

Product Overview

The NSI67x0 is a single-channel reinforced isolated smart gate driver to drive IGBT and SiC MOSFETs in many applications. It can source and sink 10A peak current. System robustness is supported by 150kV/ μ s minimum common-mode transient immunity (CMTI).

The NSI67x0 includes crucial protection features such as miller clamp, DESAT or OC, UVLO and soft turn off. UVLO and short circuit fault are reported through separate pins. It integrates the isolated analog to PWM sensor, which can be used for easier temperature or voltage sensing, further increasing the drivers' versatility and simplifying the system design effort, size, and cost.

Key Features

- 5.7kV_{RMS} withstand isolation voltage
- SiC MOSFETs and IGBTs up to 2121V_{pk}
- Driver side supply voltage: up to 33V with UVLO
- 10A peak source and sink output current
- High CMTI: $\pm 150\text{kV}/\mu\text{s}$
- DESAT or OC option for protection
- Monitor status of device on FLT and RDY
- 80ns typical propagation delay
- 420mA or 900mA soft turn off current option
- 50ns maximum pulse width distortion
- Isolated analog sensor with PWM output for
 - Temperature sensing with NTC, PTC or thermal diode
 - High voltage DC-Link or phase voltage
- RoHS & REACH Compliant
- Lead-free component, suitable for lead-free soldering profile: 260°C, MSL3
- AEC-Q100 Qualified for Grade1: T_A from -40°C to 125°C

Safety Regulatory Approvals

- UL recognition: 5700V_{RMS}
- DIN EN IEC 60747-17(VDE 0884-17)
- CSA component notice 5A
- CQC certification per GB4943.1

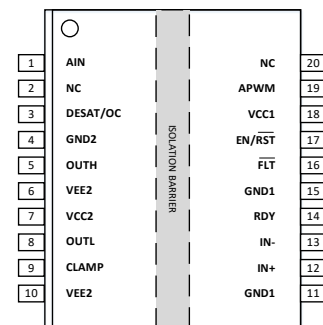
Applications

- Traction Inverter for EVs
- On-board Charger and charging pile
- DC/DC Converter for HEV/EVs

Device Information

Part Number	over current protection	Internal current source	STO current
NSI6730ASA-Q1SSWAR	OC(0.7V)	YES	I _{STO} =420mA
NSI6730ASC-Q1SSWAR	DESAT(9V)	YES	I _{STO} =420mA
NSI6770ASC-Q1SSWAR	DESAT(9V)	NO	I _{STO} =420mA
NSI6770AHC-Q1SSWAR	DESAT(9V)	NO	I _{STO} =900mA

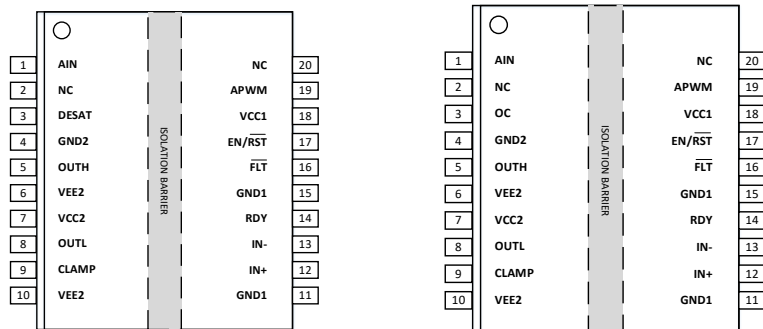
Pin map



INDEX

1. PIN CONFIGURATION AND FUNCTIONS	3
2. ABSOLUTE MAXIMUM RATINGS.....	4
3. ESD RATINGS.....	4
4. RECOMMENDED OPERATING CONDITIONS	5
5. THERMAL INFORMATION	5
6. SPECIFICATIONS	6
6.1. DC ELECTRICAL CHARACTERISTICS	6
6.2. SPECIALIZED CHARACTERISTICS.....	9
6.3. SWITCHING ELECTRICAL CHARACTERISTICS.....	12
7. HIGH VOLTAGE FEATURE DESCRIPTION.....	13
7.1. INSULATION AND SAFETY RELATED SPECIFICATIONS	13
7.2. INSULATION CHARACTERISTICS FOR SSOW20 PACKAGE	14
7.3. SAFETY LIMITING VALUES FOR SSOW20 PACKAGE	15
7.4. REGULATORY INFORMATION FOR SSOW20 PACKAGE	16
8. TYPICAL CHARACTERISTICS	17
9. FUNCTION DESCRIPTION	21
9.1. OVERVIEW.....	21
9.2. POWER SUPPLY.....	22
9.3. OUTPUT STAGE.....	22
9.4. ACTIVE PULL-DOWN.....	22
9.5. INTERNAL ACTIVE MILLER CLAMP	22
9.6. SHORT CIRCUIT CLAMPING	23
9.7. VCC1 AND VCC2 UNDER VOLTAGE LOCK OUT (UVLO)	24
9.8. DESATURATION (DESAT) PROTECTION	26
9.9. OVER CURRENT (OC) PROTECTION	26
9.10. SOFT TURN-OFF	27
9.11. FAULT ($\overline{\text{FLT}}$ AND $\overline{\text{RST/EN}}$).....	27
9.12. ISOLATED ANALOG SIGNAL SENSING FUNCTION	29
9.13. DEVICE FUNCTIONAL MODES	30
10. APPLICATION NOTE	31
10.1. TYPICAL APPLICATION CIRCUIT	31
10.2. DESIGN FOR IN+, IN- AND $\overline{\text{RST/EN}}$	31
10.3. DESIGN FOR EN/ $\overline{\text{RST}}$, RDY AND $\overline{\text{FLT}}$	31
10.4. DESIGN FOR AUTOMATIC RESET CONTROL.....	31
10.5. PWM INTERLOCK PROTECTION	32
10.6. DESIGN FOR R _{ON} AND R _{OFF}	32
10.7. DESIGN FOR DESAT PROTECTION.....	33
10.8. DESIGN FOR OC PROTECTION	34
10.9. DESIGN FOR AIN AND APWM.....	34
10.10. PCB LAYOUT.....	36
11. PACKAGE INFORMATION.....	37
12. ORDERING INFORMATION.....	38
13. TAPE AND REEL INFORMATION.....	39
14. REVISION HISTORY	41

1. Pin Configuration and Functions



NSI6730ASC/ NSI6770ASC/ NSI6770AHC

NSI6730ASA

Table 1.1 NSI67x0 Pin Configuration and Description

SYMBOL	Pin NO.		FUNCTION
	NSI6730ASA	NSI6730ASC NSI6770ASC NSI6770AHC	
AIN	1	1	Isolated Analog sensing input
NC	2,20	2,20	Not connect
DESAT	/	3	DESAT for Fast overcurrent and short circuit protection
OC	3	/	OC for Fast overcurrent and short circuit protection
GND2	4	4	Driver side ground pin
OUTH	5	5	Driver source output pin
V _{EE2}	6, 10	6, 10	Driver side negative supply pin
V _{CC2}	7	7	Driver side positive supply pin
OUTL	8	8	Driver sink output pin
CLAMP	9	9	Internal active miller clamp to prevent false turn-on
GND1	11, 15	11, 15	Input-side ground pin
IN+	12	12	Non-inverting gate driver control input
IN-	13	13	Inverting gate driver control input
RDY	14	14	Power good signal. Active low to report under voltage lock
FLT	16	16	Fault output pin. Active low to report overcurrent or short circuit
RST/EN	17	17	Enable the device if this pin is set to high, or set low to reset the fault signal under DESAT condition
V _{CC1}	18	18	Input-side power supply
APWM	19	19	Isolated Analog Sensing PWM output

2. Absolute Maximum Ratings

Parameters	Symbol	Min	Max	Unit
Driver Side Supply Voltage	$V_{CC2-V_{EE2}}$	-0.3	38	V
Driver Side Supply Voltage	$V_{CC2-GND2}$	-0.3	38	V
Driver Side Supply Voltage	$V_{EE2-GND2}$	-17.5	0.3	V
Output Signal Voltage – DC	$V_{OUTH}, V_{OUTL}, V_{CLAMP}$	$V_{EE2}-0.3$	V_{CC2}	V
Input Side Supply Voltage	V_{CC1}	-0.3	6	V
Input Signal Voltage – DC	$V_{IN+}, V_{IN-}, V_{RST}$	$GND1-0.3$	$V_{CC1}+0.3$	V
RDY, FLT (Input Side) voltage	V_{RDY}, V_{FLT}	$GND1-0.3$	V_{CC1}	V
DESAT or OC (Driver Side) input voltage	V_{DESAT}	$GND2-0.3$	$V_{CC2}+0.3$	V
AIN input voltage	V_{AIN}	$GND2-0.3$	$GND2+6$	V
FLT and RDY input current	I_{FLT}, I_{RDY}		20	mA
APWM output current	I_{APWM}		20	mA
Operating Junction Temperature	T_J	-40	150	°C
Storage Temperature	T_{stg}	-65	150	°C

3. ESD Ratings

		Symbol	Value	Unit
Electrostatic discharge	Human-body model (HBM), per AEC Q100-002 ⁽¹⁾	V_{ESD_HBM}	±3000	V
	Charged-device model (CDM), per AEC Q100-011	V_{ESD_CDM}	±1500	V

1) AEC Q100-002 indicates that HBM stressing shall be in accordance with the ANSI/ESDA/JEDEC JS-001 specification.

4. Recommended Operating Conditions

Parameters	Symbol	Min	Max	Unit
Ambient Temperature	T_A	-40	125	°C
Input Side Supply Voltage	$V_{CC1-GND1}$	3	5.5	V
Driver Side Supply Voltage	$V_{CC2-GND2}$	13	33	V
Driver Side Supply Voltage	$V_{CC2-V_{EE2}}$	-	33	V
AIN input voltage	V_{AIN}	0	5	V
IN+, IN-, $\overline{RST}$ /EN (Respect to GND1)	High level input voltage	$0.7 \times V_{CC1}$	V_{CC1}	V
	Low level input voltage	0	$0.3 \times V_{CC1}$	

5. Thermal Information

Parameters	Symbol	SSOW20	Unit
Junction-to-ambient thermal resistance	$R_{\theta JA}$	77.7	°C/W
Junction-to-top characterization parameter	Ψ_{JT}	9.4	°C/W
Junction-to-board characterization parameter	Ψ_{JB}	27	°C/W
Junction-to-case(top) thermal resistance	$R_{JC(top)}$	38.5	°C/W
Junction-to-board thermal resistance	$R_{\theta JB}$	30	°C/W

- 1) Standard JESD51-7 High Effective Thermal Conductivity Test Board (2S2P) in an environment described in JESD51-2a.
- 2) Standard JESD51-7 High Effective Thermal Conductivity Test Board (2S2P) by transient dual interface test method described in JESD51-14.
- 3) Obtained by Simulating in an environment described in JESD51-2a.

6. Specifications

6.1. DC Electrical Characteristics

All min and max specifications are at $T_A = -40^{\circ}\text{C}$ to 125°C . Typical values are tested at $V_{CC1} = 3.3\text{V}$ or 5V , $V_{CC2} = 15\text{V}$ or 33V , $V_{EE2} = \text{GND2}$.

Parameter	Symbol	Min	Typ	Max	Unit	Condition
Input Side Supply						
Input side Supply Quiescent Current	I _{CC1_ON}	2.5	3.6	4.5	mA	V _{CC1} =5V, OUT=High, V _{AIN} =2V
	I _{CC1_OFF}	0.6	1.5	2.6		V _{CC1} =5V, OUT=Low, V _{AIN} =2V
V _{CC1} UVLO Rising Threshold	V _{CC1_ON}	2.5	2.72	2.95	V	
V _{CC1} UVLO Falling Threshold	V _{CC1_OFF}	2.35	2.57	2.75	V	
V _{CC1} UVLO Hysteresis	V _{CC1_HYS}		0.15		V	
V _{CC1} UVLO deglitch time	t _{VCC1_FIL} ⁽¹⁾		7		μs	IN+=V _{CC1} IN- =GND1
V _{CC1} UVLO on delay to output high	t _{VCC1H_OU T} ⁽¹⁾		60			
V _{CC1} UVLO on delay to output low	t _{VCC1L_OUT} ⁽¹⁾		5			
V _{CC1} UVLO on delay to RDY high	t _{VCC1H_RD Y} ⁽¹⁾		60			$\overline{RST}/EN = V_{CC1}$
V _{CC1} UVLO on delay to RDY low	t _{VCC1L_RDY} ⁽¹⁾		5			
Driver Side Supply						
Driver side Supply Quiescent Current	I _{CC2_ON}	3.4	4.6	6	mA	V _{CC2} =15V, V _{EE2} =GND2, OUT=High, V _{AIN} =2V
	I _{CC2_OFF}	2	4	5.5		V _{CC2} =15V, V _{EE2} =GND2, OUT=Low, V _{AIN} =2V
V _{CC2} UVLO Rising Threshold	V _{CC2_ON}	10.5	12.1	13	V	
V _{CC2} UVLO Falling Threshold	V _{CC2_OFF}	9.9	11.1	11.8	V	
V _{CC2} UVLO Hysteresis	V _{CC2_HYS}		1		V	
V _{CC2} UVLO deglitch time	t _{VCC2_FIL} ⁽¹⁾		4.9		μs	IN+=V _{CC1} IN- =GND1
V _{CC2} UVLO on delay to output high	t _{VCC2H_OU T} ⁽¹⁾		14			
V _{CC2} UVLO on delay to output low	t _{VCC2L_OUT} ⁽¹⁾		5.5			

