To our customers,

Old Company Name in Catalogs and Other Documents

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April 1st, 2010
Renesas Electronics Corporation

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M63151FP

Polygon Scanner Motor Driver (DMOS Driver)

REJ03F0028-0100Z
Rev.1.0
Sep.16.2003

Description

The M63151FP is a driver and controller for use with three-phase brushless motor. A DMOS element with high withstand voltage and low levels of switching loss is used on each output. Acceleration and deceleration inputs are operable at TTL levels.

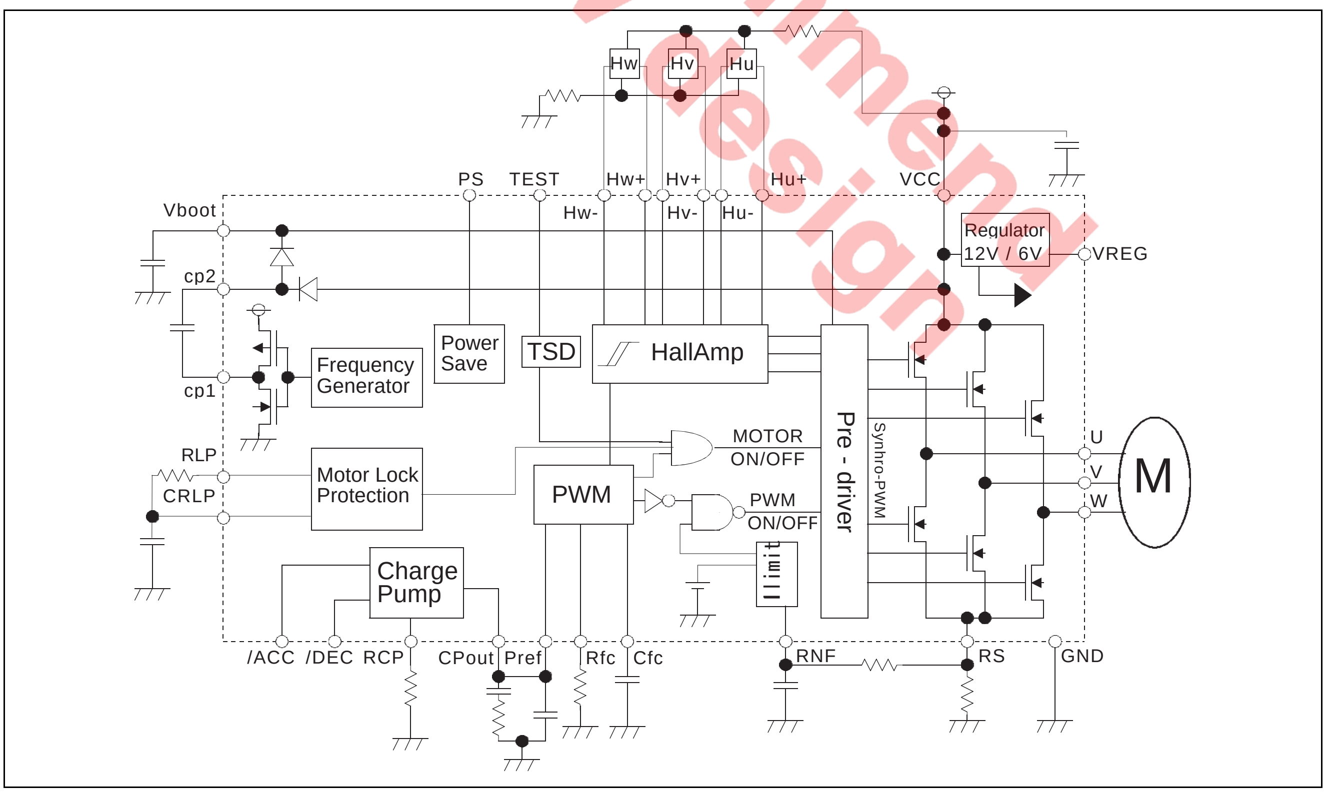
Features

- Power-supply voltage (max.): 30 V
- Output current (max.): 2.5 A
- RDS (typ.): 140 Ω (total of the upper and lower DMOS FETs)
- Built-in chip circuit for preventing through current in commutation
- Built-in chip comparator for current detection
- Buil-in chip overheating protection circuit
- Built-in chip motor-lock protection circuit

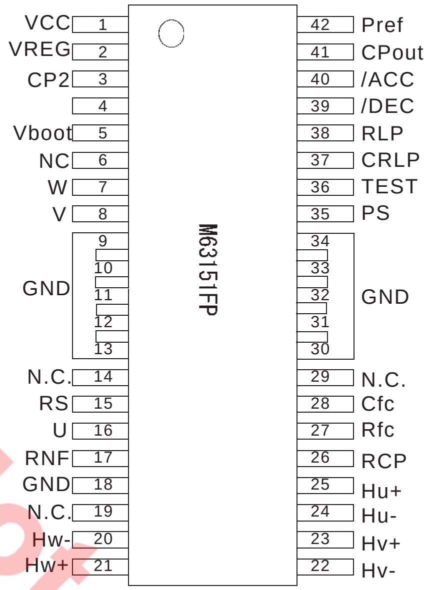
Applications

- OA equipment such as LBPs, copiers, and fax machines

Block diagram



Pin Functions



Package outline (42P9R)

