Ordering number : ENN7983

SANYO Semiconductors
DATA SHEET

LB8658FN LB8658PL — Monolithic Digital IC DSC Motor Driver

Features

- An actuator driver for digital camera is implemented on a single chip.
  - (1) Supports a constant voltage for the AF H-bridge ×2 : a stepping motor (STM) ×1.
    - Constant voltage drive.
    - Enables 1 phase, 1-2 phase and 2-phase excitation.
    - VC1 and VC2 allow the constant voltage for each channel to be set independently.
  - (2) Supports a constant current for the shutter H-bridge ×1 : a voice coil motor (VCM) ×1.
    - Constant current drive.
    - ICH allows current setting for each current carrying direction.
      → Supports current suppression while the shutter is Open.
    - A fast charge/discharge circuit allows for stabilization of response speed of the continuous drive mode.
    - Allows offsetting of the constant current rising waveform with an external C.
      (The external C is not required when an offset is not performed)
      → Prevents current rising variation of coil caused by supply voltage fluctuation.
    - Implements regenerative brake logic.
  - (3) Supports a constant voltage for the iris H-bridge ×1 : a voice coil motor (VCM) ×1.
    - Constant voltage drive.
    - VC4 allows the independent constant voltage to be set.
  - (4) Supports a constant voltage for the zoom H-bridge ×1 : a DC motor (DCM) ×1.
    - Constant voltage drive.
    - VC3 allows the independent constant voltage to be set.
    - Built-in short brake.
  - (5) Supports an open collector output for the photo sensor ×3 : a photo sensor (PR/PI) ×3.
    - AFPI and ZMPI are turned ON in synchronization with focus mode and zoom mode, respectively.
    - ZMPR can be controlled independently, regardless of mode.

[Actuator applications]

	Focus	Shutter	Iris	Zoom
Applications	STM	VCM	VCM	DCM

Continued on next page.

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Continued from preceding page.

- Synchronous actuator driving is possible.

[Table Showing Combinations of Actuators which Can Be Driven Simultaneously]

	Focus	Shutter	Iris	Zoom
When “MD1” not used (6 input ports required)	○			○
		○		○
			○	○
When “MD1” used (7 input ports required)	○			○
		○		○
			○	○
	○		○	○

- Parallel control via 7 or 8 input ports (one of which is used to photo sensor control).
- Two power supply systems.
- Supports low voltage drive (1.9V min).
- Low saturation output (Vsat = 0.37Vtyp at I_O = 200mA).
- Current dissipation in stand-by state is 0 (zero).
- Built-in overheat protection circuit.
- Small and thin package. VQFN44 (6.0×6.0) for LB8658FN and VQLP40 (5.0×5.0) for LB8658PL.

Specifications

Absolute Maximum Ratings at Ta = 25°C [LB8658PL : Preliminary]

Parameter	Symbol	Conditions	Ratings	Unit
Maximum power supply voltage	VB1 max		-0.3 to 10.5	V
	VB2 max		-0.3 to 10.5	
Maximum applied output voltage	V_{OUT} max	OUT1, 2, 3, 4, 7, 8, 9, 10	-0.3 to VB1+VF	V
		OUT5, 6	-0.3 to VB2+VF	
		ZMPR, ZMPI, AFPI	-0.3 to 10.5	
Maximum output current	I_{OUT} max	OUT1, 2, 3, 4, 7, 8	600	mA
		OUT5, 6, 9, 10	800	
		ZMPR, ZMPI, AFPI	30	
Maximum applied input voltage	V_{IN} max	MD1 to 3, IN1 to 5	-0.3 to 10.5	V
Allowable power dissipation	Pd max	Standard PWB mounting (*1) [LB8658FN]	1.9	W
		Standard PWB mounting (*2) [LB8658PL]	1.1	
Operating temperature	Topr		-20 to +80	°C
Storage temperature	Tstg	[LB8658FN]	-55 to +150	°C
		[LB8658PL]	-55 to +125	

(*1) Standard PWB : 30mm×50mm×0.8mm glass epoxy resin 4-layer PWB
(*2) Standard PWB : 40mm×50mm×0.8mm glass epoxy resin 4-layer PWB

Recommended Operating Range at Ta = 25°C [LB8658PL : Preliminary]

Parameter	Symbol	Conditions	Ratings	Unit
Voltage for guarantee of function	VB1 opr		2.2 to 10	V
	VB2 opr		2.2 to 10	
Constant-voltage setting range	$V_{OUT}1$	OUT1, 2, 3, 4, 7, 8	0 to VB1	V
	$V_{OUT}2$	OUT5, 6	0 to VB2	
Constant-current setting range	I_{OUT}	OUT9, 10	50 to 500	mA
Constant-voltage setting input range	VVC1	VC1, VC2, VC4	0.1 to VB1	V
	VVC2	VC3	0.1 to VB2	
Constant-current setting input range	VIC	IC	0.1 to 1.0	V
Input pin “H” voltage	$V_{IN}H$	MD1 to 3, IN1 to 5	1.8 to 10	V
Input pin “L” voltage	$V_{IN}L$	MD1 to 3, IN1 to 5	-0.3 to 0.4	V

Electrical Characteristics at Ta = 25°C, VB1 = VB2 = 3V [LB8658PL : Preliminary]