Parameter	Symbol	Min	Typ	Max	Unit	Condition
V _{CC2} UVLO on delay to RDY high	t _{VCC2H_RDY} ⁽¹⁾		18			$\overline{RST}/EN=V_{CC1}$, DESAT=GND2
V _{CC2} UVLO on delay to RDY low	t _{VCC2L_RDY} ⁽¹⁾		10			
Input Pin Characteristic						
Logic High Input Threshold (IN+, IN-, RST)	V _{INH}	2.2	2.8	3.5	V	V _{CC1} =5V
Logic Low Input Threshold (IN+, IN-, RST)	V _{INL}	1.5	2.2	2.9	V	V _{CC1} =5V
Input Hysteresis Voltage (IN+, IN-, RST)	V _{hys_IN}		0.6		V	V _{CC1} =5V
IN+ Input Current	I _{IN+_H}		95		μA	V _{IN+} =5V
IN- Input Current	I _{IN-_L}		-95		μA	V _{IN-} =GND1
RST Input Current	I _{RST_H}		105		μA	V _{RST} =5V
IN+ pull down resistance	R _{IN+}		55		kΩ	
IN- pull up resistance	R _{IN-}		55			
RST pull down resistance	R _{RST}		50			
RST deglitch filter time for Enable/Shutdown	t _{min_RST}	28	40	60	ns	
RST deglitch filter time for Resetting FLT	t _{RST_FIL}	400	660	800	ns	
FLT Reporting						
Open drain low output voltage	V _{FLT_L}			0.3	V	I _{SINK_FLT} =5mA
FLT mute time	t _{FLT_MUTE}	0.55		1	ms	
FLT open drain output on resistance	R _{ODON_FLT}		31		Ω	I _{SINK_FLT} =5mA
RDY Reporting						
Open drain low output voltage	V _{RDY_L}			0.3	V	I _{SINK_RDY} =5mA
V _{CC2} UVLO RDY low minimum holding time	t _{RDY_HLD}	0.55		1	ms	
RDY open drain output on resistance	R _{ODON_RDY}		31		Ω	I _{SINK_RDY} =5mA
Output Pin Characteristic						
High Level Output Voltage	V _{OH}		V _{CC2} -0.1		V	I _{OUT} =-100mA, V _{IN+} =High, V _{IN-} =Low
Low Level Output Voltage	V _{OL}		40		mV	I _{OUT} =100mA, V _{IN+} =Low, V _{IN-} =Low
Output pull-up resistance	R _{OH}		0.7		Ω	I _{OUT} =-100mA, V _{IN+} =High, V _{IN-} =Low
Output pull-down resistance	R _{OL}		0.4		Ω	I _{OUT} =100mA, V _{IN+} =Low, V _{IN-} =High
High Level Peak Output Current	I _{OUTH} ⁽¹⁾		10		A	

Parameter	Symbol	Min	Typ	Max	Unit	Condition
Low Level Peak Output Current	$I_{OUTL}^{(1)}$		10		A	
OUT Short Circuit Clamping Voltage	V_{CLP_OUT}		$V_{CC2}+1.35$		V	$V_{IN+}=High, V_{IN-}=Low, I_{OUTL}=0.5A$, pulse width<10 μs
OUT Active Pull-Down Voltage	V_{SD_OUT}	1.5	2.4	3	V	$V_{CC2}=OPEN$, $I_{OUTL}=0.1 \times I_{OUTL}(typ)$
Internal miller clamp						
Clamp Threshold Voltage	V_{CLAMP_TH}	1.5	2.1	2.5	V	V_{CLAMP} falling, $V_{IN+}=Low, V_{IN-}=Low$
Clamp Delay	$t_{DCLMP}^{(2)}$		70		ns	
Miller clamp pull down resistance	R_{clamp}		0.6		Ω	$I_{CLAMP}=0.1A$
Output low clamp voltage	V_{clamp_L}		60		mV	$I_{CLAMP}=0.1A$
Output low clamp current	$I_{clamp}^{(1)}$		5.7		A	
CLAMP Short Circuit Clamping Voltage	V_{CLP_CLAMP}		$V_{CC2}+1.4$		V	$V_{IN+}=High, V_{IN-}=Low, I_{OUTH}=0.5A$, pulse width<10 μs
			$V_{CC2}+0.9$			$V_{IN+}=High, V_{IN-}=Low, I_{CLAMP}=20mA$

⁽¹⁾ Not test covered, guaranteed by characterization.

⁽²⁾ Not test covered, guaranteed by design.

6.2. Specialized Characteristics

All min and max specifications are at $T_A = -40^{\circ}\text{C}$ to 125°C . Typical values are tested at $V_{CC1} = 3.3\text{V}$ or 5V , $V_{CC2} = 15\text{V}$ or 32V , $V_{EE2} = \text{GND2}$.

Parameter	Symbol	Min	Typ	Max	Unit	Condition
NSI6730ASA						
OC PROTECTION						
Blanking Capacitor Discharge Current	I _{DCHG}		40		mA	V _{OC} =6v
Leading edge blank time	t _{OC_LEB} ⁽¹⁾		230		ns	
Detection Threshold	V _{OCTH}	0.63	0.69	0.77	V	
OC deglitch filter time	t _{oc_FIL}	120	170	220	ns	
OC sense to OUT(L) 90% delay	t _{oc_OFF}	150	230	400	ns	
OC sense to FLT low delay	t _{OC_FLT}		1.5		μs	
Soft turn off current	I _{STO}	250	420	600	mA	
AIN-APWM SENSING						
Internal current source	I _{AIN}		200		μA	
Analog sensing voltage range (Linear region)	V _{AIN}	0.3		4.6	V	
APWM output frequency	f _{APWM}	8	10	12	kHz	
AIN-APWM bandwidth	BW _{AIN} ⁽²⁾		5		kHz	
APWM Duty cycle (Linear region)	D _{APWM}	91.2	92	92.8	%	V _{AIN} =0.4V
		74.2	75	75.8		V _{AIN} =1.25V
		48.9	50	51.1		V _{AIN} =2.5V
		8.5	10	11.5		V _{AIN} =4.5V
NSI6770AHC						
DESAT PROTECTION						
Blanking Capacitor Discharge Current	I _{DCHG}	20	43	60	mA	V _{DESAT} =6V
Blanking Capacitor Charge Current	I _{CHG}	430	510	570	μA	V _{DESAT} =2V
Leading edge blank time	t _{DESAT_LEB} ⁽¹⁾		230		ns	
DESAT deglitch filter time	t _{DESAT_FIL}	50	160	230	ns	
DESAT sense to OUT(L) 90% delay	t _{DESAT_OFF}	150	230	300	ns	
DESAT sense to FLT low delay	t _{DESAT_FLT}		1.4		μs	
Detection Threshold	V _{DESAT_TH}	8.5	9.1	10	V	
Soft turn off current	I _{STO}	600	900	1200	mA	
AIN-APWM SENSING						
Analog sensing voltage range (Linear region)	V _{AIN}	0.3		4.6	V	
APWM output frequency	f _{APWM}	8	10	12	kHz	

Parameter	Symbol	Min	Typ	Max	Unit	Condition
AIN-APWM bandwidth	BW _{AIN} ⁽²⁾		5		kHz	
APWM Duty cycle (Linear region)	D _{APWM}	91.2	92	92.8	%	V _{AIN} =0.4V
		74.2	75	75.8		V _{AIN} =1.25V
		48.9	50	51.1		V _{AIN} =2.5V
		8.5	10	11.5		V _{AIN} =4.5V
NSI6730ASC						
DESAT PROTECTION						
Blanking Capacitor Discharge Current	I _{DCHG}	20	43	60	mA	V _{DESAT} =6V
Blanking Capacitor Charge Current	I _{CHG}	430	510	570	μA	V _{DESAT} =2V
Leading edge blank time	t _{DESAT_LEB} ⁽¹⁾		230		ns	
DESAT deglitch filter time	t _{DESAT_FIL}	50	160	230	ns	
DESAT sense to OUT(L) 90% delay	t _{DESAT_OFF}	150	230	300	ns	
DESAT sense to FLT low delay	t _{DESAT_FLT}		1.4		μs	
Detection Threshold	V _{DESAT_TH}	8.5	9.1	10	V	
Soft turn off current	I _{STO}	250	420	600	mA	
AIN-APWM SENSING						
Internal current source	I _{AIN}		200		μA	
Analog sensing voltage range (Linear region)	V _{AIN}	0.3		4.6	V	
APWM output frequency	f _{APWM}	8	10	12	kHz	
AIN-APWM bandwidth	BW _{AIN} ⁽²⁾		5		kHz	
APWM Duty cycle (Linear region)	D _{APWM}	91.2	92	92.8	%	V _{AIN} =0.4V
		74.2	75	75.8		V _{AIN} =1.25V
		48.9	50	51.1		V _{AIN} =2.5V
		8.5	10	11.5		V _{AIN} =4.5V
NSI6770ASC						
DESAT PROTECTION						
Blanking Capacitor Discharge Current	I _{DCHG}	20	43	60	mA	V _{DESAT} =6V
Blanking Capacitor Charge Current	I _{CHG}	430	510	570	μA	V _{DESAT} =2V
Leading edge blank time	t _{DESAT_LEB} ⁽¹⁾		230		ns	
DESAT deglitch filter time	t _{DESAT_FIL}	50	160	230	ns	
DESAT sense to OUT(L) 90% delay	t _{DESAT_OFF}	150	230	300	ns	
DESAT sense to FLT low delay	t _{DESAT_FLT}		1.4		μs	
Detection Threshold	V _{DESAT_TH}	8.5	9.1	10	V	

Parameter	Symbol	Min	Typ	Max	Unit	Condition
Soft turn off current	I _{STO}	250	420	600	mA	
AIN-APWM SENSING						
Analog sensing voltage range (Linear region)	V _{AIN}	0.3		4.6	V	
APWM output frequency	f _{APWM}	8	10	12	kHz	
AIN-APWM bandwidth	BW _{AIN} ⁽²⁾		5		kHz	
APWM Duty cycle (Linear region)	D _{APWM}	91.2	92	92.8	%	V _{AIN} =0.4V
		74.2	75	75.8		V _{AIN} =1.25V
		48.9	50	51.1		V _{AIN} =2.5V
		8.5	10	11.5		V _{AIN} =4.5V

⁽¹⁾ Not test covered, guaranteed by characterization.

⁽²⁾ Not test covered, guaranteed by design.

6.3. Switching Electrical Characteristics

Typical values are at $V_{CC1}=5V$, $V_{CC2}=15V$, $V_{EE2}=GND2$. All min and max specifications are at $T_A=-40^{\circ}C$ to $125^{\circ}C$. If not mentioned, $C_L=0.1nF$.

Parameter	Symbol	Min	Typ	Max	Unit	Condition
Minimum Pulse Width	t_{PWmin_IN+}	10	30	60	ns	
Output Rise Time	t_R		45		ns	$C_{LOAD}=10nF$
Output Fall Time	t_F		47		ns	
Propagation Delay	t_{pLH_IN+}	50	80	140	ns	$C_{LOAD}=0.1nF$
	t_{pHL_IN+}	50	90	140	ns	
Pulse Width Distortion $ t_{pHL}-t_{pLH} $	t_{PWD}			50	ns	
Common Mode Transient Immunity	$CMTI^{(1)}$	150			kV/ μs	

⁽¹⁾ Not test covered, guaranteed by characterization.

⁽²⁾ Not test covered, guaranteed by design.

