Ordering number : EN7897A

SANYO

SANYO Semiconductors
DATA SHEET

LB8656FN LB8656W

Monolithic Digital IC
Digital Camera Motor Driver

Features

- Integrates the actuator drivers required in a digital camera on a single chip

(1) Two focus motor constant voltage H-bridge drivers : can be used as a single stepping motor driver
- Constant voltage drive
- Supports both single-phase and 1-2 phase drive
- ♦ The voltage for each constant voltage channel can be set independently

(2) One shutter actuator constant current H-bridge driver : can be used as a voice coil motor driver
- Constant current drive
- ♦ The current level can be set independently for each excitation direction → Supports current limitation when the shutter is open.
- Stable response speed during continuous drive provided by rapid charge and rapid discharge circuits
- Supports constant current rising waveform correction using an external RC circuit (The external RC components are not required when correction is not used.)
  → Changes in the coil current rise due to supply voltage fluctuations are suppressed.
- ♦ Includes regenerative braking logic

(3) Two aperture or zoom actuator low saturation voltage H-bridge drivers : can be used as a single stepping motor driver
- Constant voltage drive
- Supports both single-phase and 1-2 phase drive

(4) One zoom or aperture actuator constant voltage H-bridge driver : can be used as a single DC motor driver
- Constant voltage drive
- Can be switched between constant voltage drive and low saturation voltage drive → Switched by the IN13 input logic.
- Built-in short-circuit braking function

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Actuator Application Example

	Focus	Shutter	Aperture	Zoom
Application example 1	STM	VCM	STM	DCM
Application example 2	STM	VCM	VCM	STM

- Supports simultaneous drive of multiple actuators
- Five independent power supply systems (focus, shutter, aperture, zoom, and control)
- Supports low-voltage operation (from 1.9V)
- Low saturation voltage outputs (Vsat = 0.3V typical at I_O = 200mA)
- Zero current consumption in standby mode
- Built-in thermal protection circuit
- Miniature, thin-form packages. LB8656FN : VQFN48 (7×7), LB8656W : SQFP48 (7×7)

Specifications

Absolute Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	VB max	VB1, VB2, VB3, VB4	10.5	V
	V_{CC} max	V_{CC}	10.5	
Maximum input voltage	V_{IN} max	IN1 to IN13	-0.3 to 10.5	V
Maximum output current	I_O max1	OUT1, OUT2 , OUT3, OUT4	600	mA
	I_O max2	OUT5, OUT 6	600	
	I_O max3	OUT7, OUT8, OUT9, OUT10	600	
	I_O max4	OUT11, OUT12	600	
Maximum output voltage	V_{OUT} max1	OUT1, OUT2, OUT 3, OUT4	VB1 + VSF	V
	V_{OUT} max2	OUT5, OUT6	VB2 + VSF	
	V_{OUT} max3	OUT7, OUT8, OUT9, OUT10	VB3 + VSF	
	V_{OUT} max4	OUT11, OUT12	VB4 + VSF	
Allowable power dissipation	Pd max	Mounted on the standard circuit board *1 (for both the LB8656FN and the LB8656W)	1.0	W
Operating temperature	Topr		-20 to +80	°C
Storage temperature	Tstg		-55 to +150	°C

*1 Specified circuit board : 76.1 × 114.3 × 1.6mm^3, glass epoxy.

Allowable Operating Ranges at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage range	VB	VB1, VB2, VB3, VB4 *2	1.9 to 10	V
	V_{CC}	V_{CC} *2	1.9 to 10	
High-level input pin voltage	$V_{IN}H$	IN1 to IN13 *2	1.8 to 10	V
Low-level input pin voltage	$V_{IN}L$	IN1 to IN13 *2	-0.3 to 0.4	V
Constant voltage setting input range	VC	VC1, VC2, VC3	0.1 to VB	V
Constant current setting input range	VIC	ICR, I_{CC}	0.1 to 1.0	V

*2 There are no limitations on the relative levels of the voltages on the VB1, 2, 3, and 4, V_{CC}, and IN1 to IN13 pins.

Electrical Characteristics at Ta = 25°C, VB = V_{CC} = 2.4V

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Standby mode current consumption	ISTB	VB1 = VB2 = VB3 = VB4 = V_{CC} = 10V, IN1 to IN13 = Low		0.1	5.0	μA
V_{CC} system operating current consumption	I_{CC}	*10		3.0	5.5	mA
Reference voltage	Vref	Iref = -1mA	0.95	1.0	1.05	V
Control pin input current	$I_{IN}H$	V_{IN} = 5.0V		80	100	μA
	$I_{IN}L$	V_{IN} = 0V			0	
Thermal shutdown operating temperature	TSD	Design guarantee *9	160	180	200	°C

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Parameter	Symbol	Conditions	Ratings min	Ratings typ	Ratings max	Unit
Focus Constant Voltage Stepping Motor Driver (OUT1, OUT2, OUT3, and OUT4)						
Output constant voltage 1	V_O1	VC1, VC1 = 0.30V	1.48	1.55	1.62	V
Output saturation voltage 1	VSAT1	I_O = 0.2A (High and low side total)		0.37	0.50	V
VB system operating current consumption	IB1-1	*3		1.4	1.9	mA
	IB1-2	*4		2.7	3.6	
	IB1-3	*5		0.7	1.0	
	IB1-4	IN1/IN2/IN3/IN4 = High/High/High/High		1.1	1.5	
Shutter Constant Current VCM Driver (OUT5 and OUT6)						
Output constant current	I_O	ICR = 0.3V, Rf = 1Ω	253	270	287	mA
Output saturation voltage 2	VSAT2	I_O = 0.3A (High and low side total)		0.44	0.60	V
ICH saturation voltage	VICH	I_O = 1mA			0.1	V
VB system operating current consumption 2	IB2-1	IN5/IN6 = High/Low or Low/High		13	18	mA
	IB2-2	IN5/IN6 = High/High		6	8	
Aperture/Zoom Low Saturation Voltage Stepping Motor Driver (OUT7, OUT8, OUT9, and OUT10)						
Output saturation voltage 3	VSAT3	I_O = 0.2A (High and low side total)		0.30	0.45	V
VB system operating current consumption 3	IB3-1	*6		2.5	3.4	mA
	IB3-2	*7		5.0	6.7	
	IB3-3	*8		0.9	1.2	
	IB3-4	IN7/IN8/IN9/IN10 = High/High/High/High		1.5	2.0	
Zoom/Aperture Constant Voltage DCM Driver (OUT11 and OUT12)						
Output constant voltage 2	V_O2	VC3 = 0.30V	1.48	1.55	1.62	V
Output saturation voltage 4	VSAT4	I_O = 0.3A (High and low side total)		0.44	0.60	V
VB system operating current consumption 4	IB4-1	IN11/IN12 = High/Low or Low/High		1.5	2.0	mA
	IB4-2	IN12/IN12 = High/High		7.5	10.0	

