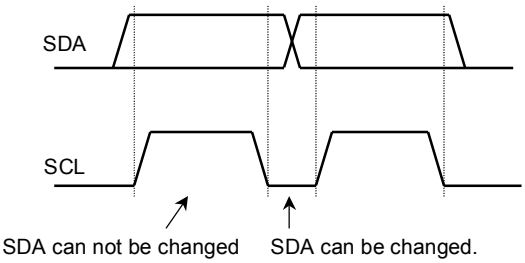


Note 17: It is transmitting, without forgetting. P conditions.

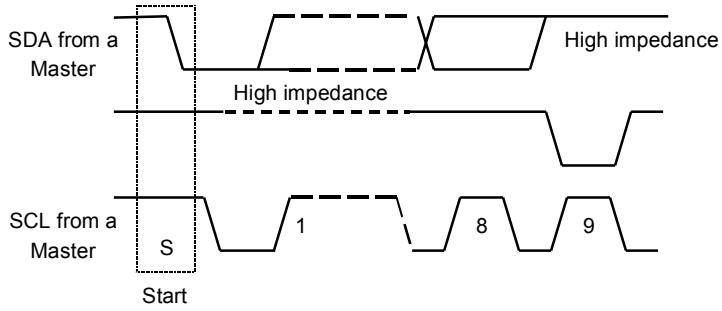
(1) Start conditions&stop conditions



(2) Bit transmission



(3) Acknowledgement



A7	A6	A5	A4	A3	A2	A1	A0 R/$\overline{W}$
1	1	0	1	1	0	0	X

Purchase of TOSHIBA I²C components conveys a license under the Philips I²C Patent Rights to use these components in an I²C system, provided that the system conforms to the I²C Standard Specification as defined by Philips.

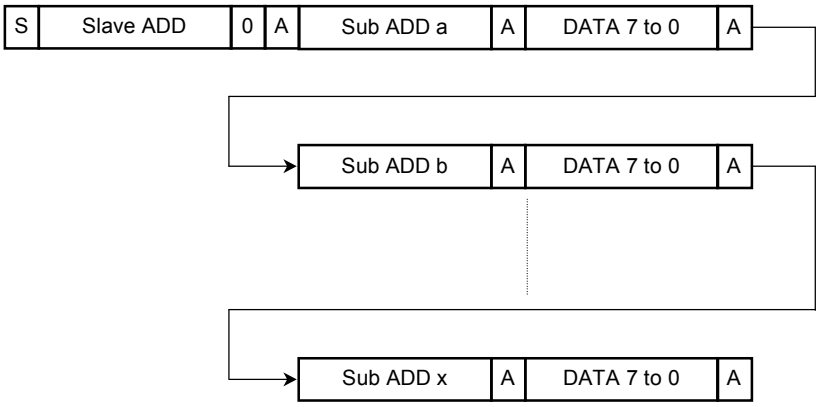
TB2902H I²C Bus Transmission Format

(1) Write mode

In addition to usual transmission, it corresponds to continuation transmission and the auto increment mode as a transmission format. After a transmission end, in case data transmission is newly, it is necessary to open the term beyond 1 V.

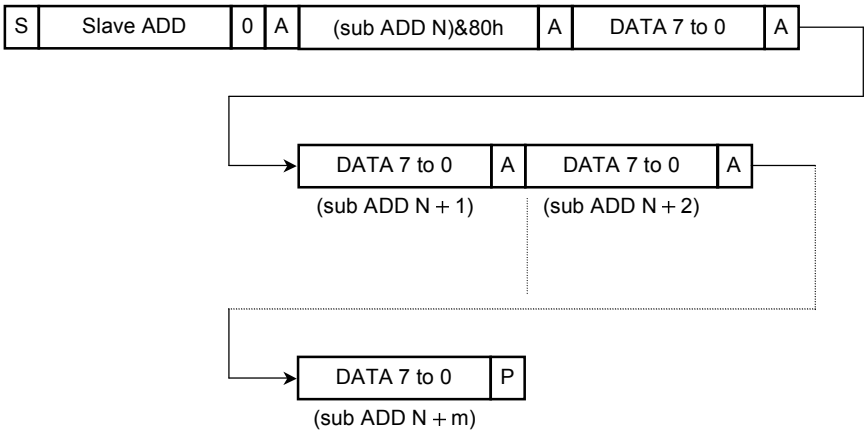
1) Continuation transmission

(An address to change is specified. At this time, MSB of a sub-address is set as 0.)