7. High Voltage Feature Description

7.1. Insulation and Safety Related Specifications

Parameter	Symbol	SSOW20	Unit	Comments
Minimum External Clearance	CLR	8.0	mm	IEC 60664-1:2007
Minimum External Creepage	CPG	8.0	mm	IEC 60664-1:2007
Distance Through Insulation	DTI	20	µm	Minimum internal gap
Tracking Resistance (Comparative Tracking Index)	CTI	>600	V	DIN EN 60112 (VDE 0303-11); IEC 60112
Material Group		I		

Description	Test Condition	Value
Overvoltage Category per IEC60664-1	For Rated Mains Voltage 150Vrms	I to IV
	For Rated Mains Voltage 300Vrms	I to IV
	For Rated Mains Voltage 600Vrms	I to IV
	For Rated Mains Voltage 1000Vrms	I to III
Climatic Classification		40/125/21
Pollution Degree per DIN VDE 0110		2

7.2. Insulation Characteristics for SSOW20 Package

Description	Test Condition	Symbol	Value	Unit
Maximum Working Isolation Voltage	AC voltage (sine wave) Time dependent dielectric breakdown (TDDb) test	V_{IOWM}	1500	V_{RMS}
	DC voltage		2121	V_{DC}
Maximum Repetitive Peak Isolation Voltage	AC voltage(bipolar)	V_{IORM}	2121	V_{PEAK}
Apparent Charge	Method a, after Input/output safety test subgroup 2/3, $V_{ini}=V_{IOTM}$, $t_{ini} = 60s$, $V_{pd}(m)=1.2 \times V_{IORM}$, $t_m=10s$.	q_{pd}	<5	pC
	Method a, after environmental tests subgroup 1, $V_{ini}=V_{IOTM}$, $t_{ini}=60s$, $V_{pd}(m)=1.6 \times V_{IORM}$, $t_m=10s$			
	Method b, routine test (100% production) and preconditioning (type test); $V_{ini}=1.2 \times V_{IOTM}$, $t_{ini}=1s$ $V_{pd}(m)=1.875 \times V_{IORM}$, $t_m=1s$ (method b1) or $V_{pd}(m)=V_{ini}$, $t_m=t_{ini}$ (method b2)			
Maximum Transient Isolation Voltage	$t = 60s$	V_{IOTM}	8000	V_{PEAK}
Maximum impulse voltage	Tested in air, 1.2/50- μs waveform per IEC62368-1	V_{IMP}	6250	V_{PEAK}
Maximum Surge Isolation Voltage	Test method per IEC60065, 1.2/50 μs waveform, $V_{TEST}=V_{IOSM} \times 1.6$	V_{IOSM}	10000	V_{PEAK}
Isolation Resistance	$V_{IO} = 500V$ at $T_A=T_S$	R_{IO}	$>10^9$	Ω
	$V_{IO} = 500V$ at $100^\circ C \leq T_A \leq 125^\circ C$		$>10^{11}$	Ω
	$V_{IO} = 500V$, $T_A=25^\circ C$		$>10^{12}$	Ω
Isolation Capacitance	$f = 1MHz$	C_{IO}	0.8	pF
UL1577				
Maximum Withstanding Isolation Voltage	$V_{TEST}= V_{ISO}$, $t = 60s$ (qualification); $V_{TEST}= 1.2 \times V_{ISO}$, $t = 1s$ (100%production)	V_{ISO}	5700	V_{RMS}

7.3. Safety Limiting Values for SSOW20 Package

Description	Test Condition	Symbol	Value		Unit
Maximum Safety Temperature		T _s	150		°C
Maximum Safety Power Dissipation	R _{θJA} =77.7°C/W, T _J =150°C, V _{CC2} =20V, V _{EE2} =-5V T _A =25°C	P _s	Total	1160	mW
Maximum Safety Current	R _{θJA} =77.7°C/W, V _{CC2} =15V, V _{EE2} =-5V T _J =150°C, T _A =25°C	I _s	Driver side	58	mA
	R _{θJA} =77.7°C/W, V _{CC2} =20V, V _{EE2} =-5V T _J =150°C, T _A =25°C		Driver side	46	

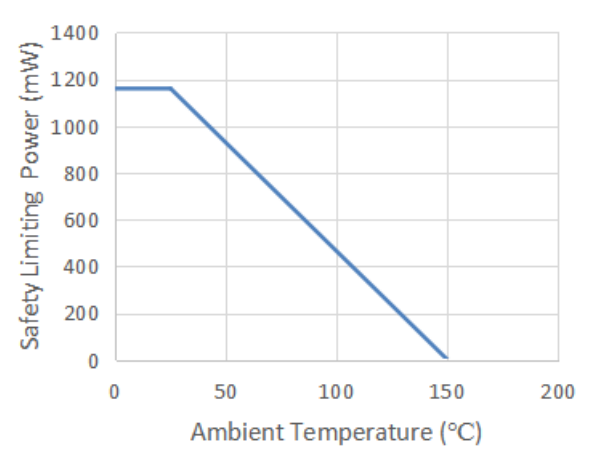


Figure 7.1 Thermal Derating Curve for Limiting Power per DIN VDE V 0884-17 for SSOW20 Package

7.4. Regulatory Information for SSOW20 Package

<i>UL</i>		<i>TUV</i>	<i>CQC</i>
UL 1577 Component Recognition Program	Approved under CSA Component Acceptance Notice 5A	DIN EN IEC 60747-17 (VDE 0884-17)	Certified according to GB4943.1
Single Protection, 5700V _{RMS} Isolation Voltage	Single Protection, 5700V _{RMS} Isolation voltage	Reinforced Insulation V _{IORM} =2121V _{PEAK} , V _{IOTM} =8000V _{PEAK}	Reinforced Insulation
TBD		TBD	TBD

