

Glossary of High-Voltage Intelligent Power Device Terms

Outline

This document describes the terms used in data sheets of high-voltage intelligent power devices (HV-IPDs).

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1. Absolute Maximum Ratings


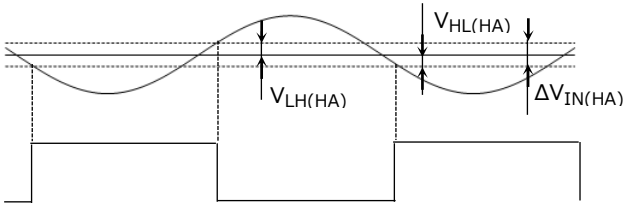
Parameter	Symbol	Definition
Power supply voltage	V_{BB} V_{CC}	The rated voltage of the high-voltage power supply terminal V_{BB} and the control power supply terminal V_{CC} at which an IC will not suffer breakdown, deterioration of characteristics, or reduced reliability
Output current (DC)	I_{out}	The rated current of the output terminals at which an IC will not suffer breakdown, deterioration of characteristics, or reduced reliability
Output current (pulsed)	I_{outp}	The rated pulse current of the output terminals at which an IC will not suffer breakdown, deterioration of characteristics, or reduced reliability
Input voltage	V_{IN}	The rated voltage of the Hall amp input terminals H^*/\pm and the control terminals L^*/H^* at which an IC will not suffer breakdown, deterioration of characteristics, or reduced reliability
	V_{Vs}	The rated voltage of the speed control input terminal V_S at which an IC will not suffer breakdown, deterioration of characteristics, or reduced reliability
V_{REG} current	I_{REG}	The rated current of the regulator output terminal V_{REG} at which an IC will not suffer breakdown, deterioration of characteristics, or reduced reliability
DIAG voltage	V_{DIAG}	The rated voltage of the diagnostic output terminal DIAG at which an IC will not suffer breakdown, deterioration of characteristics, or reduced reliability
DIAG current	I_{DIAG}	The rated current of the diagnostic output terminal DIAG at which an IC will not suffer breakdown, deterioration of characteristics, or reduced reliability
FG voltage	V_{FG}	The rated voltage of the pulse-per-revolution output terminal FG at which an IC will not suffer breakdown, deterioration of characteristics, or reduced reliability
FG current	I_{FG}	The rated current of the pulse-per-revolution output terminal FG at which an IC will not suffer breakdown, deterioration of characteristics, or reduced reliability

*: U/V/W

Parameter	Symbol	Definition
Power dissipation	P_C	The power consumption that does not cause IC breakdown over the entire operating temperature range
Operating temperature	T_{jopr}	The operating junction temperature range over which the normal operation and electrical characteristics of an IC are guaranteed
Operating case temperature	T_{copr}	The operating case temperature range over which the normal operation and electrical characteristics of an IC are guaranteed
Junction temperature	T_j	The maximum junction temperature at which an IC can operate normally
Storage temperature	T_{stg}	The ambient temperature range over which no deterioration of characteristics or reliability occurs when an IC is stored for a long period of time or is transported with no applied voltage present

*: U/V/W

2. Electrical Characteristics

Parameter	Symbol	Definition
Operating power supply voltage	V_{BB}	The supply voltage range of the high-voltage power supply terminal V_{BB} over which the normal operation of an IC is guaranteed
Operating power supply voltage	V_{CC}	The supply voltage range of the control power supply terminal V_{CC} over which the normal operation of an IC is guaranteed
Current dissipation	I_{BB}	The current that flows into an IC via the high-voltage power supply terminal V_{BB} when the specified test conditions are applied to the terminal
	I_{CC}	The current that flows into an IC via the control power supply terminal V_{CC} when the specified test conditions are applied to the terminal
	$I_{BS(ON)}$ $I_{BS(OFF)}$	The current that flows into an IC through bootstrap capacitance terminal BS* when the specified test conditions are applied to the terminal
Hall amp input sensitivity	$V_{HSENS(HA)}$	The peak-to-peak minimum voltage of Hall-effect device output voltage over which the Hall amp can operate normally
		Hall-effect device output 
Hall amp input current	$I_{HB(HA)}$	The current that flows through Hall amp input terminals H* +/-
Hall amp common-input voltage	$CMV_{IN(HA)}$	The voltage range of the Hall amp input terminals H* +/- over which the normal operation and electrical characteristics of the Hall amp are guaranteed. This is specified at common-input voltage with the same voltage level.
Hall amp input voltage L→H	$V_{LH(HA)}$	The differential voltage between the Hall amp differential input voltage and the average voltage required for the Hall amp output to turn on from "L" to "H"
Hall amp input voltage H→L	$V_{HL(HA)}$	The differential voltage between the Hall amp differential input voltage and the average voltage required for the Hall amp output to turn on from "H" to "L"
		The voltage between input and output of Hall-effect sensor 

