STGIPL14K60

600 V, 14 A SDIP 38L molded IGBT intelligent power module

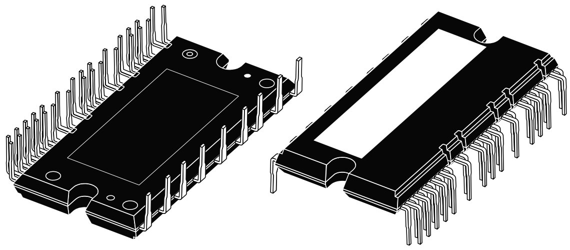
Preliminary data

Features

- 600 V, 14 A 3-phase IGBT inverter bridge including control ICs for gate driving and free-wheeling diodes
- 3.3 V, 5 V, 15 V CMOS/TTL inputs comparators with hysteresis
- Internal bootstrap diode
- Dead time and interlocking function
- 5 kΩ NTC for temperature control
- $V_{CE(sat)}$ negative temperature coefficient
- Short-circuit rugged IGBT
- Under-voltage lockout
- DBC fully isolated package
- Isolation rating of 2500 Vrms/min
- Smart shut down function
- Op-amps for advanced current sensing
- Comparators for fault protection against over current and short-circuit

Applications

- 3-phase inverters for motor drives
- Home appliances, such as washing machines, refrigerators, air conditioners



SDIP 38L molded

AM01193v1

Description

The new intelligent power module developed by STMicroelectronics provides a compact, high performance AC motor drive for a simple and rugged design. It mainly targets low power inverters for applications such as home appliances and air conditioners. It combines ST proprietary control ICs with the most advanced short circuit rugged IGBT system technology.

Table 1. Device summary

Order code	Marking	Package	Packaging
STGIPL14K60	GIPL14K60	SDIP 38L molded	Tube

This is preliminary information on a new product now in development or undergoing evaluation. Details are subject to change without notice.

