DATA SHEET

RENESAS

MOS INTEGRATED CIRCUIT

μPD168104

6-CHANNEL OPERATIONAL AMPLIFIER, IRIS DRIVER, AND 4-CHANNEL H-BRIDGE DRIVER

DESCRIPTION

The μPD168104 is the motor driver IC with IRIS control circuit, operational amplifier and 4-ch H-bridge output. Smooth operation is possible for IRIS control with linear method.

The package is 56-pin thin type QFN and then it helps reduce the mounting area and height.

The μPD168104 is suitable for the lens drive of a camcorder, DSC, etc.

FEATURES

- 5-ch H-bridge circuits employing power MOSFET
  Stepping motors driver : 4 circuits, IRIS driver : 1 circuit.
- Low-voltage driving
  LV_{DD} = 2.7 to 3.6 V, AV_{DD} = 4.5 to 5.5 V, V_M = $V_{SHUTTER}$ = V_{IRIS} = 2.7 to 5.5 V
- Output on-state resistance: 2.0 Ω TYP., 3.0 Ω MAX. (4-ch H-bridge block, sum of top and bottom stage, V_M = 5 V)
- PWM output (ch1 to ch4)
- Output current
  DC current: ±0.3 A/ch (when each channel is used independently)
  Peak current: ±0.7 A/ch (when each channel is used independently)
- 6-ch general-purpose operational amplifier
  Input offset voltage: ±5 mV
  Input voltage range: 0 to AV_{DD} – 1.5 V
  Output voltage range: 0.2 to AV_{DD} – 0.2 V
- 1-ch 1/2AV_{DD} output amplifier
- IRIS driver block supporting linear driving
- Pre-driver amplifier of the IRIS driver block
- Undervoltage lockout circuit
  Output circuit and amplifier stop at LV_{DD} = 1.7 V TYP. or less.
- Overheat protection circuit
  Operates at 150°C or more and shuts down the output circuit.
- Mounted on 56-pin plastic WQFN (8 x 8)

APPLICATIONS

Lens motor driving for DVC and DSC, etc.

ORDERING INFORMATION

Part Number	Package	Marking	Packing Type
μPD168104K9-9B4-A [Note]	56-pin plastic WQFN (8 x 8)	D168104K	• Tray stuffing • Dry pack

Note Pb-free (This product does not contain Pb in external electrode and other parts.)

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Not all products and/or types are available in every country. Please check with an NEC Electronics sales representative for availability and additional information.

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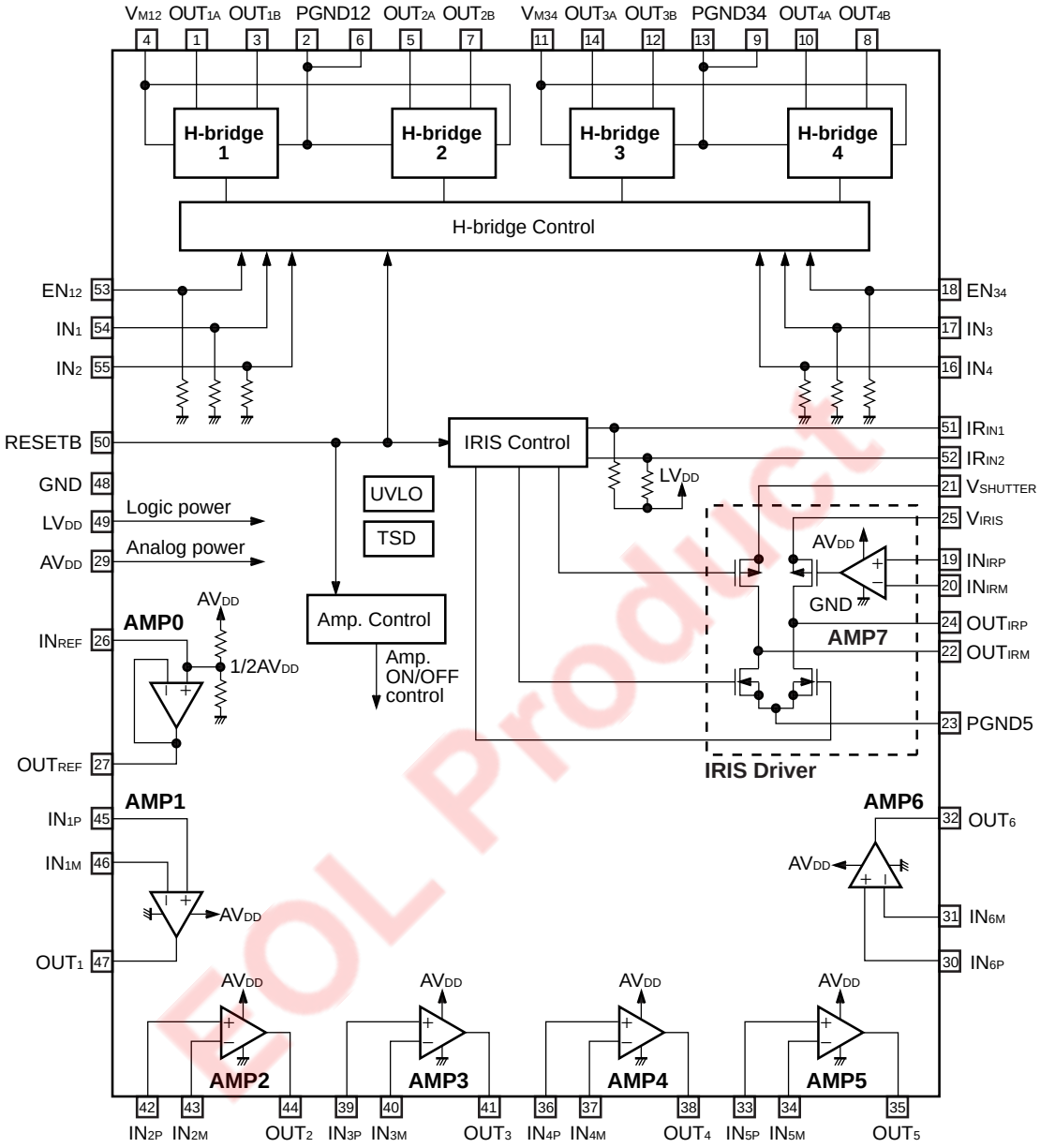
1. BLOCK DIAGRAM



