HDL6M05586

OCTAL ±100V 1.6A 5-LEVEL ULTRASOUND PULSER

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Rev.1.0_01

The ABLIC Inc. HDL6M05586 is an octal, 5-level RTZ, high-voltage, high-speed ultrasound pulser.
The HDL6M05586 comprises logic interfaces, level translators, MOSFET gate drive buffers with floating voltage regulators, high-voltage, high-current MOSFETs, and active T/R switches.

Functions

- Octal 5-level pulser with active T/R switch with 3-input per channel

Features

- 0 to ±100V output voltage
- ±1.6A source and sink peak current for the 1st and 2nd high-voltage pulses ($V_{PP}1/V_{NN}1$,$V_{PP}2/V_{NN}2$)
- ±1.6A source and sink peak current for active ground clamp
- 250Ω (±0.1A) active ground clamp without blocking diode for anti-leakage (Analog SW type)
- Embedded floating voltage regulators
- Symmetrical positive and negative pulse waveforms for low 2nd order harmonic distortion
- Up to 200MHz LVDS/LVCMOS clock (transparent mode available)
- 12Ω active T/R switch with 2-bit turn-on timing control
- 20MHz output frequency @±60V output, 220pF load
- 1.8V to 5V CMOS logic interface
- Noise-cut diodes at each high-voltage output
- Embedded high-voltage clamp diodes
- 4-mode output current control for the 2nd high-voltage rail
- Automatic thermal protection with indicator
- Power-up/down reset function for free power sequencing and for fail-safe in abrupt power drop
- Latch-up free, low crosstalk between channels by SOI CMOS technology
- 84-lead 10x10mm QFN package (RoHS compliant)

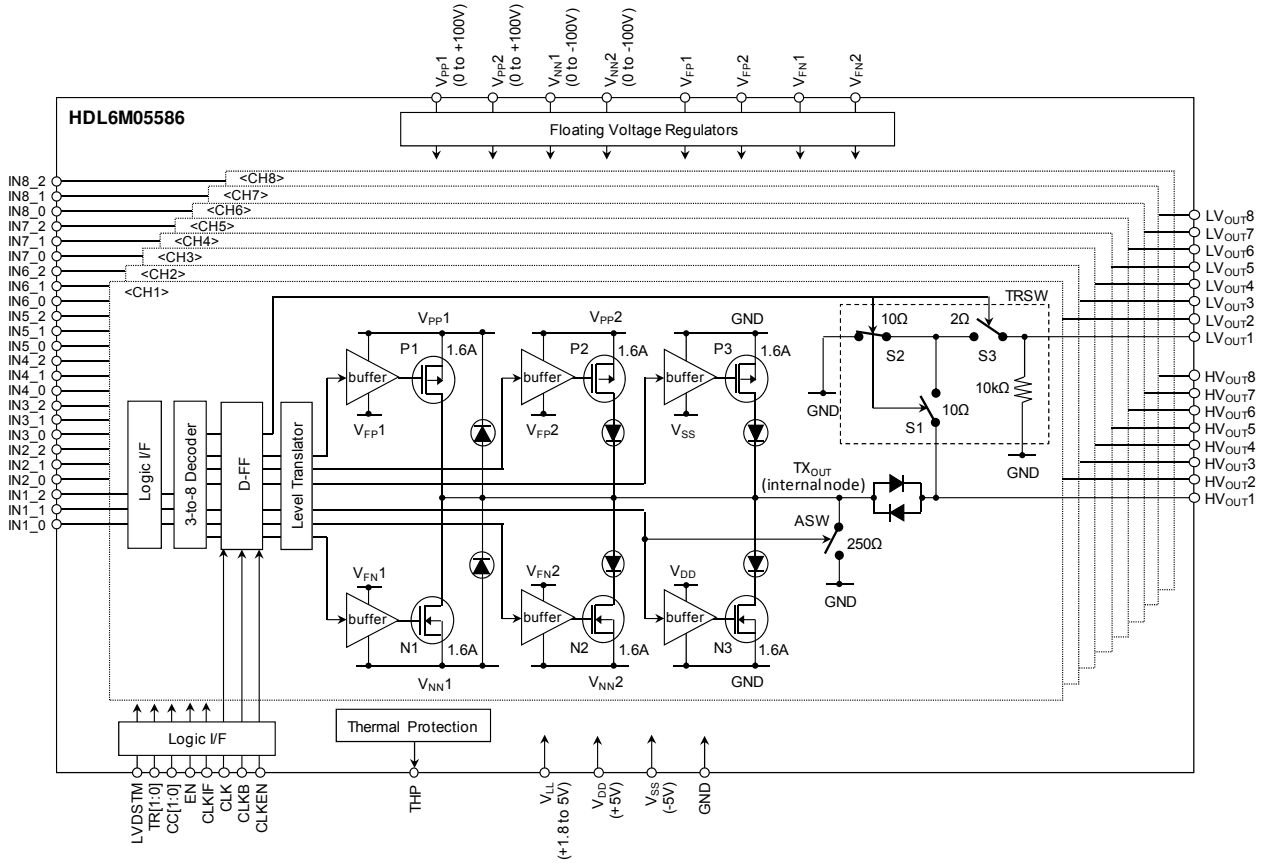


Fig.1 Block diagram

1. Absolute Maximum Ratings

T_A=25°C unless otherwise noted.

Table 1 Absolute Maximum Ratings

No.	Items	Symbol	Value	Units	Condition
1	Logic supply voltage	V_{LL}	-0.4 to +7	V	
2	Positive supply voltage	V_{DD}	-0.4 to +7	V	
3	Negative supply voltage	V_{SS}	-7 to +0.4	V	
4	Positive high-voltage supplies	$V_{PP}1$, $V_{PP}2$	-0.5 to +105	V	
5	Negative high-voltage supplies	$V_{NN}1$, $V_{NN}2$	-105 to +0.5	V	
6	Positive high-voltage difference	($V_{PP}1$-$V_{PP}2$)	-0.5 to +105	V	INx_[2:0]='001'
			-105 to +105	V	Other than above
7	Negative high-voltage difference	($V_{NN}1$-$V_{NN}2$)	-105 to +0.5	V	INx_[2:0]='101'
			-105 to +105	V	Other than above
8	High-voltage outputs (x=1~8)	$HV_{OUT}x$	-105 to +105	V	
9	Low-voltage outputs (x=1~8)	$LV_{OUT}x$	-1 to +1	V	
10	THP (Thermal Protection) output	THP	-0.4 to +7	V	
11	All Logic input voltages (x=1~8)	INx_[2:0], EN, CLKEN, CLK, CLKB, CLKIF, CC[1:0], TR[1:0], LVDSTM	-0.4 to +7	V	
12	Operating junction temperature	T_{Jop}	-20 to +150	°C	
13	Operating free-air Temperature	T_A	0 to +75	°C	
14	Storage temperature	T_{STG}	-55 to +150	°C	
15	Maximum power dissipation	P_{Dmax}	4	W	

NOTE: Stresses beyond the absolute maximum ratings may cause permanent damage to the product.

2. Operating Supply Voltages, Logic Inputs, and Power sequencing

2.1 Operating Supply Voltages

Table 2 Operating Supply Voltages

No	Items	Symbol	Min	Typ	Max	Units	Condition
1	Logic supply voltage	V_{LL}	2.4	2.5 to 3.3	3.6	V	Clock mode
			1.7	1.8 to 5	V_{DD}	V	Transparent mode
2	Positive supply voltage	V_{DD}	4.75	5	5.25	V	
3	Negative supply voltage	V_{SS}	-5.25	-5	-4.75	V	
4	Positive high-voltage supplies	$V_{PP}1$, $V_{PP}2$	0	-	100	V	
5	Negative high-voltage supplies	$V_{NN}1$, $V_{NN}2$	-100	-	0	V	
6	Positive high-voltage difference	($V_{PP}1$-$V_{PP}2$)	0	-	100	V	
7	Negative high-voltage difference	($V_{NN}1$-$V_{NN}2$)	-100	-	0	V	
8	IC substrate voltage *	V_{SUB}	-	0	-	V	
9	$V_{PP}x$, $V_{NN}x$ slew rate (x=1,2)	SR_{MAX}	-	-	25	V/ms	

NOTE: * The package exposed pad internally connected to the chip substrate must be soldered to the ground.

2.2 Logic Inputs

Clock (CLK) mode synchronizes data inputs INx_[2:0] (x=1~8) with a differential LVDS/CMOS clock. Transparent (TP) mode without using clock is also available.

CLK mode:

Set CLKEN=0. INx_[2:0] are decoded, clocked, level-translated, then sent to high-voltage output stage.

Differential clock input has two modes as shown below.

- LVDS CLK mode: Set CLKIF=0. See Table 3 and 4 for the logic inputs, CLK, and CLKB.
- CMOS CLK mode: Set CLKIF=1. See Table 3 for all the logic inputs.

TP mode:

Set CLKEN=CLKIF=1, CLK=CLKB=0. INx_[2:0] are decoded, level-translated, then sent to high-voltage output stage. See Table 3 for all the logic inputs.

Table 3 Logic Inputs

No	Items	Symbol	Min	Typ	Max	Units	Condition	
1	High-level logic input voltage	V_{IH}	$0.8V_{LL}$	-	V_{LL}	V		
2	Low-level logic input voltage	V_{IL}	0	-	$0.2V_{LL}$	V		
3	Logic input capacitance	C_{IN}	-	3	-	pF		
4	Logic input high current *1	I_{IH}	-10	-	10	μA		
5	Logic input low current *2	I_{IL}	-10	-	10	μA		
6	Input rise/fall time	t_r, t_f	-	-	800	ps	CLK≥100MHz	CMOS CLK mode 10~90% CLK, CLKB, INx_[2:0]
			-	-	2.0	ns	CLK<100MHz	
7	Input clock frequency	f_{CLK}	-	-	200	MHz	CMOS CLK mode, CLK, CLKB, f_{CLK}=1/T, D_{CLK}=τ/T, See Fig.3	
8	Clock duty cycle	D_{CLK}	40	50	60	%		
9	Data setup time	t_{SU}	1.4	-	-	ns	CLK mode INx_[2:0] to CLK/CLKB, See Fig.3	
10	Data hold time	t_{HLD}	1.4	-	-	ns		

NOTE:

*1) TR[1:0] and LVDSTM have 50μA leakage at V_{LL}=2.5V due to 50kΩ internal pull-down resistor.