Contents

1 Internal block diagram and pin configuration

Figure 1. Internal block diagram

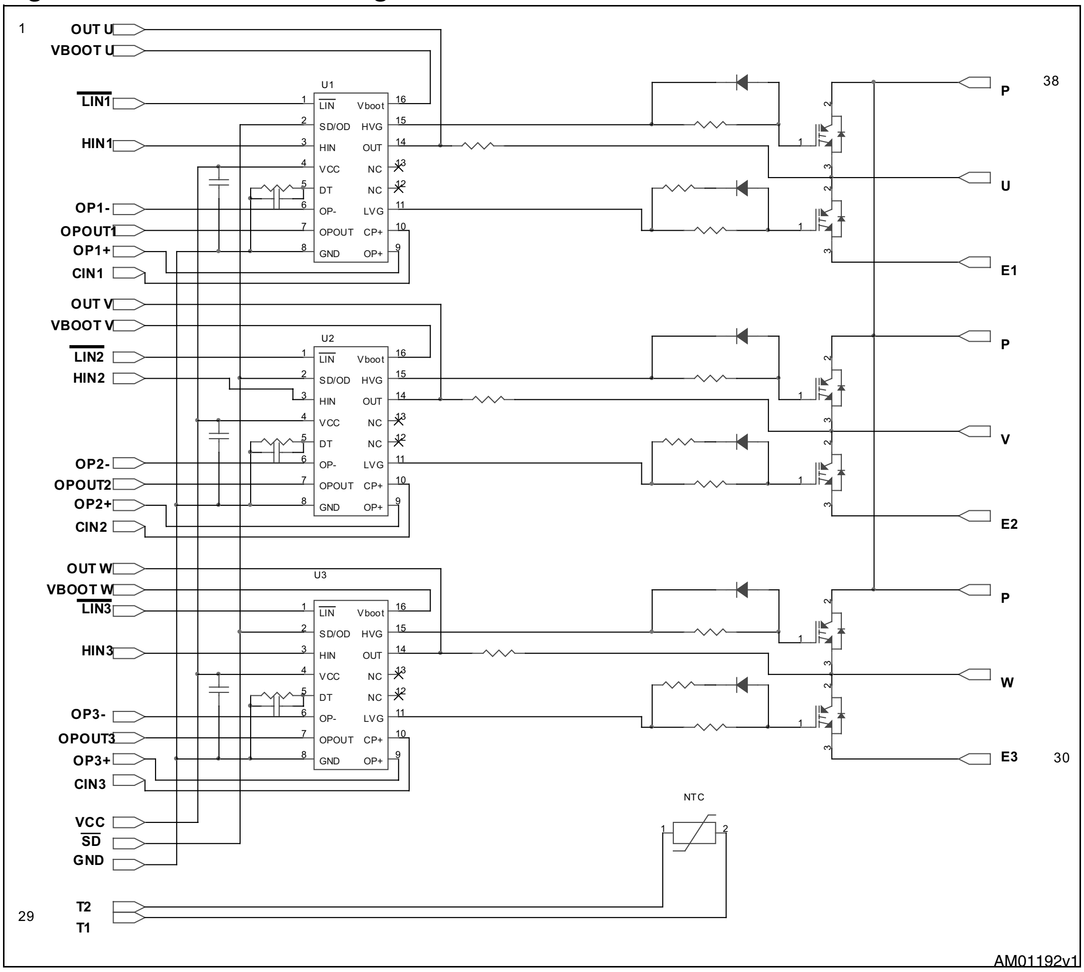
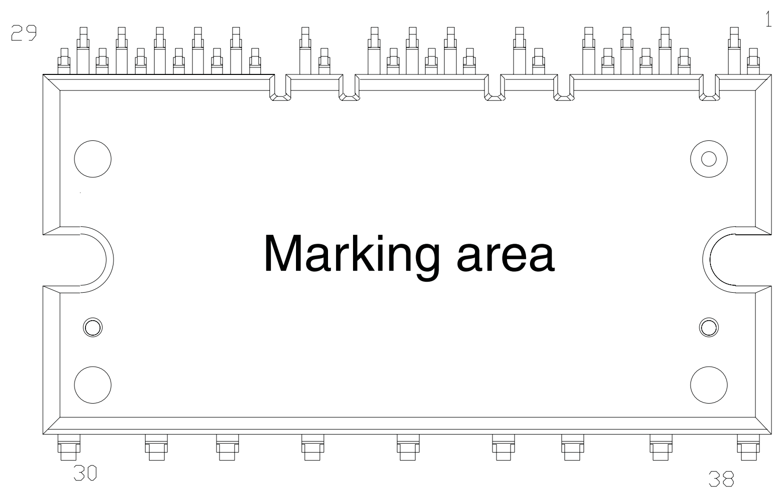


Table 2. Pins description

Pin no.	Pin name	Pin no.	Pin name
1	OUT U	20	HIN3
2	Vboot U	21	OP3-
3	$\overline{\text{LIN1}}$	22	OPOUT3
4	HIN1	23	OP3+
5	OP1-	24	CIN3
6	OPOUT1	25	V_{CC}
7	OP1+	26	$\overline{\text{SD}}$
8	CIN1	27	GND
9	OUT V	28	T1
10	Vboot V	29	T2
11	$\overline{\text{LIN2}}$	30	E3
12	HIN2	31	W
13	OP2-	32	P
14	OPOUT2	33	E2
15	OP2+	34	V
16	CIN2	35	P
17	OUT W	36	E1
18	Vboot W	37	U
19	$\overline{\text{LIN3}}$	38	P

Figure 2. Pin layout (bottom view)



2 Electrical ratings

Table 3. Absolute maximum ratings: inverter part

Symbol	Parameter	Value	Unit
V_{PE}	Supply voltage (applied between P-E1, E2, E3)	450	V
$V_{PE(surge)}$	Supply voltage (surge) (applied between P-E1, E2, E3))	500	V
V_{CES}	Collector emitter voltage (HIN = 0, $\overline{LIN}$ = 1)	600	V
$\pm I_C$ (1)	Each IGBT continuous collector current at T_C = 25°C	14	A
$\pm I_{CP}$ (2)	Each IGBT pulsed collector current	30	A
P_{TOT}	Each IGBT total dissipation at T_C = 25°C	35	W
t_{scw}	Short circuit withstand time, V_{CE} = 0.5 $V_{(BR)CES}$ T_j = 125 °C, V_{CC} = V_{boot}= 15 V, V_i (3)= 5 V	5	µs