Cautions 1. P in pin name means plus, and M in pin name means minus.

2. A pull-down resistor (50 to 200 kΩ) is connected to the logic input pins (EN_{12}, EN_{34}, IN_1, IN_2, IN_3, and IN_4). A pull-up resistor (50 to 200 kΩ) is connected to the IR_{IN1} and IR_{IN2} pins.

2. PIN FUNCTIONS

(1/2)

Pin No.	Pin Name	I/O	Function
1	OUT_{1A}	Output	ch1 output pin A
2	PGND12	–	ch1 and ch2 GND pin
3	OUT_{1B}	Output	ch1 output pin B
4	V_{M12}	–	ch1 and ch2 power supply voltage pin
5	OUT_{2A}	Output	ch2 output pin A
6	PGND12	–	ch1 and ch2 GND pin
7	OUT_{2B}	Output	ch2 output pin B
8	OUT_{4B}	Output	ch4 output pin B
9	PGND34	–	ch3 and ch4 GND pin
10	OUT_{4A}	Output	ch4 output pin A
11	V_{M34}	–	ch3 and ch4 power supply voltage pin
12	OUT_{3B}	Output	ch3 output pin B
13	PGND34	–	ch3 and ch4 GND pin
14	OUT_{3A}	Output	ch3 output pin A
15	NC	–	No connection
16	IN_4	Input	ch4 input pin
17	IN_3	Input	ch3 input pin
18	EN_{34}	Input	ch3 and ch4 output control input pin
19	IN_{IRP}	Input	IRIS linear control (AMP5) plus input pin
20	IN_{IRM}	Input	IRIS linear control (AMP5) minus input pin
21	$V_{SHUTTER}$	–	Shutter (ON/OFF) power supply voltage pin
22	OUT_{IRM}	Output	IRIS minus output pin
23	PGND5	–	IRIS and shutter GND pin
24	OUT_{IRP}	Output	IRIS plus output pin
25	V_{IRIS}	–	IRIS (linear) power supply voltage pin
26	IN_{REF}	Input	1/2AV_{DD} amplifier (AMP0) input pin (for capacitor connection)
27	OUT_{REF}	Output	1/2AV_{DD} amplifier (AMP0) output pin
28	NC	–	No connection
29	AV_{DD}	–	Analog power supply voltage pin
30	IN_{6P}	Input	Amplifier 6 (AMP6) plus input pin
31	IN_{6M}	Input	Amplifier 6 (AMP6) minus input pin
32	OUT_6	Output	Amplifier 6 (AMP6) output pin
33	IN_{5P}	Input	Amplifier 5 (AMP5) plus input pin
34	IN_{5M}	Input	Amplifier 5 (AMP5) minus input pin
35	OUT_5	Output	Amplifier 5 (AMP5) output pin

(2/2)

Pin No.	Pin Name	I/O	Function
36	IN_{4P}	Input	Amplifier 4 (AMP4) plus input pin
37	IN_{4M}	Input	Amplifier 4 (AMP4) minus input pin
38	OUT_4	Output	Amplifier 4 (AMP4) output pin
39	IN_{3P}	Input	Amplifier 3 (AMP3) plus input pin
40	IN_{3M}	Input	Amplifier 3 (AMP3) minus input pin
41	OUT_3	Output	Amplifier 3 (AMP3) output pin
42	IN_{2P}	Input	Amplifier 2 (AMP2) plus input pin
43	IN_{2M}	Input	Amplifier 2 (AMP2) minus input pin
44	OUT_2	Output	Amplifier 2 (AMP2) output pin
45	IN_{1P}	Input	Amplifier 1 (AMP1) plus input pin
46	IN_{1M}	Input	Amplifier 1 (AMP1) minus input pin
47	OUT_1	Output	Amplifier 1 (AMP1) output pin
48	GND	–	Logic and analog GND pin
49	LV_{DD}	–	Logic power supply voltage pin
50	RESETB	Input	Reset input pin
51	IR_{IN1}	Input	IRIS control logic input pin 1
52	IR_{IN2}	Input	IRIS control logic input pin 2
53	EN_{12}	Input	ch1 and ch2 output control input pin
54	IN_1	Input	ch1 input pin
55	IN_2	Input	ch2 input pin
56	NC	–	No connection