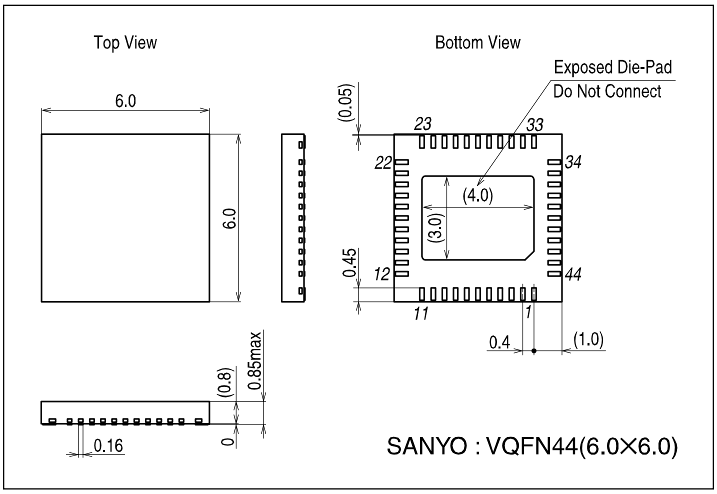
Parameter	Symbol	Conditions	Ratings			Unit	Remarks
			min	typ	max		
Current dissipation in stand-by state	ISTB	VB1 = VB2 = 10V		0.1	1.0	μA	1
VB1 system operation current dissipation	IB11	MD1/2/3/IN1/2 = L/L/L/*/*		12	16	mA	2
	IB12	MD1/2/3/IN1/2 = L/L/H/*/*		8	11		
	IB13	MD1/2/3/IN1/2 = L/H/L/*/*		12	16		
	IB14	MD1/2/3/IN1/2 = L/H/H/*/*		8	11		
	IB15	MD1/2/3/IN1/2 = H/*/L/*/*		15	20		
	IB16	MD1/2/3/IN1/2 = H/*/H/*/*		12	16		
	IB17	IN3/4 = */*		10	14		
VB2 system operation current dissipation	IB21	IN3/4 = L/L		0.1	1.0	μA	3
	IB22	IN3/4 = L/H or H/L or H/H		8	11	mA	
[Constant-voltage driver for AF] (OUT1, OUT2, OUT3, OUT4)							
Output constant-voltage 1	V_O11	VC1 or VC2 = 0.3V	1.52	1.57	1.62	V	4
	V_O12	VC1 or VC2 = VREF×0.3 (partial resistance)	1.47	1.57	1.67		
Output saturation voltage 1	VSAT1	VB1 = 3.0V, I_O = 200mA		0.37	0.50	V	5
[Constant-Voltage driver for zoom] (OUT5, OUT6)							
Output constant-voltage 2	V_O21	VC3 = 0.3V	1.52	1.57	1.62	V	6
	V_O22	VC3 = VREF×0.3 (partial resistance)	1.47	1.57	1.67		
Output saturation voltage 2	VSAT2	VB2 = 3.0V, I_O = 300mA		0.44	0.60	V	7
[Constant-voltage driver for iris] (OUT7, OUT8)							
Output constant-voltage 3	V_O31	VC4 = 0.3V	1.52	1.57	1.62	V	8
	V_O32	VC4 = VREF×0.3 (partial resistance)	1.47	1.57	1.67		
Output saturation voltage 3	VSAT3	VB1 = 3.0V, I_O = 200mA		0.37	0.50	V	9
[Constant-current driver] (OUT9, OUT10)							
Output constant-current	I_O	VB1 = 3.0V, between IM and GND : 1.0Ω, IC = VREF/5	188	200	212	mA	10
Output constant-current/ voltage variation	IOLIN	VB1 = 3V to 5V (VB1 = 4V typ), I_O = 200 mA	-1	0	+1	%	11
Output saturation voltage 4	VSAT4	VB1 = 3.0V, I_O = 300mA		0.44	0.60	V	12
IC output saturation voltage	VSAT5	VB1 = 3.0V, I_O = 1mA		0.12	0.2	V	13
ICH output saturation voltage	VSAT6	VB1 = 3.0V, I_O = 1mA			0.1	V	14
[Reference voltage circuit] (VREF)							
VREF output constant-voltage	VREF	IREF = -1mA	0.95	1.00	1.05	V	15
[Photo sensor drive circuit] (ZMPR, ZMPI, AFPI)							
Output saturation voltage 7	VSAT7	I_O = 10mA		0.3	0.45	V	16
[Input circuit] (MD1 to 3, IN1 to 5)							
Control pin input current	$I_{IN}H$	V_{IN} = 5.0V		70	90	μA	17
	$I_{IN}L$	V_{IN} = 0V			0	μA	18
[Others]							
Overheat protection detection temperature	TTSD	*Design guarantee	160	180	200	°C	19

* Temperature characteristics of design guaranteed, however individual unit testing is not performed.

[Remarks]
1) Specifies the IC standby leak current.
2) Specifies the current dissipated at the pin VB1 in each mode. (Specifies the maximum value for each condition.)
3) Specifies the current dissipated at the pin VB2 in each mode. (Specifies the maximum value for each condition.)
4) Specifies the output voltage when the constant voltage is output from pins OUT5 to OUT4.
5) Specifies the output transistor (upper and lower) saturation voltage at pins OUT1 to OUT4
6) Specifies the output voltage when the constant voltage is output from pins OUT5 to OUT6.
7) Specifies the output transistor (upper and lower) saturation voltage at pins OUT5 to OUT6.
8) Specifies the output voltage when the constant voltage is output from pins OUT7 and OUT8.
9) Specifies the output transistor (upper and lower) saturation voltage at pins OUT7 to OUT8.
10) Specifies the output current when the constant current is output from pins OUT9 to OUT10.
11) Specifies the output current variation caused by supply voltage fluctuation when the constant current is output from pins OUT9 to OUT10.
12) Specifies the output transistor (upper and lower) saturation voltage at pins OUT9 to OUT10.
13) Specifies the saturation voltage of the IC pin discharge transistor.
14) Specifies the saturation voltage of the ICH pin discharge transistor.
15) Specifies the output voltage at VREF.
16) Specifies the saturation voltage of the output transistor at pins ZMPR, ZMPI and AFPI.
17) Specifies the input current when the voltage inputs at pins MD1 to MD3 and IN1 to IN5 is “H”.
18) Specifies the input current when the voltage inputs at pins MD1 to MD3 and IN1 to IN5 is “L”.
19) Specifies the overheat protection circuit detection temperature. (design guaranteed)