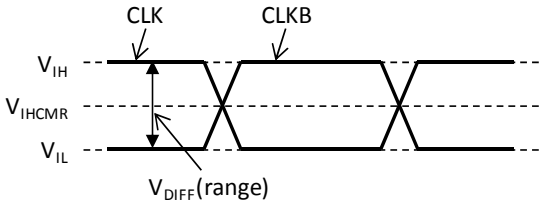
*2) EN, CC[1:0], CLKEN, and CLKIF have 50μA leakage at V_{LL}=2.5V due to 50kΩ internal pull-up resistor.

Table 4 LVDS Clock Inputs (CLK, CLKB)

No	Items	Symbol	Min	Typ	Max	Units	Condition
1	High-level input voltage	V_{IH}	1.265	-	-	V	V_{IHCMR}(Typ)+V_{DIFF}(Min)/2
2	Low-level input voltage	V_{IL}	-	-	1.135	V	V_{IHCMR}(Typ)-V_{DIFF}(Min)/2
3	Differential input voltage range	$V_{DIFF(range)}$	0.13	0.35	0.49	±V	same as CLK,CLKB voltage swing See Fig.2
4	Differential input voltage peak to peak swing	$V_{DIFF(p-p)}$	0.26	0.7	0.98	V_{pp}	|CLK-CLKB| differential peak-to-peak voltage swing, See Fig.2
5	Input voltage common mode range	V_{IHCMR}	0.84	1.2	1.56	V	
6	Differential input impedance	R_{IN}	85	100	115	Ω	LVDSTM=1
7	High-level input current	I_{IH}	-	-	5.8	mA	
8	Low-level input current	I_{IL}	-	-	5.8	mA	
9	Input rise/fall time	t_r, t_f	-	-	600	ps	20% to 80% of V_{DIFF}
10	Input clock frequency	f_{CLK}	-	-	200	MHz	LVDS CLK mode, CLK, CLKB, f_{CLK}=1/T, D_{CLK}=τ/T, See Fig.3
11	Clock duty cycle	D_{CLK}	40	50	60	%	

NOTE: Please refer to table 3 for the logic inputs other than CLK, CLKB in LVDS CLK mode.

Differential input voltage range (V_{DIFF}(range))



Differential input voltage peak to peak swing (V_{DIFF}(p-p))

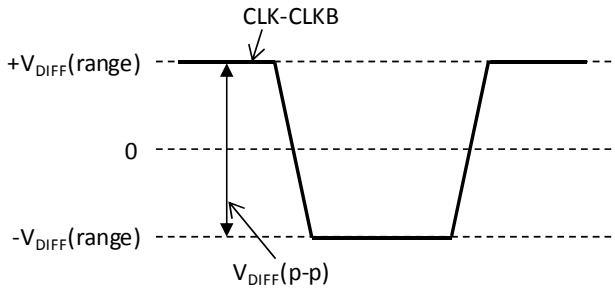


Fig.2 LVDS clock inputs

LVDS/CMOS CLK mode (CLKEN=0)

TP mode (CLKEN=1)

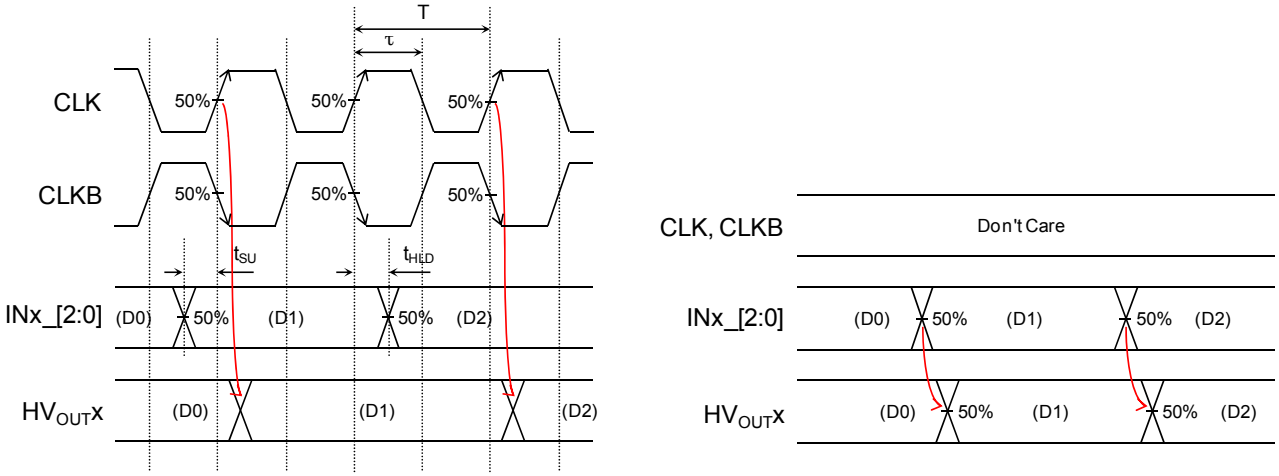


Fig.3 Setup/Hold Time

2.3 Power Supply Sequencing

Embedded low-voltage (LV) power-up/down reset function provides free power supply sequencing.

It also provides fail-safe system in abrupt LV power supply drop.

When any one of LV power supplies is turned off during operation, all internal circuits will be immediately reset, and both inputs and outputs will be disabled.

Once all LV power supplies are restored, both inputs and outpus will be enabled.

3. Typical Application Circuit

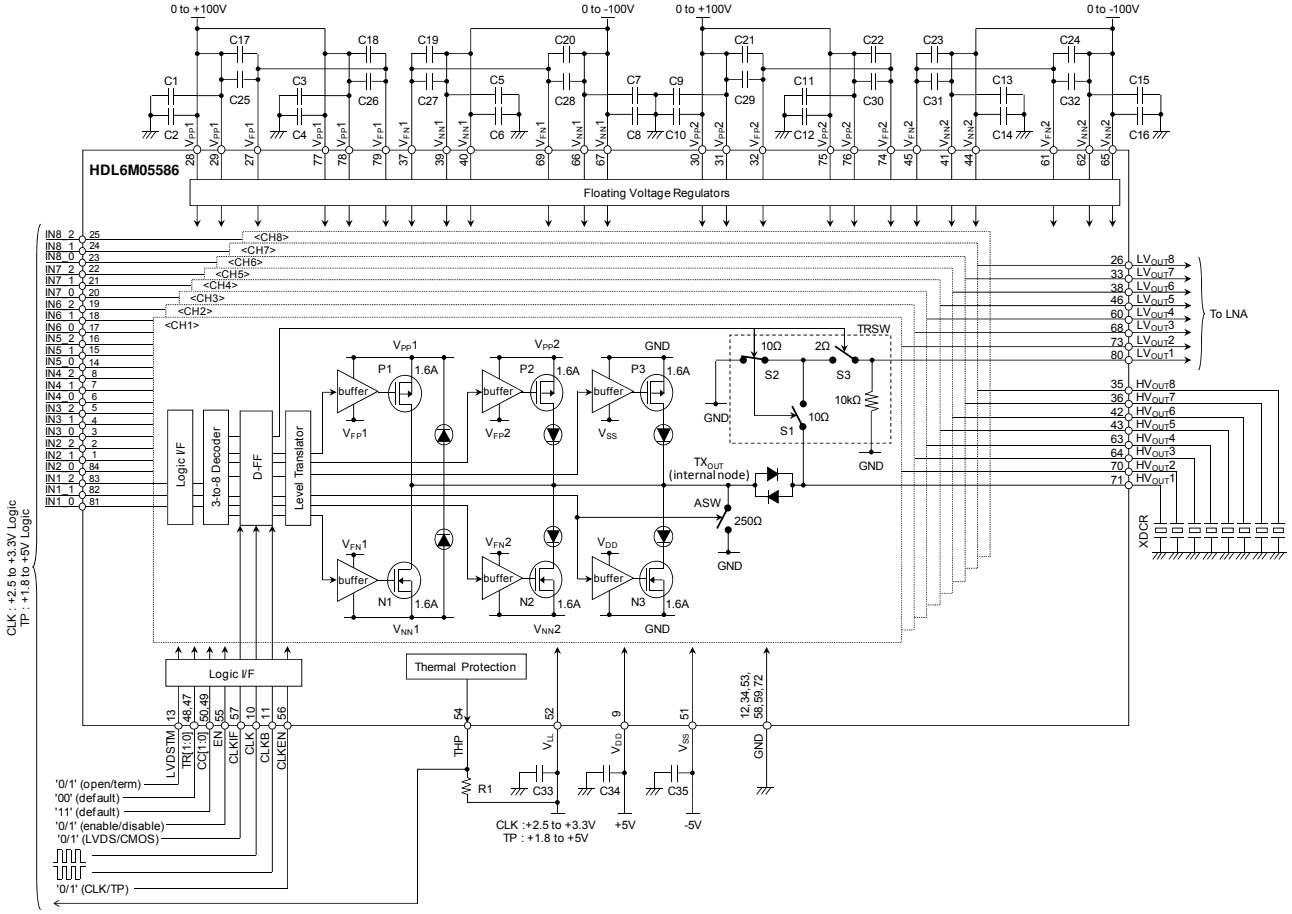


Fig.4 Typical Application Circuit

Note:

1. High-voltage power supply pins, $V_{PP}x/V_{NN}x$ (x=1,2), can draw fast transient currents up to ±1.6A. Therefore, ceramic capacitors of ≥200V 0.1µF to 1µF (C1~16) should be connected as close to the pins as possible for bypassing purpose.
2. Ceramic capacitors of ≥16V 10µF (C17~24), ≥16V 100nF (C25~32), and ≥16V 0.1µF to 1µF (C33~35) should also be connected between high-voltage power supply pins and corresponding floating voltage pins $V_{FP}x/V_{FN}x$ (x=1,2), and low-voltage power supply pins for bypassing purpose. Connect those as close to the pins as possible.
3. It is also important to minimize the trace length and to have enough trace width of those high voltage and floating voltage lines.
4. The thermal tab on the bottom of the package must be soldered to the GND.