Description of Pin Functions

Pin No.	Pin Name	Description
1	VCC	Motor power supply
2	VREG	Internal power supply
3	cp2	Pin 2 for connection of the step-up voltage capacitor
4	cp1	Pin 1 for connection of the step-up voltage capacitor
5	Vboot	Stepped-up voltage power-supply (internal)
6	N.C.	Open
7	W	W-phase drive output
8	V	V-phase drive output
9 to 13	GND	Ground
14	N.C.	Open
15	Rs	Output of detected current
16	U	U-phase drive output
17	Rss	Current detection
18	GND	Ground
19	N.C.	Open
20	Hw-	Hall signal input pin
21	Hw+	Hall signal input pin

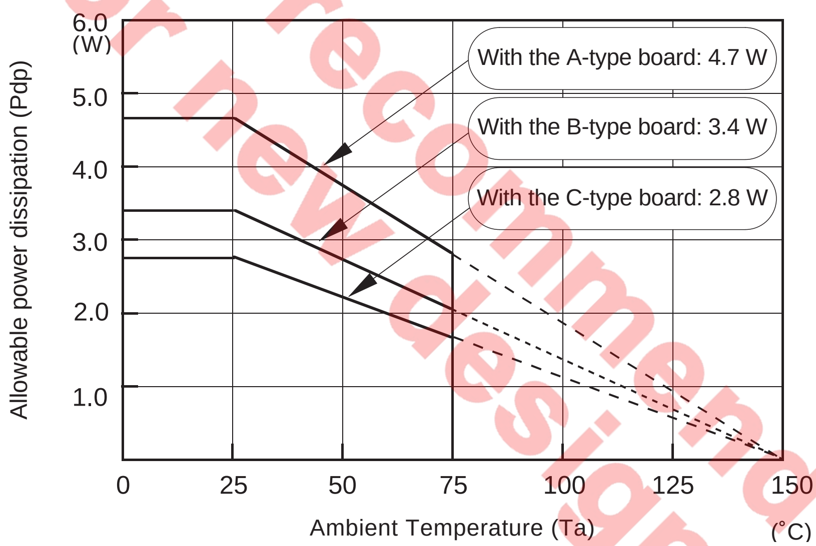
Pin No.	Pin Name	Description
42	Pref	PWM control voltage input
41	CPout	Charge-pump output
40	/ ACC	Input: request for acceleration
39	/ DEC	Input: request for deceleration
38	RLP	Resistor connection pin for lock protection
37	CRLP	Capacitor connection pin for lock protection
29	N.C.	Open
36	TEST	Test pin (Tj detection)
35	PS	Power-save switchover
30 to 34	GND	Ground
28	Cfc	For connecting the resistor used to set the PWM cycle
27	Rfc	For connecting the capacitor used to set the PWM cycle
26	RCP	Charge-pump output current setting
25	Hu+	Hall signal input pin
24	Hu-	Hall signal input pin
23	Hv+	Hall signal input pin
22	Hv-	Hall signal input pin

Absolute Maximum Ratings

(Ta = 25°C)

No.	Item	Symbol	Rated Value	Unit	Remarks
1	Power-supply voltage	Vcc	30	V	
2	Output current	Ipeak	3.0	A	
3	Hall-sensor amp. differential input range	VHA	4.5	V	
4	Voltage on input pins	Vin	–0.3 to 7	V	/ ACC, / DEC, / PS, Pref
5	Allowable dissipation	Pd	2.5	W	During start-up at Ta = 60°C, with the device mounted on an iron substrate
6	Parameter for thermal derating	Kθ	25	mW / °C	
7	Conjunction temperature	Tj	150	°C	
8	Ambient temperature during operation	Ta	–20 to +75	°C	
9	Temperature during storage	Tstg	–40 to +125	°C	

Thermal derating



Note: The large values for allowable power dissipation make it possible to use this device without a heat sink. At the very least, dissipation of 2.8 W is possible with a glass-epoxy single-layered board, and 4.7 W is obtained by applying special design measures to the board. For details on the configurations of boards A, B, and C, refer to ‘Boards used in the evaluation of thermal dating’ on page 11.

Electrical Characteristics (DC)

(Unless otherwise noted, Ta = 25°C, Vcc = 24 V)

Item	Symbol	Rated Values Min.	Typ.	Max.	Unit	Conditions of Measurement and Remarks
Output DMOS on-resistance	RDS	—	1.40	2.20	Ω	Total of on-resistance for upper and lower DMOS FET Iout = 1.0 A
Power-supply voltage range	Vcc	21.6	24.0	26.4	V	
Circuit current with no signal	Icc	—	5.4	10.0	mA	PS = 0 V
RNF pin threshold voltage	VRNF	212	250	288	mV	
PREF threshold voltage	Vpref	1.00	1.25	1.50	V	PREF voltage that satisfies RS current > 1 mA
/ACC input current H	IACCH	–1.0	—	1.0	µA	/ ACC = 5V
/ACC input current L	IACCL	–50	–10	—	µA	/ ACC = 0V
/DEC input current H	IDECH	—	250	500	µA	/ ACC = 5V
/DEC input current L	IDECL	–50	–10	—	µA	/ ACC = 0V
Acceleration current	ISS	–240	–200	–160	µA	/ ACC = Lo, / DEC = Hi, Rcp = 12KΩ at CPout = 2.0 V
Deceleration current	ISD	160	200	240	µA	/ ACC = Hi, / DEC = Lo, Rcp = 12KΩ at CPout = 2.0 V
Detent current	IZ	–100	0	+100	nA	/ ACC =5V, / DEC = Hi or Lo, at CPout =2.0 V
CPout output voltage range	VCPout	0.85	—	3.90	V	Less than the min. rated value when / ACC = 5 V, / DEC = 0 V; More than the max. rated value when / ACC = 0 V, / DEC = 5 V
Output leakage current	I leak	–100	0	100	µA	
Hall-sensor amp. same-phase input voltage range	VHA1	1.5	—	Vcc–2	V	
Hall-sensor amp input current	IHA	—	0.5	4.0	µA	Hµ+ = Hµ, Hv+ = Hv, Hw+ = Hw–
Hall-sensor amp input voltage hysteresis	Vhys	6.95	11.0	15.45	mV	Between Hµ+ and Hµ–, Hv+ and Hv–, and HW+ and HW-
Hall-sensor amp. min. input amplitude for operation	VHA2	50	—	—	mV	Between Hµ+ and Hµ–, Hv+ and Hv–, and Hw+ and Hw–; The amplitude that satisfies phase delay < 5 deg for the above variation of hysteresis voltage
PREF input current	IPref	–100	10	100	nA	Pref = 2.5 V