Package Dimensions

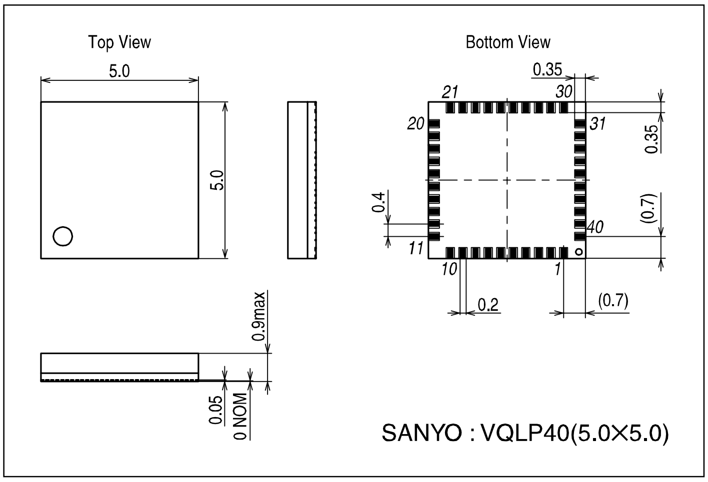
unit : mm
3293 [LB8658FN]



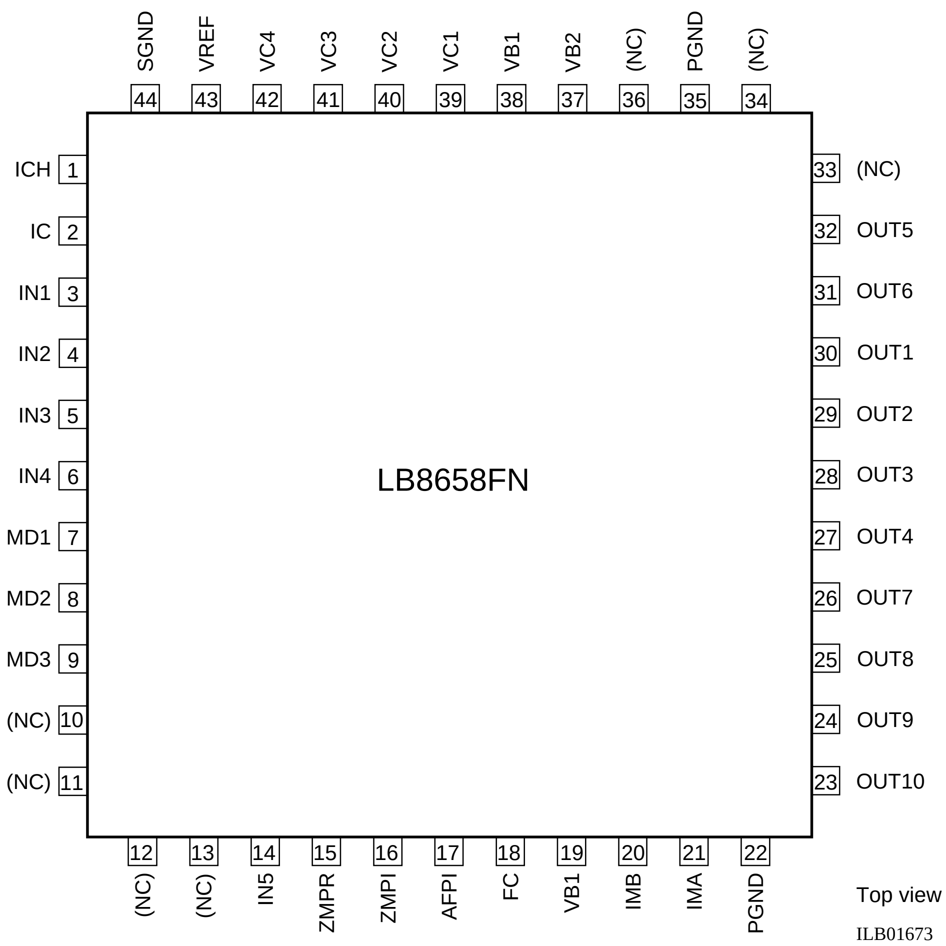
Package Dimensions

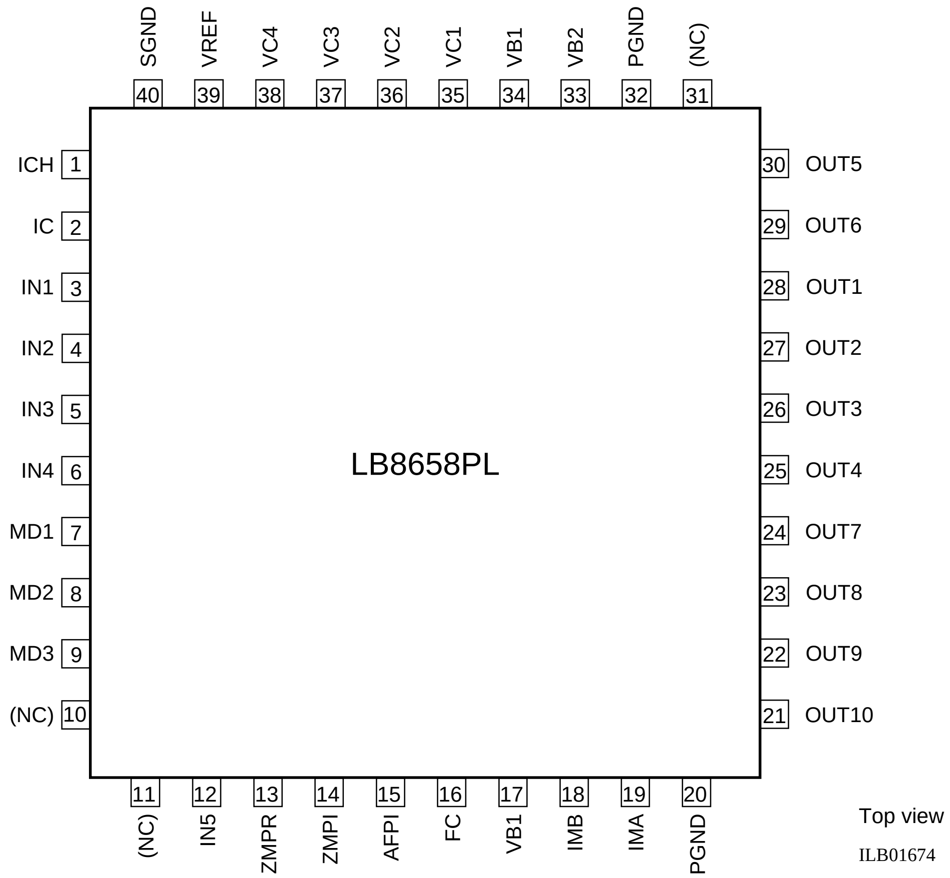
unit : mm

3302 [LB8658PL]



Pin Assignment

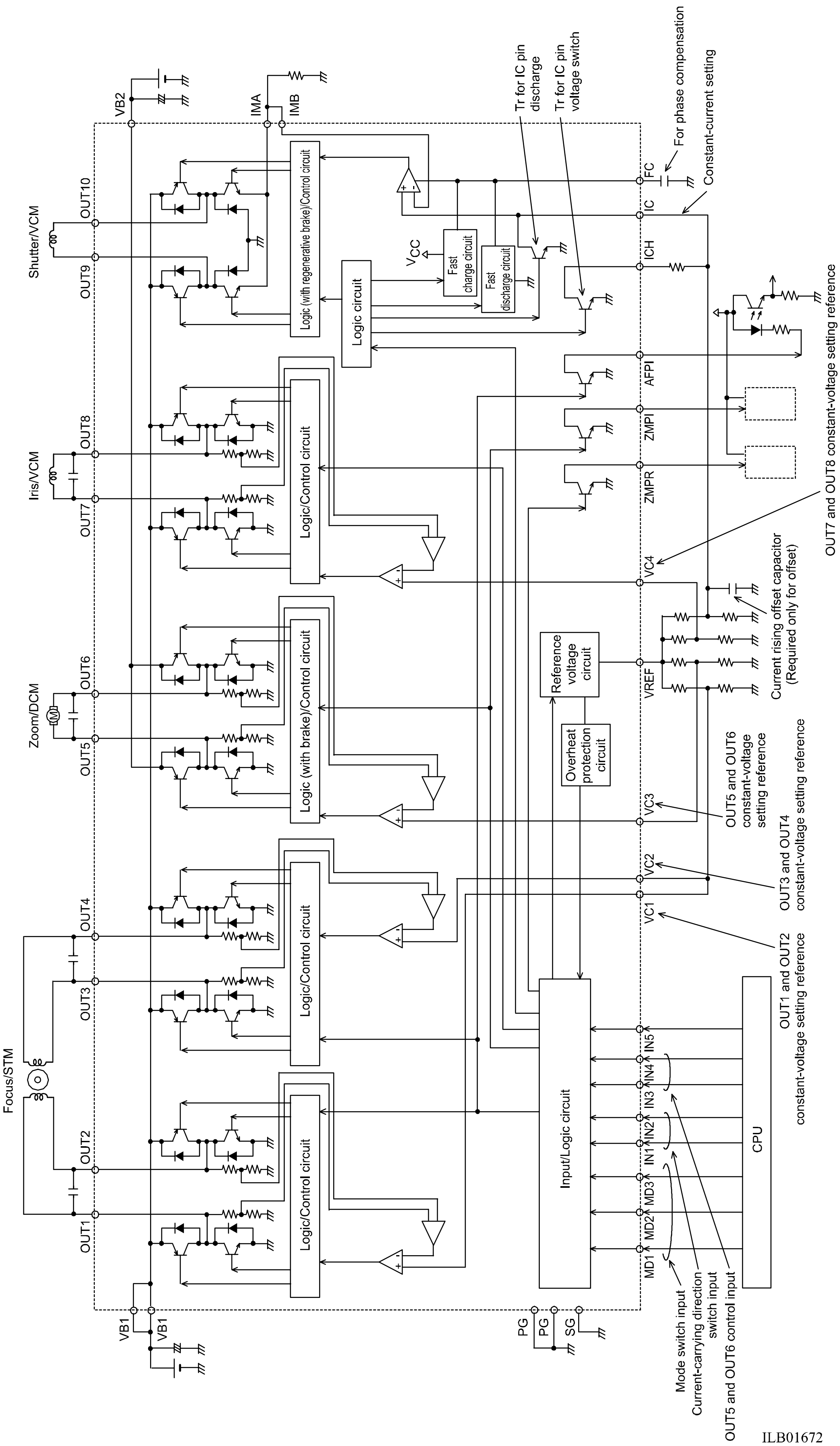



SGND
VREF
VC4
VC3
VC2
VC1
VB1
VB2
PGND
(NC)
40
39
38
37
36
35
34
33
32
31
ICH 1
IC 2
IN1 3
IN2 4
IN3 5
IN4 6
MD1 7
MD2 8
MD3 9
(NC) 10
30 OUT5
29 OUT6
28 OUT1
27 OUT2
26 OUT3
25 OUT4
24 OUT7
23 OUT8
22 OUT9
21 OUT10
LB8658PL
11
12
13
14
15
16
17
18
19
20
(NC)
IN5
ZMPR
ZMPI
AFPI
FC
VB1
IMB
IMA
PGND
Top view
ILB01674