4. Electrical Characteristics

4.1 Operating Supply Currents

Table 5 Operating Supply Currents

V_{LL}=2.5V, V_{DD}/V_{SS}=+/-5V, T_A=25°C, CLK=CLKB=100MHz/0(CLKEN=0/1), TR[1:0]='00',
HV_{OUT} load=220pF//200Ω, LV_{OUT} load=47pF//200Ω, unless otherwise specified.

No.	Items		Symbol	Spec			Units	Conditions
				Min	Typ	Max		
1	V_{LL} current	TP	I_{LLQD}	-	0.03	-	mA	Quiescent current-1 EN=1(Disable) INx_[2:0]='000' Current mode 3 (CC[1:0]='11') $V_{PP}1/V_{NN}1$=+/-100V $V_{PP}2/V_{NN}2$=+/-100V
		LVDS CLK		-	0.13	-	mA	
		CMOS CLK		-	0.08	-	mA	
2	V_{DD} current	TP	I_{DDQD}	-	3.3	-	mA	
		LVDS CLK		-	3.3	-	mA	
		CMOS CLK		-	3.3	-	mA	
3	V_{SS} current		I_{SSQD}	-	1.0	-	mA	
4	$V_{PP}1$ current		I_{PP1QD}	-	0.03	-	mA	
5	$V_{NN}1$ current		I_{NN1QD}	-	0.03	-	mA	
6	$V_{PP}2$ current		I_{PP2QD}	-	0.05	-	mA	
7	$V_{NN}2$ current		I_{NN2QD}	-	0.05	-	mA	
8	V_{LL} current	TP	I_{LLQE}	-	0.08	-	mA	Quiescent current-2 EN=0(Enable) INx_[2:0]='000' Current mode 3 (CC[1:0]='11') $V_{PP}1/V_{NN}1$=+/-100V $V_{PP}2/V_{NN}2$=+/-100V
		LVDS CLK		-	0.18	-	mA	
		CMOS CLK		-	0.13	-	mA	
9	V_{DD} current	TP	I_{DDQE}	-	4.2	-	mA	
		LVDS CLK		-	29	-	mA	
		CMOS CLK		-	27	-	mA	
10	V_{SS} current		I_{SSQE}	-	1.6	-	mA	
11	$V_{PP}1$ current		I_{PP1QE}	-	0.15	-	mA	
12	$V_{NN}1$ current		I_{NN1QE}	-	0.15	-	mA	
13	$V_{PP}2$ current		I_{PP2QE}	-	0.17	-	mA	
14	$V_{NN}2$ current		I_{NN2QE}	-	0.17	-	mA	
15	V_{LL} current	TP	I_{LLPW}	-	0.18	-	mA	PW operating current EN=0 Current mode 3 (CC[1:0]='11') 8-channel active Bipolar 3-level 2-cycle P1/N1-drive f=5MHz, PRT=200µs $V_{PP}1/V_{NN}1$=+/-60V $V_{PP}2/V_{NN}2$=+/-60V
		LVDS CLK		-	0.18	-	mA	
		CMOS CLK		-	0.13	-	mA	
16	V_{DD} current	TP	I_{DDPW}	-	11	-	mA	
		LVDS CLK		-	37	-	mA	
		CMOS CLK		-	35	-	mA	
17	V_{SS} current		I_{SSPW}	-	10	-	mA	
18	$V_{PP}1$ current		I_{PP1PW}	-	4.0	-	mA	
19	$V_{NN}1$ current		I_{NN1PW}	-	4.6	-	mA	
20	$V_{PP}2$ current		I_{PP2PW}	-	0.17	-	mA	
21	$V_{NN}2$ current		I_{NN2PW}	-	0.17	-	mA	

Table 5 Operating Supply Currents (continued)

No.	Items		Symbol	Spec			Units	Conditions
				Min	Typ	Max		
22	V_{LL} current	TP	I_{LLCW3}	-	0.43	-	mA	CW operating current-1 EN=0 Current mode 3 (CC[1:0]='11') 8-channel active Bipolar 3-level Continuous P2/N2-drive f=5MHz $V_{PP}1/V_{NN}1$=+/-5V $V_{PP}2/V_{NN}2$=+/-5V
		LVDS CLK		-	0.53	-	mA	
		CMOS CLK		-	0.48	-	mA	
23	V_{DD} current	TP	I_{DDCW3}	-	39	-	mA	
		LVDS CLK		-	60	-	mA	
		CMOS CLK		-	58	-	mA	
24	V_{SS} current		I_{SSCW3}	-	26	-	mA	
25	$V_{PP}1$ current		I_{PP1CW3}	-	0.15	-	mA	
26	$V_{NN}1$ current		I_{NN1CW3}	-	0.15	-	mA	
27	$V_{PP}2$ current		I_{PP2CW3}	-	171	-	mA	
28	$V_{NN}2$ current		I_{NN2CW3}	-	173	-	mA	
29	V_{LL} current	TP	I_{LLCW2}	-	0.48	-	mA	CW operating current-2 EN=0 Current mode 2 (CC[1:0]='10') 8-channel active Bipolar 3-level Continuous P2/N2-drive f=5MHz $V_{PP}1/V_{NN}1$=+/-5V $V_{PP}2/V_{NN}2$=+/-5V
		LVDS CLK		-	0.58	-	mA	
		CMOS CLK		-	0.53	-	mA	
30	V_{DD} current	TP	I_{DDCW2}	-	35	-	mA	
		LVDS CLK		-	57	-	mA	
		CMOS CLK		-	55	-	mA	
31	V_{SS} current		I_{SSCW2}	-	23	-	mA	
32	$V_{PP}1$ current		I_{PP1CW2}	-	0.15	-	mA	
33	$V_{NN}1$ current		I_{NN1CW2}	-	0.15	-	mA	
34	$V_{PP}2$ current		I_{PP2CW2}	-	164	-	mA	
35	$V_{NN}2$ current		I_{NN2CW2}	-	166	-	mA	
36	V_{LL} current	TP	I_{LLCW1}	-	0.48	-	mA	CW operating current-3 EN=0 Current mode 1 (CC[1:0]='01') 8-channel active Bipolar 3-level Continuous P2/N2-drive f=5MHz $V_{PP}1/V_{NN}1$=+/-5V $V_{PP}2/V_{NN}2$=+/-5V
		LVDS CLK		-	0.58	-	mA	
		CMOS CLK		-	0.53	-	mA	
37	V_{DD} current	TP	I_{DDCW1}	-	31	-	mA	
		LVDS CLK		-	53	-	mA	
		CMOS CLK		-	51	-	mA	
38	V_{SS} current		I_{SSCW1}	-	19	-	mA	
39	$V_{PP}1$ current		I_{PP1CW1}	-	0.15	-	mA	
40	$V_{NN}1$ current		I_{NN1CW1}	-	0.15	-	mA	
41	$V_{PP}2$ current		I_{PP2CW1}	-	153	-	mA	
42	$V_{NN}2$ current		I_{NN2CW1}	-	155	-	mA	
43	V_{LL} current	TP	I_{LLCW0}	-	0.53	-	mA	CW operating current-4 EN=0 Current mode 0 (CC[1:0]='00') 8-channel active Bipolar 3-level Continuous P2/N2-drive f=5MHz $V_{PP}1/V_{NN}1$=+/-5V $V_{PP}2/V_{NN}2$=+/-5V
		LVDS CLK		-	0.63	-	mA	
		CMOS CLK		-	0.58	-	mA	
44	V_{DD} current	TP	I_{DDCW0}	-	26	-	mA	
		LVDS CLK		-	48	-	mA	
		CMOS CLK		-	46	-	mA	
45	V_{SS} current		I_{SSCW0}	-	15	-	mA	
46	$V_{PP}1$ current		I_{PP1CW0}	-	0.15	-	mA	
47	$V_{NN}1$ current		I_{NN1CW0}	-	0.15	-	mA	
48	$V_{PP}2$ current		I_{PP2CW0}	-	131	-	mA	
49	$V_{NN}2$ current		I_{NN2CW0}	-	133	-	mA	

4.2 Static Characteristics

Table 6 Static Characteristics

V_{LL}=2.5V, V_{DD}/V_{SS}=+/-5V, T_A=25°C, unless otherwise specified.