*3 : IN1/IN2/IN3/IN4 = High/Low/Low/Low, Low/High/Low/ Low, Low/Low/High/Low, or Low/Low/Low/High

*4 : IN1/IN2/IN3/IN4 = High/Low/High/Low, High/Low/Low/High, Low/High/High/Low, or Low/High/Low/High

*5 : IN1/IN2/IN3/IN4 = High/High/Low/Low or Low/Low/High/High

*6 : IN7/IN8/IN9/IN10 = High/Low/Low/Low, Low/High/Low/ Low, Low/Low/High/Low, or Low/Low/Low/High

*7 : IN7/IN8/IN9/IN10 = High/Low/High/Low, High/Low/Low/High, Low/High/High/Low, or Low/High/Low/High

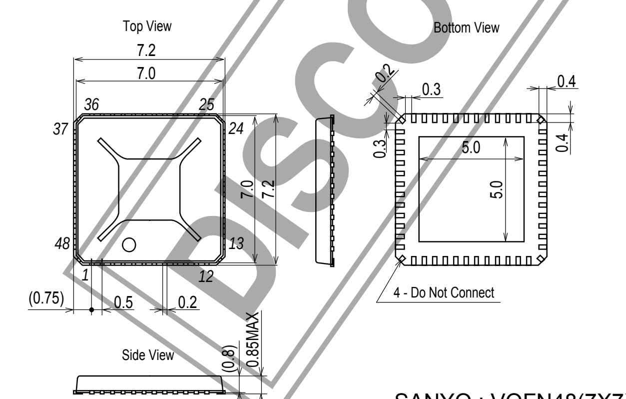
*8 : IN7/IN8/IN9/IN10 = High/High/Low/Low or Low/Low/High/High

*9 : The design specification items are design guarantees.

*10 : With at least one of IN1 to IN13 at the high level

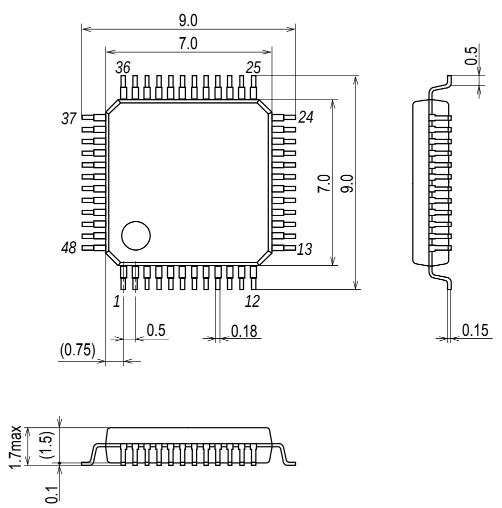
Package Dimensions

unit:mm (typ)
3272 [LB8656FN]



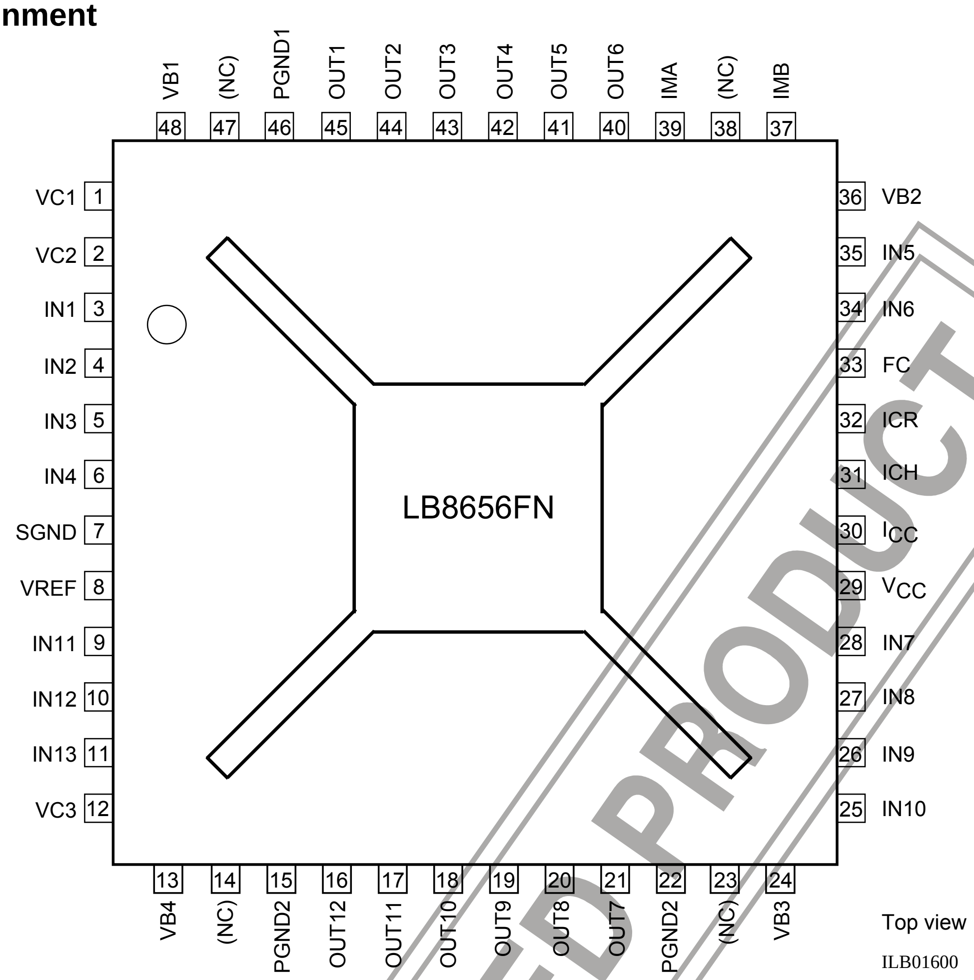
SANYO : VQFN48(7X7)