3. FUNCTION OPERATION TABLE

3.1 Reset Function

The internal circuit is shut off and the circuit current is kept to 1 μA MAX. when the RESETB pin is set L (reset status). In this status, all of the output pins are Hi-Z (High impedance). Set the RESETB pin H for normal usage.

Remark H: High level, L: Low level

3.2 Stepping Motor Driving Block

Table 3–1. I/O Truth Table of the Stepping Motor Driving Block

EN_{12}, EN_{34}	IN_1, IN_2, IN_3, IN_4	OUT_{1A}, OUT_{2A}, OUT_{3A}, OUT_{4A}	OUT_{1B}, OUT_{2B}, OUT_{3B}, OUT_{4B}
H	L	H	L
	H	L	H
L	L	Hi-Z	Hi-Z
	H	Hi-Z	Hi-Z

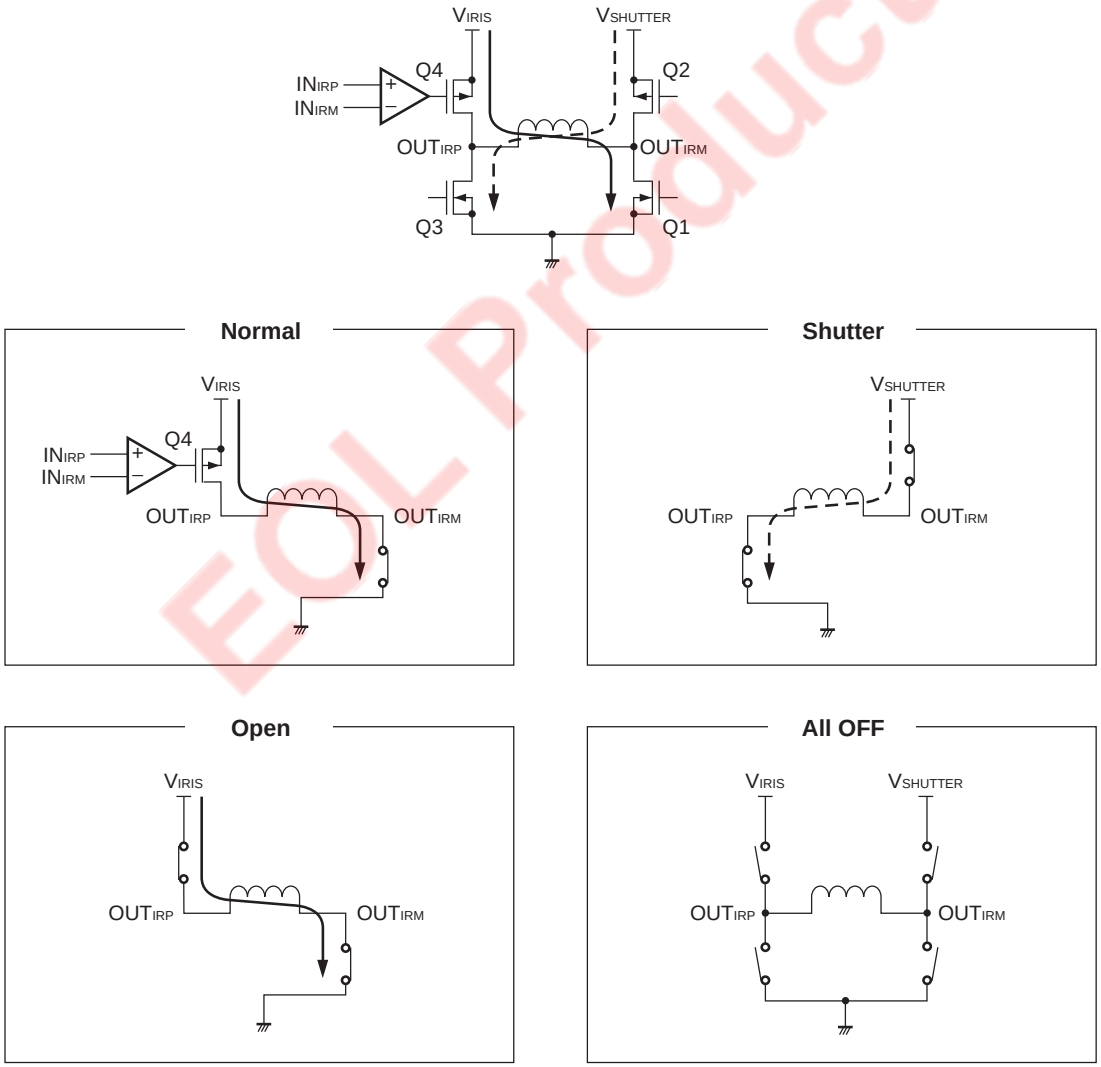
Remark Hi-Z: High impedance

3.3 IRIS Motor Driving Block

Table 3–2. I/O Truth Table of the IRIS Driving Block

IR_{IN1}	IR_{IN2}	Operation Mode	Output State of H-bridge				OUT_{IRP}	OUT_{IRM}
			Q1	Q2	Q3	Q4		
L	L	Normal operation (Amp. control)	ON	OFF	OFF	ON (Linear)	Linear	Linear
L	H	Shutter	OFF	ON	ON	OFF	L	H
H	L	IRIS open	ON	OFF	OFF	ON	H	L
H	H	Output all OFF	OFF	OFF	OFF	OFF	Hi-Z	Hi-Z

Figure 3–1. Description of the Operation Figure of the IRIS Motor Driving Block



4. FUNCTIONAL DEPLOYMENT

4.1 Undervoltage Lockout (UVLO) Circuit

This function is to forcibly stop the operation of the μPD168104 to prevent malfunctioning if LV_{DD} drops.

When UVLO operates, the driver output and amplifier circuit are the OFF status.

The UVLO circuit detects a voltage drop if LV_{DD} drops to 1.7 V TYP. in the non-reset status (RESETB = H). In the reset status (RESETB = L), it detects a voltage drop if LV_{DD} drops to 0.6 V TYP. This circuit may not operate if the LV_{DD} voltage abruptly drops for just a few μs.

4.2 Overheat Protection (TSD) Circuit

This function is to forcibly stop the operation of the driver output to protect it from destruction due to overheating if the chip temperature of the μPD168104 rises.

The overheat protection circuit operates when the chip temperature rises to 150°C or more. When overheat is detected, the driver output is stopped.

When RESETB = L (the reset status) or when UVLO is detected, the overheat protection circuit does not operate.

4.3 Current of motor power supply terminal