Electrical Characteristics (AC)

(Unless otherwise noted, Ta = 25°C, Vcc = 24 V)

Item	Symbol	Rated Values			Unit	Measurement Conditions and Remarks
		Min.	Typ.	Max.		
Delay from turning on to output	Tdon	—	1.0	1.5	µS	
Delay from turning off to output	Tdoff	—	0.5	1.0	µS	
Frequency of Fc oscillation	Fc	17.3	21.6	25.9	KHz	When RfC = 24 KΩ , Cfc = 470 pF
Time for motor-lock protection to operate	TML - ON	10.0	—	20.0	SEC	Between RLP and CRLP, 4.7 MΩ, between CRLP and GNDE, 1 µF, load for resistors U, V, W: 2R = 10 Ω
Time to resume after motor-lock protection	TML - OFF	10.0	—	20.0	SEC	As above

Items for Confirmation in Evaluation

Item	Symbol	Rated Values			Unit	Measurement Conditions and Remarks
		Min.	Typ.	Max		
Overheating shutdown operating temperature	TSG - ON	—	160	—	°C	
Overheating shutdown temperature hysteresis	TSD - OFF	—	30	—	°C	Temperature for resumption after reaching the shutdown operating temperature

Note: Operation of the device within the above TSD operating temperature range is not guaranteed. The guaranteed operation range of the device is up to Tjmax, that is, the absolute max. rating. The TSD operation is thus activation of the thermal protection circuit when Tjmax has been exceeded by mistake. Accordingly, the device must be operated at Tj = 150°C or below.

Precautions during Use

Protection from overheating:

The impedance between the power supply and output pins of the circuit board is low when the IC is in use. Contingencies such as the application of excessive voltage by voltage surges may lead to short-circuits forming between the output pins of the IC can lead to damage which includes destruction of the TSD module. The chip is then liable to catch fire. Accordingly, we strongly recommend that you consider the application of safety measures such as fuses.

Dissipation of heat:

Sufficient thermal evaluation must be performed before changes to the thermal environment (including power-supply voltage, output current, the circuit board, etc.). The new design must be brought within the margins for thermal dissipation. Also, note that a higher carrier frequency setting leads to a larger level of IC-internal switching loss.

Wiring on the board:

Within the IC, the output current flows through the current-sense resistor (in the 0.17-Ω level), and current control is applied when a fall in this voltage is detected. Also, since the flow of output current is for a high-speed switching operation, take care to avoid the generation of crosstalk between the wiring which carries the current and the wiring which is connected to the high-impedance input pins (Hall output), etc.

The motor-lock protection circuit:

Holding of the motor by some external or other factor leads to a continuous flow of the maximum current to the IC. The IC is thus equipped with a module that detects this condition; at specified intervals after the condition has been detected, the module stops the flow of current to the motor and automatically attempts to resumes operation. The time constant set by the resistor and capacitor which are externally connected to pins 37 and 38 determines the time from when the maximum current begins to flow until the motor is stopped; the same R and C values set the time from stopping to restarting of the motor. Make sure that the specified interval is longer than the time the motor takes to start up.

When the motor characteristics and setting for maximum current are such that the maximum current is exceeded when the duty cycle is 75% (RS voltage high period: low period = 3:1) or more, the IC judges that the maximum current is not continuously flowing. In such a case, this protection circuit does not operate.

If the IC junction temperature rises before or during the operation of this protective circuit, the overheat-protection circuit operation takes precedence.