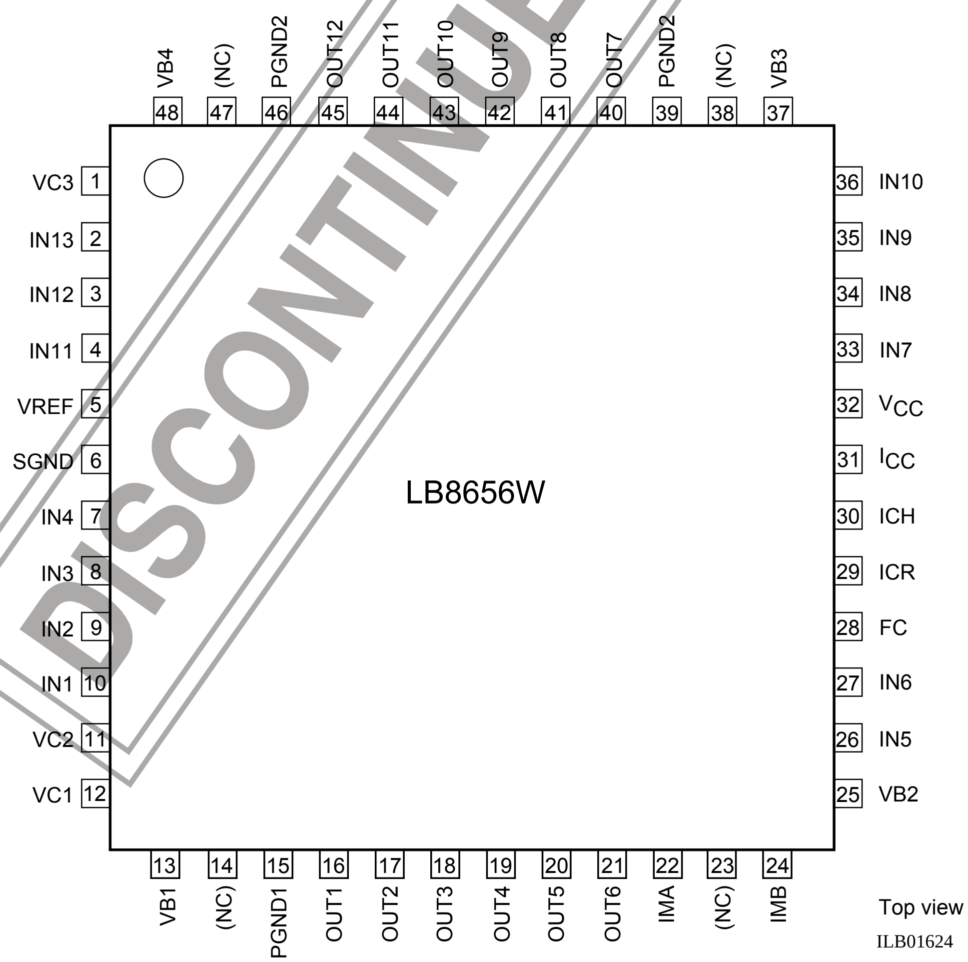
unit : mm (typ)
3163B [LB8656W]



SANYO : SQFP48(7X7)