The μPD168104 has a circuit that prevents current from flowing into the V_M, $V_{SHUTTER}$ and V_{IRIS} pins (from the next, these are written as the motor power supply pins) when LV_{DD} = 0 V or AV_{DD} = 0 V.

Because the LV_{DD} pin voltage, the AV_{DD} pin voltage and the motor power supply pins voltage are monitored, a current of 1 μA TYP. flows into each one of the motor power supply pins when LV_{DD} is applied.

5. NOTE ON CORRECT USE

5.1 Pin Processing of Unused Circuit

The input/output pins of an unused circuit must be processed as specified below.

A pull-down or pull-up resistor is connected inside to the logic input pins. Connect the input pins so that IR_{IN1} and IR_{IN2} become LV_{DD} potential, and the other pins become GND potential when they are not used.

A pull-down resistor is not connected to the RESETB pin. Be sure to fix the RESETB pin to the LV_{DD} potential when it is used.

6. ELECTRICAL SPECIFICATIONS

Absolute Maximum Ratings (T_A = 25°C, glass epoxy board of 100 mm x 100 mm x 1 mm with copper foil area of 15%)

Parameter	Symbol	Condition	Rating	Unit
Power supply voltage	LV_{DD}	Control block	−0.5 to +6.0	V
	AV_{DD}	Analog block	−0.5 to +6.0	V
	V_{M12}, V_{M34}	Stepping motor block	−0.5 to +6.0	V
	$V_{SHUTTER}$, V_{IRIS}	IRIS block	−0.5 to +6.0	V
Input voltage	V_{IN}		−0.5 to LV_{DD} + 0.5	V
Output pin voltage 1	V_{OUT1}	Motor block	6.2	V
Output pin voltage 2	V_{OUT2}	Amplifier block	−0.5 to AV_{DD} + 0.5	V
DC output current	$I_{D1(DC)}$	DC (stepping motor)	±0.3	A/ch
	$I_{D2(DC)}$	DC (IRIS)	±0.2	A/ch
Instantaneous output current	$I_{D(pulse)}$	PW < 10 ms, Duty Cycle ≤ 20%	±0.7	A/ch
Power consumption	P_T		1.0	W
Peak junction temperature	$T_{ch(MAX.)}$ Note		150	°C
Storage temperature	T_{stg}		−55 to +150	°C

Note The overheat protection circuit operates at T_{ch} > 150°C. When overheat is detected, all the circuits are stopped. The overheat protection circuit does not operate at reset or on detection of ULVO.

Cautions 1. Product quality may suffer if the absolute maximum rating is exceeded even momentarily for any parameter. That is, the absolute maximum ratings are rated values at which the product is on the verge of suffering physical damage, and therefore the product must be used under conditions that ensure that the absolute maximum ratings are not exceeded.