1. Calculated according to the iterative formula:

$$I_C(T_C) = \frac{T_{j(max)} - T_C}{R_{thj-c} \times V_{CE(sat)(max)}(T_{j(max)}, I_C(T_C))}$$

2. Pulse width limited by max junction temperature
3. Applied between HIN_i (LIN_i) - G_{NDi} for i=1,2,3

Table 4. Absolute maximum ratings: control part

Symbol	Parameter	Value	Unit
V_{OUT}	Output voltage	V_{boot} - 21 to V_{boot} + 0.3	V
V_{CC}	Supply voltage	-0.3 to +21	V
Vop+	Opamp non-inverting input	-0.3 to V_{CC} +0.3	V
Vop-	Opamp inverting input	-0.3 to V_{CC} +0.3	V
Vcp+	Comparator input voltage	-0.3 to V_{CC} +0.3	V
V_{boot}	Floating supply voltage	V_{CC}-0,3 to 620	V
V_I	Logic input voltage	-0.3 to 15	V
V_{od}	Open drain voltage	-0.3 to 15	V
dV_{out}/dt	Allowed output slew rate	50	V/ns

Table 5. Absolute maximum ratings: total system

Symbol	Parameter	Value	Unit
V_{OUT}	Output voltage (pins OUT U, V, W)	450	V
V_{CC} 1,2,3	Supply voltage (pins 3, 11, 19)	17	V
T_j	Operating junction temperature	-40 to 125	°C
V_{INS}	Insulation withstand voltage applied between each pin and heatsink plate (AC voltage, t = 60sec.)	2500	V

Table 6. Thermal data

Symbol	Parameter	Value	Unit
$R_{th(j-c)}$	Thermal resistance junction-case single IGBT	2.8	°C/W
	Thermal resistance junction-case single diode	5	°C/W

3 Electrical characteristics

(T_j = 25 °C unless otherwise specified)