8. Typical Characteristics

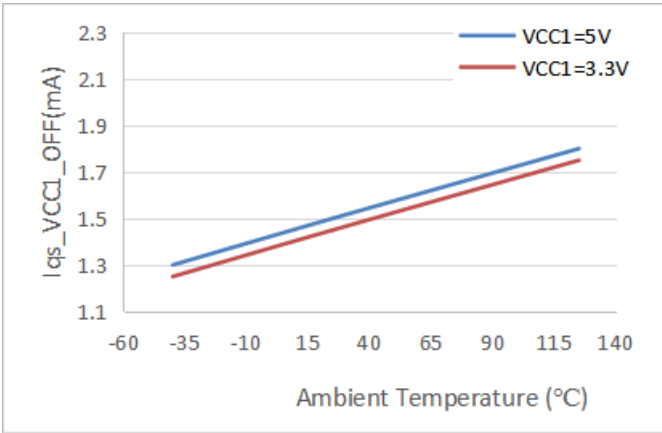


Figure 8.1 VCC1 OFF supply current vs temperature

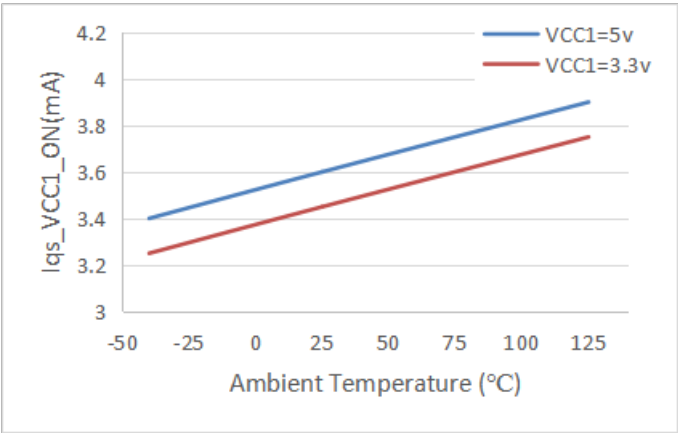


Figure 8.2 VCC1 ON supply current vs temperature

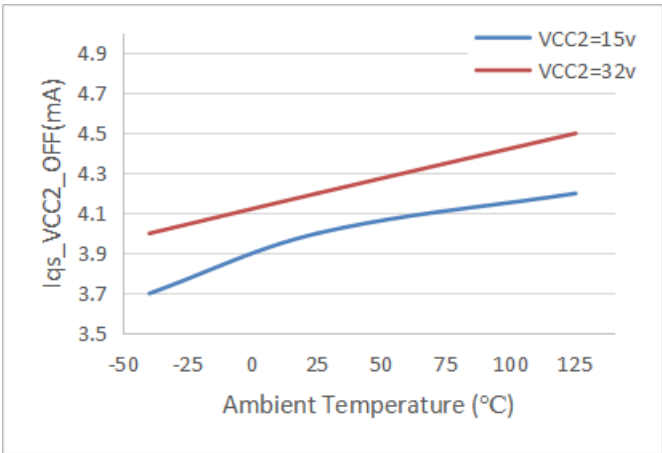


Figure 8.3 VCC2 OFF supply current vs temperature

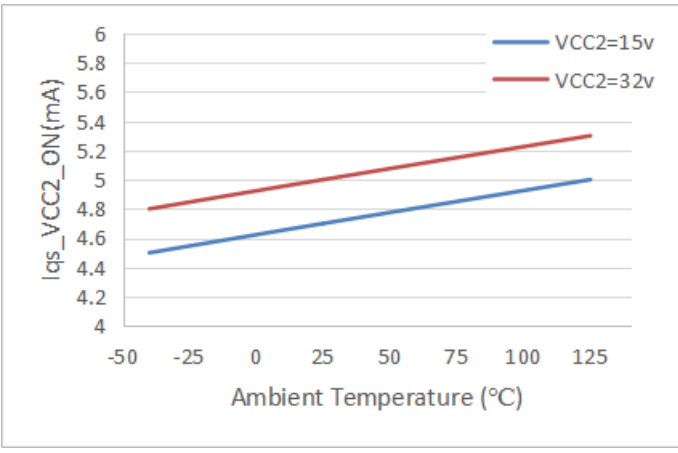


Figure 8.4 VCC2 ON supply current vs temperature

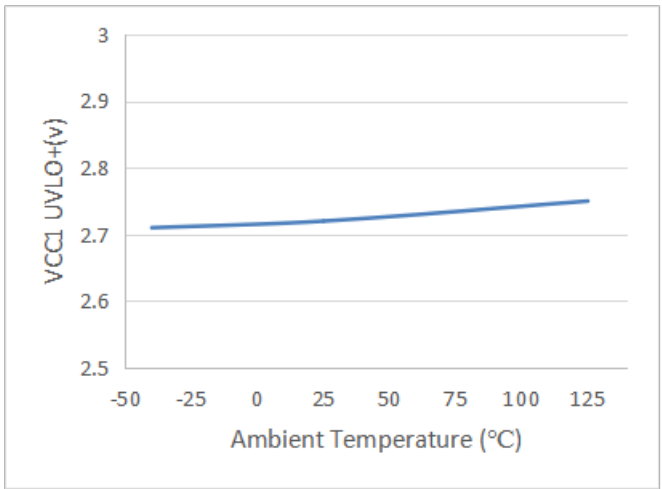


Figure 8.5 VCC1 UVLO+ vs temperature

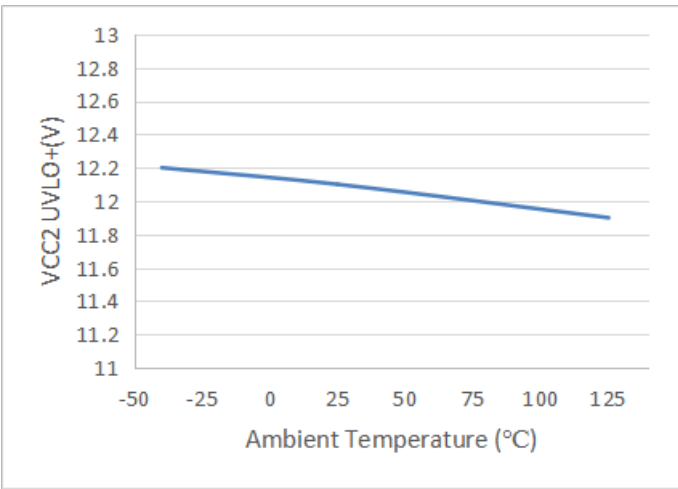


Figure 8.6 VCC2 UVLO+ vs temperature

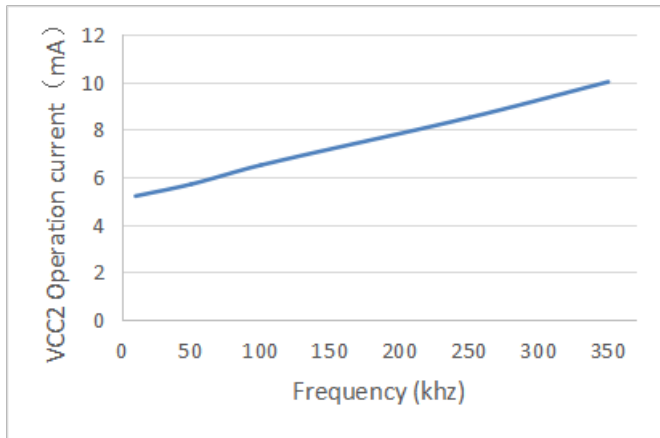


Figure 8.7 VCC2 operation current vs temperature

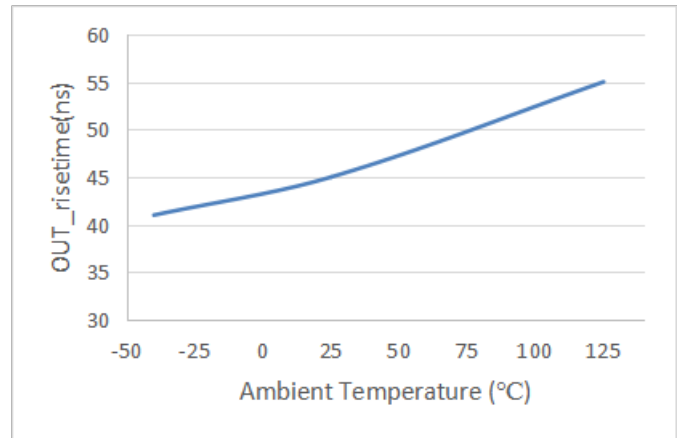


Figure 8.8 risetime vs temperature

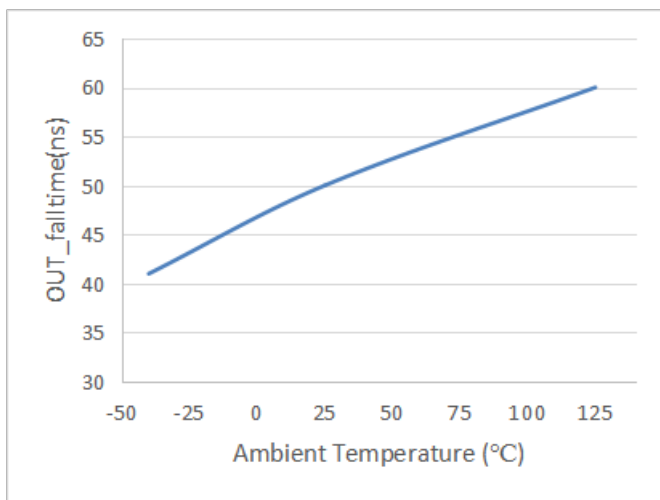


Figure 8.9 fall time vs temperature

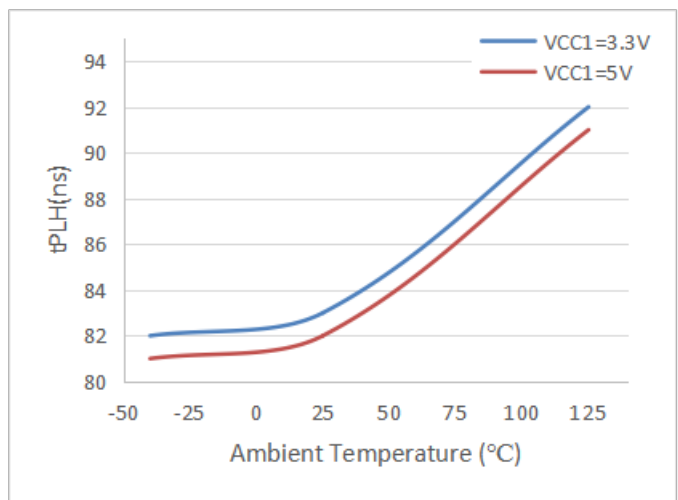


Figure 8.10 t_{PLH_IN+} vs temperature

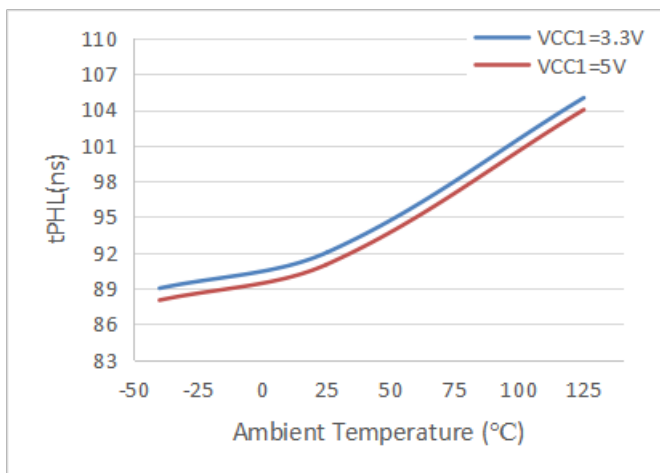


Figure 8.11 t_{PHL_IN+} vs temperature

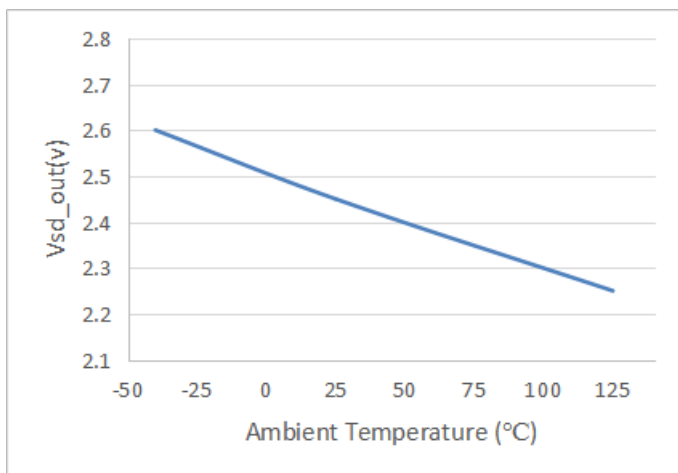


Figure 8.12 Active pulldown voltage vs temperature

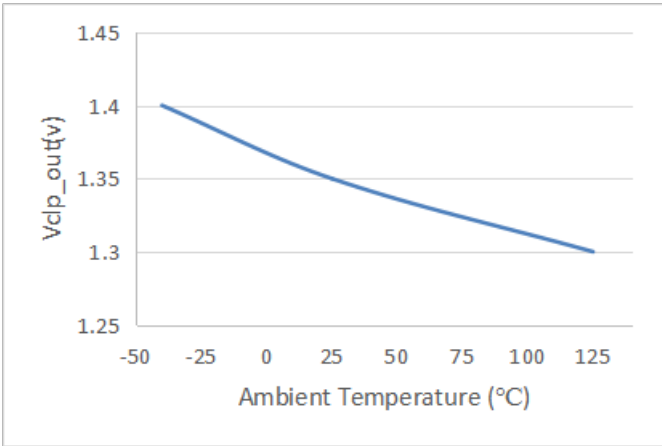


Figure 8.13 short circuit clamp vs temperature

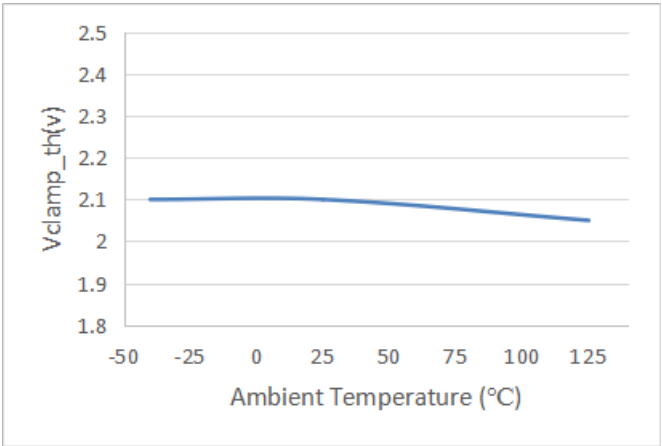


Figure 8.14 miller clamp threshold vs temperature

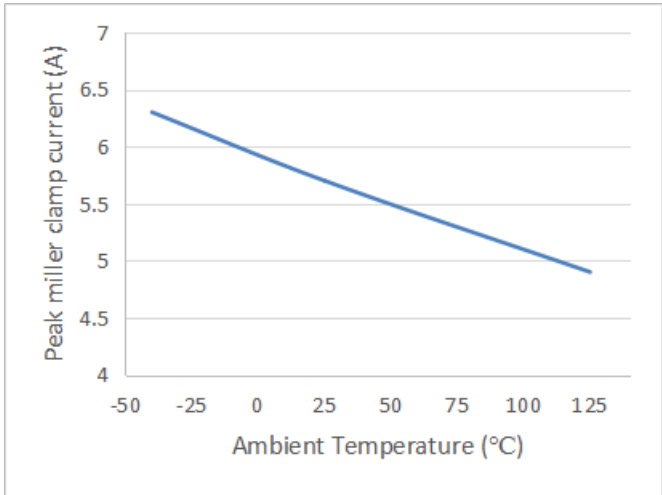


Figure 8.15 peak miller clamp current vs temperature

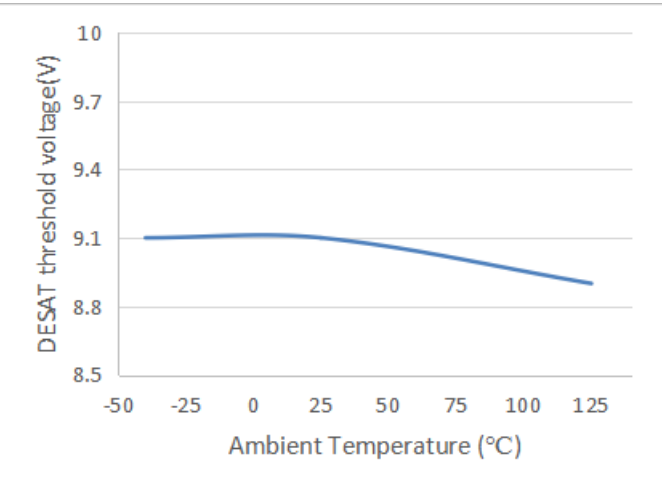


Figure 8.16 DESAT threshold vs temperature

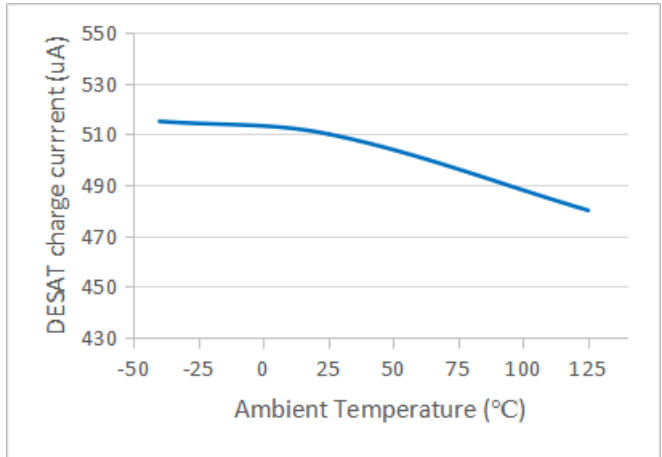


Figure 8.17 DESAT charge current vs temperature

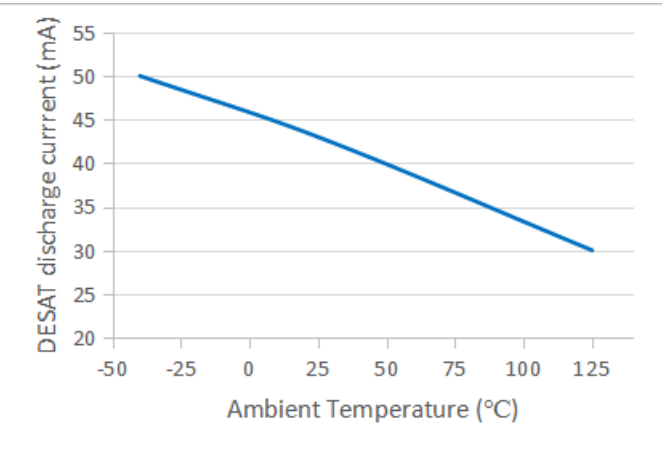


Figure 8.18 DESAT discharge current vs temperature

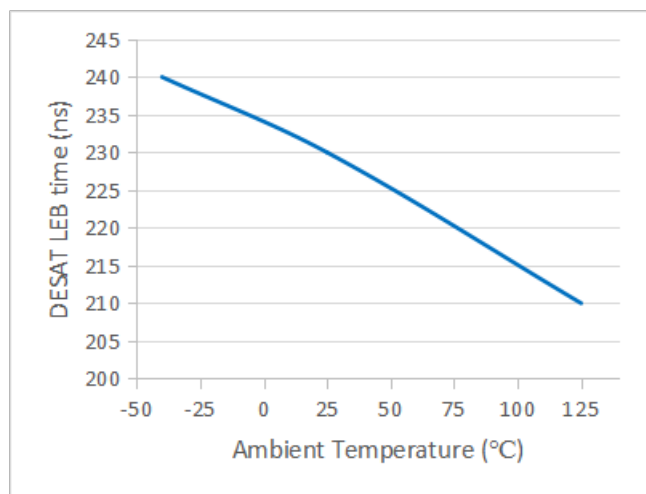


Figure 8.19 DESAT LEB time vs temperature

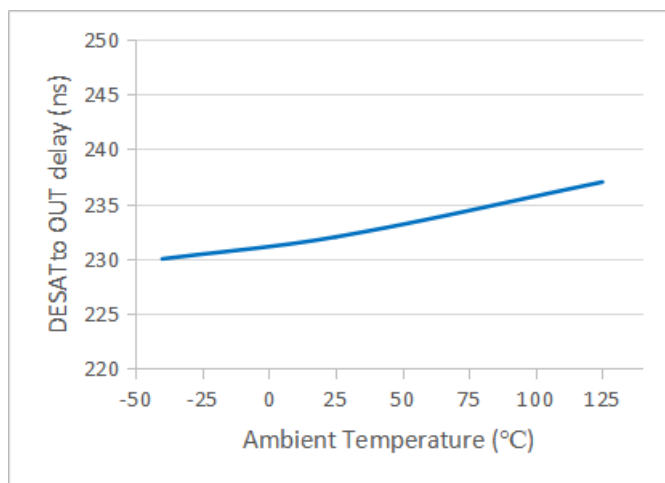


Figure 8.20 DESAT to OUT delay vs temperature

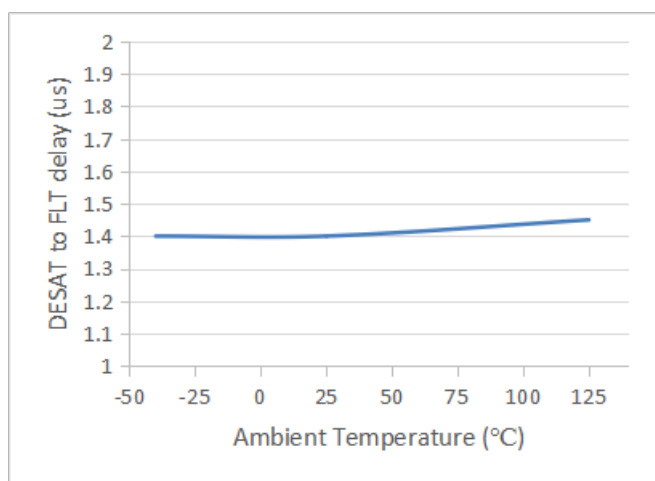


Figure 8.21 DESAT to FLT delay vs temperature

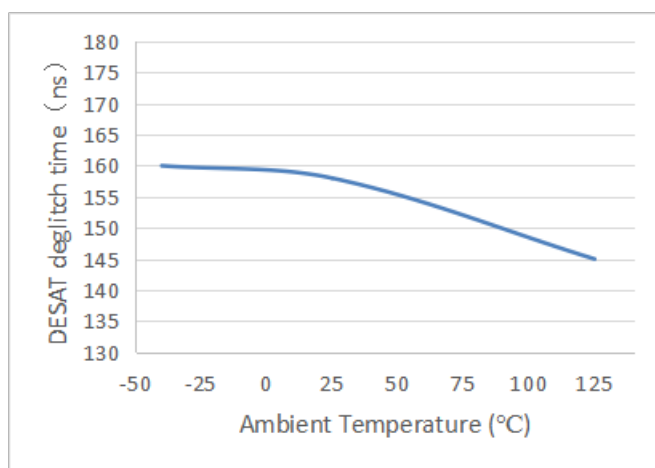


Figure 8.22 DESAT deglitch time vs temperature

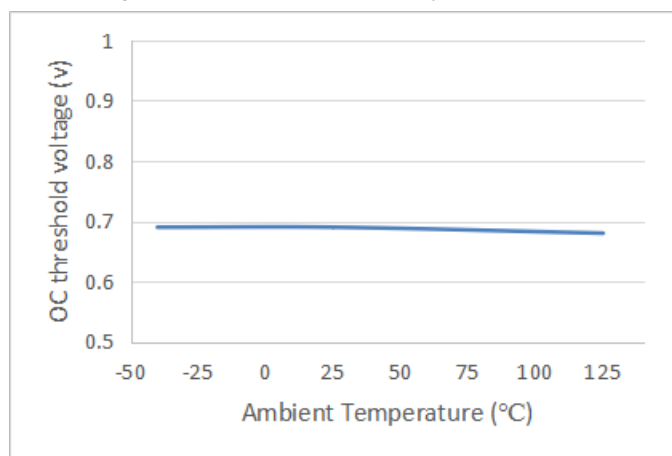


Figure 8.23 OC threshold voltage vs temperature

9. Function Description

9.1. Overview

The NSI67x0 is a highly reliable power transistor gate driver. It can source and sink 10A peak current, which is suitable for driving MOSFET, IGBT, or SiC MOSFET. The NSI67x0 is available in SSOW20 package, which can support 5700V_{RMS} isolation per UL1577. System robustness is supported by 150kV/ μ s minimum common-mode transient immunity (CMTI).

Besides, the NSI67x0 includes crucial protection features such as miller clamp, DESAT short circuit detection and soft turn off. UVLO and short circuit fault are reported through separate pins.

The isolation barrier inside NSI67x0 is based on the capacitive isolation. The modulation uses OOK modulation technique with key benefits of high noise immunity and low radiation EMI. The digital signal is modulated with RF carrier generated by the internal oscillator at the transmitter side, then it is transferred through the capacitive isolation barrier and demodulated at the receiver side.