No.	Items	Symbol	Spec			Units	Conditions
			Min	Typ	Max		
1	$HV_{OUT}x$ output voltage range	$HV_{OUT}x$	-100	-	+100	V	
2	$HV_{OUT}x$ high-side peak current	I_{OH}	-	1.6	-	A	P1 active, $V_{PP}1/V_{NN}1=V_{PP}2/V_{NN}2$=+/-60V
			-	1.6	-	A	P2 active, $V_{PP}1/V_{NN}1=V_{PP}2/V_{NN}2$=+/-60V Current mode 3 (CC[1:0]='11')
			-	1.28	-	A	P2 active, $V_{PP}1/V_{NN}1=V_{PP}2/V_{NN}2$=+/-60V Current mode 2 (CC[1:0]='10')
			-	0.96	-	A	P2 active, $V_{PP}1/V_{NN}1=V_{PP}2/V_{NN}2$=+/-60V Current mode 1 (CC[1:0]='01')
			-	0.64	-	A	P2 active, $V_{PP}1/V_{NN}1=V_{PP}2/V_{NN}2$=+/-60V Current mode 0 (CC[1:0]='00')
3	$HV_{OUT}x$ high-side GND clamp peak current	I_{OHCL}	-	1.6	-	A	N3 active, $V_{PP}1/V_{NN}1=V_{PP}2/V_{NN}2$=+/-60V
4	$HV_{OUT}x$ low-side peak current	I_{OL}	-	1.6	-	A	N1 active, $V_{PP}1/V_{NN}1=V_{PP}2/V_{NN}2$=+/-60V
			-	1.6	-	A	N2 active, $V_{PP}1/V_{NN}1=V_{PP}2/V_{NN}2$=+/-60V Current mode 3 (CC[1:0]='11')
			-	1.28	-	A	N2 active, $V_{PP}1/V_{NN}1=V_{PP}2/V_{NN}2$=+/-60V Current mode 2 (CC[1:0]='10')
			-	0.96	-	A	N2 active, $V_{PP}1/V_{NN}1=V_{PP}2/V_{NN}2$=+/-60V Current mode 1 (CC[1:0]='01')
			-	0.64	-	A	N2 active, $V_{PP}1/V_{NN}1=V_{PP}2/V_{NN}2$=+/-60V Current mode 0 (CC[1:0]='00')
5	$HV_{OUT}x$ low-side GND clamp peak current	I_{OLCL}	-	1.6	-	A	P3 active, $V_{PP}1/V_{NN}1=V_{PP}2/V_{NN}2$=+/-60V
6	$HV_{OUT}x$ high-side on-resistance	R_{ONH}	-	15	-	Ω	P1 active, I_{OH}=100mA
			-	15	-	Ω	P2 active, I_{OH}=100mA Current mode 3 (CC[1:0]='11')
			-	17	-	Ω	P2 active, I_{OH}=100mA Current mode 2 (CC[1:0]='10')
			-	20	-	Ω	P2 active, I_{OH}=100mA Current mode 1 (CC[1:0]='01')
			-	30	-	Ω	P2 active, I_{OH}=100mA Current mode 0 (CC[1:0]='00')
7	$HV_{OUT}x$ high-side GND clamp on-resistance	R_{ONHCL}	-	15	-	Ω	N3 active, I_{OHCL}=100mA
8	$HV_{OUT}x$ low-side on-resistance	R_{ONL}	-	15	-	Ω	N1 active, I_{OL}=100mA
			-	15	-	Ω	N2 active, I_{OL}=100mA Current mode 3 (CC[1:0]='11')
			-	17	-	Ω	N2 active, I_{OL}=100mA Current mode 2 (CC[1:0]='10')
			-	20	-	Ω	N2 active, I_{OL}=100mA Current mode 1 (CC[1:0]='01')
			-	30	-	Ω	N2 active, I_{OL}=100mA Current mode 0 (CC[1:0]='00')
9	$HV_{OUT}x$ low-side GND clamp on-resistance	R_{ONLCL}	-	15	-	Ω	P3 active, I_{OLCL}=100mA
10	$HV_{OUT}x$ off-capacitance	C_{HVOFF}	-	34	-	pF	$TX_{OUT}x$=GND, TRSW=off

4.3 Dynamic Characteristics

Table 7 Dynamic Characteristics

V_{LL}=2.5V, V_{DD}/V_{SS}=+/-5V, $V_{PP}1/V_{NN}1=V_{PP}2/V_{NN}2$=+/-60V, T_A=25°C, TR[1:0]='00', CC[1:0]='11', CLK=CLKB=100MHz/0(CLKEN=0/1), HV_{OUT} load=220pF//200Ω, LV_{OUT} load=47pF//200Ω, unless otherwise specified.

No.	Items		Symbol	Spec			Units	Conditions	
				Min	Typ	Max			
1	Output frequency		f_{OUT}	-	20	-	MHz		
2	Output rise propagation delay	TP mode	t_{dr}	-	28	-	ns	See Fig.5	
		CLK mode		-	36	-	ns		
3	Output fall propagation delay	TP mode	t_{df}	-	28	-	ns		
		CLK mode		-	36	-	ns		
4	Output rise propagation delay clamp	TP mode	t_{drCL}	-	28	-	ns		
		CLK mode		-	36	-	ns		
5	Output fall propagation delay clamp	TP mode	t_{dfCL}	-	28	-	ns		
		CLK mode		-	36	-	ns		
6	Propagation delay matching		Δt_d	-	±1	±3	ns		
7	Output rise time		t_r	-	19	-	ns	P1 active	See Fig.5
				-	19	-	ns	P2 active, CC[1:0]='11'	
				-	23	-	ns	P2 active, CC[1:0]='10'	
				-	31	-	ns	P2 active, CC[1:0]='01'	
				-	44	-	ns	P2 active, CC[1:0]='00'	
			t_{rCL}	-	10	-	ns	P3 active	
8	Output fall time		t_f	-	19	-	ns	N1 active	
				-	19	-	ns	N2 active, CC[1:0]='11'	
				-	23	-	ns	N2 active, CC[1:0]='10'	
				-	31	-	ns	N2 active, CC[1:0]='01'	
				-	44	-	ns	N2 active, CC[1:0]='00'	
			t_{fCL}	-	10	-	ns	N3 active	
9	2nd harmonic distortion		HD2	-	-40	-	dBc	Bipolar, 2-cyc, f_{OUT}=5MHz See Fig.6	
10	Pulse cancellation		HDPC	-	-40	-	dBc		
			HDPC2	-	-40	-	dBc		
11	RMS output jitter		t_J	-	10	-	ps	Bipolar CW, f_{OUT}=5MHz $V_{PP}1/V_{NN}1= V_{PP}2/V_{NN}2$=+/-5V	
12	Crosstalk between channels		X_{TLK}	-	-70	-	dB	f_{OUT}=5MHz, $10V_{p-p}$, HV_{OUT} load=50Ω	
13	Output enable time	TP	t_{EN}	-	28	-	ns	See Fig.7	
		LVDS CLK		-	115	-	ns		
		CMOS CLK		-	140	-	ns		
14	Output disable time		t_{DS}	-	36	-	ns		
15	Clock mode enable time		t_{CLKEN}	-	36	-	ns		
16	Clock mode disable time		t_{CLKDS}	-	36	-	ns		

4.4 Integrated Peripheral Circuits Characteristics

T/R Switch

Table 8 T/R Switch Characteristics

V_{LL}=2.5V, V_{DD}/V_{SS}=+/-5V, $V_{PP}1/V_{NN}1=V_{PP}2/V_{NN}2$=+/-60V, T_A=25°C, unless otherwise specified.

No.	Items		Symbol	Spec			Units	Conditions
				Min	Typ	Max		
1	$LV_{OUT}x$ output voltage range		$LV_{OUT}x$	-0.85	-	0.85	V	
2	TRSW on-resistance		R_{ONTR}	-	12	-	Ω	$HV_{OUT}x$=100mV, $LV_{OUT}x$=0V
3	TRSW on-capacitance		C_{ONTR}	-	13	-	pF	$LV_{OUT}x$=0V
4	TRSW off-resistance on HVOUTx		$R_{OFFTRHV}$	1	-	-	MΩ	
5	TRSW off-resistance on LVOUTx		$R_{OFFTRLV}$	8	10	12	kΩ	
6	Spike voltage on $HV_{OUT}x$ and $LV_{OUT}x$		V_{TRN}	-	-	50	mV_{PP}	50pF//200Ω load on $HV_{OUT}x$ 20pF//200Ω load on $LV_{OUT}x$
7	TRSW turn-on time	TR[1:0]='00'	t_{dTRON}	-	300	-	ns	Logic input-to-ready for Rx signal See Fig.8
		TR[1:0]='01'		-	400	-	ns	
		TR[1:0]='10'		-	500	-	ns	
		TR[1:0]='11'		-	600	-	ns	
8	TRSW turn-off time		t_{dTROFF}	-	50	100	ns	See Fig.8
9	Tx setup time		t_{TXSU}	100	-	-	ns	INx_[2:0]='100'(GND) for at least 100ns before Tx burst. See Fig.8

Analog Switch

Table 9 Analog Switch Characteristics

T_A=25°C

No.	Items	Symbol	Spec			Units	Conditions
			Min	Typ	Max		
1	ASW on-resistance	R_{ONASW}	-	250	-	Ω	

HV Blocking Diode

Table 10 Output HV Blocking Diode Characteristics

T_A=25°C

No.	Items	Symbol	Spec			Units	Conditions
			Min	Typ	Max		
1	Forward voltage	V_{FHVD}	-	1.0	-	V	I_F=100mA
			-	1.2	-	V	I_F=200mA
2	Reverse voltage	V_{RHVD}	200	-	-	V	I_R=1μA

LV Noise-cut Diode

Table 11 Output LV Noise-cut Diode Characteristics

T_A=25°C

No.	Items	Symbol	Spec			Units	Conditions
			Min	Typ	Max		
1	Forward voltage	V_{FLVD}	-	1.1	-	V	I_F=100mA
			-	1.25	-	V	I_F=200mA

Thermal Protection

Table 12 Thermal Protection Characteristics

V_{LL}=2.5V, V_{DD}/V_{SS}=+/-5V, T_A=25°C, unless otherwise specified.