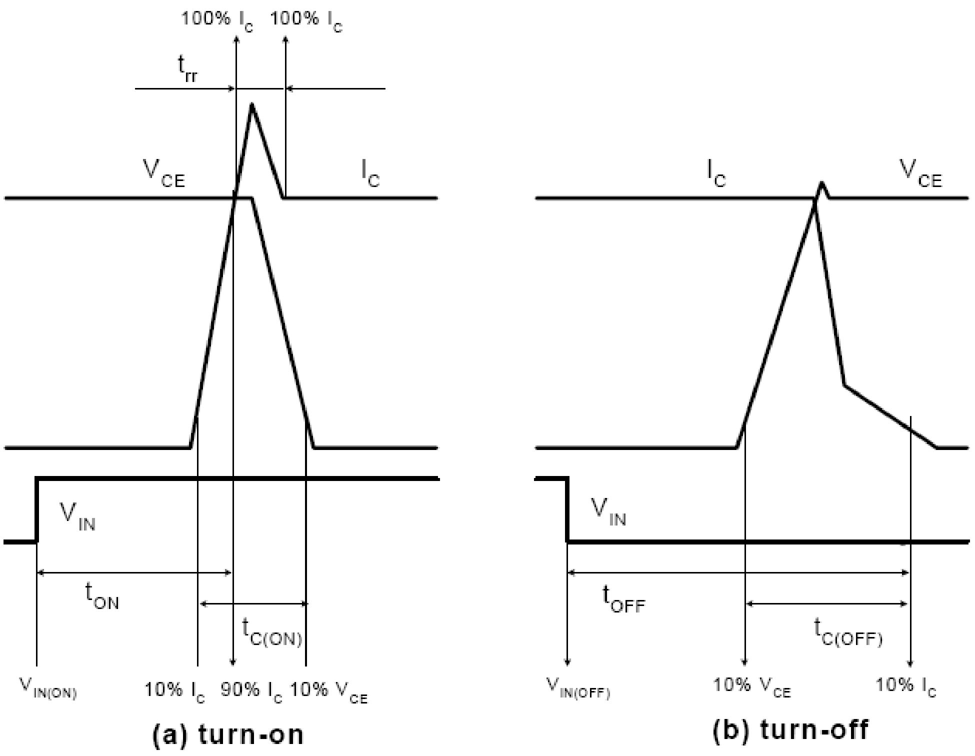
Table 7. Inverter part

Symbol	Parameter	Condition	Value			Unit
			Min.	Typ.	Max.	
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{CC} = V_{Boot}$ = 15 V, V_I(1)= 5 V, I_C = 7 A	-	2.1		V
		$V_{CC} = V_{Boot}$ = 15 V, V_I(1)= 5 V, I_C = 7 A, T_j= 125 °C	-	1.8		
I_{CES}	Collector-cut off current (V_{IN}(1)=0)	V_{CE} = 600 V	-		100	µA
V_F	Diode forward voltage	(HIN = 0, $\overline{LIN}$ = 1), I_C = 5 A	-		2.2	V
High side inductive load						
t_{on}	Turn-on time	V_{PN} = 300 V, $V_{CC} = V_{boot}$ = 15 V, V_{IN}(1)= 0 ↔ 5 V, I_C = 7 A (see *Figure 3*)	-	270		ns
$t_{c(on)}$	Crossover time (on)		-	130		
t_{off}	Turn-off time		-	320		
$t_{c(off)}$	Crossover time (off)		-	105		
t_{rr}	Reverse recovery time		-	150		
E_{on}	Turn-on switching losses		-	170		µJ
E_{off}	Turn-off switching losses		-	85		
Low side inductive load						
t_{on}	Turn-on time	V_{PN} = 300 V, $V_{CC} = V_{boot}$ = 15 V, V_{IN}(1)= 0 ↔ 5 V, I_C = 5 A (see *Figure 3*)	-	240		ns
$t_{c(on)}$	Crossover time (on)		-	110		
t_{off}	Turn-off time		-	220		
$t_{c(off)}$	Crossover time (off)		-	220		
t_{rr}	Reverse recovery time		-	110		
E_{on}	Turn-on switching losses		-	140		µJ
E_{off}	Turn-off switching losses		-	90		

1. V_I: applied between HIN / LIN and GND

Note: t_{on} and t_{off} include the propagation delay time of the internal drive. $t_{C(ON)}$ and $t_{C(OFF)}$ are the switching time of IGBT itself under the internally given gate driving condition

Figure 3. Switching time definition



3.1 Control part

Table 8. Control part (V_{CC} = 15 V)

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
Low supply voltage section						
V_{cc_hys}	V_{cc} UV hysteresis		1.2	1.5		V
V_{cc_thON}	V_{cc} UV turn ON threshold		11.5	12.0		V
V_{cc_thOFF}	V_{cc} UV turn OFF threshold		10	10.5		V
I_{qccu}	Undervoltage quiescent supply current	V_{cc} = 10 V $\overline{SD}$ = 5 V; $\overline{LIN}$ = 5 V; and HIN = GND; R_{DT} = 150 Ω; CP+=OP+=GND; OP-=5 V		350	450	µA
I_{qcc}	Quiescent current	V_{cc} = 15 V $\overline{SD}$ = 5 V; $\overline{LIN}$ = 5 V; and HIN = GND; R_{DT} = 150 Ω; CP+=OP+=GND; OP-=5 V		2	3.5	mA
V_{ref}	Internal reference voltage		0.5	0.54	0.58	mV
Bootstrapped supply voltage section						
V_{BS_hys}	V_{BS} UV hysteresis		1.2	1.5		V
V_{BS_thON}	V_{BS} UV turn ON threshold		10.6	11.5		V
V_{BS_thOFF}	V_{BS} UV turn OFF threshold		9.0	10.0		V
I_{QBSU}	Undervoltage V_{BS} quiescent current	V_{BS} = 10 V $\overline{SD}$ = 5 V; $\overline{LIN}$ and HIN = 5 V; R_{DT} = 150 Ω; CP+=OP+=GND; OP-=5 V		70	110	µA
I_{QBS}	V_{BS} quiescent current	V_{BS} = 15 V $\overline{SD}$ = 5 V; $\overline{LIN}$ and HIN = 5 V; R_{DT} = 150 Ω; CP+=OP+=GND; OP-=5 V		150	210	µA
I_{LK}	High voltage leakage current	V_{hvg} = V_{out} = V_{boot} = 600 V			10	µA
$R_{DS(on)}$	Bootstrap driver on resistance	LVG ON		120		Ω
Logic inputs						
V_{il}	Low logic level voltage				0.83	V
V_{ih}	High logic level voltage		2.21			V
I_{HINh}	HIN logic “1” input bias current	HIN = 15 V		175	260	µA
I_{HINl}	HIN logic “0” input bias current	HIN = 0 V			1	µA