2) Auto increment

(Sub address are set to increment from N one by one. MSB of a sub-address is set as 1.)



(2) Read mode

The slave address became the read mode by changing the 8 Bit of the slave address from 0 to 1.

The data output from TB2902H starts after the micro controller receives the ACK 1 bit which follows a slave address.

Stop condition are shown in the under the map.

The micro controller shall send the stop condition P after it sent the reversed Acknowledge (high) in case of the read mode finished.

The data transmission became not available condition if the micro controller intended to send the stop condition P expect for this procedure because this IC occupies the data bus until the micro controller send the start conditions again.

.....send a DATA from Micro controller.

.....send a DATA from TB2902H.

Maximum Ratings (Ta = 25°C)

Characteristics	Symbol	Rating	Unit
Peak supply voltage (0.2 s)	$V_{CC\ (surge)}$	50	V
DC supply voltage	$V_{CC\ (DC)}$	25	V
Operation supply voltage	$V_{CC\ (opr)}$	18	V
Output current (peak)	$I_{O\ (peak)}$	9	A
Power dissipation	P_D (Note 18)	125	W
Operation temperature	T_{opr}	−40 to 85	°C
Storage temperature	T_{stg}	−55 to 150	°C

Note 18: Package thermal resistance $\theta_{j\text{-}T}$ = 1°C/W (typ.) (Ta = 25°C, with infinite heat sink)

The absolute maximum ratings of a semiconductor device are a set of specified parameter values, which must not be exceeded during operation, even for an instant. If any of these rating would be exceeded during operation, the device electrical characteristics may be irreparably altered and the reliability and lifetime of the device can no longer be guaranteed. Moreover, these operations with exceeded ratings may cause break down, damage and/or degradation to any other equipment. Applications using the device should be designed such that each maximum rating will never be exceeded in any operating conditions. Before using, creating and/or producing designs, refer to and comply with the precautions and conditions set forth in this documents.

Electrical Characteristics
(unless otherwise specified, V_{CC} = 13.2 V, f = 1 kHz, R_L = 4 Ω, Ta = 25°C)