No.	Items	Symbol	Spec			Units	Conditions
			Min	Typ	Max		
1	THP pull-up voltage	V_{PUTHP}	-	-	5.25	V	Open drain
2	THP output current	I_{THP}	-	1.0	-	mA	-
3	THP output low voltage	V_{OLTHP}	-	-	0.5	V	THP active, V_{LL}=2.5V, I_{THP}=1mA
4	THP temperature threshold	T_{THP}	90	110	130	ºC	
5	THP reset hysteresis	T_{HYSTHP}	-	10	-	ºC	

5. Switching Time Diagram

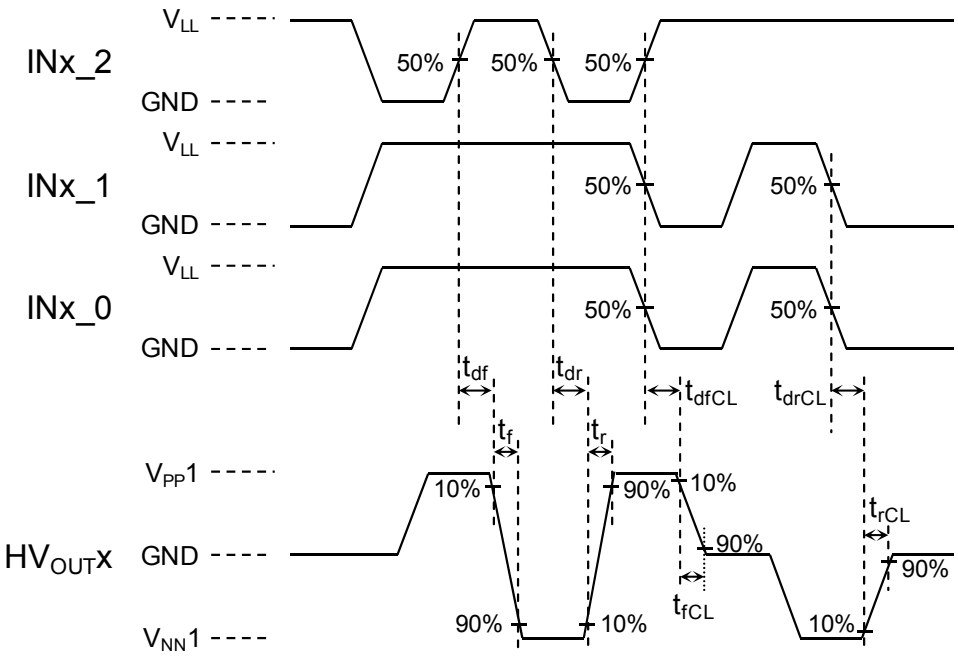
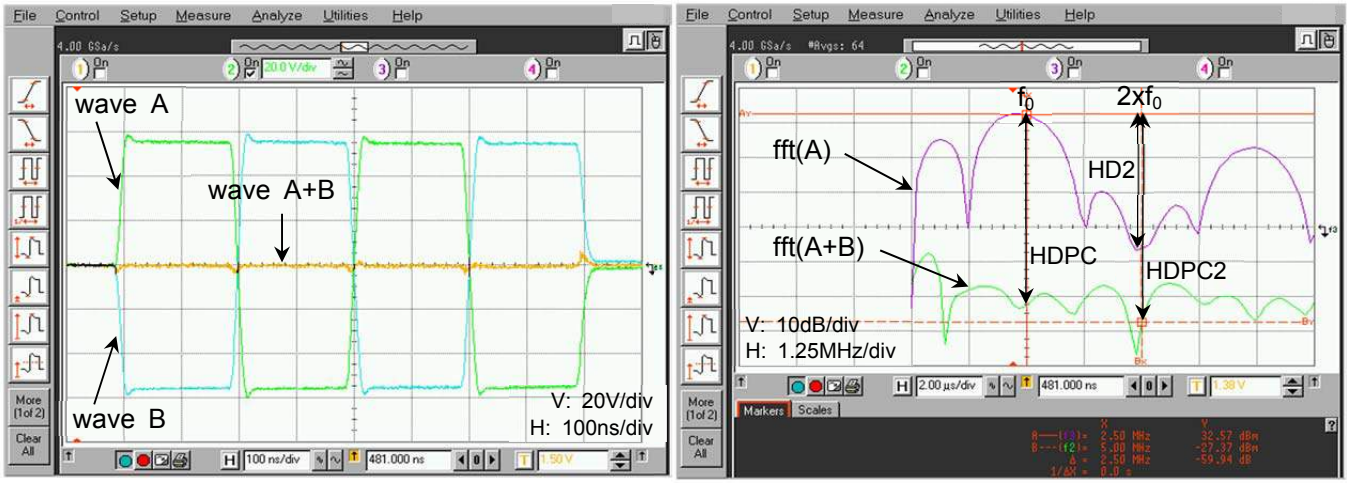


Fig.5 Propagation delay and Output rise/fall time



Example waveforms: VPP/VNN=+/-60V, f_0=2.5MHz, 2-cycle, HV_{OUT} load=220pF//200Ω

Fig.6 2nd harmonic distortion and Pulse cancellation

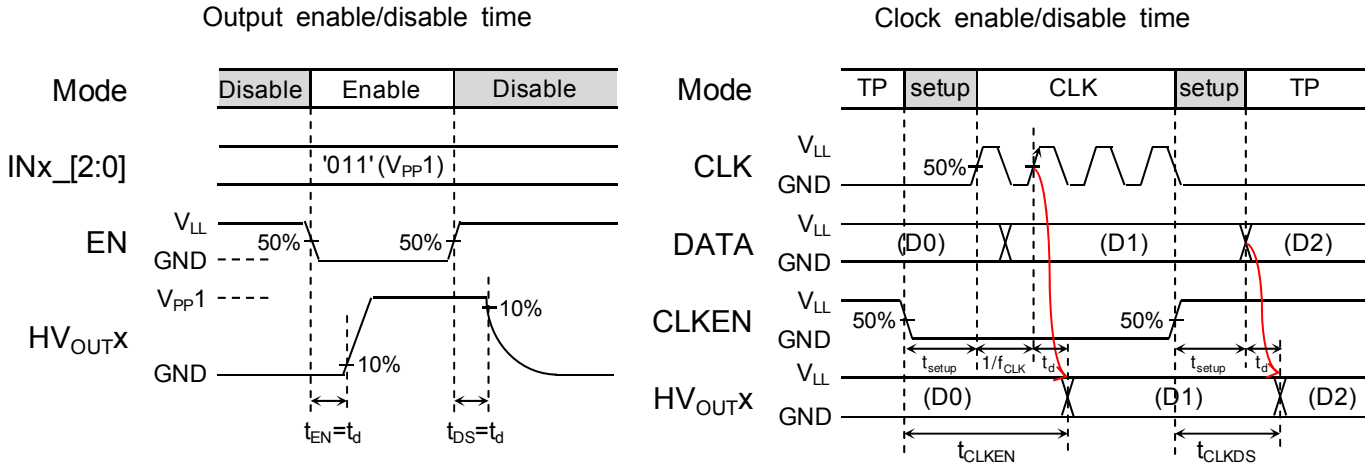


Fig.7 Output enable/disable and Clock enable/disable time

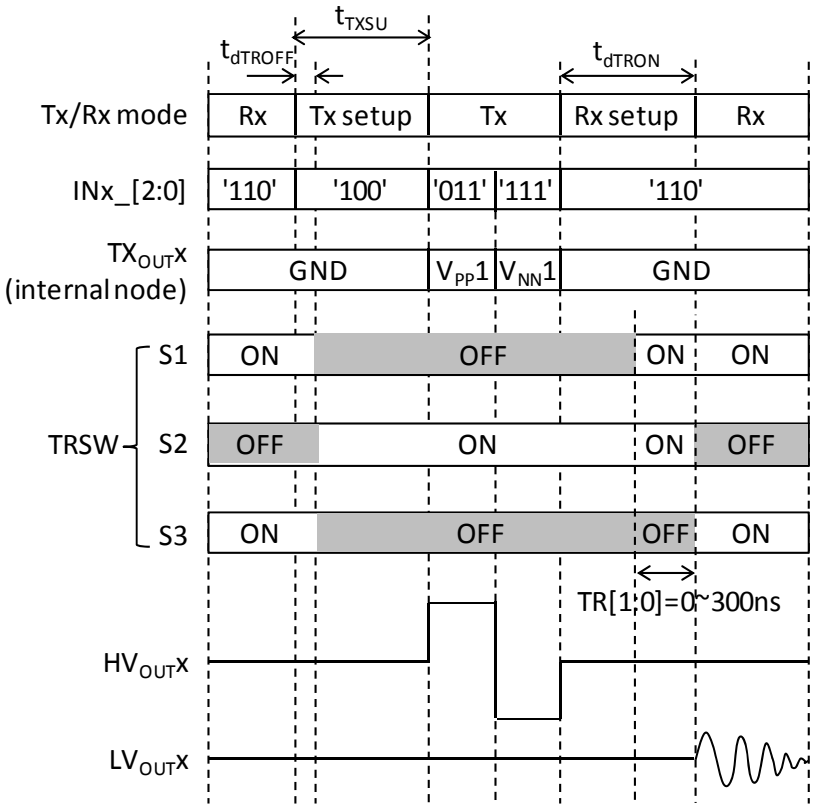


Fig.8 T/R Switch turn-on/off time

6. Truth Table and Mode Control table

Table 13 Truth table

Logic Inputs				Internal MOSFET state										Output state	
EN	**INx_2**	**INx_1**	**INx_0**	**P1**	**N1**	**P2**	**N2**	**P3**	**N3**	**ASW**	**TRSW**			**$TX_{OUT}x$**	**$LV_{OUT}x$**
				+HV1	-HV1	+HV2	-HV2	GND	GND	GND	S1	S2	S3	(internal node)	
0	0	0	0	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	**ON**	OFF	HiZ	10kΩ
0	0	0	1	OFF	OFF	**ON**	OFF	OFF	OFF	OFF	OFF	**ON**	OFF	+HV2	10kΩ
0	0	1	0	OFF	OFF	OFF	OFF	OFF	OFF	OFF	**ON**	OFF	**ON**	HiZ	$HV_{OUT}x$
0	0	1	1	**ON**	OFF	OFF	OFF	OFF	OFF	OFF	OFF	**ON**	OFF	+HV1	10kΩ
0	1	0	0	OFF	OFF	OFF	OFF	**ON**	**ON**	**ON**	OFF	**ON**	OFF	GND	10kΩ
0	1	0	1	OFF	OFF	OFF	**ON**	OFF	OFF	OFF	OFF	**ON**	OFF	-HV2	10kΩ
0	1	1	0	OFF	OFF	OFF	OFF	**ON**	**ON**	**ON**	**ON**	OFF	**ON**	GND	$HV_{OUT}x$
0	1	1	1	OFF	**ON**	OFF	OFF	OFF	OFF	OFF	OFF	**ON**	OFF	-HV1	10kΩ
1	X	X	X	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	**ON**	OFF	HiZ	10kΩ