Pin Description

Pin number		Pin name	Description	Protection diode			
				Upper side		Lower side	
LB8658FN	LB8658PL			VB1	VB2	PGND	SGND
19, 38	17, 34	VB1	Battery power supply				
37	33	VB2	ditto				
22, 35	20, 32	PGND	Power system GND				
44	40	SGND	Control system GND				
20	18	IMB	OUT9 and OUT10 current detection feedback pin				
21	19	IMA	OUT9 and OUT10 current detection pin				
30	28	OUT1	Motor drive output	○		○	
29	27	OUT2	ditto	○		○	
28	26	OUT3	ditto	○		○	
27	25	OUT4	ditto	○		○	
32	30	OUT5	ditto		○	○	
31	29	OUT6	ditto		○	○	
26	24	OUT7	ditto	○		○	
25	23	OUT8	ditto	○		○	
24	22	OUT9	ditto	○		○	
23	21	OUT10	ditto	○		○	
7	7	MD1	Control signal input				○
8	8	MD2	ditto				○
9	9	MD3	ditto				○
3	3	IN1	ditto				○
4	4	IN2	ditto				○
5	5	IN3	ditto				○
6	6	IN4	ditto				○
14	12	IN5	ditto				○
43	39	VREF	Reference voltage output				○
39	35	VC1	Constant-voltage setting reference input				○
40	36	VC2	ditto				○
41	37	VC3	ditto				○
42	38	VC4	ditto				○
18	16	FC	Phase compensation pin				○
2	2	IC	Constant-current setting reference input				○
1	1	ICH	Constant-current setting switching output				○
15	13	ZMPR	Photo sensor drive output				○
16	14	ZMPI	ditto				○
17	15	AFPI	ditto				○

Block Diagram

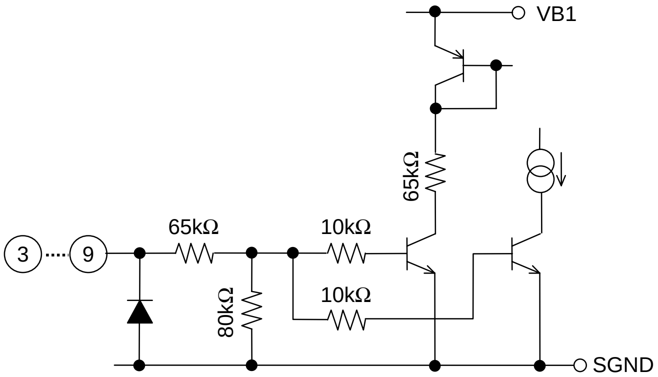
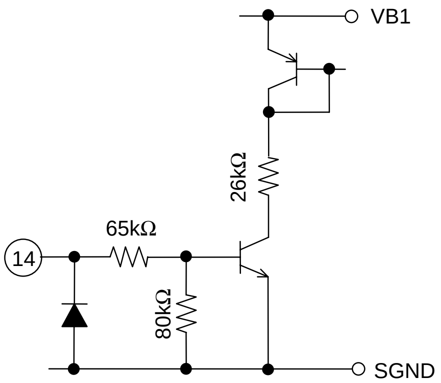
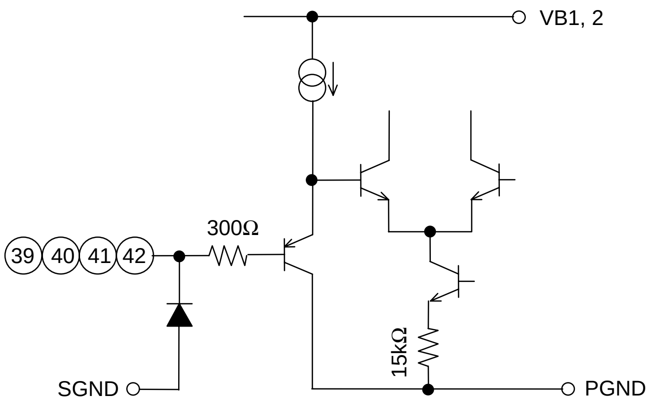
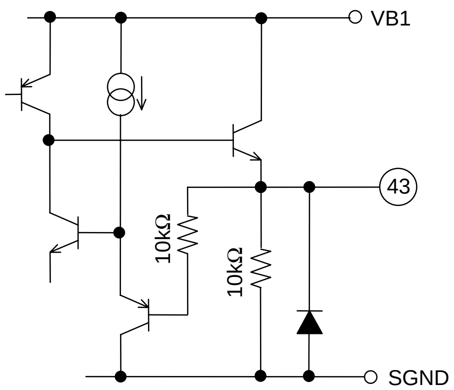


Note : When the input voltage for IC pin is set with partial resistance from the reference voltage such as VREF, make sure not to use “VC1”, “VC2”, “VC3” and “VC4”, and partial resistance together.
(In any mode other than shutter mode, the IC pin discharge transistor inside the IC pin switches to ON.)