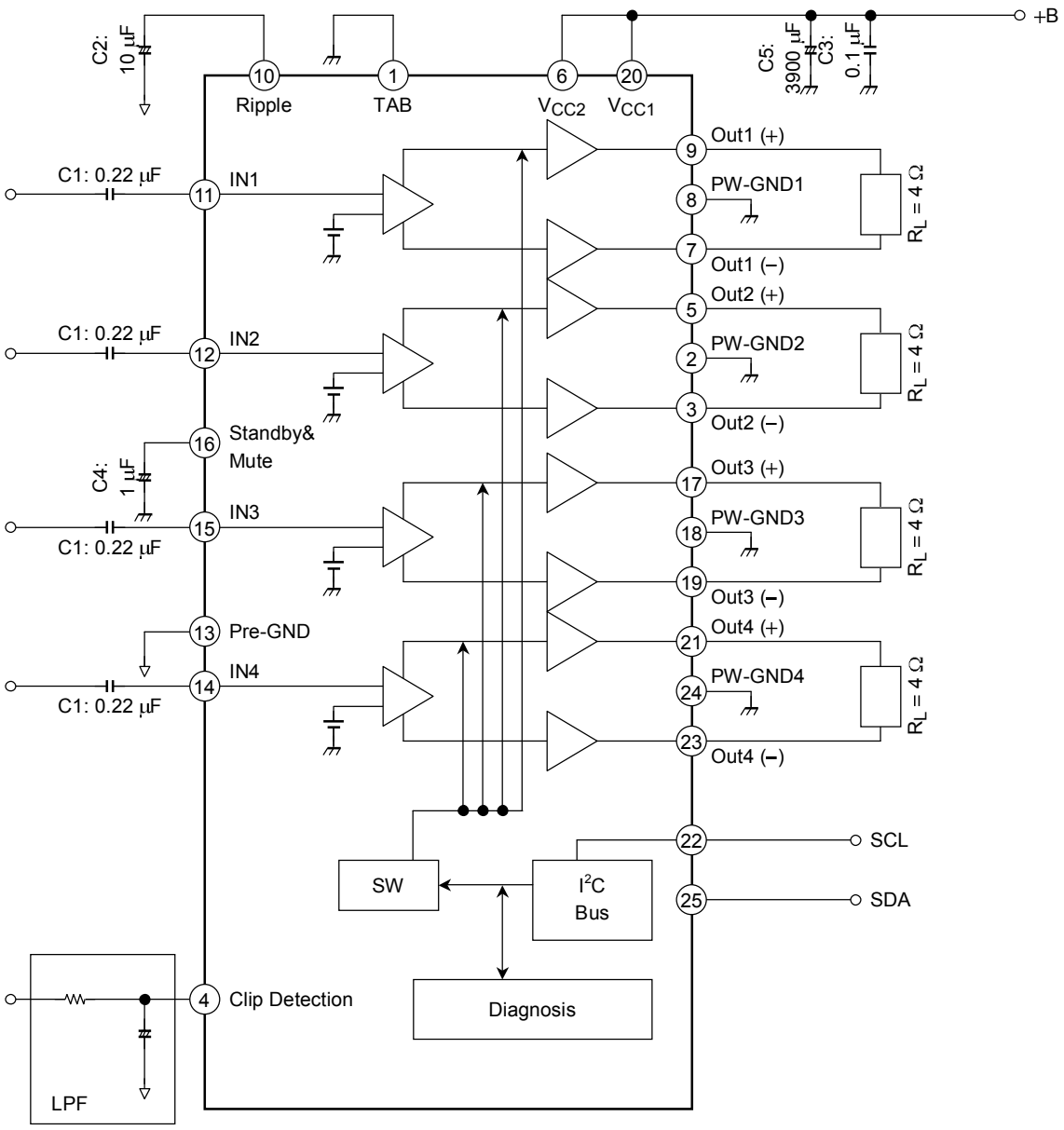
Characteristics	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Quiescent current	I_{CCQ}	—	V_{IN} = 0	—	200	300	mA
Output power	P_{OUT} MAX (1)	—	V_{CC} = 14.4 V, max POWER	—	41	—	W
	P_{OUT} MAX (2)	—	V_{CC} = 13.7 V, max POWER	—	37	—	
	P_{OUT} (1)	—	V_{CC} = 14.4 V, THD = 10%	24	27	—	
	P_{OUT} (2)	—	THD = 10%	—	23	—	
Output power (R_L = 2 Ω)	P_{OUT} MAX (3)	—	V_{CC} = 14.4 V, max POWER	—	70	—	W
	P_{OUT} MAX (4)	—	V_{CC} = 13.7 V, max POWER	—	64	—	
	P_{OUT} (3)	—	V_{CC} = 14.4 V, THD = 10%	42	45	—	
	P_{OUT} (4)	—	THD = 10%	—	39	—	
Total harmonic distortion	THD (1)	—	P_{OUT} = 5 W	—	0.015	0.1	%
	THD (2)	—	Vo = 2 Vrms, G_V = 12dB	—	0.01	0.1	
Voltage gain	G_V (1)	—	V_{OUT} = 0.775 Vrms	25	26	27	dB
	G_V (2)	—	V_{OUT} = 0.775 Vrms, G_V = 12dB	11	12	13	
Voltage gain ratio	ΔG_V	—	V_{OUT} = 0.775 Vrms	−1	0	1	dB
Output noise voltage	Vno (1)	—	R_g = 0 Ω, DIN45405	—	100	—	μVrms
	Vno (2)	—	R_g = 0 Ω, BW = 20 Hz to 20 kHz	—	90	200	
	Vno (3)	—	R_g = 0 Ω, BW = 20 Hz to 20 kHz G_V = 12dB	—	30	50	
Ripple rejection ratio	R.R.	—	fripple = 100 Hz, R_g = 620 Ω Vrip = 0.775 Vrms	40	50	—	dB
Cross talk	C.T.	—	R_g = 620 Ω V_{OUT} = 0.775 Vrms	—	65	—	dB
Output offset voltage	VOFFSET	—	—	−150	0	150	mV
Input resistance	RIN	—	—	—	90	—	kΩ
Standby current	ISB	—	Stand-by condition by pin 16	—	30	60	μA
Stand by&mute control voltage	VSM H	—	For operation, mute enable	7.0	—	V_{CC}	V
	VSM L	—	For mute, stand by OFF	0	—	5.0	
Mute attenuation	ATT M	—	Mute: ON V_{OUT} = 7.75 Vrms → Mute: OFF	80	90	—	dB
Clip det THD level	CD (1)	—	Low (01H D = 0)	—	1	2.5	%
	CD (2)	—	High (01H D = 1)	5	10	15	

Note 19: ISB specification will be decided to after final evaluation on tolerance spls.