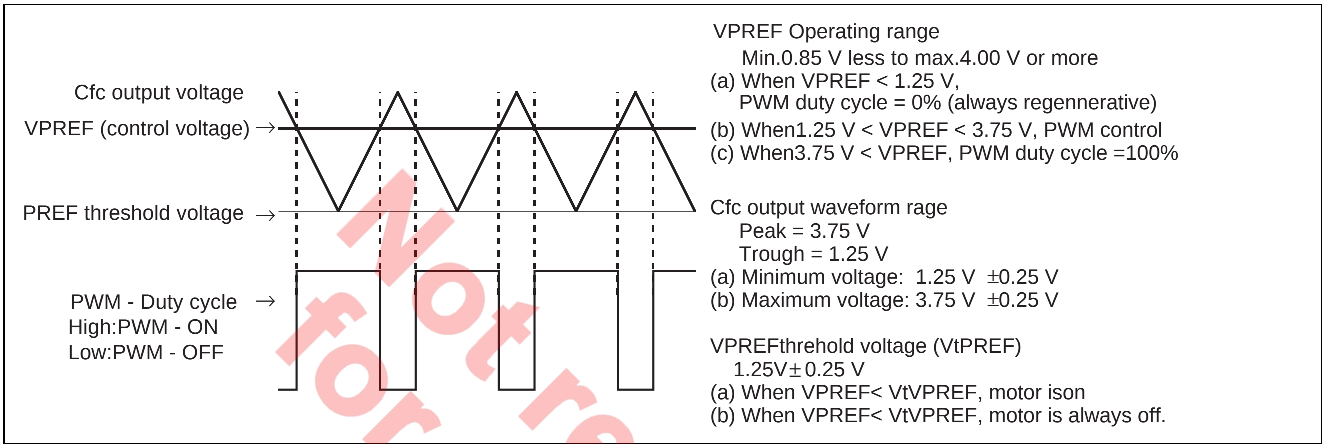
Short circuits between output pins and adjacent pins

This IC does not incorporate protection against short-circuits between pins. An attempt to output a current while there is a short-circuit between an output and VCC or ground, an output and VREG, or VCC and VREG may cause an over-current to flow; this may adversely affect the IC.

M63151FP PWM control method

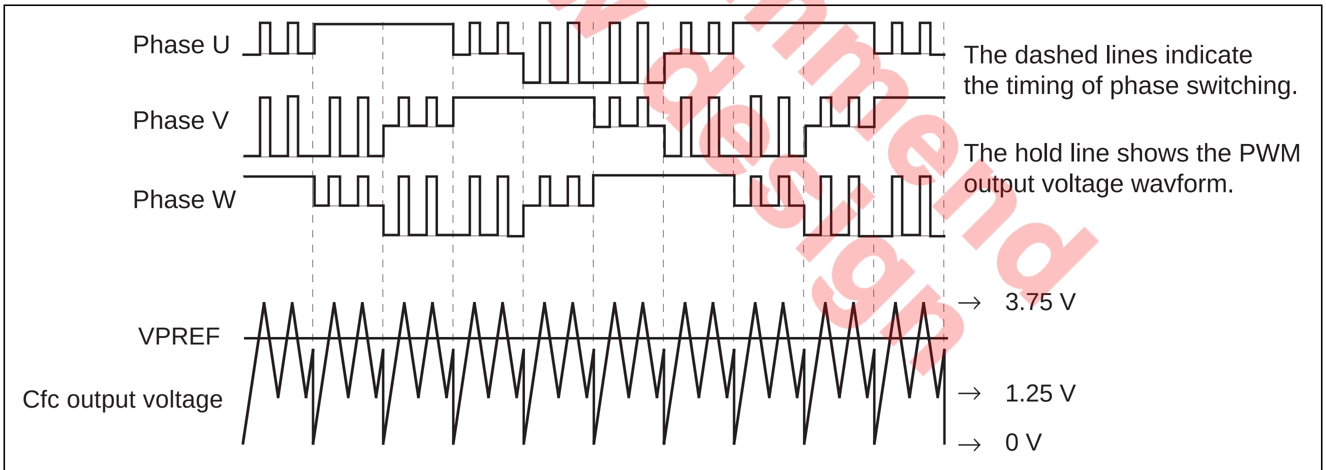
A triangular waveform is output on the CFC pin under the control of the values of the external capacitor connected to Cfc and the external resistor connected to Rfc. The PWM duty cycle is determined through comparison of this voltage with the control voltage determined by the current output from CPout and the external filter connected to the CPout and PREF pins, i.e. the voltage on PREF.

That is, PWM-ON is satisfied when the triangular waveform is at a level below the control voltage and PWM-OFF is satisfied (regenerative) when the triangular waveform rises above the control voltage. How the relation between the voltages on Cfc and Pref determines the output voltage is depicted below.



While the motor is rotating, the Cfc output voltage is driven low with the same timing as switching of phase for the motor in order to improve changes in the rotation speed.

Therefore, the voltage waveform output on <u>Cfc during actual motor operation</u> is as shown in the following figure.



Motor-Lock Protection Circuit (1)

As well as the overheating protection function, this IC incorporates a module that turns off current to the motor after the motor has been mechanically held over a specified period. This prevents overheating. The operating conditions of this module and a timing chart that depicts its operation are given below. Note, however, that when the IC does become overheated, the overheating protection circuit still operates because it takes precedence over the lock protection function.