Truth Table

Input								Output										ZM PR	ZM PI	AF PI	VREF	ICH	IC pin discharge	Mode	
MD1	MD2	MD3	IN1	IN2	IN3	IN4	IN5	OUT1	OUT2	OUT3	OUT4	OUT5	OUT6	OUT7	OUT8	OUT9	OUT10								
L	L	L	L	L												-	-			-	OFF	-	OFF	Stand-by	Shutter
			L	H												L	H				ON			Closed	
			H	L												H	L					L		Open	
			H	H												-	H					-		Regeneration	
		H	L	L										-	-							-	ON	Iris	
			L	H										L	H										
			H	L										H	L										
			H	H										-	-										
	H	L	L	L				L	H	H	L									L				AF only (2-phase excitation)	
			L	H				L	H	L	H														
			H	L				H	L	H	L														
			H	H				H	L	L	H														
		H	L	L				-	-	H	L													AF only (1-phase excitation)	
			L	H				L	H	-	-														
			H	L				H	L	-	-														
			H	H				-	-	L	H														
H	L	L	L	L				L	H	H	L			L	H									AF&Iris (1) (2-phase excitation)	
			L	H				L	H	L	H														
			H	L				H	L	H	L														
			H	H				H	L	L	H														
		H	L	L				-	-	H	L													AF&Iris (1) (1-phase excitation)	
			L	H				L	H	-	-														
			H	L				H	L	-	-														
			H	H				-	-	L	H														
	H	L	L	L				L	H	H	L			H	L									AF&Iris (2) (2-phase excitation)	
			L	H				L	H	L	H														
			H	L				H	L	H	L														
			H	H				H	L	L	H														
		H	L	L				-	-	H	L													AF&Iris (2) (1-phase excitation)	
			L	H				L	H	-	-														
			H	L				H	L	-	-														
			H	H				-	-	L	H														
					L	L						-	-						-					Zoom (with brake)	
					L	H						L	H						L						
					H	L						H	L												
					H	H						L	L												
							L											-						PR	
							H											L							

Internal Equivalent Circuit Diagram (Pin number in the figure applies to LB8658FN)

Pin number		Pin name	Internal equivalent circuit diagram
LB8658FN	LB8658PL		
7 8 9 3 4 5 6	7 8 9 3 4 5 6	MD1 MD2 MD3 IN1 IN2 IN3 IN4	 ILB01675
14	12	IN5	 ILB01676
39 40 41 42	35 36 37 38	VC1 VC2 VC3 VC4	 ILB01677
43	40	VREF	 ILB01678

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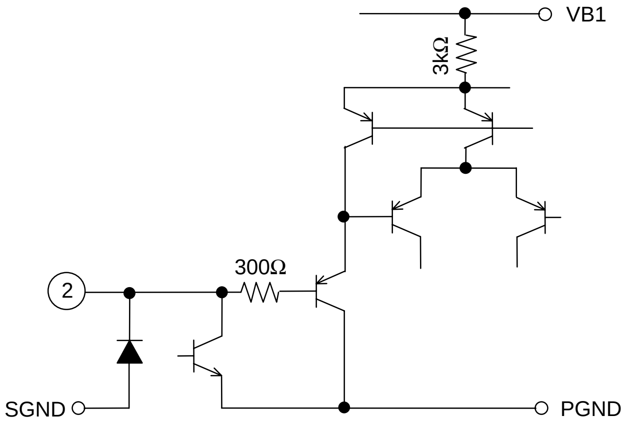
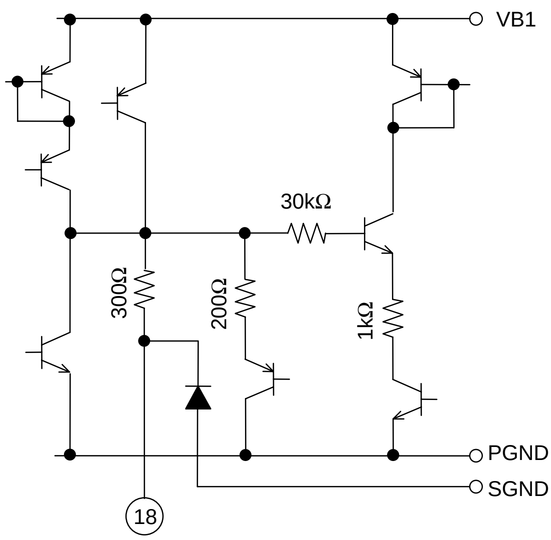
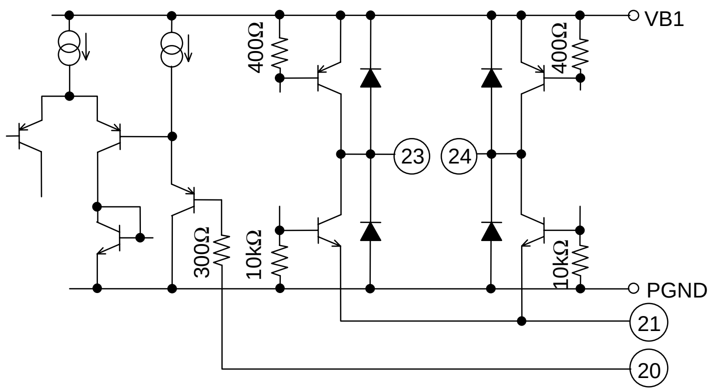
Pin number		Pin name	Internal equivalent circuit diagram
LB8658FN	LB8658PL		
2	2	IC	 ILB01679
18	16	FC	 ILB01680
20 21	18 19	IMB IMA	 ILB01681