Diagnosis/Bus Specification

Characteristics	Test Condition	Min	Typ.	Max	Unit
Turn on diagnosis (power amplifier mode)					
Short to GND det.	Under stand-by condition	—	—	1.2	V
Short to V_{CC} det.		V_{CC} – 1.2	—	—	V
Shorted load		—	—	0.5	Ω
Open load		85	—	—	Ω
Normal load		1.5	—	45	Ω
Turn on diagnosis (line driver mode)					
Short to GND det.	Under stand-by condition	—	—	1.2	V
Short to V_{CC} det.		V_{CC} – 1.2	—	—	V
Shorted load		—	—	2	Ω
Open load		330	—	—	Ω
Normal load		6	—	180	Ω
Permanent diagnosis (power amplifier and line driver mode)					
Short to GND det.	Power amplifier in mute or play	—	—	1.2	V
Short to V_{CC} det.		V_{CC} – 1.2	—	—	V
Shorted load	Power amp mode only	—	0.5	—	Ω
Offset detection	Power amplifier in play (no signal)	—	+/–2	—	V
Current detector threshold 1		250		500	mA
Current detector threshold 2		100		300	mA
I^2C bus interface					
Clock frequency		—	400	—	kHz

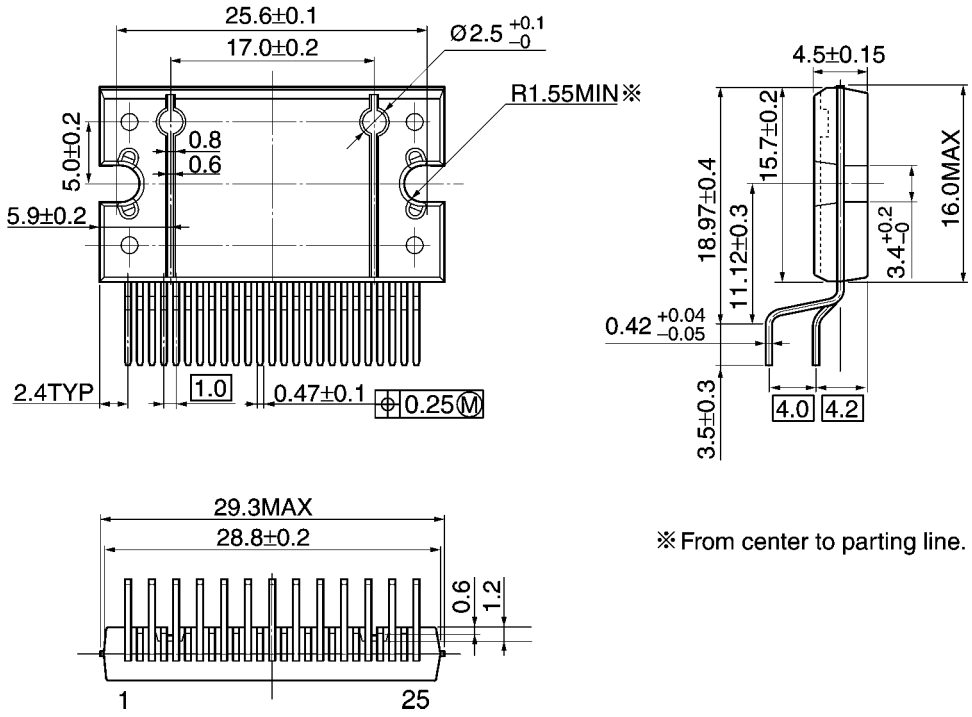
Test Circuit



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

Package Dimensions

HZIP25-P-1.00F Unit: mm



※ From center to parting line.

Weight: 7.7 g (typ.)

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