(1) Conditions of operation

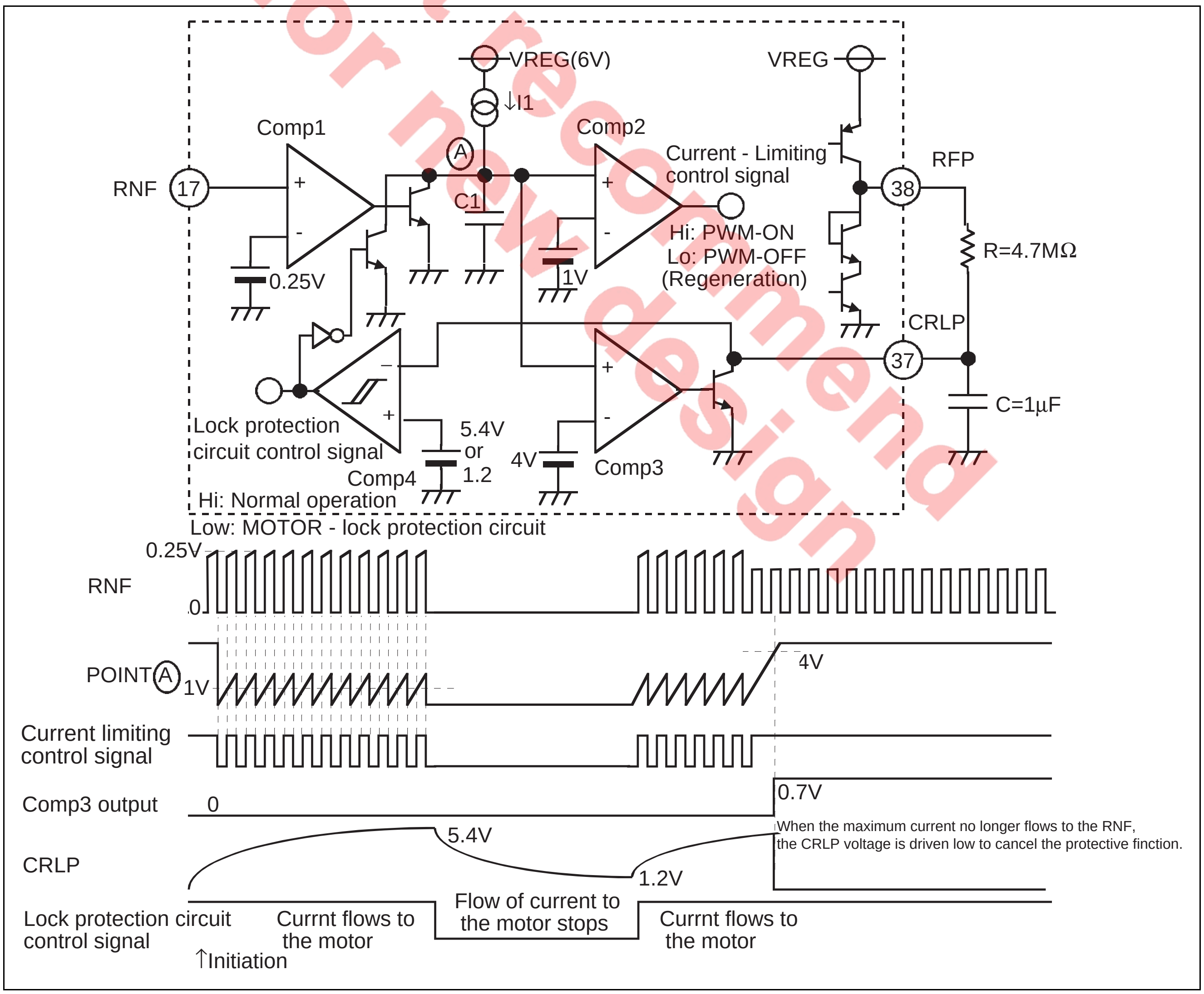
(a) The RS current detection resistor detects a continuous flow of the limit current (in practice, the current-limiting circuit leaves the IC operating as long as the voltage on RS stays within the range 0 to 0.25 V).

(b) Normally, the period at 0 V in item (a) will be 3.5 µs, and this is approximately equal to the period at 0.25 V. However, this circuit does not operate when motor characteristics, etc. mean that the period at 0.25 V is three times the period at 0 V (duty cycle = 75%) or longer.

(c) The period of the lock-protection circuit operations (the period from locking of the motor to the time when current to the motor is stopped) is determined by the time constant set up by the capacitor and resistor externally connected to pins 37 (CRLP) and 38 (RLP).

(d) After the motor has been turned off, automatic resumption is attempted at a time determined by the same R and C values as in point (c). External signals are not accepted until resumption.

(2) Block diagram



Motor Lock Protection Circuit (2)

The time intervals in the block diagram on the previous page are set up in the following ways.

(1) Current-limiting control signal low period

The flow of the limiting current to the RNF pin is detected, and the motor is regenaratively operated over the period indicated below:

Toff = C1 x V1 ÷ LI
= 17.5pF x 1V ÷ 6.25 μA
= 2.8 μs

Note, however, that a delay time of about 0.5 μs from the time when the high-side or low-side of a phase is turned off to the time when the output of the opposite side is turned on is set in the pre-drive stage of output. This prevents through current to and from upper and lower transistors within the same phase. Accordingly, the output voltage off period (regenerative time) is 0.5 μs plus the result of the above calculation, which is about 3.3 μs.