2. Keep V_{IN} to less than 6 V.

Recommended Operating Conditions (T_A = 25°C, glass epoxy board of 100 mm x 100 mm x 1 mm with copper foil area of 15%)

Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit
Power supply voltage	LV_{DD}	Control block	2.7		3.6	V
	AV_{DD}	Analog block	4.5		5.5	V
	V_{M12}, V_{M34}	Stepping motor block	2.7		5.5	V
	$V_{SHUTTER}$, V_{IRIS}	IRIS block	2.7		5.5	V
Input voltage	V_{IN}		0		LV_{DD}	V
DC output current	$I_{D1(DC)}$	DC (stepping motor, when 2 chs are driven at same time)	−0.2		+0.2	A/ch
	$I_{D2(DC)}$	DC (IRIS), maximum current when the shutter operates	−0.1		+0.1	A/ch
Amplifier output current	I_{OUT_AMP1}	AMP1 to AMP6	−5		+5	mA/ch
Logic input frequency	f_{IN}				100	kHz
Operating temperature range	T_A		−10		70	°C

Caution Design each output current so that the junction temperature does not exceed 150°C.

Electrical Characteristics (Unless otherwise specified, T_A = 25°C, LV_{DD} = 3.0 V, AV_{DD} = 5.0 V, V_M = $V_{SHUTTER}$ = V_{IRIS} = 5.0 V)

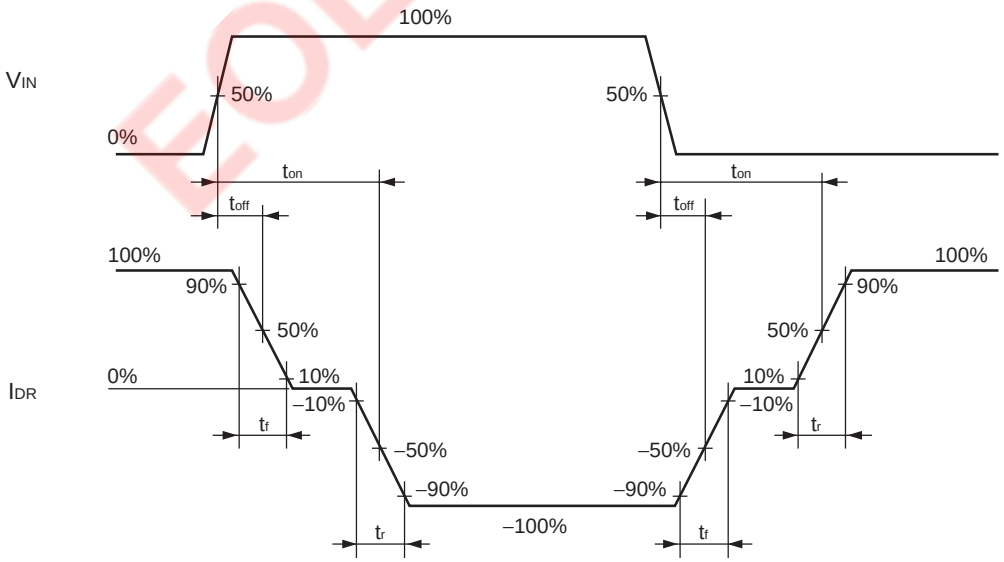
Overall and H-bridge block (stepping motor)

Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit
LV_{DD} pin current in standby mode	$ILV_{DD(STB)}$	RESETB = 0 V, IR_{IN1-2} = H			1.0	μA
AV_{DD} pin current in standby mode	$IAV_{DD(STB)}$	RESETB = 0 V			1.0	μA
V_M pin current in standby mode	$IV_{M(STB)}$	RESETB = 0 V			1.0	μA
LV_{DD} pin current in during operation	$I_{DD(ACT)}$	RESETB = LV_{DD}			2.0	mA
High-level input current	I_{IH}	V_{IN} = LV_{DD}			60	μA
Low-level input current	I_{IL}	V_{IN} = 0 V	−1.0			μA
Input pull-down resistance	R_{IND}		50		200	kΩ
High-level input voltage	V_{IH}		0.7 x LV_{DD}			V
Low-level input voltage	V_{IL}				0.3 x LV_{DD}	V
H-bridge on-state resistance	R_{on}	I_M = 0.2 A, sum of upper and lower stages		2.0	3.0	Ω
Output leakage current Note1	$I_{M(off)}$	Per V_M pin, All control pins: low level			1.0	μA
Low-voltage detection voltage Note2	V_{DDS1}	RESETB = H		1.7	2.5	V
Output turn-on time	t_{on}	R_L = 20 Ω		0.5	1.0	μs
Output turn-off time	t_{off}			0.1	0.4	μs
Output rise time	t_r		0.05	0.2	0.4	μs
Output fall time	t_f			50	100	ns

Notes 1. μPD168104 has a circuit that prevents current from flowing into the V_M pin when LV_{DD} = 0 V.