Note: $V_{PP}1$/ $V_{NN}1$=+/-HV1, $V_{PP}2$/ $V_{NN}2$=+/-HV2, x=1~8

Table 14 P2/N2 drive current mode

			Iout [A]	
Current Mode	CC1	CC0	P2	N2
0	0	0	0.64	0.64
1	0	1	0.96	0.96
2	1	0	1.28	1.28
3	1	1	1.6	1.6

Note:
Recommended mode is as follows:

- Current mode 2 or 3 for high-amplitude short cycle pulse waveforms, or for driving a heavy load
- Current mode 0 or 1 for low-amplitude long pulse train waveforms (e.g. CW), or for driving a light load

Table 15 TRSW S1-S2 turn-on overlap time control mode

			S1-S2 ON
TRSW Control Mode	TR1	TR0	overlap time [ns]
0	0	0	0 (default)
1	0	1	100
2	1	0	200
3	1	1	300

Note: Detailed switching time diagram is shown in Fig.8

7. Pin Configuration

Table 16 Pin Configuration

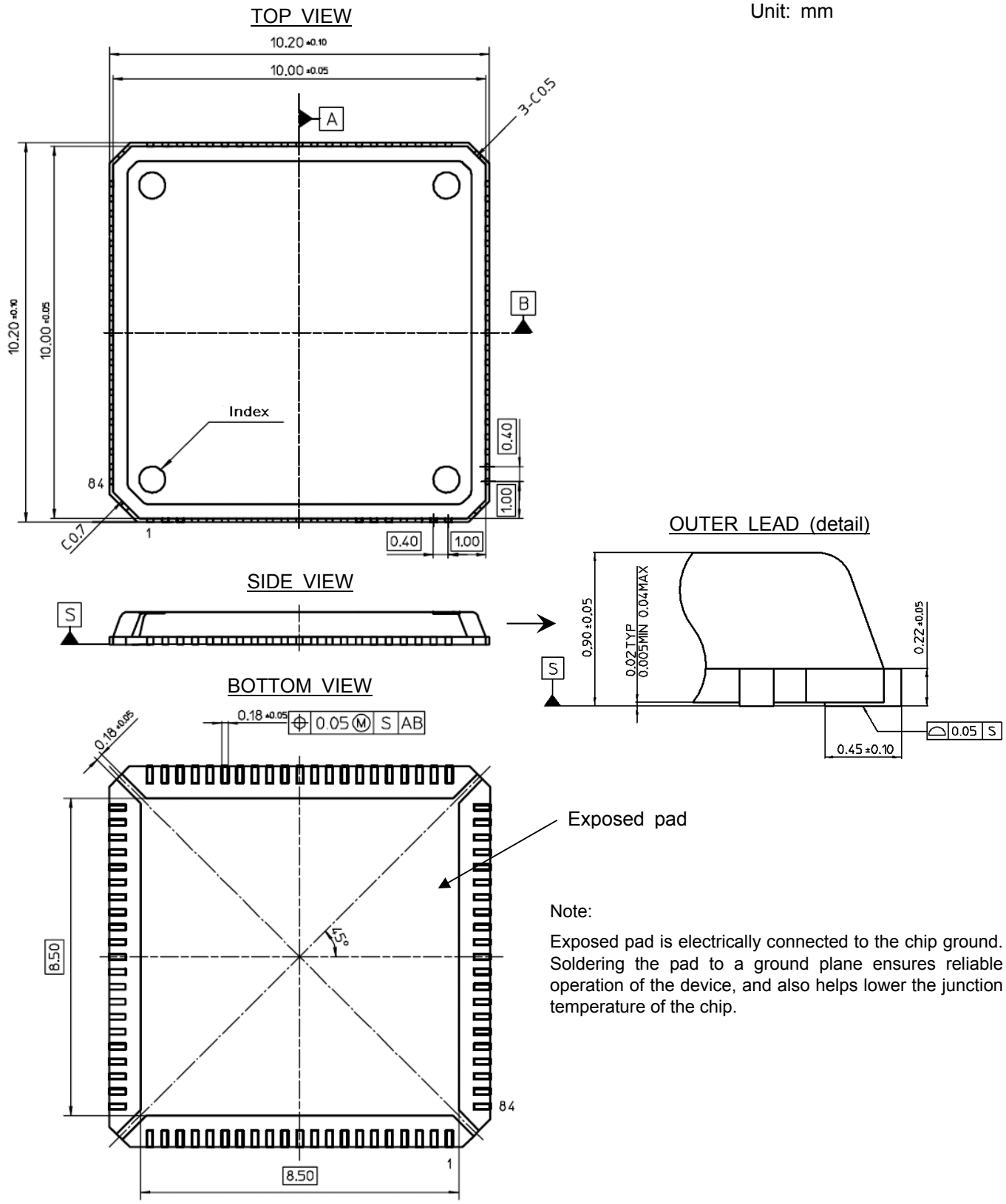
Pin#	Pin Name	I/O	Function
1	IN2_1	I	The 2nd significant bit of logic input of channel 2
2	IN2_2	I	The most significant bit of logic input of channel 2
3	IN3_0	I	The least significant bit of logic input of channel 3
4	IN3_1	I	The 2nd significant bit of logic input of channel 3
5	IN3_2	I	The most significant bit of logic input of channel 3
6	IN4_0	I	The least significant bit of logic input of channel 4
7	IN4_1	I	The 2nd significant bit of logic input of channel 4
8	IN4_2	I	The most significant bit of logic input of channel 4
9	V_{DD}	-	Positive low voltage power supply (+5V)
10	CLK	I	Positive clock input (up to 200MHz)
11	CLKB	I	Negative clock Input (up to 200MHz)
12	GND	-	Drive power ground (0V)
13	LVDSTM	I	Control of LVDS termination between CLK and CLKB, Hi=embedded 100Ω, Low=open (50kΩ internal pull-down resistor)
14	IN5_0	I	The least significant bit of logic input of channel 5
15	IN5_1	I	The 2nd significant bit of logic input of channel 5
16	IN5_2	I	The most significant bit of logic input of channel 5
17	IN6_0	I	The least significant bit of logic input of channel 6
18	IN6_1	I	The 2nd significant bit of logic input of channel 6
19	IN6_2	I	The most significant bit of logic input of channel 6
20	IN7_0	I	The least significant bit of logic input of channel 7
21	IN7_1	I	The 2nd significant bit of logic input of channel 7
22	IN7_2	I	The most significant bit of logic input of channel 7
23	IN8_0	I	The least significant bit of logic input of channel 8
24	IN8_1	I	The 2nd significant bit of logic input of channel 8
25	IN8_2	I	The most significant bit of logic input of channel 8
26	$LV_{OUT}8$	O	Low voltage output of channel 8
27	$V_{FP}1$	-	Built-in power supply for P-MOS (P1) gate drive
28	$V_{PP}1$	-	Positive high voltage power supply 1 (0 to +100V)
29	$V_{PP}1$	-	Positive high voltage power supply 1 (0 to +100V)
30	$V_{PP}2$	-	Positive high voltage power supply 2 (0 to +100V)
31	$V_{PP}2$	-	Positive high voltage power supply 2 (0 to +100V)
32	$V_{FP}2$	-	Built-in power supply for P-MOS (P2) gate drive
33	$LV_{OUT}7$	O	Low voltage output of channel 7
34	GND	-	Drive power ground (0V)
35	$HV_{OUT}8$	O	High voltage output of channel 8
36	$HV_{OUT}7$	O	High voltage output of channel 7
37	$V_{FN}1$	-	Built-in power supply for N-MOS (N1) gate drive
38	$LV_{OUT}6$	O	Low voltage output of channel 6
39	$V_{NN}1$	-	Negative high voltage power supply 1 (0 to -100V)
40	$V_{NN}1$	-	Negative high voltage power supply 1 (0 to -100V)
41	$V_{NN}2$	-	Negative high voltage power supply 2 (0 to -100V)
42	$HV_{OUT}6$	O	High voltage output of channel 6

Table 16 Pin Configuration (cont.)

Pin#	Pin Name	I/O	Function
43	$HV_{OUT}5$	O	High voltage output of channel 5
44	$V_{NN}2$	-	Negative high voltage power supply 2 (0 to -100V)
45	$V_{FN}2$	-	Built-in power supply for N-MOS (N2) gate drive
46	$LV_{OUT}5$	O	Low voltage output of channel 5
47	TR0	I	Lower bit of control of T/R switch S1 and S2 turn-on overlap time (50kΩ internal pull-down resistor)
48	TR1	I	Upper bit of control of T/R switch S1 and S2 turn-on overlap time (50kΩ internal pull-down resistor)
49	CC0	I	Lower bit of control of P2/N2 drive current (50kΩ internal pull-up resistor)
50	CC1	I	Upper bit of control of P2/N2 drive current (50kΩ internal pull-up resistor)
51	V_{SS}	-	Negative low voltage power supply (-5V)
52	V_{LL}	-	Positive voltage supply of logic input interface (1.8 to 5V)
53	GND	-	Drive power ground (0V)
54	THP	O	Thermal protection output flag, open N-MOS drain
55	EN	I	Control of drive output enable, Hi=disable, Low=enable (50kΩ internal pull-up resistor)
56	CLKEN	I	Control of clock enable, Hi=clock disable, Low=clock enable (50kΩ internal pull-up resistor)
57	CLKIF	I	Control of clock interface, Hi=differential CMOS, Low=LVDS (50kΩ internal pull-up resistor)
58	GND	-	Drive power ground (0V)
59	GND	-	Drive power ground (0V)
60	$LV_{OUT}4$	O	Low voltage output of channel 4
61	$V_{FN}2$	-	Built-in power supply for N-MOS (N2) gate drive
62	$V_{NN}2$	-	Negative high voltage power supply 2 (0 to -100V)
63	$HV_{OUT}4$	O	High voltage output of channel 4
64	$HV_{OUT}3$	O	High voltage output of channel 3
65	$V_{NN}2$	-	Negative high voltage power supply 2 (0 to -100V)
66	$V_{NN}1$	-	Negative high voltage power supply 1 (0 to -100V)
67	$V_{NN}1$	-	Negative high voltage power supply 1 (0 to -100V)
68	$LV_{OUT}3$	O	Low voltage output of channel 3
69	$V_{FN}1$	-	Built-in power supply for N-MOS (N1) gate drive
70	$HV_{OUT}2$	O	High voltage output of channel 2
71	$HV_{OUT}1$	O	High voltage output of channel 1
72	GND	-	Drive power ground (0V)
73	$LV_{OUT}2$	O	Low voltage output of channel 2
74	$V_{FP}2$	-	Built-in power supply for P-MOS (P2) gate drive
75	$V_{PP}2$	-	Positive high voltage power supply 2 (0 to +100V)
76	$V_{PP}2$	-	Positive high voltage power supply 2 (0 to +100V)
77	$V_{PP}1$	-	Positive high voltage power supply 1 (0 to +100V)
78	$V_{PP}1$	-	Positive high voltage power supply 1 (0 to +100V)
79	$V_{FP}1$	-	Built-in power supply for P-MOS (P1) gate drive
80	$LV_{OUT}1$	O	Low voltage output of channel 1
81	IN1_0	I	The least significant bit of logic input of channel 1
82	IN1_1	I	The 2^{nd} significant bit of logic input of channel 1
83	IN1_2	I	The most significant bit of logic input of channel 1
84	IN2_0	I	The least significant bit of logic input of channel 2