The functional block diagram of NSI67x0 is shown below. Two input pins with non-inverting and inverting logic support interlock and shoot through protection. Low resistance of high side and low side MOSFET in the output stage ensures high driving capability. Split outputs can control the rise and fall time individually. Active pull-down and short circuit clamping features are implemented to protect power transistor.

In summary, the NSI67x0 is suitable to replace source and sink reinforced gate driver in high reliability, power density and efficiency switching power system.

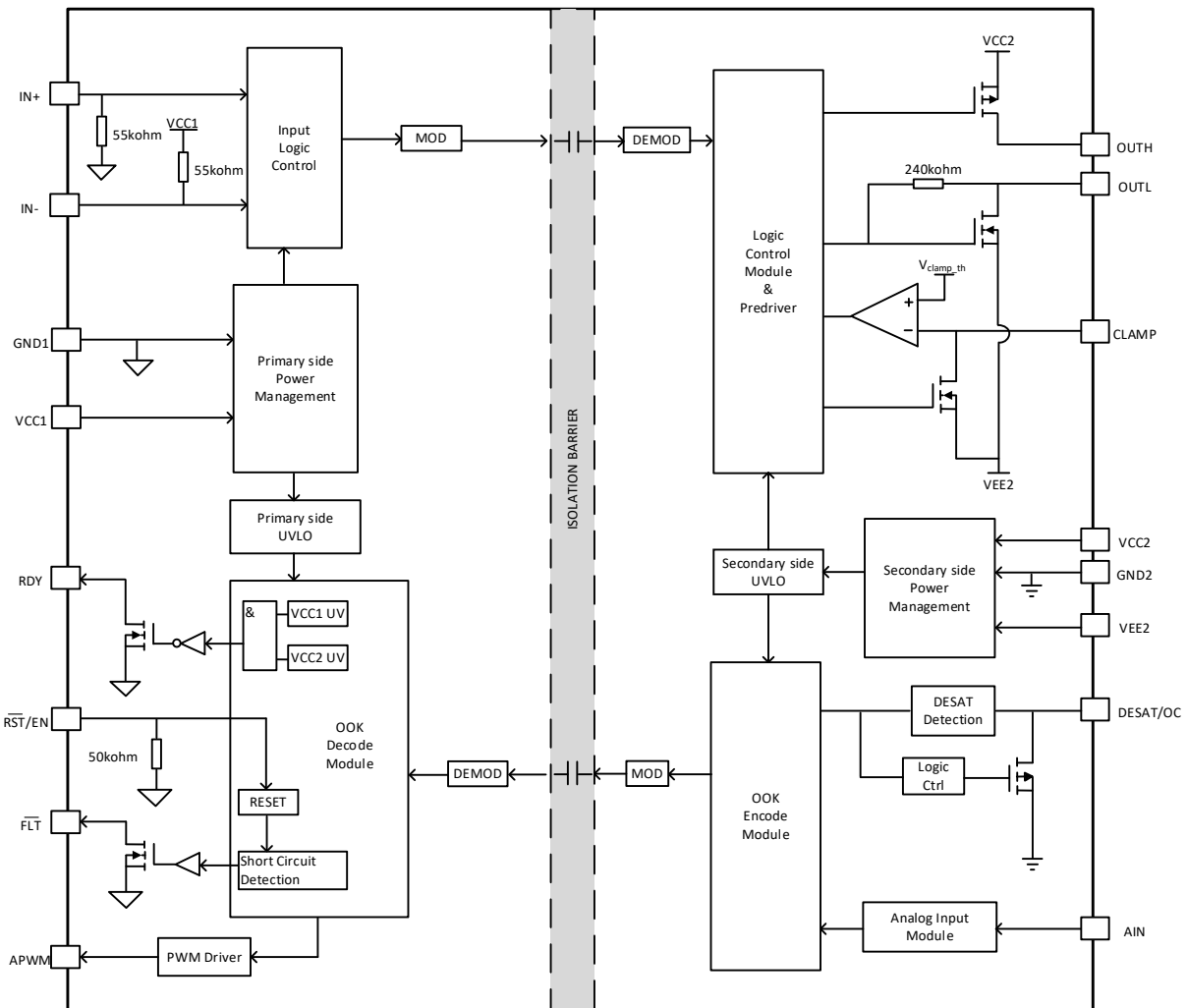


Figure 9.1 NSI67x0 Function Blocks

9.2. Power Supply

Power supply V_{CC1} is able to support from 3.3V to 5.5V. Power supply V_{CC2} is able to support from 13V to 32V. To be mentioned, NSI67x0 also supports bipolar power supply mode on the driver side. In the case of fast switching speed, the negative power supply is crucial to prevent false turn on from parasitic Miller capacitor.

9.3. Output Stage

NSI67x0 supports the split output, which means the rising time and falling time can be adjusted independently. The output voltage is switched between V_{CC2} and $VEE2$. It can be controlled by $IN+$, $IN-$ and $\overline{RST}/EN$. The NSI67x0 has a P-channel MOSFET pulled up the OUTH pin when turning on external power transistor. The measurement result R_{OH} represents the on-resistance of P-channel MOSFET. The voltage and current of external power transistor drain to source or collector to emitter change during turn on. The pull-down structure of NSI67x0 is simply composed of an N-channel MOSFET with on-resistance of R_{OL} . The result is quite small, indicating the strong driving capability of NSI67x0.

9.4. Active Pull-Down

The Active Pull-Down feature ensures a safe IGBT or MOSFET off-state if V_{CC2} is not connected to the power supply. When V_{CC2} is floating, the driver output is still able to be held low.

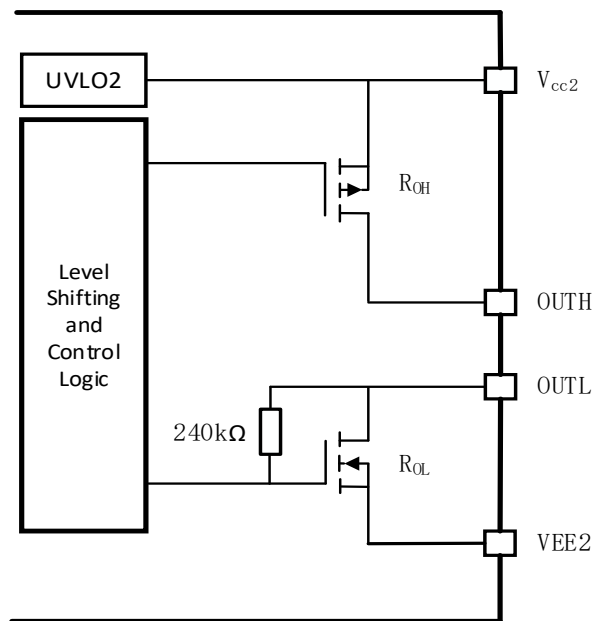


Figure 9.2 NSI67x0 output stage

9.5. Internal Active Miller Clamp

Active miller clamp is used to prevent false turn on. After the external power transistor is turned off, the other one of the phase leg is turned on. The voltage of the drain-source or collector-emitter rises instantly. The dv/dt will cause a high current on miller parasitic capacitor. The voltage drops on the gate resistor possibly turn on the external power transistor unintentionally, which will cause a catastrophic damage. To deal with that, NSI67x0 is equipped with a miller clamp pin. The clamp pin detects the gate voltage of IGBT or MOSFET. When the gate voltage is decreasing and reaches the V_{CLAMP_TH} , the clamp pin will be pulled down by the internal MOSFET, providing a low impedance path to avoid the false turn on.

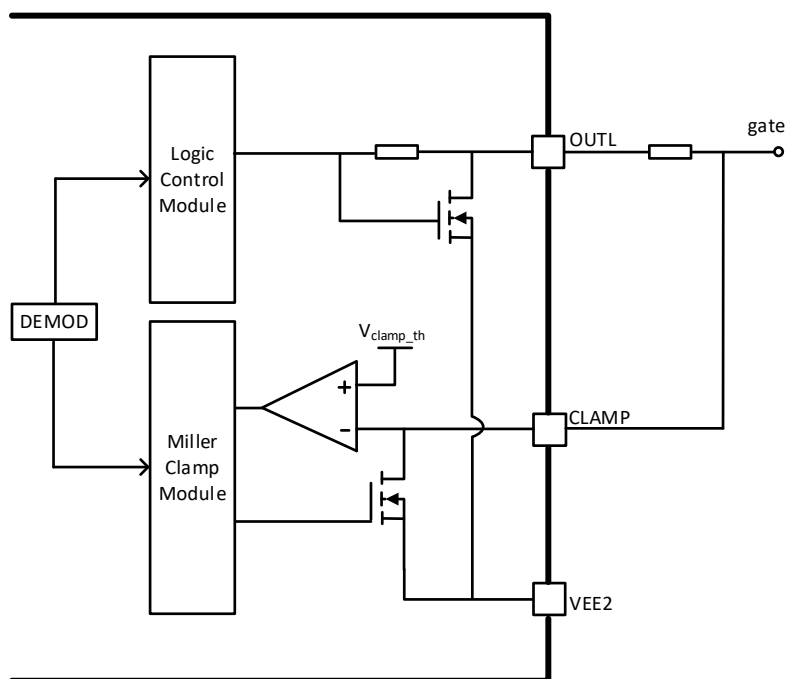


Figure 9.3 Active Miller Clamp

9.6. Short circuit Clamping

During a short circuit, the gate voltage of IGBT or MOSFET tends to rise because of the feedback via the miller capacitance. The diode between OUTH/OUTL/CLAMP and V_{CC2} pins inside the driver limits this voltage when the output voltage is higher than the supply voltage. A maximum current of 500mA may be fed back to the supply through this path for 10 μ s. If higher currents are expected or tighter clamping is desired, external Schottky diodes may be added.