Table 8. Control part (V_{CC} = 15 V) (continued)

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
I_{LINl}	$\overline{LIN}$ logic "0" input bias current	$\overline{LIN}$ = 0 V		6	40	µA
I_{LINh}	$\overline{LIN}$ logic "1" input bias current	$\overline{LIN}$ = 15 V			1	µA
I_{SDh}	$\overline{SD}$ logic "1" input bias current	$\overline{SD}$ = 15 V		30	100	µA
I_{SDl}	$\overline{SD}$ logic "0" input bias current	$\overline{SD}$ = 0 V			1	µA
Dt	Dead time	see *Figure 5*		320		ns

Table 9. OPAMP characteristics (V_{CC} = 15 V)

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
V_{io}	Input offset voltage	V_O = TBD; $0 < V_{icm} < V_{CC}$ - TBD			3	mV
I_{ib}	Input bias current (1)			100	200	nA
V_{icm}	Input common mode voltage range		0		V_{CC} - TBD	V
V_{OL}	Low level output voltage - low level	Isink = 3.5 mA, RL = 2 kΩ		180	360	mV
V_{OH}	High level output voltage - high level	Isource = 3.5 mA, R_L = 2 kΩ	13.5	14.3		V
I_o	Output short circuit current	Source, V_{id} = ±1 V; V_o = 0 V	16	30		mA
		Sink, V_{id} = ±1; V_o = 0 V	50	80		mA
SR	Slew rate	V_i = 1 ÷ 4 V; R_L = 2 kΩ; C_L = 100 pF; unity gain	2.5	3.8		V/µs
GBWP	Gain bandwidth product	V_o = 7.5 V; R_L = 2 kΩ		12		MHz
A_{vd}	Large signal voltage gain			85		dB
SVR	Supply voltage rejection ratio			70		dB
CMRR	Common mode rejection ratio			70		dB

1. The direction of input current is out of the IC.

Table 10. Sense comparator characteristics (V_{CC} = 15 V)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{io}	Input bias current	V_{CP+} = 1 V	-		1	µA
V_{ol}	Open drain low level output voltage	I_{od} = - 3 mA	-		0.5	V
t_{d_comp}	Comparator delay	$\overline{SD}$/OD pulled to 5 V through 100 kΩ resistor	-	90	130	ns
SR	Slew rate	C_L = 180 pF; R_{pu} = 5 kΩ	-	60		V/µsec

Table 11. NTC thermistor

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit.
R_{25}	Resistance	$T_C = 25°C$		5		kΩ
R_{125}	Resistance	$T_C = 125°C$		300		Ω
B	B-constant	$T_C = 25°C$		3435		k
T	Operating temperature		-40		125	°C