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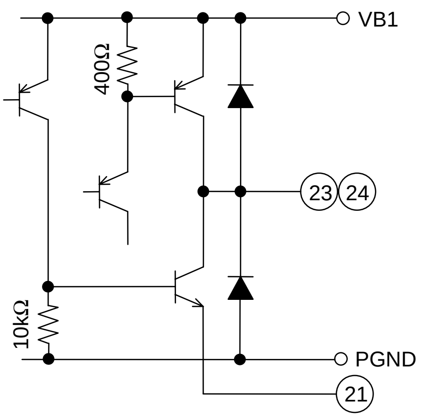
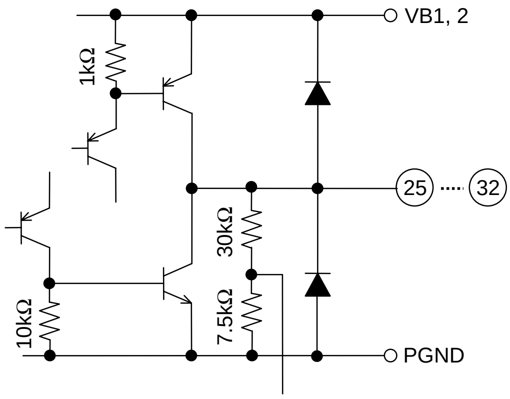
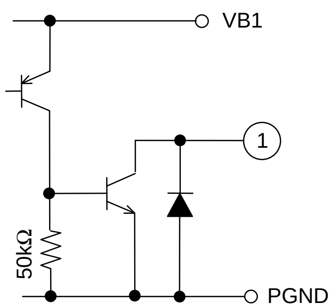
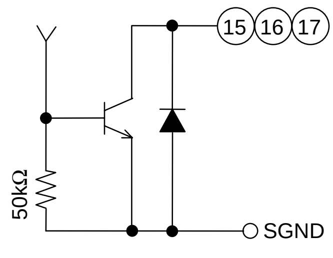
Pin number		Pin name	Internal equivalent circuit diagram
LB8658FN	LB8658PL		
24 23	22 21	OUT9 OUT10	 ILB01682
30 29 28 27 32 31 26 25	28 27 26 25 30 29 24 23	OUT1 OUT2 OUT3 OUT4 OUT5 OUT6 OUT7 OUT8	 ILB01683
1	1	ICH	 ILB01684
15 16 17	13 14 15	ZMPR ZMPI AFPI	 ILB01685

Application Design Notes

(1) Constant-voltage setting for OUT1 to OUT8
"H" output voltage for OUT1 and OUT2 can be set by the VC1 pin input voltage.
The setting formula is as follows:

(OUT1/OUT2 output voltage) = (VC1 input voltage) $\times$5.23

Correspondingly, OUT3 and OUT4 can be set by VC2, OUT5 and OUT6 can be set by VC3, and OUT7 and OUT8 can be set by VC4. The setting formula is as follows:

(OUT3/OUT4 output voltage) = (VC2 input voltage) $\times$5.23
(OUT5/OUT6 output voltage) = (VC3 input voltage) $\times$5.23
(OUT7/OUT8 output voltage) = (VC4 input voltage) $\times$5.23

In addition, if the right side setting of the above formula exceeds the supply voltage (VB), the output voltage is saturated.

(2) Output pin oscillation prevention capacitor for OUT1 to OUT8 constant-voltage control
For constant-voltage control of OUT1 to OUT8, a capacitor must be placed between OUT pins in order to prevent oscillation.
Test capacitor values between 0.01μF to 0.1μF and choose a value that does not cause output oscillation problems.
However, for the saturated drive, no oscillation prevention capacitor is necessary.

(3) Constant-current setting of OUT9 and OUT10
Constant-current setting between OUT9 and OUT10 depends on the IC pin input voltage and IMA/IMB pin connection resistance (current detection resistor). The IMA pin is connected to the GND side of H-bridge and the IMB pin is connected to the negative input of constant-current control amplifier. The IMA pin and the IMB pin are short circuited on the PWB to be used. (Short circuit near the current detection resistor is recommended.)
As shown in the block diagram, the output current is controlled so that the IC pin input voltage can be equal to the voltage generated on the current detection resistor, which is connected between IMA (IMB) and GND.
The formula for output current is as follows:

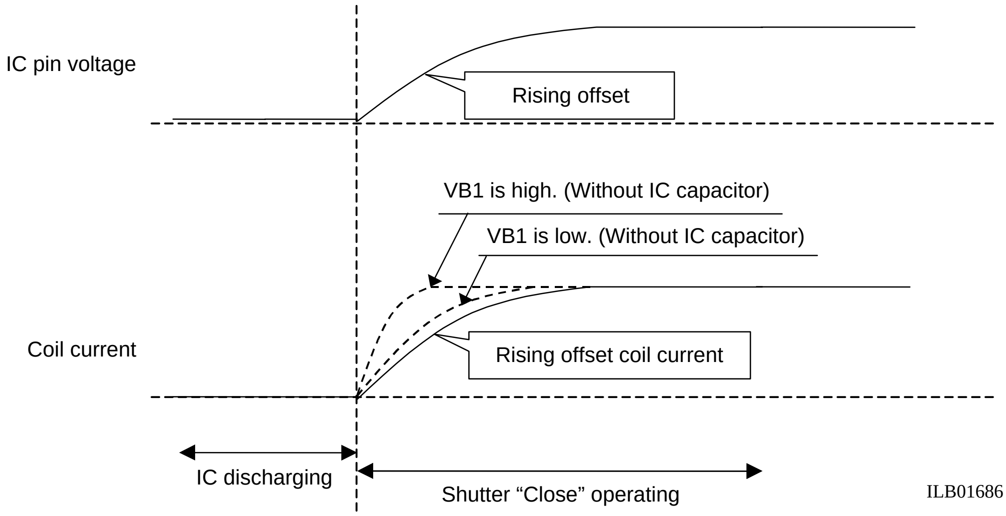
(Output current) = (IC input pin voltage) $\div$ (current detection resistance)

In addition, since the constant-current control block is connected to PGND inside the IC, when the voltage is supplied to the IC pin with partial resistance, GND side of the resistor must be connected to PGND.

(4) ICH pin
For the application when current is switched between shutter "Close" and "Open", the ICH pin is used.
The ICH pin is changed to "L" only in "Open" mode (refer to the Truth table). This allows the current for shutter "Open" to be set (switched) lower than the current for shutter "Close".
The IC pin input voltage is switched by the combined resistance value which is obtained from resistance connected to the IC pin (2 resistors between VREF and GND) and a resistor connected to the ICH pin.

(5) Fast charge/discharge circuit for the FC pin
In order to support high speed shutter control (sequential shutter), a built-in fast charge/fast discharge circuit is implemented in the shutter control block (OUT9 and OUT10).