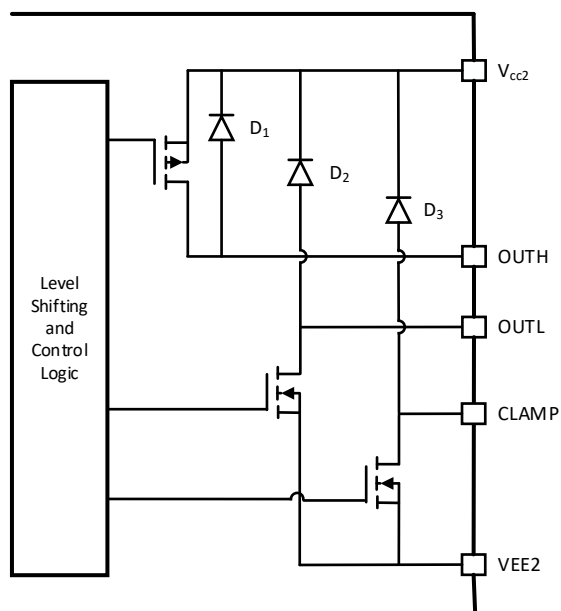


Figure 9.4 Short circuit Clamping

9.7. VCC1 and VCC2 Undervoltage Lock Out (UVLO)

To ensure correct switching, NSI67x0 is equipped with an under-voltage lockout for input and output power supply independently. VCC1 voltage should not fall below the UVLO threshold for normal operation, or the gate-driver output can become clamped low. Output supply UVLO is referred to GND2 pin. If VCC2-GND2 falls below the UVLO threshold, OUTL of the gate-driver will be clamped low.

Local bypass capacitors should be placed between the VCC2 and GND2 pins, as well as the VCC1 and GND1 pins. 220nF to 10μF is recommended for device biasing. Additional 100nF capacitor in parallel with the device biasing capacitor is recommended for high frequency filtering. The capacitors should be positioned as close to the device as possible for better noise filtering. Low-ESR, ceramic surface-mount capacitors are recommended. The RDY pin will report a power good signal if the device is out of UVLO condition.

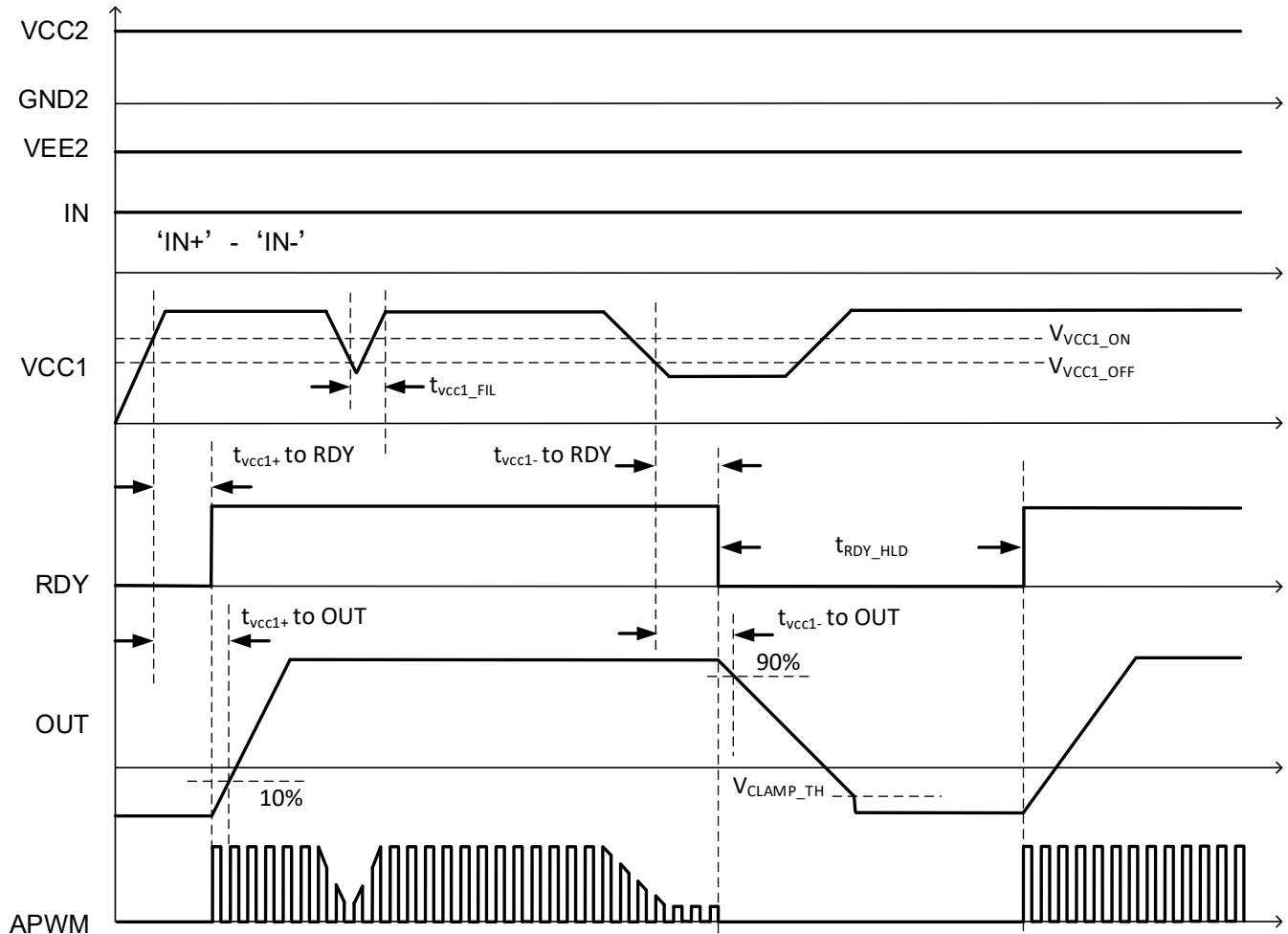


Figure 9.5 RDY vs VCC1 timing Diagram

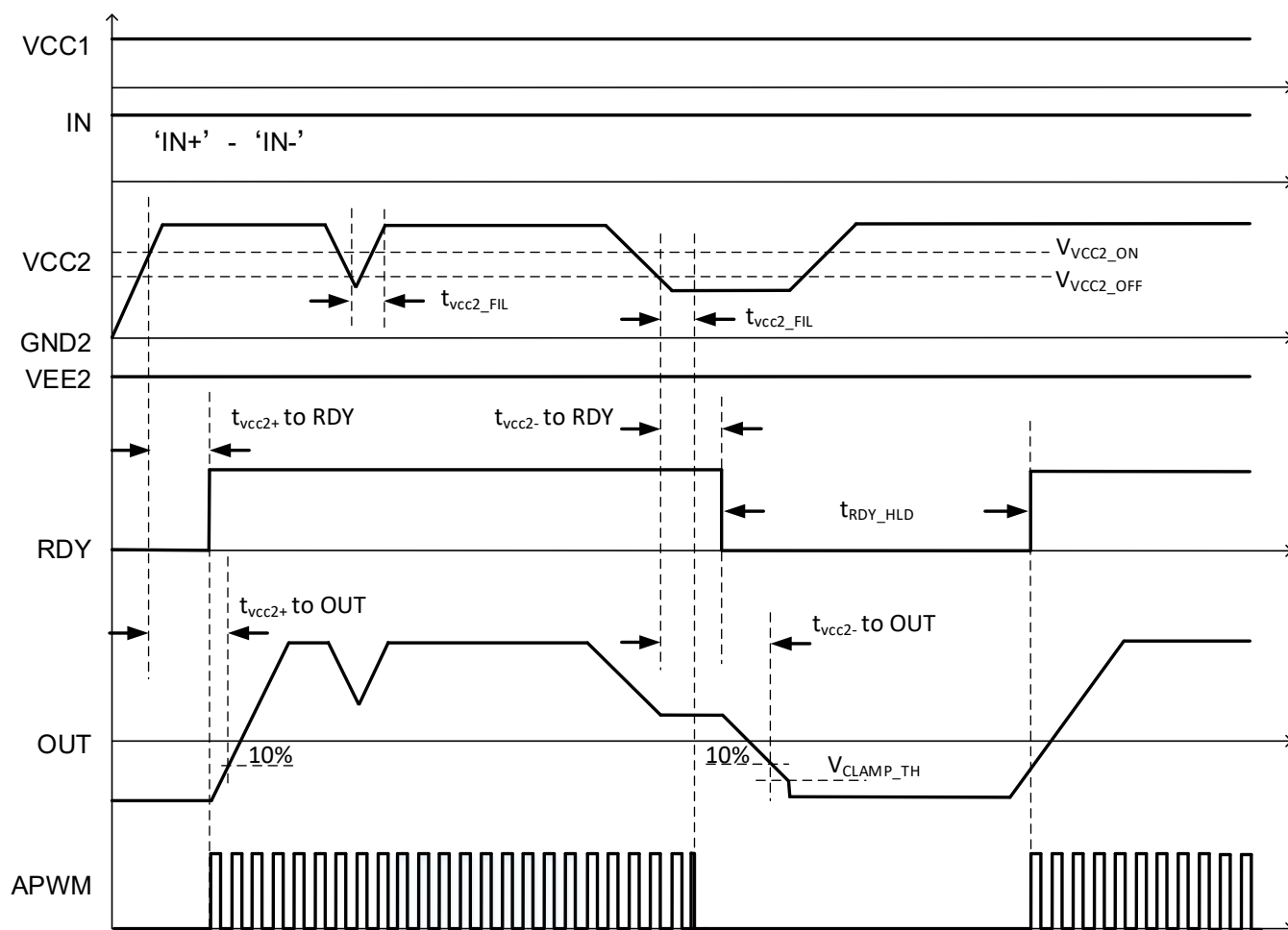


Figure 9.6 RDY vs V_{CC2} timing Diagram

9.8. Desaturation (DESAT) Protection

Desaturation protection is used to prevent the power transistor from a short circuit. The DESAT pin has a typical threshold voltage, which means the output will be driven low if DESAT pin reaches threshold voltage. By default, the DESAT pin is pulled down by an internal MOSFET. The internal current source is designed to work only when the output is high level. There is a leading-edge blanking time to filter the overshoot when the external power transistor is turned on. The current source begins to charge after the internal leading-edge blanking time.

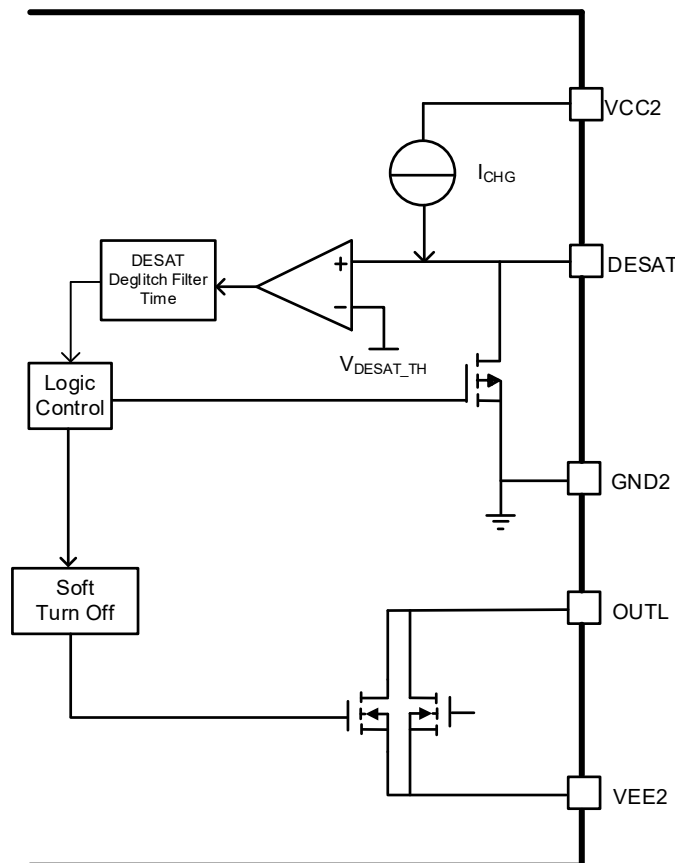


Figure 9.7 DESAT Protection

9.9. Overcurrent (OC) Protection

The Overcurrent protection is used to implement a fast overcurrent and short circuit protection feature to protect the SiC MOSFET or IGBT from catastrophic breakdown during fault. The OC threshold voltage is respected to GND2. When the input is in floating condition, or the output is held in low state, the OC pin is pulled down by an internal MOSFET and held in LOW state, which prevents the overcurrent and short circuit fault from false triggering. The OC pin is in high-impedance state when the output is in high state, which means the overcurrent and short circuit protection feature only works when the power semiconductor is in on state. The internal pulldown MOSFET helps to discharge the voltage of OC pin when the power semiconductor is turned off.