Pin Assignment

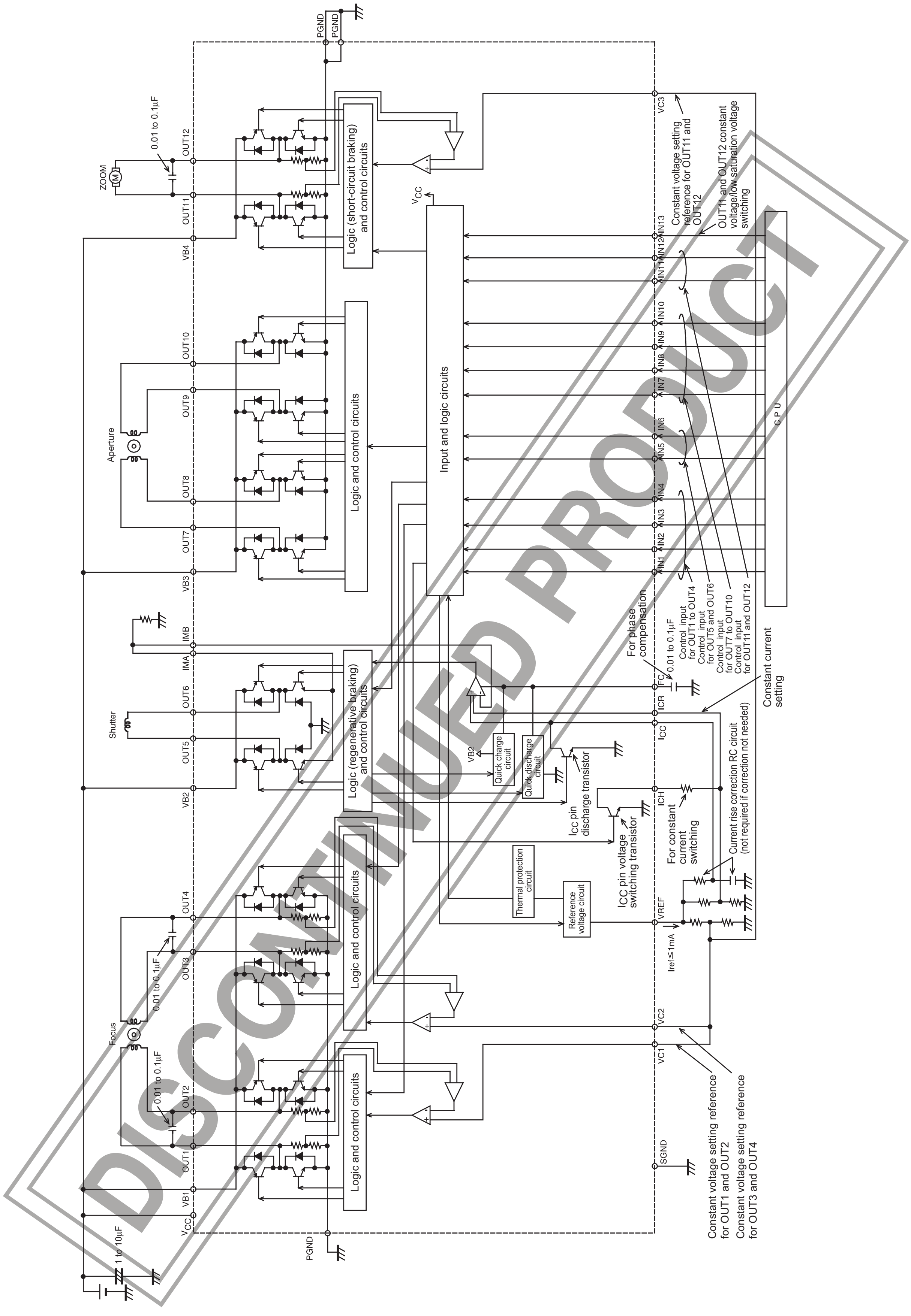




Pin Functions

Pin No.		Pin	Description	Protective diodes						
				High side					Low side	
-FN	-W			VB1	VB2	VB3	VB4	V_{CC}	PGND	SGND
48	13	VB1	Battery power supply							
36	25	VB2								
24	37	VB3								
13	48	VB4								
29	32	V_{CC}	Control system power supply							
15 22 46	15 39 46	PGND	Power system ground							
7	6	SGND	Control system ground							
39	22	IMA	Current detection for OUT5 and OUT6							
37	24	IMB	Current detection feedback for OUT5 and OUT6							
45	16	OUT1	Motor drive output	○					○	
44	17	OUT2		○					○	
43	18	OUT3		○					○	
42	19	OUT4		○					○	
41	20	OUT5			○				○	
40	21	OUT6			○				○	
21	40	OUT7				○			○	
20	41	OUT8				○			○	
19	42	OUT9				○			○	
18	43	OUT10				○			○	
17	44	OUT11					○		○	
16	45	OUT12					○		○	
3	10	IN1	Control signal input							○
4	9	IN2								○
5	8	IN3								○
6	7	IN4								○
35	26	IN5								○
34	27	IN6								○
28	33	IN7								○
27	34	IN8								○
26	35	IN9								○
25	36	IN10								○
9	4	IN11								○
10	3	IN12								○
11	2	IN13								○
8	5	VREF	Reference voltage output							○
1	12	VC1	Constant voltage setting reference input							○
2	11	VC2								○
12	1	VC3								○
33	28	FC	Phase compensation							○
32	29	ICR	Constant current setting reference input							○
30	31	I_{CC}	Constant current rise correction							○
31	30	ICH	Constant current setting switching output							○

Block Diagram



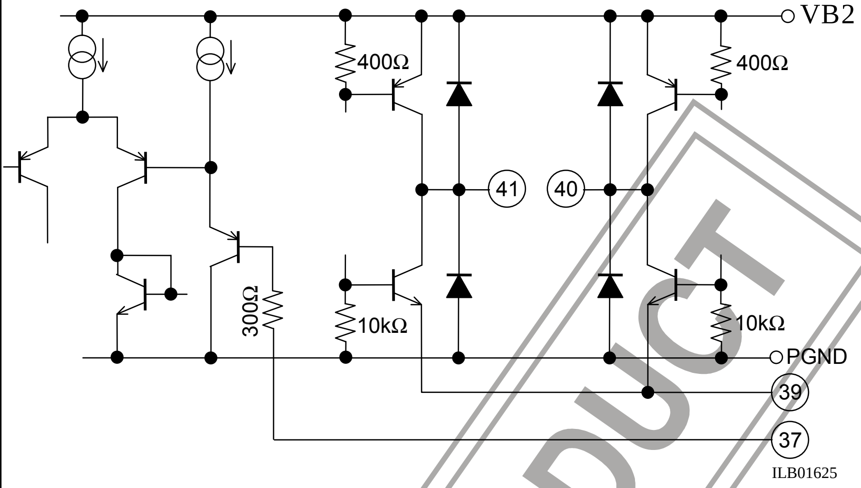
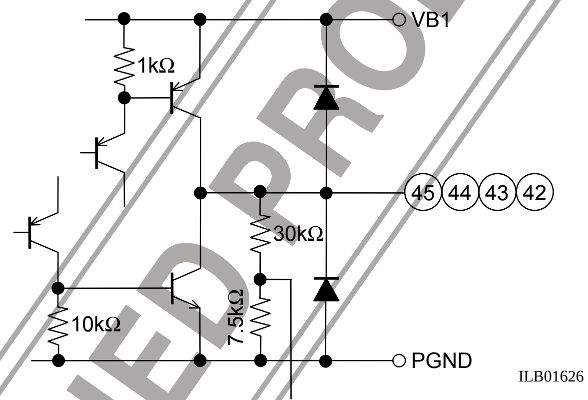
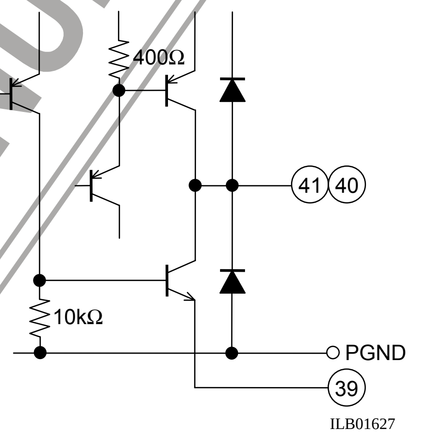
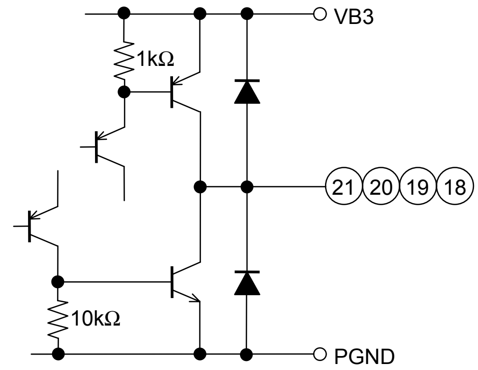
Note : For space reasons, not all of the protective diodes are shown.
See pages 9 to 11, Pin Internal Equivalent Circuits, for details on the protective diodes for each pin.

Truth Table

Input													Output												VREF	ICH	Mode		
IN1	IN2	IN3	IN4	IN5	IN6	IN7	IN8	IN9	IN 10	IN 11	IN 12	IN 13	OUT1	OUT2	OUT3	OUT4	OUT5	OUT6	OUT7	OUT8	OUT9	OUT 10	OUT 11	OUT 12					Application
L	L	L	L	L	L	L	L	L	L	L	L	L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Standby		
L	L												-	-												-	off	Constant voltage	Focus Stepping Motor
L	H												L	H													2→1		
H	L												H	L													1→2		
H	H												-	-													off		
		L	L												-	-										-	off		
		L	H												L	H											4→3		
		H	L												H	L											3→4		
		H	H												-	-											off		
				L	L												-	-								-	off	Constant current	Shutter VCM*
				H	L												H	L									Close		
				H	H												H	-									Regeneration		
				L	H												L	H								L	Open		
						L	L												-	-						-	off	Saturation	Exposure or Zoom
						L	H												L	H							8→7		
						H	L												H	L							7→8		
						H	H												-	-							off		
								L	L												-	-				-	off		Stepping Motor
								L	H												L	H					10→9		
								H	L												H	L					9→10		
								H	H												-	-					off		
										L	L	L											-	-		-	off	Constant voltage	Zoom DC Motor or Exposure VCM
										L	H												L	H			Forward		
										H	L												H	L			Reverse		
										H	H												L	L			Brake		
										L	L	H											-	-		-	off	Saturation	
										L	H												L	H			Forward		
										H	L												H	L			Reverse		
										H	H												L	L			Brake		
With at least one of IN1 to IN13 at the high level																									1.0V				

* : VCM : Voice Coil Motor

Internal Equivalent Circuits (The pin numbers in the figures apply to the LB8656FN.)