Equation 1: Resistance variation vs temperature

$$R(T) = R_{25} \cdot e^{B\left(\frac{1}{T} - \frac{1}{298k}\right)}$$

Figure 4. NTC resistance vs temperature

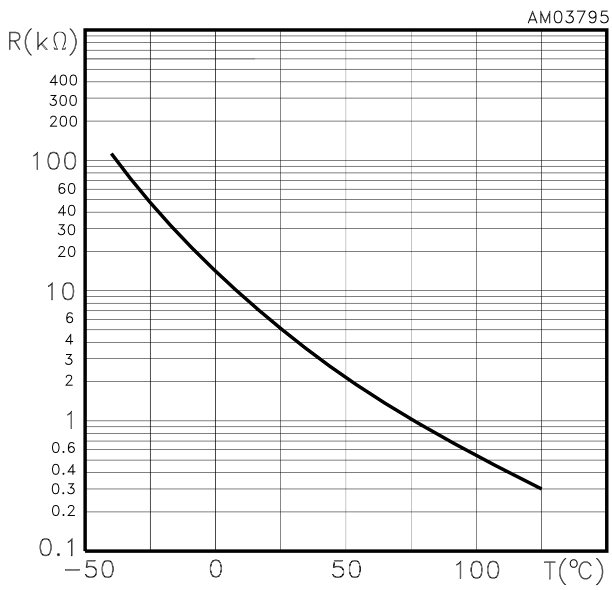
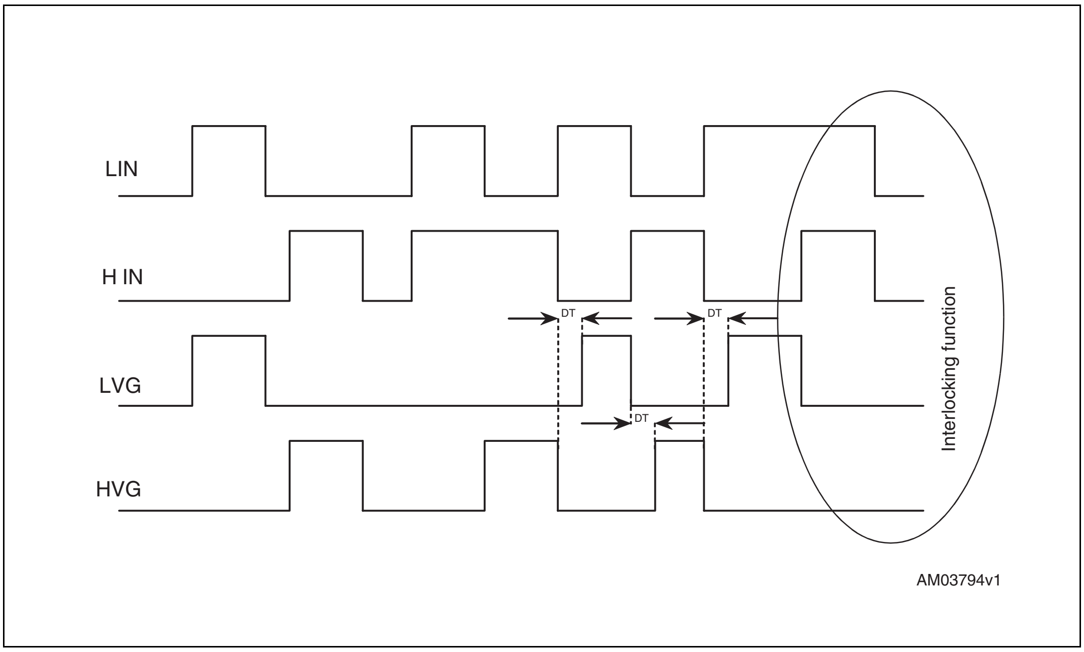
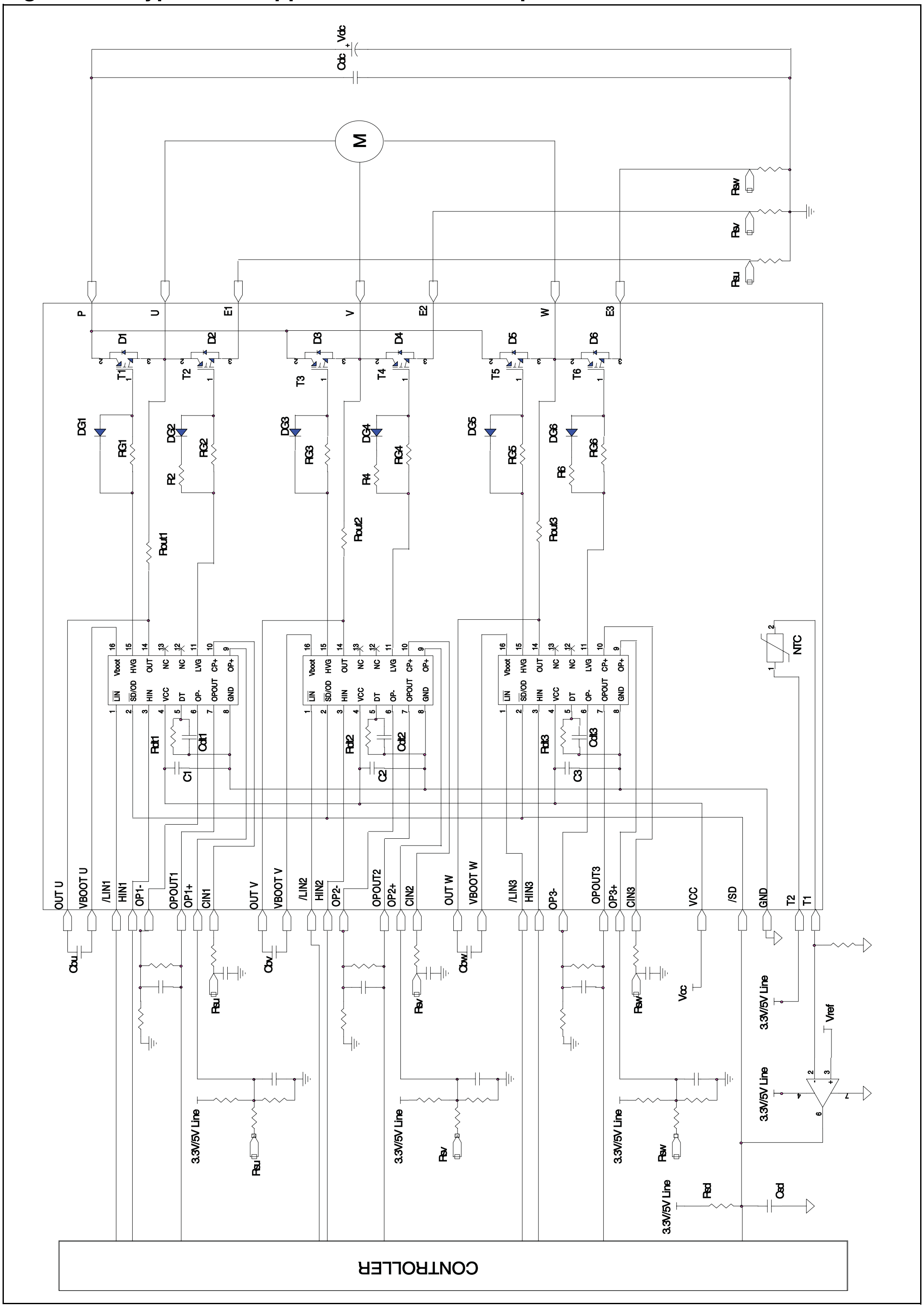