8. Package Outline

Unit: mm

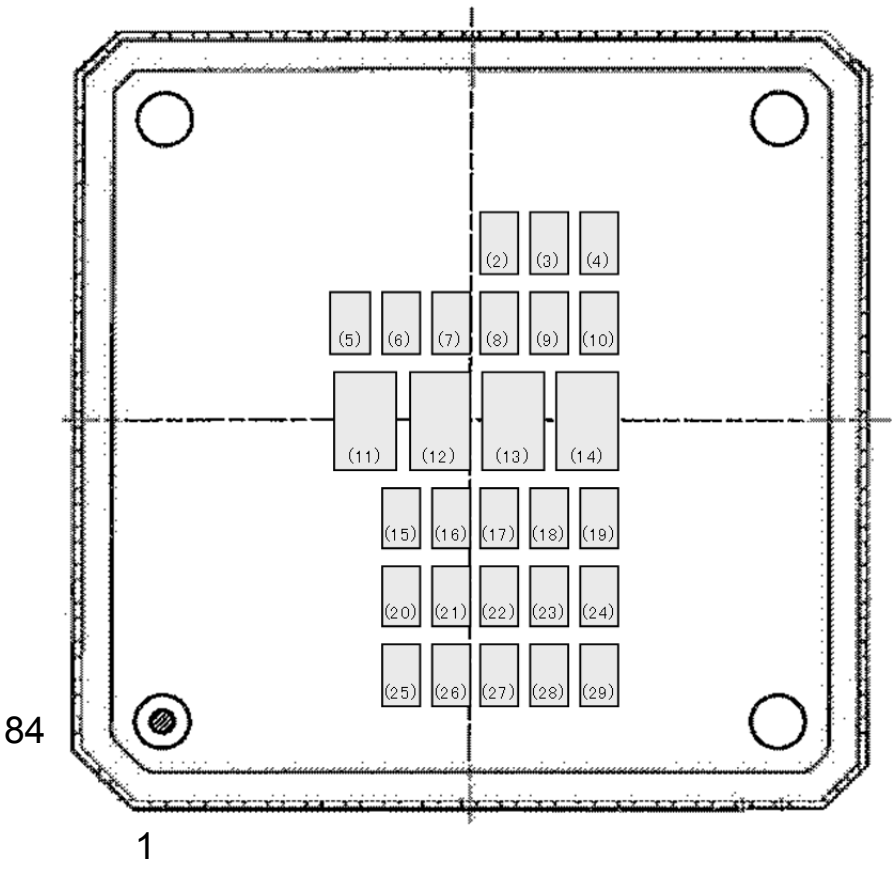


Note:

Exposed pad is electrically connected to the chip ground. Soldering the pad to a ground plane ensures reliable operation of the device, and also helps lower the junction temperature of the chip.

Fig.9 Package Outline (84-Lead QFN Package)

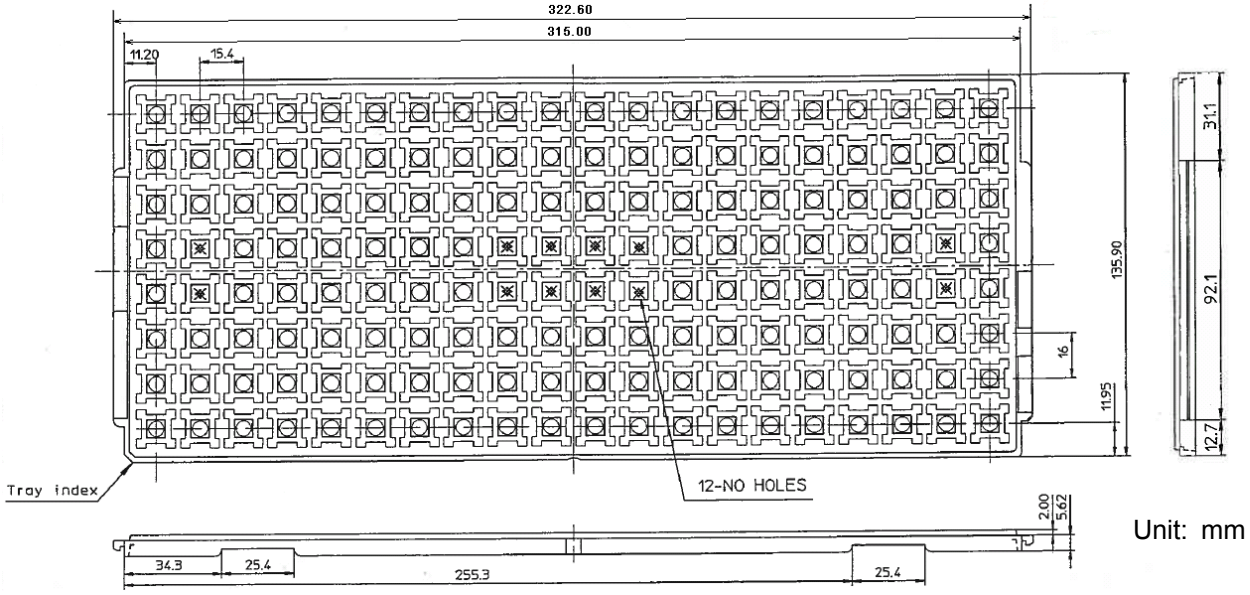
9. Package Marking



No.	Code
(2)	Year sealed : the last one digit of the year
(3)	Month sealed : A~M (exc. " I ") in the order of Jan. to Dec.
(4)	Week sealed : 1~5
(5)~(14)	HDL6M05586 (product name)
(15)~(24)	Quality control code
(25)~(29)	Country of origin

Fig.10 Package Marking

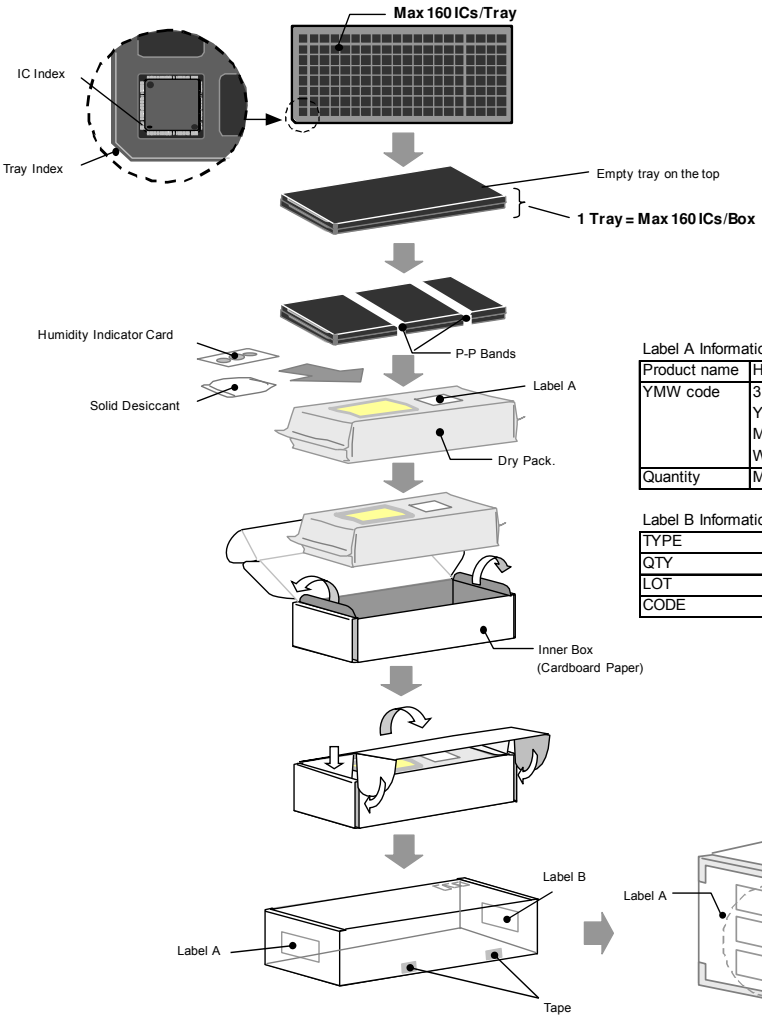
10. Transport Media, Quantity



Unit: mm

Fig.11 IC Tray Outline

1. Max 160 IC/Tray
2. 12 positions without holes (*)
3. PPE containing carbon and static proof
4. Heat proof: 130ºC, 24hr