Pin No.		Pin	Equivalent Circuit
LB8656FN	LB8656W		
39 37	22 24	IMA IMB	
45 44 43 42	16 17 18 19	OUT1 OUT2 OUT3 OUT4	
41 40	20 21	OUT5 OUT6	
21 20 19 18	40 41 42 43	OUT7 OUT8 OUT9 OUT10	

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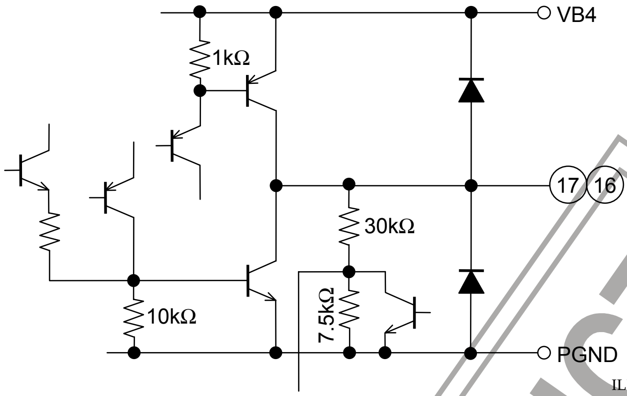
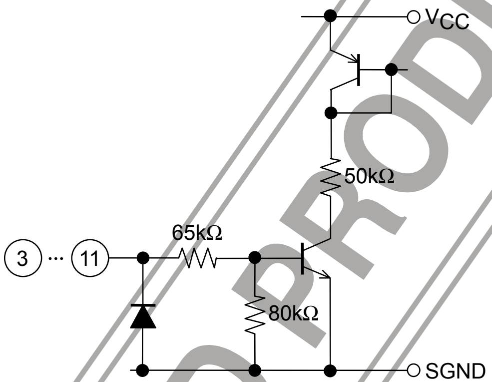
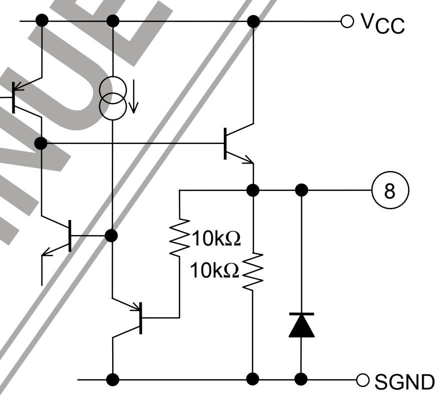
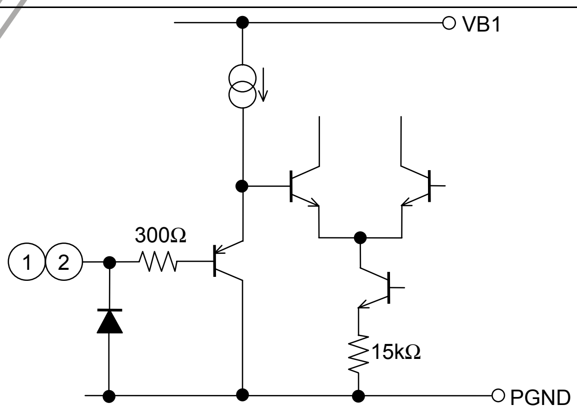
Pin No.		Pin	Equivalent Circuit
LB8656FN	LB8656W		
17 16	44 45	OUT11 OUT12	ILB01629
3 4 5 6 35 34 28 27 26 25 9 10 11	10 9 8 7 26 27 33 34 35 36 4 3 2	IN1 IN2 IN3 IN4 IN5 IN6 IN7 IN8 IN9 IN10 IN11 IN12 IN13	ILB01630
8	5	VREF	ILB01631
1 2	12 11	VC1 VC2	ILB01632