(2) Operation time of the motor-lock protection circuit

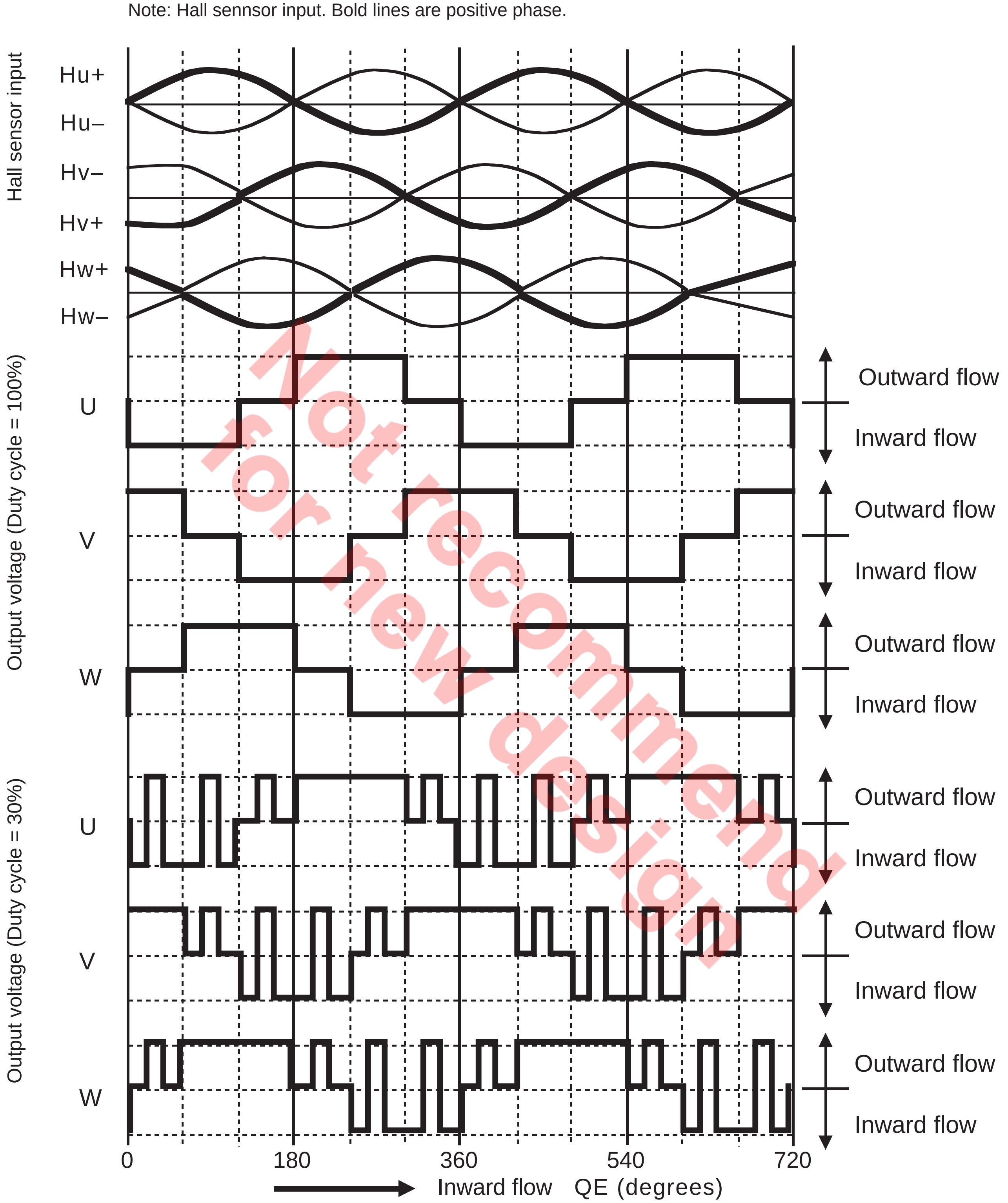
The following equation gives the time from locking of the motor to stoppage of current flow.

TML-ON = C x R x ln ((Vreg – R x I) ÷ ((Vreg – R x I) – V3))
= 1 μF x 4.7 MΩ x ln ((6 V – 4.7 MΩ x 17 nA ÷ ((6 V – 4.7 MΩ x 17 nA) – 5.4V))
= 11.42 s

Similarly, the period from the time when the motor is turned off to automatic resumption is:

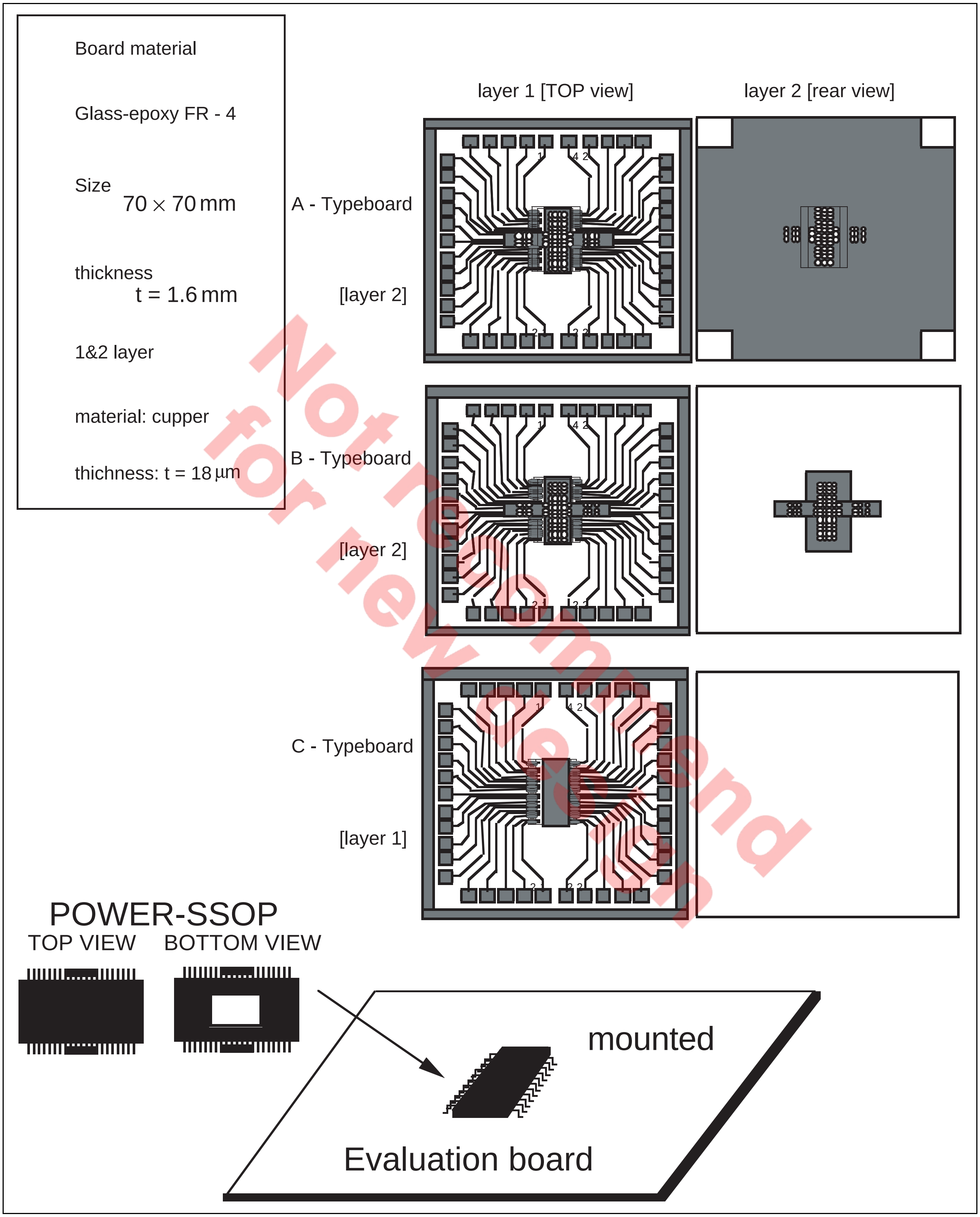
TML-OFF = C x R x ln ((V3 – 0.7 V – R x I) ÷ (V4-7V))
= 1 μF x 4.7 MΩ x ln (5.4 V – 0.7 V – 4.7 MΩ x 17 nA ÷ 1.2 V – 0.7 V)
= 10.45 s

Timing chart: motor output current / Hall input

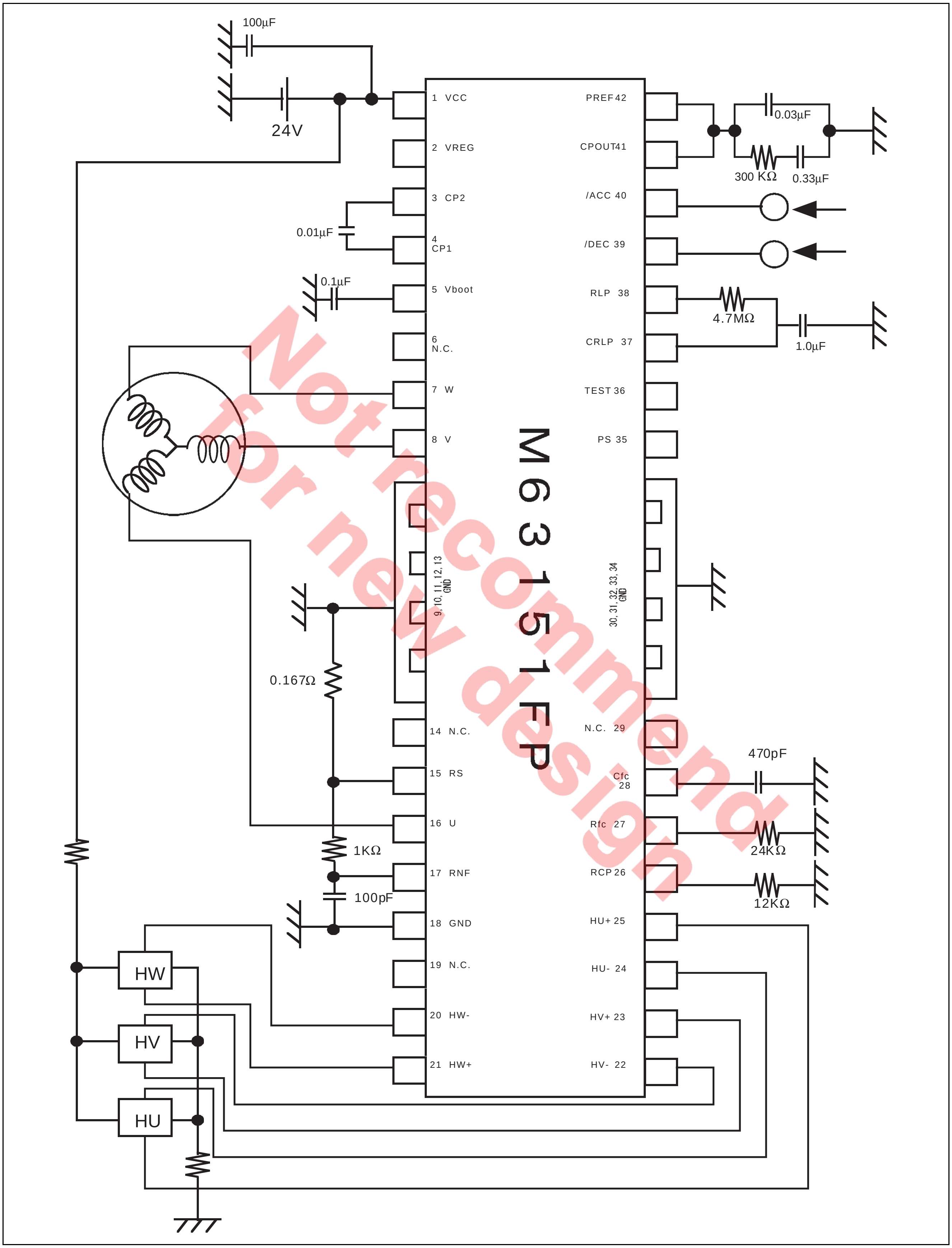


* : The above waveforms represent the tinming, and are not the same a the waveforms seen in actual operation of the motor.