Figure 5. Dead time waveforms definition



4 Applications information

Figure 6. Typical IPM application circuit example



4.1 Recommendations

- To prevent the input signals oscillation, the wiring of each input should be as short as possible.
- By integrating an application specific type HVIC inside the module, direct coupling to MCU terminals without any opto-coupler is possible.
- Each capacitor should be located as nearby the pins of IPM as possible.
- Low inductance shunt resistors should be used for phase leg current sensing.
- Electrolytic bus capacitors should be mounted as close to the module bus terminals as possible. Additional high frequency ceramic capacitor mounted close to the module pins will further improve performance.

5 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: www.st.com. ECOPACK is an ST trademark.

Table 12. SDIP 38L molded mechanical data

Dimensions	mm		
	Min.	Typ.	Max.
A	49.1		50.1
A1	44.1		45.1
A2	1.37		1.47
A3	1.23		2.23
B	24		25
B1	27.1		28.1
B2	28.6		29.6
B3	12.05		13.25
B4	11.25		12.45
C	5		6
C1	6.4		7.4
C2	10.41		11.41
e	1.1		1.5
e1	3.2		3.6
e2	5.8		6.2
e3	4.6		5
e4	5.6		6
e5	6.3		6.7
e6	4.5		4.9
F	0.8		1.2
F1	0.35		0.65
R1	2.3		2.7
T1	0.45		0.65