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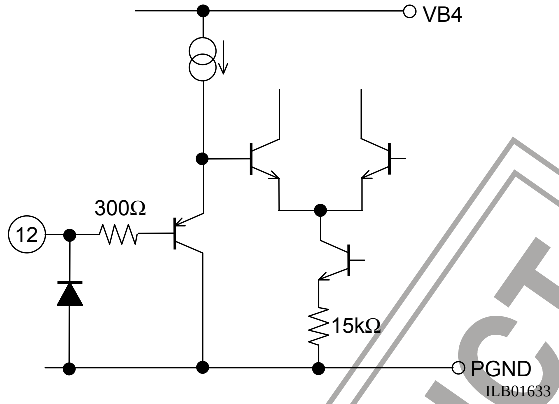
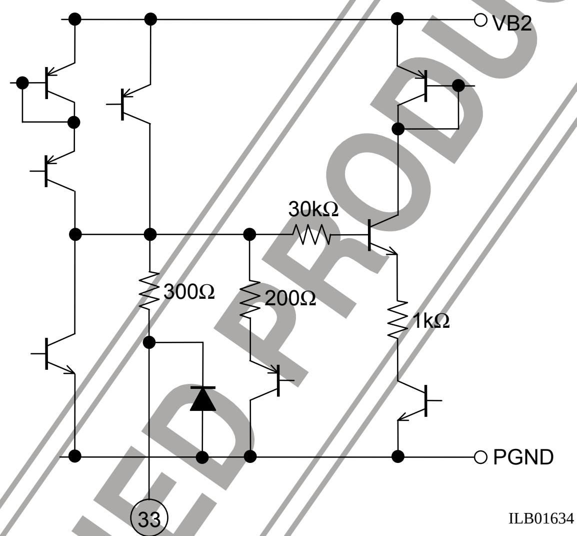
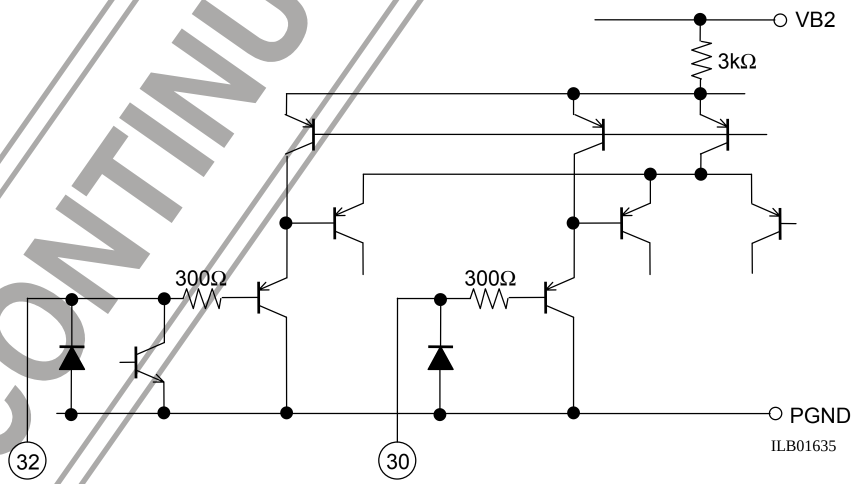
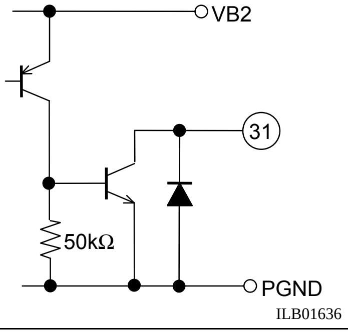
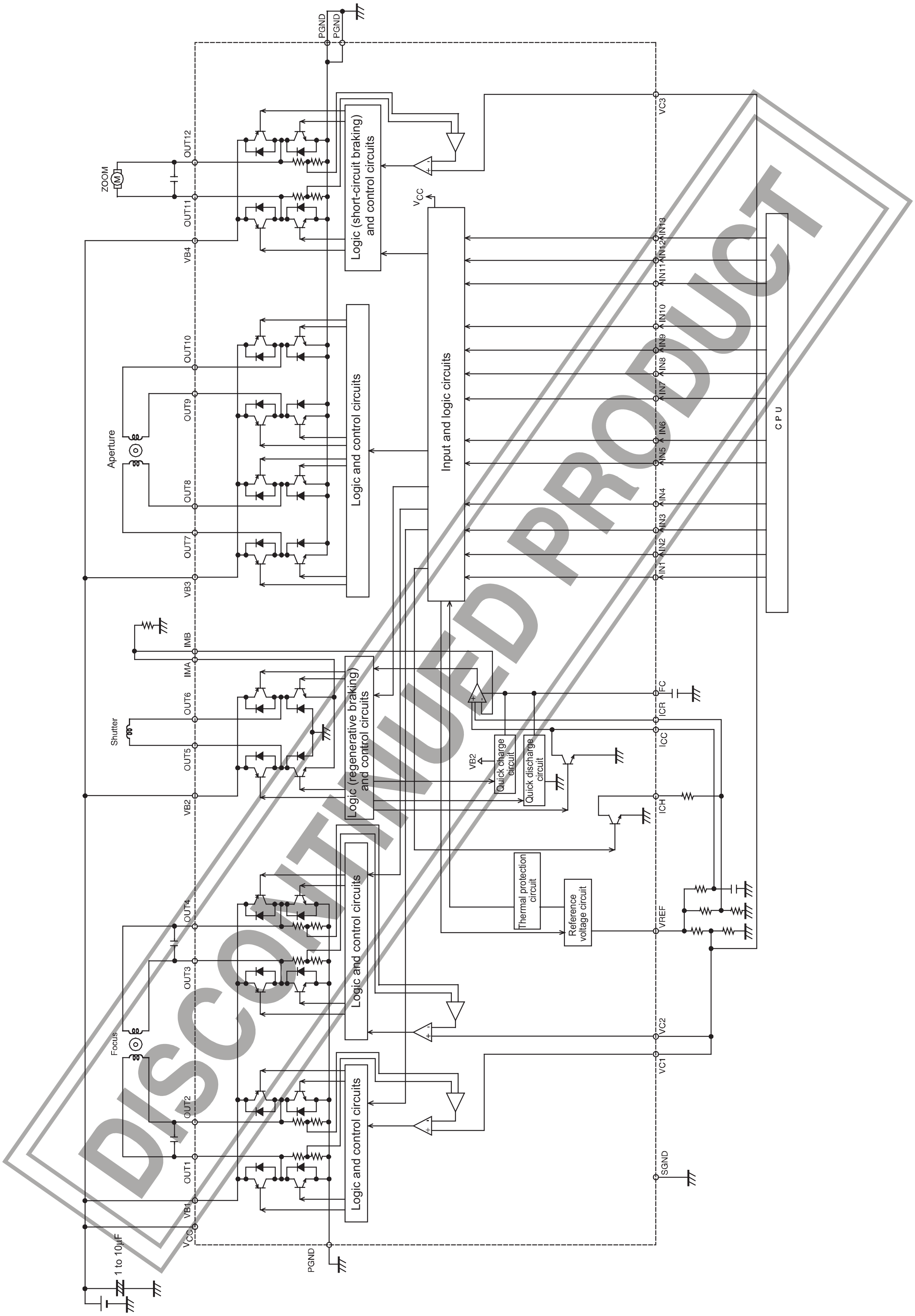
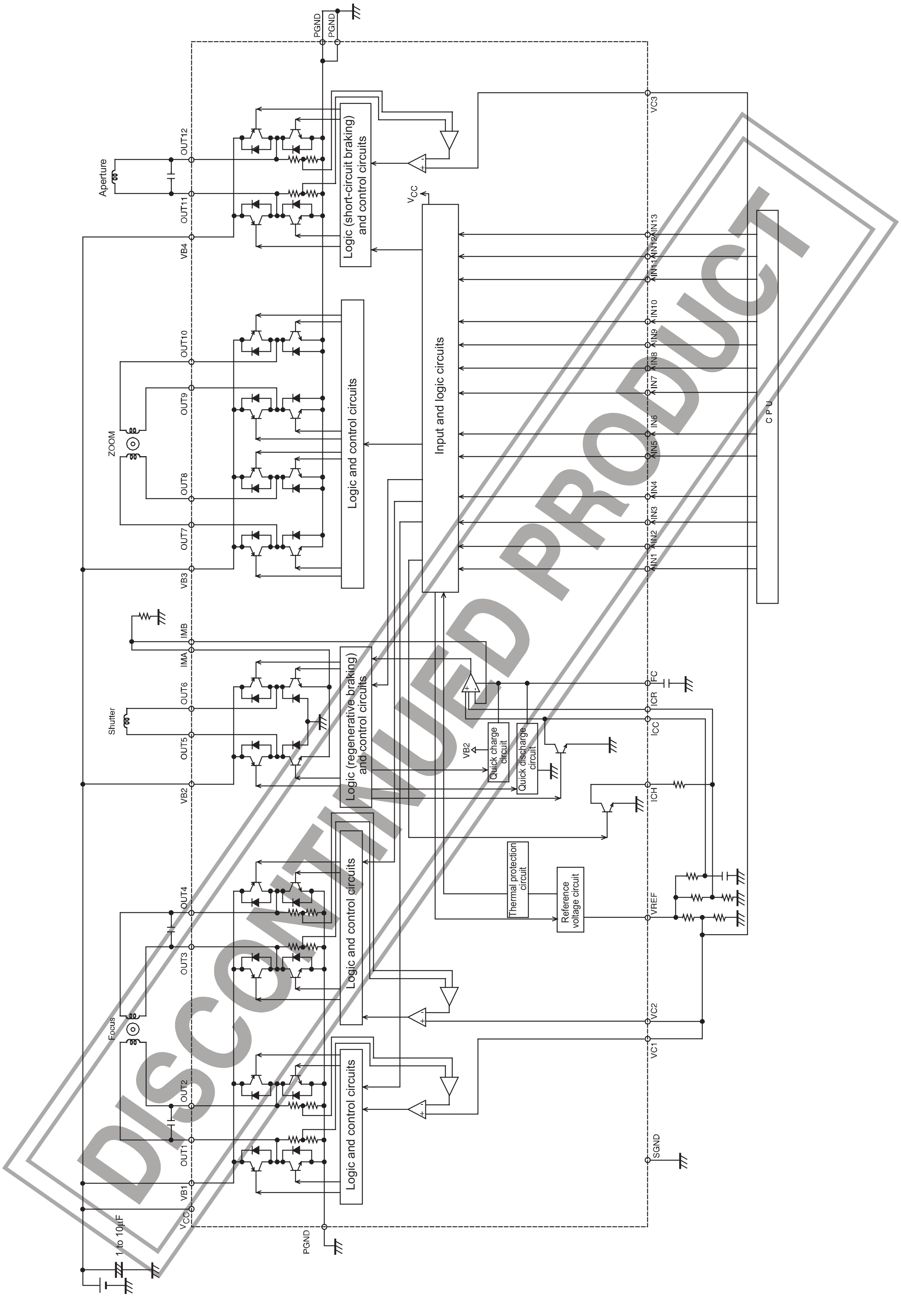
Pin No.		Pin	Equivalent Circuit
LB8656FN	LB8656W		
12	1	VC3	
33	28	FC	
32 30	29 31	ICR I_{CC}	
31	30	ICH	