Boards used in the evaluation of thermal derating



Sample circuit application



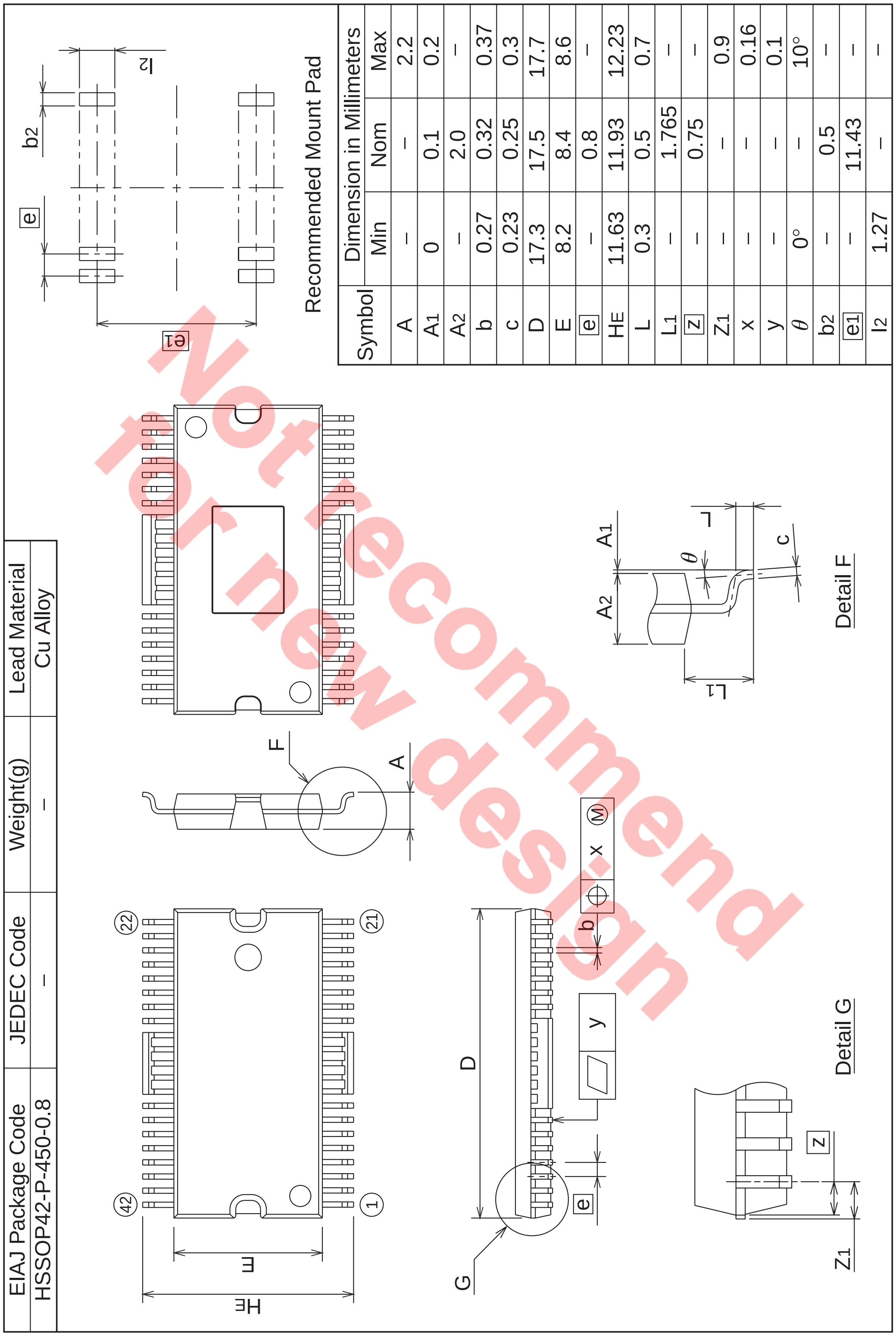
Package Dimensions

42P9R-C

MMP

Plastic 42pin 450mil HSSOP

EIAJ Package Code	JEDEC Code	Weight(g)	Lead Material
HSSOP42-P-450-0.8	–	–	Cu Alloy



Symbol	Dimension in Millimeters		
	Min	Nom	Max
A	–	–	2.2
A_1	0	0.1	0.2
A_2	–	2.0	–
b	0.27	0.32	0.37
c	0.23	0.25	0.3
D	17.3	17.5	17.7
E	8.2	8.4	8.6
e	–	0.8	–
H_E	11.63	11.93	12.23
L	0.3	0.5	0.7
L_1	–	1.765	–
z	–	0.75	–
Z_1	–	–	0.9
x	–	–	0.16
y	–	–	0.1
θ	0°	–	10°
b_2	–	0.5	–
e_1	–	11.43	–
I_2	1.27	–	–

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