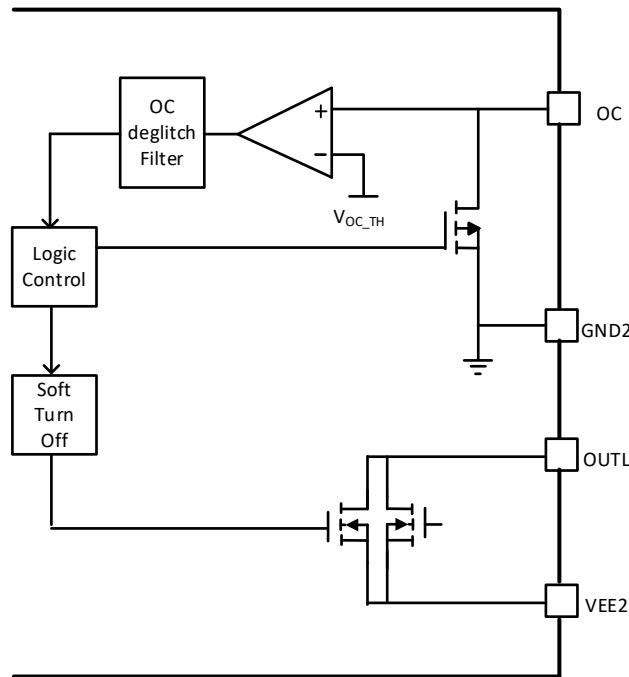


Figure 9.8 OC Protection

9.10. Soft Turn-off

The soft turn-off is designed to prevent the overshoot breakdown when DESAT protection is triggered. When the short circuit fault occurs, the external power transistor transits from the active region to ohmic region very quickly. The high di/dt may result in the overshoot voltage on the parasitic inductance of the emitter. Therefore, the device should be turned off in a soft manner. But the turn off speed should not be too slow. There is a balance between the overshoot and large energy dissipation. Soft turn off current is a compromising choice.

9.11. Fault ($\overline{FLT}$ and $\overline{RST}/EN$)

The $\overline{FLT}$ pin of NSI67x0 is used to report a warning signal if the fault is detected on DESAT. If the fault occurs, the $\overline{FLT}$ pin will be pulled down and held in low state for a mute time. During the mute time, NSI67x0 ignores any reset signal. After that, the $\overline{FLT}$ pin will be reset to high impedance status if the reset signal is checked. The $\overline{RST}/EN$ pin is pulled down to GND1 by an internal resistor, which means the device is disabled by default. Therefore, the $\overline{RST}/EN$ pin must be pulled up externally to enable the device. Timing diagram of fault report is shown below.

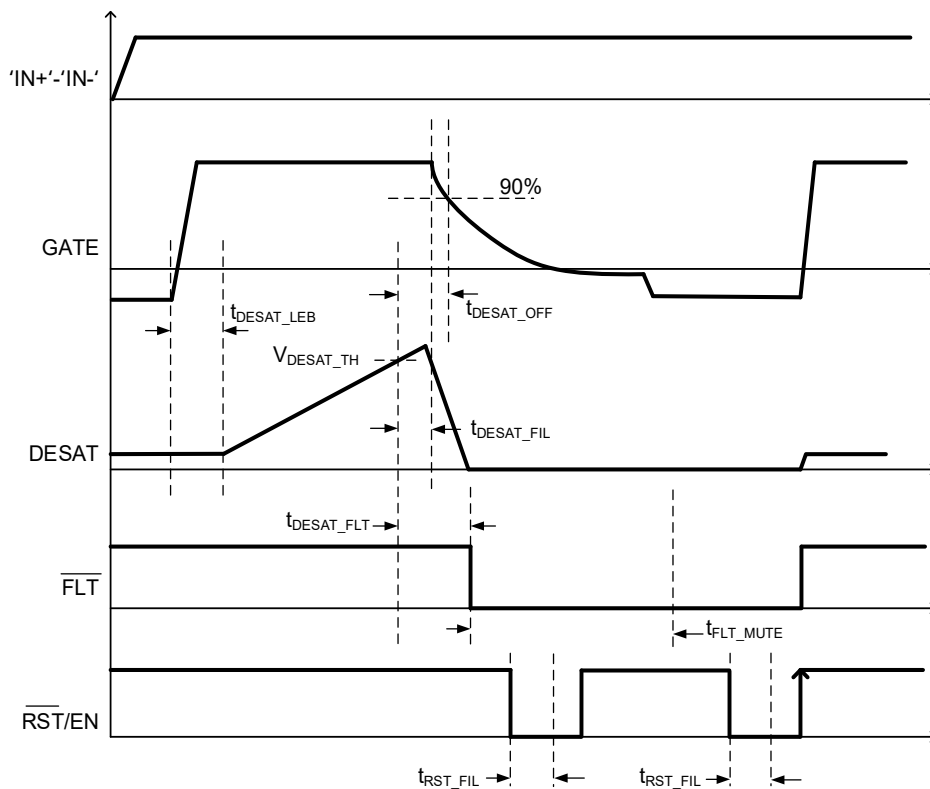


Figure 9.9 DESAT protection Timing Diagram

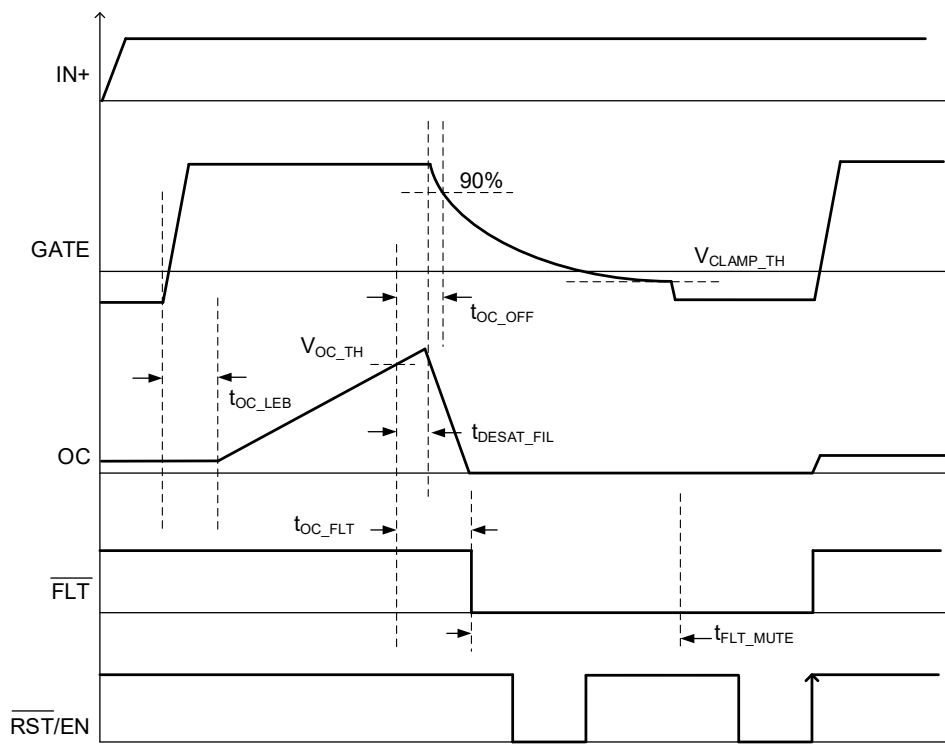


Figure 9.10 OC protection Timing Diagram

9.12. Isolated Analog Signal Sensing Function

NSI67x0 provides an AIN pin on the output side and an APWM pin on the input side. NSI67x0 can transfer the AIN voltage to the corresponding duty cycle of the APWM pin. NSI6730 integrated current source in AIN pin is used to bias the external thermal diode or thermal sensing resistor while NSI6770 does not have the current source. Therefore, AIN pin can be used to detect the HVDC bus voltage or IPM temperature. The duty cycle of output PWM signal can be directly calculated by MCU. Otherwise, the output signal can be transferred to an analog signal by a RC filter.

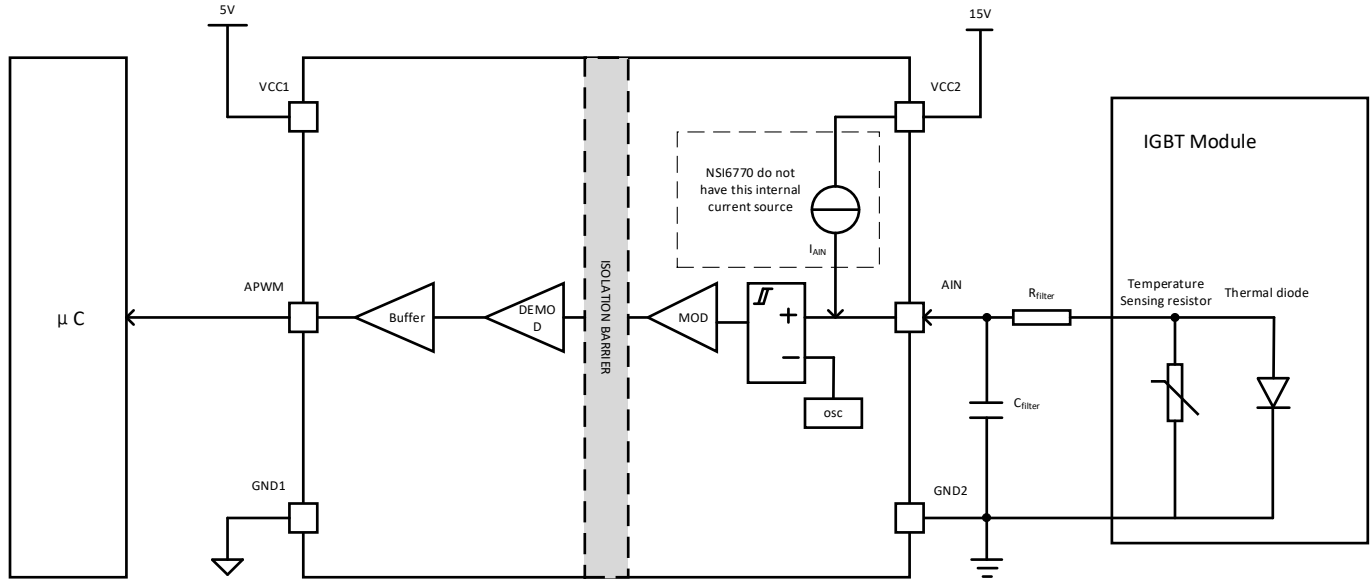


Figure 9.11 Isolated Analog signal sensing

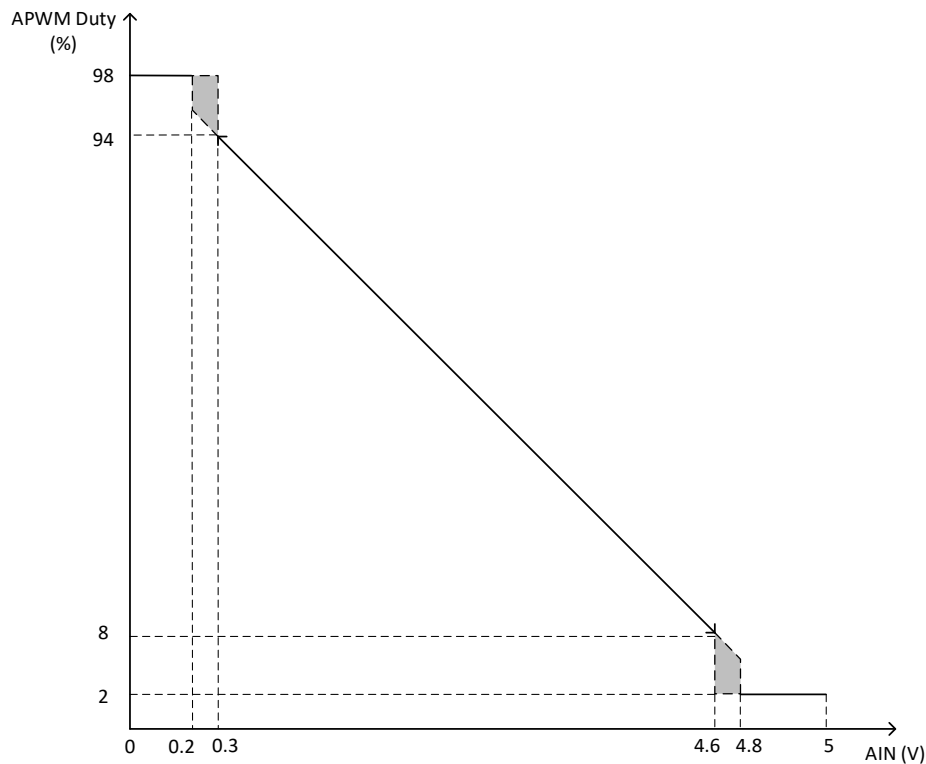


Figure 9.12 APWM duty vs analog input voltage

Note: In the gray region, the duty cycle of the APWM output is uncertain.

9.13. Device Functional Modes

Table lists the common functional modes of the device.