Application Example

[Example 1]



[Example 2]


PGND
PGND
VC3
OUT12
Aperture
OUT11
Logic (short-circuit braking) and control circuits
VCC
VB4
AIN13
AIN12
AIN11
OUT10
AIN10
AIN9
AIN8
AIN7
OUT9
ZOOM
Logic and control circuits
Input and logic circuits
IN6
CPU
AIN5
OUT8
AIN4
AIN3
OUT7
AIN2
AIN1
VB3
IMB
IMA
FC
OUT6
ICR
Shutter
Logic (regenerative braking) and control circuits
ICC
OUT5
VB2
Quick charge circuit
Quick discharge circuit
VB2
ICH
Thermal protection circuit
OUT4
Logic and control circuits
Reference voltage circuit
VREF
OUT3
Focus
VC2
VC1
OUT2
Logic and control circuits
OUT1
SGND
VB1
VCC
1 to 10μF
PGND

Notes on Application Design

(1) Notes on constant voltage settings for OUT1 to OUT4 and OUT11/OUT12.

The OUT1 and OUT2 high level output voltage can be set with the VC1 pin input voltage.
The equation below gives the output voltage.

(OUT1 and OUT2 output voltage) = (VC1 input voltage) × 5.17

Similarly, OUT3 and OUT4 are set by VC2, and OUT11 and OUT12 are set by VC3.
The equations below gives the output voltages.

(OUT3 and OUT4 output voltage) = (VC2 input voltage) × 5.17
(OUT11 and OUT12 output voltage) = (VC3 input voltage) × 5.17

Also, note that the outputs will saturate if levels that exceed the supply voltage (VB) are set up using the above equations.

(2) Output pin oscillation stopping capacitors when constant current control is used for OUT1 to OUT4 and OUT11/OUT12.

It is necessary to connect oscillation prevention capacitors between the outputs when OUT1 to OUT4 and OUT11/OUT12 are used in constant voltage control mode.
Consider capacitor values in the range 0.01μF to 0.1μF and select capacitor values such that oscillation does not occur.
Note that these oscillation prevention capacitors are not required if the outputs are driven at saturation.

(3) Notes on constant current settings for OUT5 and OUT6

The constant current setting for OUT5 and OUT6 is determined by the ICR pin input voltage and the value of the resistor (the current detection resistor) connected to the IMA and IMB pins. Here, the IMA pin is connected to the H-bridge ground side and the IMB pin is connected to the constant current control amplifier inverting input. The IMA and IMB pins are used shorted together on the circuit board. (It is ideal to short these pins together close to the current detection resistor.)
The output current is controlled so that the ICR pin input voltage and the voltage that is generated across the current detection resistor connected between IMA (IMB) and ground as shown in the block diagram are the same. The following equation calculates the output current.

(output current) = (ICR input pin voltage) ÷ (current detection resistor value)

Note that since the constant current control block in the IC is connected to PGND, if a voltage is supplied to the ICR pin with a voltage divider, the ground side of that resistor divider must be connected to PGND.

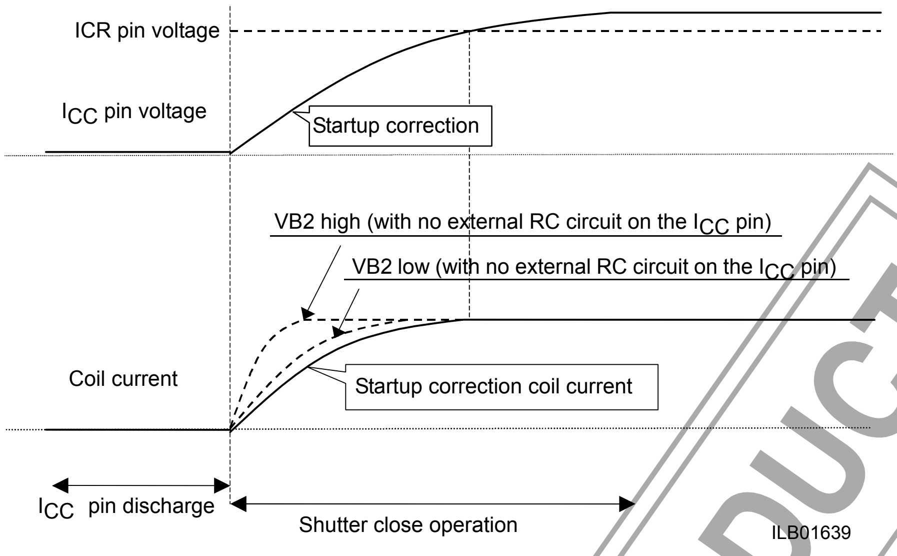
(4) Notes on the ICH pin

The ICH pin is used to switch the current used for closing and opening the shutter.
The ICH pin goes low only when the shutter circuit is in open mode. (See the truth table.) This makes it possible to set (switch) the current shutter is open to be lower than the current when the shutter is open.
The ICR pin input voltage is switched by the synthesized resistor value of the resistor connected to the ICH pin and the resistors (the two resistors between VREF and ground) connected to the ICR pin.