*: U/V/W

Parameter	Symbol	Definition
Hall amp hysteresis width	$\Delta V_{IN(HA)}$	$\Delta V_{IN(HA)} = \text{minimum of } "V_{LH(HA)}"_{\text{max}} + "V_{HL(HA)}"_{\text{min}}$
Input voltage	V_{IH}	The minimum control terminal voltage at which the inputs of built-in IGBTs or MOSFETs are guaranteed to go High
Input voltage	V_{IL}	The maximum control terminal voltage at which the inputs of built-in IGBTs or MOSFETs are guaranteed to go Low
Input current	I_{IH} I_{IL}	The current that flows through the control terminal L*/H* of an IC when the specified test conditions are applied to the terminal
SD input voltage	V_{SD}	The threshold voltage for the "H" and "L" levels of the external protection signal input terminal
SD input current	I_{SDH} I_{SDL}	The current that flows through the external protection signal input terminal SD when the specified test conditions are applied to the terminal
MOSFET ON-state resistance	R_{DSONH} R_{DSONL}	The ON-resistance between drain and source of the high- or low-side MOSFET when the specified test conditions are applied to an IC
MOSFET output leakage current	I_{DSS}	The leakage current between drain and source of the high- or low-side MOSFET when the specified test conditions are applied to an IC
Output saturation voltage	V_{CEsatH} V_{CEsatL}	The saturation voltage across collector and emitter of the high- or low-side MOSFET when the specified test conditions are applied to an IC
FRD forward voltage	V_{FH} V_{FL}	The forward voltage of the freewheeling diode connected in parallel with an IGBT or the body diode of a MOSFET under the specified test conditions
BSD forward voltage	$V_{F(BSD)}$	The forward voltage of the bootstrap diode connected to the bootstrap capacitance terminal BS* under the specified test condition.
PWM ON-duty cycle	PWMMIN PWMMAX	The minimum duty cycle that can be controlled by an IC The maximum duty cycle that can be controlled by an IC

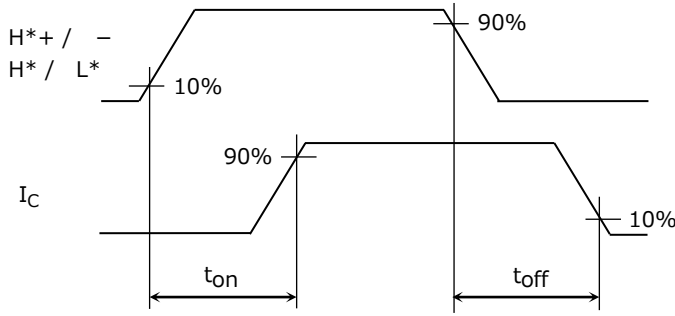
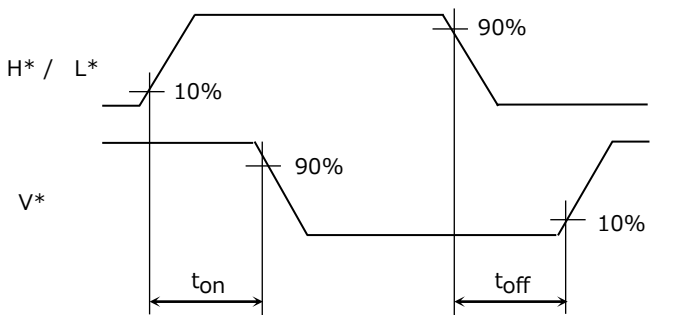
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Parameter	Symbol	Definition
PWM ON-duty cycle, 0%	$V_{VS0\%}$	The voltage of the speed control signal input terminal V_S at which the IGBT operates at a 0% duty cycle
PWM ON-duty cycle, 100%	$V_{VS100\%}$	The voltage of the speed control signal input terminal V_S at which the IGBT operates at a 100% duty cycle
PWM ON-duty voltage range	V_{VSW}	The voltage range of the speed control signal terminal V_S over which the IGBT operates in the 0% to 100% duty cycle range
Output all-OFF voltage	V_{VSOFF}	The input voltage of the speed control signal input terminal at which all IGBTs turn off
Regulator voltage	V_{REG}	The output voltage of the built-in series regulator
Speed control voltage range	V_S	The range of voltage that can be applied to the speed control signal input terminal
FG output saturation voltage	V_{FGsat}	The saturation voltage of the rotation pulse output terminal under the specified test conditions
Current limiting voltage	V_R	The reference voltage of the error amp for overcurrent detection
Current limiting dead time	Dt	The delay time required to start a protection operation after the detection of an overcurrent
Thermal shutdown temperature	TSD	The temperature at which thermal shutdown operates to turn off all outputs
Thermal shutdown hysteresis	ΔTSD	The difference between thermal shutdown temperature and output restart temperature
V_{CC} undervoltage protection	V_{CCUVD}	The voltage at which all the IGBTs or MOSFETs turn off when the control supply voltage V_{CC} is gradually reduced
V_{CC} undervoltage protection recovery	V_{CCUVR}	The V_{CC} voltage at which outputs turn on again after undervoltage lockout occurs due to a drop in the control power supply voltage