Figure 7. SDIP 38L molded drawing dimensions

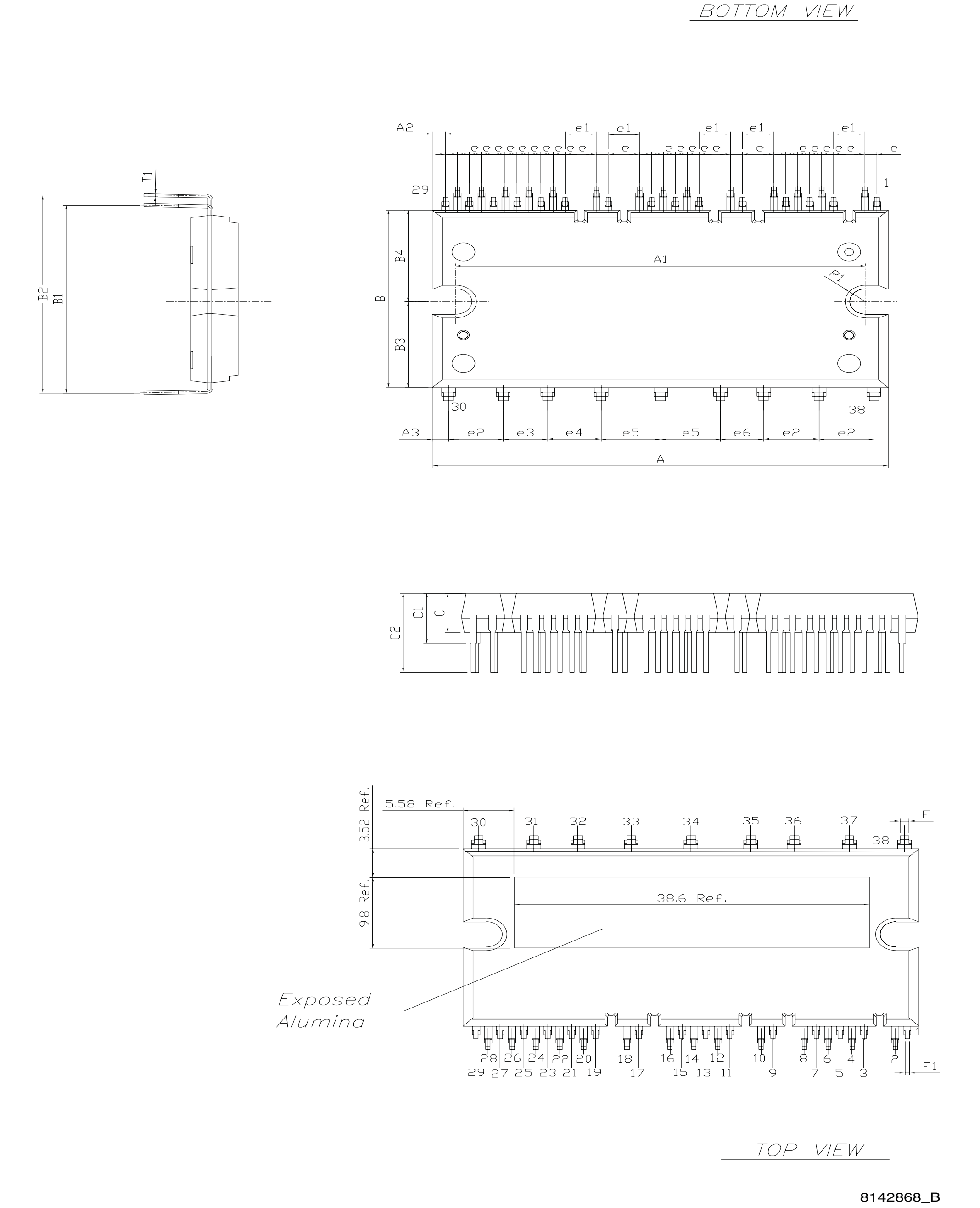


Table 13. Mechanical characteristics and ratings

Parameter	Limits			Unit
	Min.	Typ.	Max.	
Mounting torque (M3 screw)	0.59	--	0.78	N•m
Device flatness	0	--	100	µm
Weight	--	17	--	g

6 Revision history

Table 14. Document revision history

Date	Revision	Changes
16-Apr-2009	1	Initial release

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