(5) Notes on the FC pin quick charge and quick discharge circuits

To support high-speed shutter control (burst imaging) these IC include built-in quick charge and quick discharge circuits in the shutter control block (OUT5 and OUT6).

(6) Notes on the constant current rise correction function (I_{CC} pin)



There are cases when the slope of the power supply voltage dependency characteristics of the rise of the output coil current between OUT5 and OUT6 can be problematic. In such cases, the current rise slope can be set with the time constant of an external RC circuit by using the I_{CC} pin.

Although the constant current between OUT5 and OUT6 is set with the ICR pin input voltage, a slope can be imposed on the I_{CC} input voltage with an external RC circuit, and by setting that slope to be larger than the slope of the coil time constant, correction can be applied to the coil waveform for the rising section of that waveform. This makes it possible to provide stable shutter operation in the presence of power supply voltage fluctuations.

Note : For this waveform rise correction using the I_{CC} pin, take the voltage in the state where there is no external RC circuit connected to the I_{CC} pin as the lowest voltage envisioned for VB2, verify the rise waveform of the coil current at that time, and determine the capacitance so that the time constant is larger than that of this waveform. However, in cases where this rise correction circuit is not required, for example if the supply voltage is stabilized, the rise correction external RC circuit is not needed.

(7) Notes on the FC pin phase correction capacitor

The capacitor connected to the FC pin is used for phase correction of the OUT5/OUT6 constant current control circuit. Consider values in the range 0.0015μF to 0.033μF for this capacitor and select a capacitor value such that oscillation does not occur. (If a coil with a particularly large inductance is used, adequate margin must be provided in this capacitor value.)

Note that since the constant current control block is connected to PGND internally to the IC, the ground side of the FC pin capacitor must be connected to PGND.

Notes on FC pin capacitor value determination

To determined the value for this capacitor, observe the output voltage waveform and select a value such that the output does not oscillate. In circuit terms, the FC pin is connected to the constant current control amplifier output block, and the output transistor is driven by increasing the FC pin potential. That is, since the FC pin's initial state influences the output drive timing, in this IC the FC pin potential is discharged (by the rapid discharge circuit) internally by the IC to a fixed level before the shutter is activated so that the FC pin state will always be the same when the shutter is operated. This stabilizes the I/O delay time.

However, if the capacitor value is too large, the time required for charge and discharge by the previously described circuit will increase, and the amount of the changes in the I/O delay time due to changes in the capacitor value (both sample-to-sample variations and changes due to the temperature characteristics) will become larger. Another problem that can be caused by making this capacitor value larger is that the slope of the rise of the coil current will become more gradual. Although the slope of the rise of the coil current is in principle determined by the inductance of the coil, if the capacitor is made larger, the capacitor time constant will become larger and the slope of the coil current rise will become dependent on the value of this capacitor.

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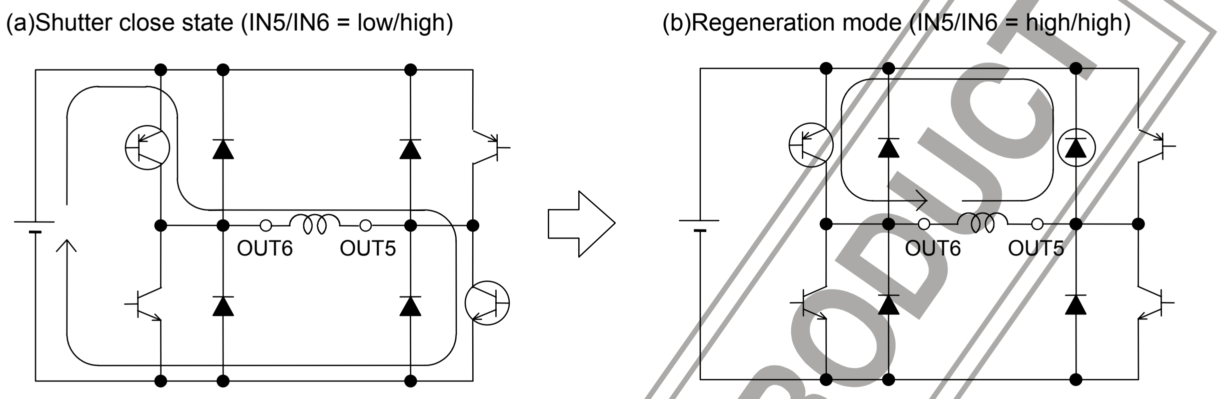
Due to the above considerations, the capacitor connected to the FC pin must be set to a value (in the range 0.0015μF to 0.033μF) that is as small as possible while still preventing oscillations, especially in applications that require high-speed shutter operation.

(8) Notes on shutter drive regeneration mode

Regeneration mode (IN5/IN6 = high/high) in the shutter modes is provided to regenerate (slow decay) the coil current within the output H bridge by switching from the shutter close state (IN5/IN6 = low/high) and gradually attenuate the coil current. (See the following figures.)



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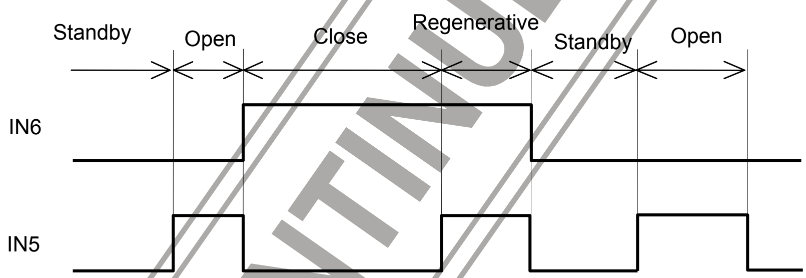
Although the output current is brought up to the target constant current value from the output current zero state in shutter control when operation is switched from the standby state to shutter close (or open), since the IC internal constant current control amplifier output goes to the full drive state when in the regenerative state described above, when switching from regenerate to shutter close (or open), operation has a form in which the current falls from full drive state to the target constant current value. Therefore, in constant current control, to switch from regenerate to shutter close (or open), a temporary standby state is inserted and then the state is switched to the target state.
The figure below presents an example of the operating sequence.



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(9) Ground wiring and the power supply capacitors

Capacitors must be connected to PGND (two places) and SGND as close to the IC as possible and they must be connected as close to the power supply pins as possible for each power supply.

This catalog provides information as of April, 2007. Specifications and information herein are subject to change without notice.