2. Unlike normal operations, after a reset the detection voltage becomes 0.6 V TYP.

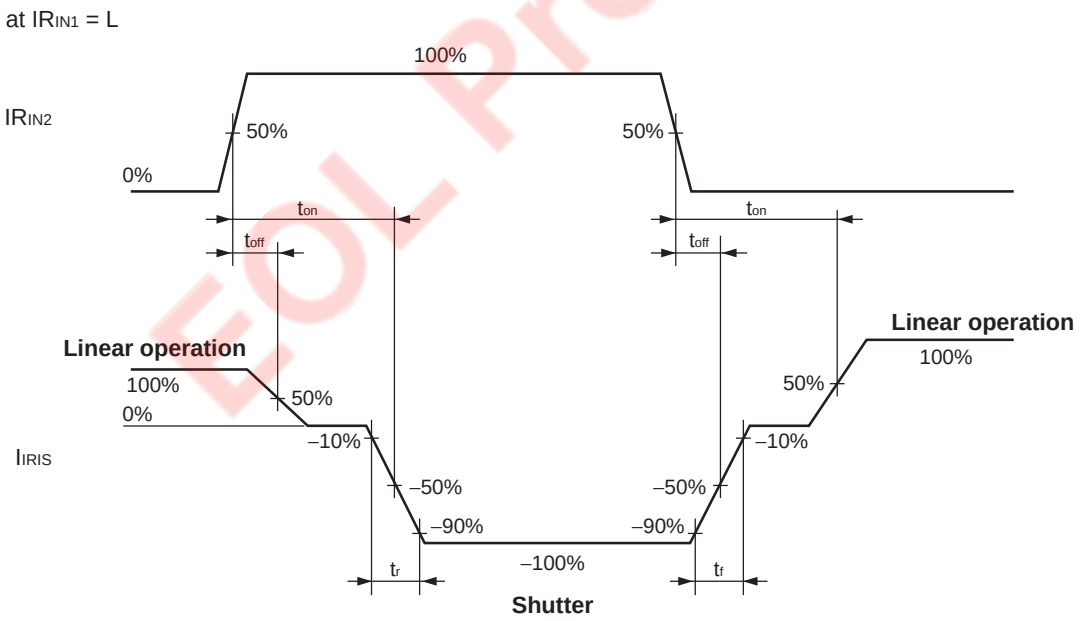
Figure 6–1. Switching Characteristic Waveform of the Stepping Motor Driving Block



H-bridge block (IRIS motor)

Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit
V_{IRIS} pin current in standby mode	$IV_{IRIS(STB)}$	RESETB = 0 V			1.0	μA
$V_{SHUTTER}$ pin current in standby mode	$IV_{SHUTTER(STB)}$	RESETB = 0 V			1.0	μA
High-level input current	I_{IH}	$V_{IN} = LV_{DD}$			1.0	μA
Low-level input current	I_{IL}	V_{IN} = 0 V	–60			μA
Input pull-up resistance	R_{IND}		50		200	kΩ
High-level input voltage	V_{IH}		0.7 x LV_{DD}			V
Low-level input voltage	V_{IL}				0.3 x LV_{DD}	V
H-bridge on-state resistance	R_{on1}	R_L = 50 Ω, sum of upper and lower stages		2.5	3.5	Ω
Output turn-on time	t_{onH1}	When linear driving, R_L = 50 Ω	0.01	25	35	μs
	t_{onH2}	When full ON, R_L = 50 Ω	0.01	1.0	2.0	μs
Output turn-off time	t_{offH}		0.01	1.0	2.0	μs
Output rise time	t_{rH}			60		ns
Output fall time	t_{fH}			80		ns
Control amplifier offset voltage	V_{IO}	AMP7		±5	±7.5	mV
Common mode input voltage range	V_{ICM}	AMP7	0		AV_{DD} – 1.5	V