(6) Constant-current rising offset function



The rising waveform of the coil current can be offset by having the external CR network give a slope to the rising waveform of the voltage input to the IC pin and setting a greater coil time constant to make the slope more gradual. This ensures stable shutter operation under severe power voltage fluctuations.

Note : When offsetting the rising waveform of the coil current using the IC pin, assume the VB1 voltage that could be obtained in the absence of the capacitor to the IC pin as the supposed minimum voltage and observe and confirm the rising waveform of the coil current that flows at that voltage, then determine the capacitance of the capacitor so as to yield a time constant value that is greater than the one that could produce the waveform generated at the supposed minimum voltage.

The rising waveform offsetting capacitor is unnecessary if the power voltage supplied is stable or in similar cases in which the rising waveform offsetting function is not required.

(7) FC pin phase compensation capacitor

The capacitor connected to the FC pin is used for phase compensation of constant-current control between OUT9 and OUT10.

Test capacitor values between 0.0015µF to 0.033µF and choose a value that does not cause output oscillation problems. (In particular, when a large-inductance coil is used, it is necessary to provide a margin to a capacity value.)

Moreover, since the constant-current control block is connected to PGND inside the IC, GND side of the FC pin capacitor must be connected to PGND.

(Cautions for FC pin capacitor setting)

For the capacitor value setting, set the value by which the output does not oscillate, observing an output voltage waveform.

In circuit, the FC pin is connected to the output part of the constant-current control amplifier, and an output transistor drives because the potential of the FC pin rises. That is, since the initial state of the FC pin influences the output-drive timing, the potential of the FC pin is discharged (fast discharge circuit) inside the IC to a certain level before the shutter is ON, and the potential of the FC pin is charged (fast charge circuit) inside the IC to a certain level when a shutter is ON, so that the state of the FC pin during shutter driving can always be constant on this IC. This allows constant input/output delay time.

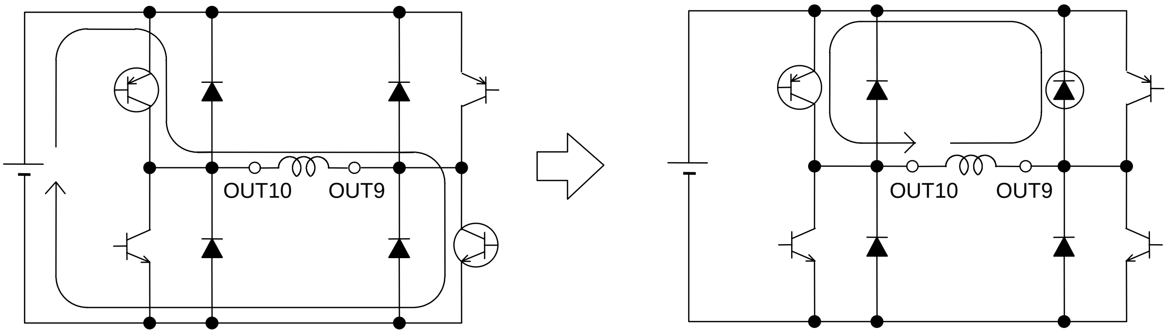
However, since the time involved in charge/discharge in the above-mentioned circuit will be long if the capacitor value setting is too large, the amount of variation in charge/discharge delay time will increase with the variation of capacitor value (absolute value variation and temperature characteristic).

Moreover, as another negative effect of setting a large value to the capacitor, it is considered that the rising inclination of coil current is moderate. Although the rising inclination of coil current originally depends on L component of the coil, if a large value is set to a capacitor and the capacitor time constant increases, the rising inclination of coil current depends on the value of the capacitor.

For the reasons mentioned above, especially in the applications in which a high-speed shutter drive is required, both the value by which output does not oscillate and as small a value as possible (0.0015µF to 0.033µF) must be set to a capacitor which is connected to the FC pin.

(8) Shutter drive “Regeneration” mode
The “Regeneration” (MD1/2/3/IN1/2 = L/L/L/H/H) in shutter mode is used to slow the coil current decay.
This mode makes coil current regenerative (Slow-Decay) within the output H-bridge by switching from “Close” (MD1/2/3/IN1/2 = L/L/L/L/H). (Refer to the following figure.)

(1) “Close” (MD1/2/3/IN1/2 = L/L/L/L/H) (2) “Regeneration” (MD1/2/3/IN1/2 = L/L/L/H/H)



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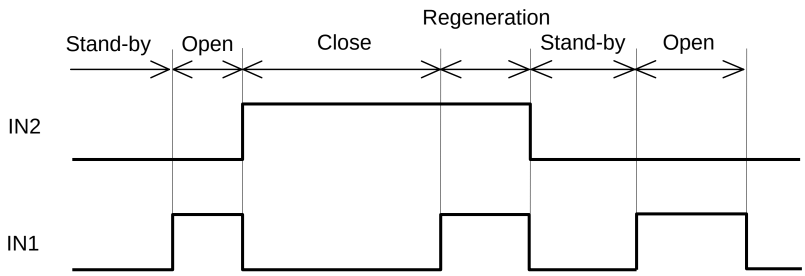
When shutter control is switched from “Stand-by” to “Close” (“Open”), the current rises to the target constant-current value from the state of output current 0 (zero). However, the output of the constant-current control amplifier inside the IC is in the full drive state during the above-mentioned “Regeneration” state. Therefore, when it is switched from “Regeneration” to “Close” (“Open”), the current falls to the target constant-current value from the state of full drive output.
For that reason, to switch the shutter drive to “Close” (“Open”) from “Regeneration” by constant-current control, it must be switched to “Stand-by” once before switching to “Close” (“Open”).
The example of drive sequence is shown in the figure below.



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(9) GND wiring and each power supply line capacitor
Connect PGND (2 places) and SGND near the IC and insert a capacitor to the part nearest the power supply pin for each power supply.