*: U/ V/W

Parameter	Symbol	Definition
V_{BS} undervoltage protection	V_{BSUVD}	The voltage at which all outputs of the IGBTs or MOSFETs turn off when the voltage of the bootstrap capacitor connection terminal BS* is gradually reduced
V_{BS} undervoltage protection recovery	V_{BSUVR}	The BS* voltage at which the outputs turn on again after undervoltage lockout occurs due to a drop in the control power supply voltage
DIAG saturation voltage	$V_{DIAGsat}$	The saturation voltage of the diagnostic output terminal DIAG under the specified test conditions
Refresh operating ON voltage	T_{RFON}	The speed control signal input terminal voltage V_S at which the bootstrap circuit begins to charge
Refresh operating OFF voltage	T_{RFOFF}	The voltage of the speed control signal input terminals at which the bootstrap circuits stop charging
Triangular wave frequency	f_C	The reference frequency for PWM operation
Dead time	t_{dead}	The period of time during which both the high and low sides are off to prevent a shoot-through current due to cross conduction
FRD reverse recovery time Diode reverse recovery time	t_{rr}	The reverse recovery time of the freewheeling diode connected in parallel with an IGBT or the body diode of a MOSFET.

*: U/V/W

Parameter	Symbol	Definition
Output on delay time Output off delay time	t_{on} t_{off}	<p>For IGBT-output ICs:</p> <p>t_{ON} is a delay from when the input voltage of each phase rises to the 10% point to when the output current rises to the 90% point.</p> <p>t_{OFF} is a delay from when the input voltage of each phase falls to the 90% point to when the output current falls to the 10% point under the specified test conditions</p> <p>For MOSFET-output ICs:</p> <p>t_{ON} is a delay from when the input voltage of each phase rises to the 10% point to when the output voltage falls to the 90% point.</p> <p>t_{OFF} is a delay from when the input of each phase voltage falls to the 90% point to when the output voltage rises to the 10% point under the specified test conditions.</p> <p>For IGBT-output ICs:</p>  <p>For MOSFET-output ICs:</p> 

*: U/V/W

3. Built-in Functions

Term	Description
PWM circuit	The control circuit for obtaining a desired output voltage or current waveform by controlling the ON pulse width of a switching device
Pulses-per-revolution output	The "H" or "L" signal is output according to the Hall amplifier input signal. The rotation speed (RPM) of a motor can be monitored by counting this signal. In the TPD4146K, the output pulse signal from the FG is selectable from one or three pulses per 360 electrical degrees via the FGC terminal signal.
Overcurrent protection circuit	The circuit that turns off the output to protect the IC when a current exceeding a limit flows into the IC
Thermal shutdown circuit	The circuit that turns off the output to protect the IC when the IC temperature exceeds a preset value
Undervoltage protection circuit	The function for turning off all the IGBTs or MOSFETs when the V_{CC} or V_{BS} voltage drops below a limit, in order to avoid operating in the active region of an IGBT or in the saturation region of a MOSFET
3-phase distribution logic circuit	The logic circuit to generate gate signals for high- and low-side IGBTs or MOSFETs in each phase (U, V and W). These signals are generated from the input signals applied by Hall-effect devices or Hall ICs.
Bootstrap circuit	The booster circuit for driving high-side IGBTs/MOSFETs
Hall amp	The amplifier circuit for transmitting the output signal from a Hall-effect device to the subsequent logic circuit
Level shift circuit	The voltage conversion circuit for driving a bootstrap circuit, a high-voltage floating power supply, from a logic control signal

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