Figure 6–2. Switching Characteristic Waveform of the IRIS Motor Driving Block

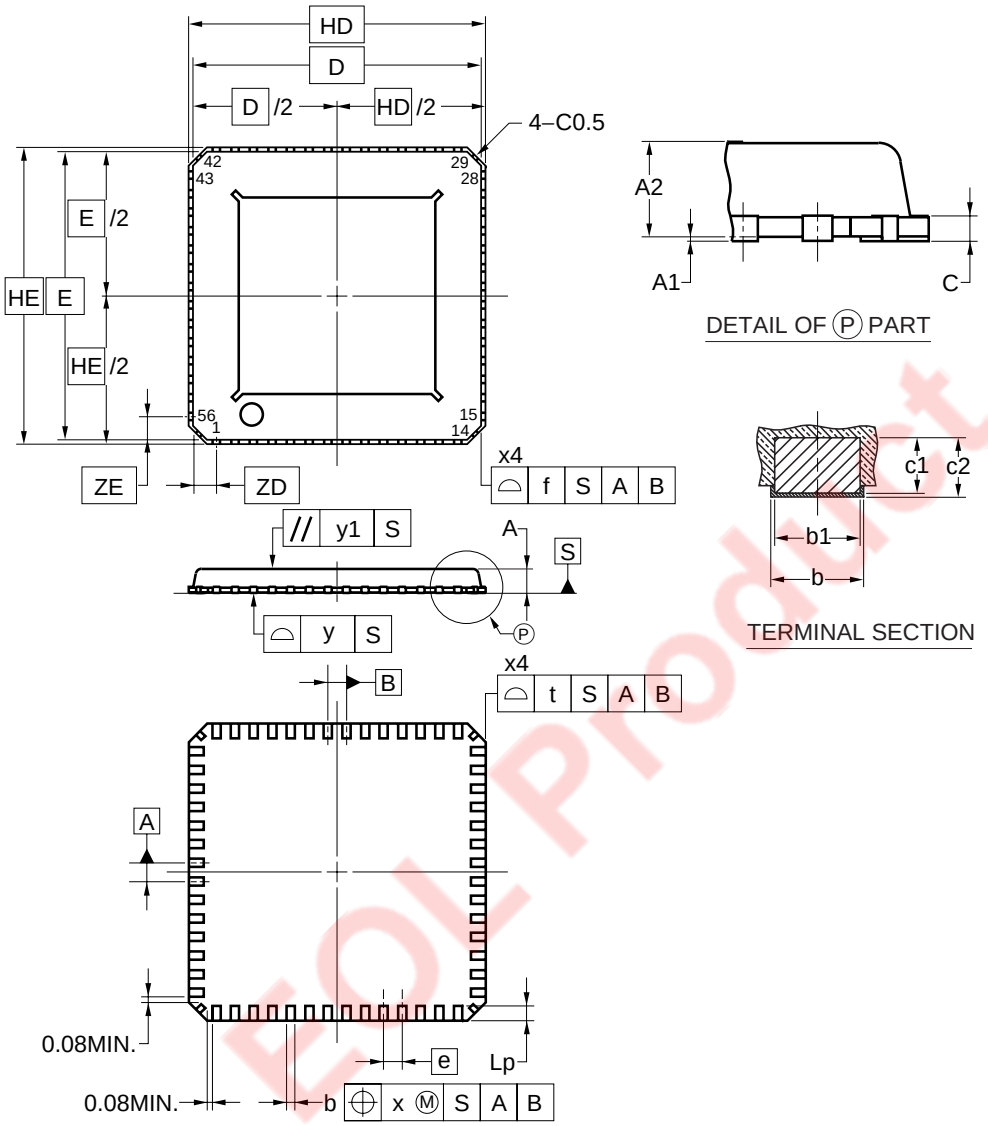


Operational amplifier block

Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit
AV_{DD} pin current in during operation	IA_{DD}	Output open			3.0	mA
Input offset voltage 1	V_{IO1}	AMP1 to AMP6		±3	±5	mV
Common mode input voltage range 1	V_{ICM1}	AMP1 to AMP6	0		AV_{DD} – 1.5	V
High-level output voltage	V_{OH}	AMP1 to AMP6, when I_{OUT} = +2 mA	AV_{DD} – 0.2			V
Low-level output voltage	V_{OL}	AMP1 to AMP6, when I_{OUT} = –2 mA			0.2	V
Large amplitude voltage gain	A_V	AMP1 to AMP6, DC	80			dB
Slew-rate	SR	AMP1 to AMP6, A_V = 1 dB ,$R_L \geq 10$ kΩ		0.5		V/μs
1/2AV_{DD} output voltage accuracy	V_O	AMP0, I_{OUT} = ±100 μA	2.4	2.5	2.6	V

7. PACKAGE DRAWING

56-PIN PLASTIC WQFN (8x8)



(UNIT:mm)

ITEM	DIMENSIONS
D	7.75
E	7.75
f	0.20
HD	8.00
HE	8.00
t	0.20
A	$0.67^{+0.08}_{-0.04}$
A1	$0.03^{+0.02}_{-0.025}$
A2	0.64
b	0.23±0.05
b1	0.20±0.03
c	0.17
c1	0.14–0.16
c2	0.14–0.20
e	0.50
Lp	0.40±0.10
x	0.05
y	0.08
y1	0.10
ZD	0.625
ZE	0.625

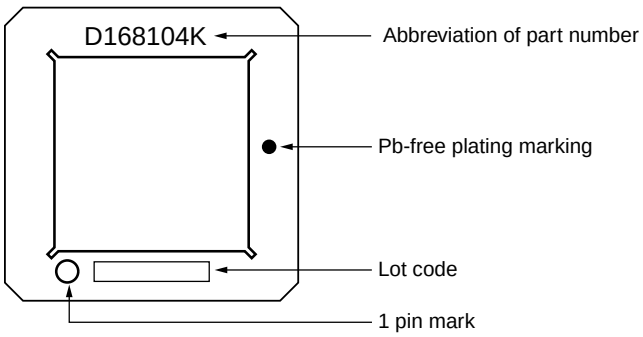
P56K9-50-9B4

NOTES

※1 "t" AND "f" EXCLUDES MOLD FLASH

※2 ALTHOUGH THERE ARE 4 TERMINALS IN THE CORNER PART OF A PACKAGE, THESE TERMINALS ARE NOT DESIGNED FOR INTERCONNECTION, BUT FOR MANUFACTURING PROCESS OF THE PACKAGE, THEREFOR DO NOT INTEND TO SOLDER THESE 4 TERMINALS, SOLDERABLITY OF THE 4 TERMINALS ARE NOT GUARANTEED.