Label A Information

Product name	HDL6M05586
YMW code	3 digits Y: Year sealed: The last one digit of the year M: Month sealed: A~M (exc. " I ") in the order of Jan. to Dec. W: Week sealed : 1~5
Quantity	Max 160 ICs/Box

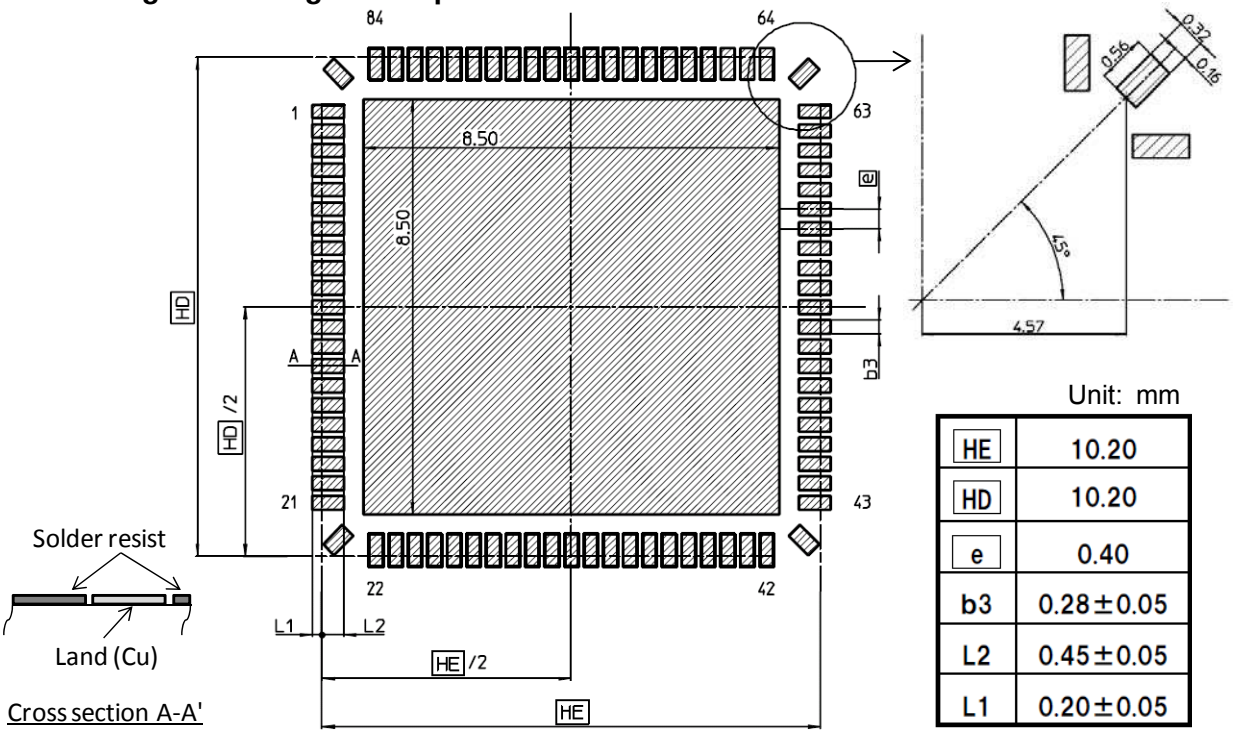
Label B Information

TYPE
QTY
LOT
CODE

Fig.12 Transport Media, Quantity

11. Mounting, Storage

11.1 Mounting Pad Design Example



Unit: mm

HE	10.20
HD	10.20
e	0.40
b3	0.28±0.05
L2	0.45±0.05
L1	0.20±0.05

Fig.13 Mounting Pad Design Example

11.2 Storage Conditions

11.2.1 The storage location should be kept at 5 to 35 °C and 40 to 70% relative humidity. Keeping in a dry box is recommended. Moisture-proof property is assured for 12 months from delivery date for sealed moisture-proof packing, while it is guaranteed for 7 days from unpacked date under the condition above.

11.2.2 When the storage conditions do not conform to those above or other conditions occur indicating moisture exposure, the ICs should be dried to avoid package cracks. A baking process at 125 °C lasting for 24 hours results in sufficient dehumidification. The baking is not allowed more than twice, and the ICs should be mounted within 7 days after initial baking or within 10 days of total exposure after the second dehumidification.

11.3 Reflow Conditions

Typical full heating methods such as Infrared (IR), Hot air, and N2 reflow process are applicable.
IR/Air reflow heating conditions are shown below.

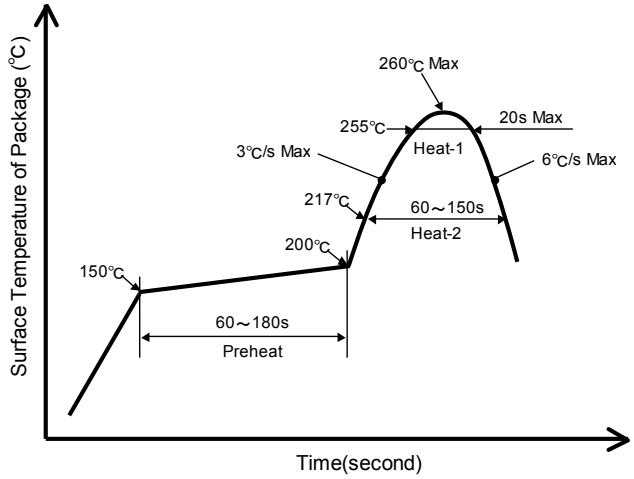


Fig.14 IR/Air Reflow Heating Conditions

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13. Cautions

13.1 Customers are advised to follow the cautions below to protect products from damage caused by electrical static discharge (ESD).

13.1.1 Material of container or any device to carry products should be free from ESD, which may be caused by vibration while transportation. It is recommended that electric-conductive container or aluminum sheet be used as an effective countermeasure.

13.1.2 Those what touch products such as work platform, machine, measurement/test equipment should be grounded.

13.1.3 Those who deal with products should be grounded through a large series impedance around 100kΩ to 1MΩ.

13.1.4 Prevent friction with other materials made with high polymer.

13.1.5 Prevent vibration or friction when carrying the printed circuit board (PCB) where products are mounted. To short circuit terminals is a recommended countermeasure to keep the same electric potential on the PCB.

13.1.6 Avoid dealing with or storing products in an extremely arid environment.

13.2 “Absolute maximum ratings” should never be exceeded during use regardless of any change in external conditions. Otherwise, products may be damaged or destroyed. In no event shall ABLIC Inc. be liable for any failure in products or any secondary damage resulting from use at a value exceeding the absolute maximum ratings.

13.3 Products may experience failures due to accident or unexpected surge voltages. Accordingly, adopt safe design features, such as redundancy or prevention of erroneous action, to avoid extensive damage in the event of a failure. (If a semiconductor device fails, there may be cases in which the semiconductor device, wiring or wiring pattern will emit smoke or cause a fire or in which the semiconductor device will burst.)

13.4 Products may experience failures or malfunction in poor surroundings, such as electrical leakage in products due to long-term use in high humidity, malfunctioning or permanent damage due to chemical reaction of products in corrosive environment or due to discharge by strongly charged object near products or due to excessive mechanical shock. To use products in radiation environment is not assumed. To use products near material easy to ignite may cause a fire due to its flammable package. Avoid using products in such environment or take appropriate countermeasures depending on the environment.

13.5 Products are not designed, manufactured, or warranted to be suitable for use where extremely high reliability is required (such as use in nuclear power control, aerospace and aviation, traffic equipment, life-support-related medical equipment, fuel control equipment and various kinds of safety equipment). Inclusion of products in such application shall be fully at the risk of customers. ABLIC Inc. assumes no liability for applications assistance, customer product design, or performance.

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2. The circuit examples and the usages described herein are for reference only, and do not guarantee the success of any specific mass-production design.
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4. Be careful to use the products within their specified ranges. Pay special attention to the absolute maximum ratings, operation voltage range and electrical characteristics, etc.
   ABLIC Inc. is not responsible for damages caused by failures and / or accidents, etc. that occur due to the use of the products outside their specified ranges.
5. When using the products, confirm their applications, and the laws and regulations of the region or country where they are used and verify suitability, safety and other factors for the intended use.
6. When exporting the products, comply with the Foreign Exchange and Foreign Trade Act and all other export-related laws, and follow the required procedures.
7. The products must not be used or provided (exported) for the purposes of the development of weapons of mass destruction or military use. ABLIC Inc. is not responsible for any provision (export) to those whose purpose is to develop, manufacture, use or store nuclear, biological or chemical weapons, missiles, or other military use.
8. The products are not designed to be used as part of any device or equipment that may affect the human body, human life, or assets (such as medical equipment, disaster prevention systems, security systems, combustion control systems, infrastructure control systems, vehicle equipment, traffic systems, in-vehicle equipment, aviation equipment, aerospace equipment, and nuclear-related equipment), excluding when specified for in-vehicle use or other uses. Do not apply the products to the above listed devices and equipments without prior written permission by ABLIC Inc.
   Especially, the products cannot be used for life support devices, devices implanted in the human body and devices that directly affect human life, etc.
   Prior consultation with our sales office is required when considering the above uses.
   ABLIC Inc. is not responsible for damages caused by unauthorized or unspecified use of our products.
9. Semiconductor products may fail or malfunction with some probability.
   The user of the products should therefore take responsibility to give thorough consideration to safety design including redundancy, fire spread prevention measures, and malfunction prevention to prevent accidents causing injury or death, fires and social damage, etc. that may ensue from the products' failure or malfunction.
   The entire system must be sufficiently evaluated and applied on customer's own responsibility.
10. The products are not designed to be radiation-proof. The necessary radiation measures should be taken in the product design by the customer depending on the intended use.
11. The products do not affect human health under normal use. However, they contain chemical substances and heavy metals and should therefore not be put in the mouth. The fracture surfaces of wafers and chips may be sharp. Be careful when handling these with the bare hands to prevent injuries, etc.
12. When disposing of the products, comply with the laws and ordinances of the country or region where they are used.
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14. For more details on the information described herein, contact our sales office.

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