8. MARKING INFORMATION



This figure shows the item and place of seal.

However, it does not specify the shape and size of letters, and the detail of the place.

9. RECOMMENDED SOLDERING CONDITIONS

The μPD168104 should be soldered and mounted under the following recommended conditions.

For soldering methods and conditions other than those recommended below, contact an NEC Electronics sales representative.

For technical information, see the following website.

Semiconductor Device Mount Manual (http://www.necel.com/pkg/en/mount/index.html)

Type of Surface Mount Device

μPD168104K9-9B4-A [Note1]: 56-pin plastic WQFN (8 x 8)

Process	Conditions	Symbol
Infrared reflow	Package peak temperature: 260°C, Time: 60 seconds or less (at 220°C or higher), Count: Three times or less, Exposure limit: 3 days [Note2] (after that, prebake at 125°C for 10 hours) , Flux: Rosin flux with low chlorine (0.2 Wt% or below) recommended. <Precaution> Products other than in heat-resistant trays (such as those packaged in a magazine, taping, or non-thermal-resistant tray) cannot be baked in their package.	IR60-103-3
Partial heating	Pin temperature: 350°C or below, Heat time: 3 seconds or less (Per each pin), Flux: Rosin flux with low chlorine (0.2 Wt% or below) recommended.	P350

Notes 1. Pb-free (This product does not contain Pb in external electrode and other parts.)

2. After opening the dry pack, store it a 25°C or less and 65% RH or less for the allowable storage period.

Caution Do not use different soldering methods together (except for partial heating).

NOTES FOR CMOS DEVICES

① VOLTAGE APPLICATION WAVEFORM AT INPUT PIN

Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between V_{IL} (MAX) and V_{IH} (MIN) due to noise, etc., the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between V_{IL} (MAX) and V_{IH} (MIN).

② HANDLING OF UNUSED INPUT PINS

Unconnected CMOS device inputs can be cause of malfunction. If an input pin is unconnected, it is possible that an internal input level may be generated due to noise, etc., causing malfunction. CMOS devices behave differently than Bipolar or NMOS devices. Input levels of CMOS devices must be fixed high or low by using pull-up or pull-down circuitry. Each unused pin should be connected to V_{DD} or GND via a resistor if there is a possibility that it will be an output pin. All handling related to unused pins must be judged separately for each device and according to related specifications governing the device.

③ PRECAUTION AGAINST ESD

A strong electric field, when exposed to a MOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop generation of static electricity as much as possible, and quickly dissipate it when it has occurred. Environmental control must be adequate. When it is dry, a humidifier should be used. It is recommended to avoid using insulators that easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors should be grounded. The operator should be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions need to be taken for PW boards with mounted semiconductor devices.

④ STATUS BEFORE INITIALIZATION

Power-on does not necessarily define the initial status of a MOS device. Immediately after the power source is turned ON, devices with reset functions have not yet been initialized. Hence, power-on does not guarantee output pin levels, I/O settings or contents of registers. A device is not initialized until the reset signal is received. A reset operation must be executed immediately after power-on for devices with reset functions.

⑤ POWER ON/OFF SEQUENCE

In the case of a device that uses different power supplies for the internal operation and external interface, as a rule, switch on the external power supply after switching on the internal power supply. When switching the power supply off, as a rule, switch off the external power supply and then the internal power supply. Use of the reverse power on/off sequences may result in the application of an overvoltage to the internal elements of the device, causing malfunction and degradation of internal elements due to the passage of an abnormal current.

The correct power on/off sequence must be judged separately for each device and according to related specifications governing the device.

⑥ INPUT OF SIGNAL DURING POWER OFF STATE

Do not input signals or an I/O pull-up power supply while the device is not powered. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements.

Input of signals during the power off state must be judged separately for each device and according to related specifications governing the device.

Reference Documents

NEC Semiconductor Device Reliability/Quality Control System (C10983E)

Quality Grades On NEC Semiconductor Devices (C11531E)

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  "Standard": Computers, office equipment, communications equipment, test and measurement equipment, audio and visual equipment, home electronic appliances, machine tools, personal electronic equipment and industrial robots.
  "Special": Transportation equipment (automobiles, trains, ships, etc.), traffic control systems, anti-disaster systems, anti-crime systems, safety equipment and medical equipment (not specifically designed for life support).
  "Specific": Aircraft, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems and medical equipment for life support, etc.

The quality grade of NEC Electronics products is "Standard" unless otherwise expressly specified in NEC Electronics data sheets or data books, etc. If customers wish to use NEC Electronics products in applications not intended by NEC Electronics, they must contact an NEC Electronics sales representative in advance to determine NEC Electronics' willingness to support a given application.

(Note)

(1) "NEC Electronics" as used in this statement means NEC Electronics Corporation and also includes its majority-owned subsidiaries.

(2) "NEC Electronics products" means any product developed or manufactured by or for NEC Electronics (as defined above).