Input						Output			
V _{CC1}	V _{CC2}	IN+	IN-	EN/RST	DESAT or OC	RDY	FLT	OUTH/OUTL	CLAMP
PU	PD/OPEN	X	X	X	X	LOW	HIZ	LOW	LOW
PD	PU	X	X	X	X	LOW	HIZ	LOW	LOW
OPEN	X	X	X	X	X	HIZ	HIZ	LOW	LOW
PU	PU	X	X	LOW	X	HIZ	HIZ	LOW	LOW
PU	PU	LOW	X	HIGH	X	HIZ	HIZ	LOW	LOW
PU	PU	HIGH	LOW	HIGH	HIGH	HIZ	LOW	LOW	LOW
PU	PU	HIGH	LOW	HIGH	LOW	HIZ	HIZ	HIGH	HIZ
PU	PU	HIGH	HIGH	HIGH	X	HIZ	HIZ	LOW	LOW

Open: V_{CC} < POR; PU: V_{CC} > V_{CC} UVLO; PD: POR < V_{CC} < V_{CC} UVLO; X: Irrelevant; HIZ: High impedance
 POR is around 1.8V.

10. Application Note

10.1. Typical Application Circuit

Bypassing capacitors for V_{CC1} and V_{CC2} supplies are needed to achieve reliable performance. To filter noise, 0.1 μ F/50V ceramic capacitor is recommended to be placed as close as possible to NSI67x0, both at V_{CC1} and V_{CC2} side. For V_{CC2} supply, additional 10 μ F/50V ceramic capacitor is recommended, to support high peak currents when turning on external power transistor. If the V_{CC1} or V_{CC2} power supply is located long distance from the IC, bigger capacitance is essential.

The input filter composed by R_{in} and C_{in} can be used if input PWM has ring due to long traces or bad PCB layout. However, it will introduce longer propagation delay.

A 4.7k Ω resistor can be used as pull-up resistor for $\overline{FLT}$, RDY and $\overline{RST}/EN$ pins.

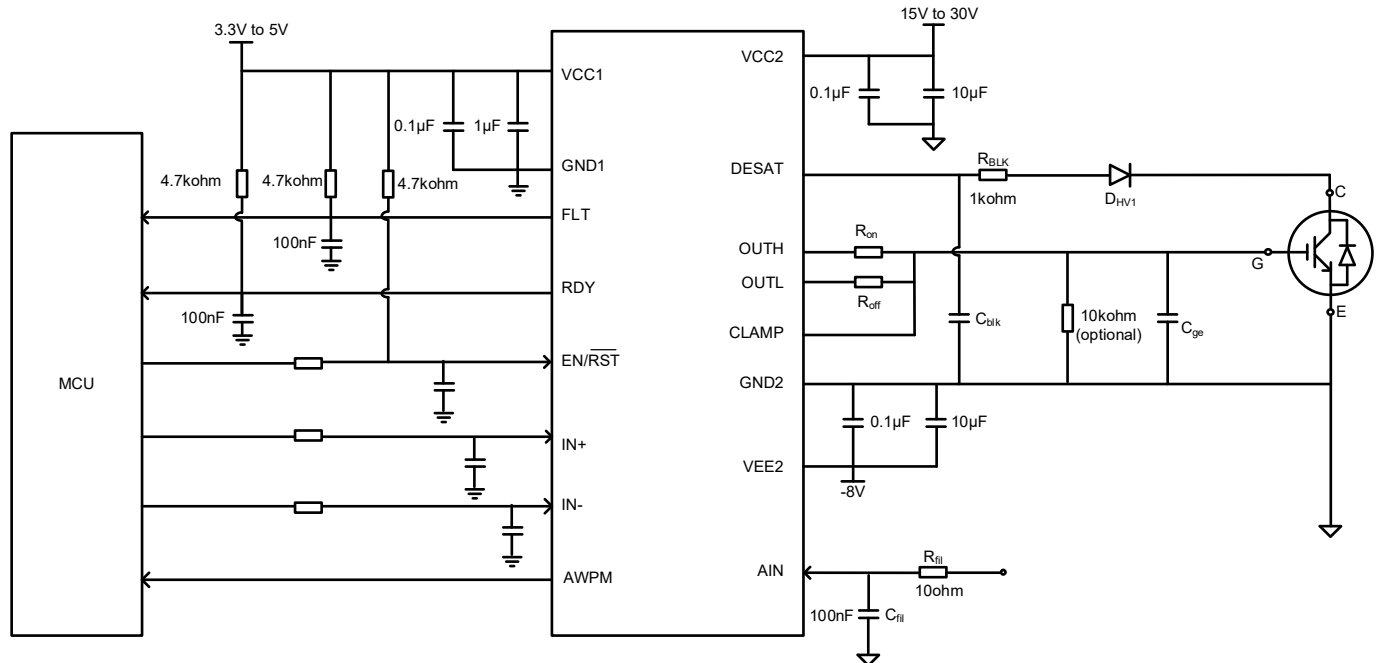


Figure 10.1 Typical Application

10.2. Design for IN+, IN- and $\overline{RST}/EN$

In the application with NSI67x0, the noise from parasitic inductance and coupled capacitance cannot be ignored. To filter the noise, NSI67x0 is designed with a 40ns deglitch filter. Besides, the external low pass filter can also be placed near the input pins. Low pass filter will increase the noise immunity and delay time, so it should be based on the requirements.

10.3. Design for EN/ $\overline{RST}$, RDY and $\overline{FLT}$

EN/ $\overline{RST}$ pin is used to enable the device and reset the fault signal. It is pulled down by default. $\overline{FLT}$ and RDY pin are open-drain output, which means they cannot work without an externally pull-up resistor. In this application, a 4.7k Ω pull-up resistor is recommended for RDY, $\overline{FLT}$ and EN/ $\overline{RST}$ pin. A 100nF can be placed near the device if it is necessary.

10.4. Design for Automatic Reset Control

$\overline{RST}/EN$ pin has two functions. It is used to enable the device and reset the fault signal after DESAT is detected. The $\overline{RST}/EN$ pin is pulled down to GND by an internal resistor, so the $\overline{RST}/EN$ pin must be pulled up externally to enable the device.

After DESAT is detected, the FLT pin will be pulled down until the rising edge of the $\overline{RST}/EN$ pin is coming. To be mentioned, there is a FLT mute time, which means the reset signal must be held for at least t_{FLT_MUTE} .

NSI67x0 can be designed for automatic reset mode. $\overline{RST}/EN$ pin can be connected to IN+ directly when the PWM is applied to the IN+. Besides, $\overline{RST}/EN$ pin can be connected with IN- through a NOT logic if the PWM is applied to the IN-. Whichever mode

is used, the PWM off time should be longer than the t_{FLT_MUTE} .

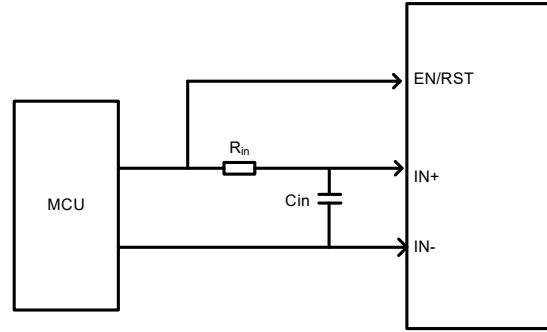


Figure 10.2 Auto-reset control

10.5. PWM Interlock Protection

For applications to drive power transistors in half bridge configuration, two NSI67x0 can be used. NSI67x0 supports Interlock protection. If the controller has some mistakes, leading to negative dead time, the output PWM of NSI67x0 is adjusted to avoid power transistor shoot through.

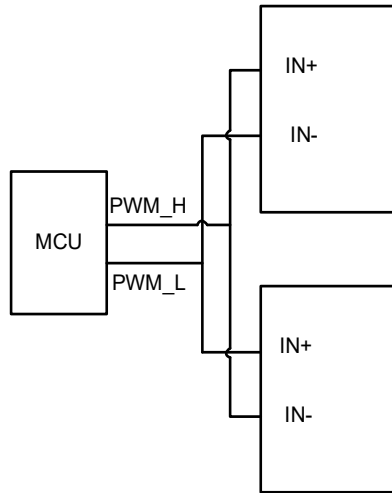


Figure 10.3 Interlock Protection

10.6. Design for R_{on} and R_{off}

NSI67x0 features split output, so the turn on and turn off switching speed can be independently controlled. The turn on and turn off resistance determine the peak source and sink current, which can be estimated by the formula:

$$I_{SOURCE} = \min \left(\frac{V_{CC2} - V_{EE2}}{R_{ON} + R_{OH} + R_{Gint}}, 10A \right)$$

$$I_{SINK} = \min \left(\frac{V_{CC2} - V_{EE2}}{R_{OFF} + R_{OL} + R_{Gint}}, 10A \right)$$

Where

R_{Gint} is the internal resistance of the SiC or IGBT.

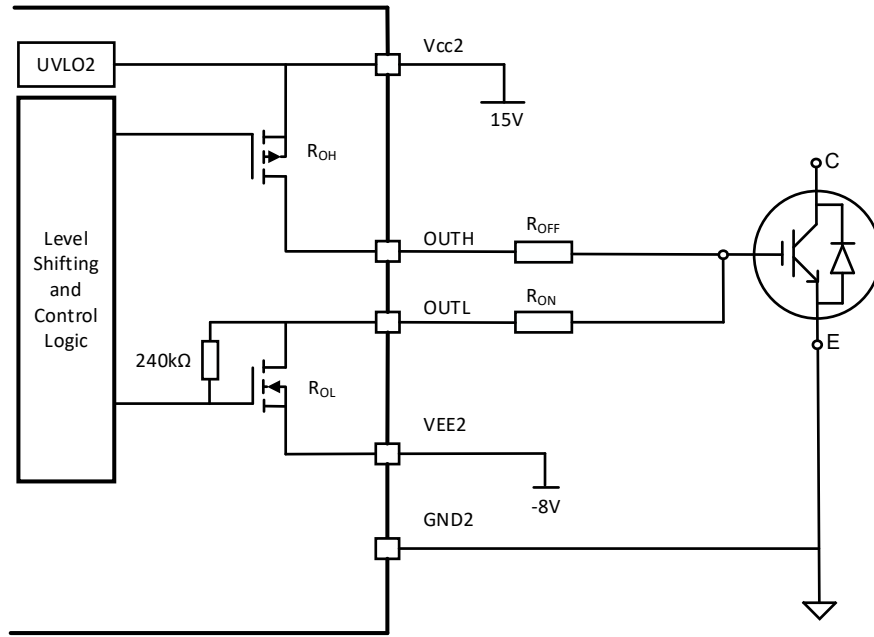


Figure10.4 Gate resistor design

10.7. Design for DESAT Protection

DESAT is used to protect the power semiconductor from overcurrent. When the voltage of DESAT is over the V_{DESAT_TH} , the block of soft turn off will be activated and the fault pin will be pulled down. For typical application, the crucial components required to build the DESAT circuit are the DESAT diode, DESAT resistor and the blank capacitor.

The DESAT diode function is to conduct forward current. In order to avoid the false detection caused by the reverse recovery spikes, a very fast reverse recovery time diode with small reverse parasitic capacitance is recommended. The DESAT detection threshold voltage of 9V can be reduced by the DESAT diode, which can be calculated as:

$$V_{DESAT} = V_{DESAT_TH} - n \times V_F$$

The anti-parallel diode of IGBT has a large transient forward voltage of the diode, which may result in a large negative voltage spike on the DESAT pin, then it may draw a large current from driver. DESAT resistor is used to limit the current. From 100Ω to 1kΩ resistor is recommended to be added in series with the DESAT diode.

The DESAT fault detection should remain a short blanking time so that the collector voltage can fall below the V_{DESAT_TH} . This blanking time can make sure that there is no nuisance tripping during the IGBT turn-on. It is based on the blank capacitor, which can be estimated as:

$$t_{BLK} = \frac{C_{BLK} \times V_{DESAT_TH}}{I_{CHG}}$$

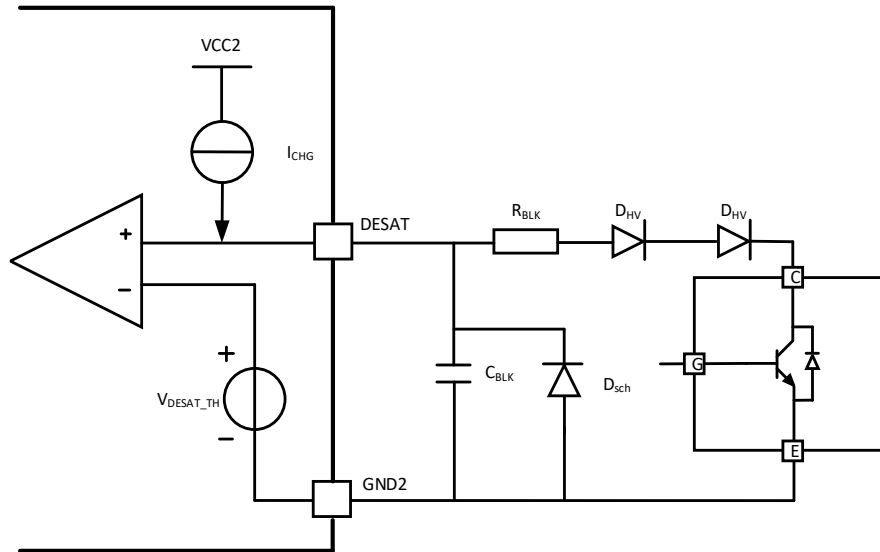


Figure10.5 DESAT protection

10.8. Design for OC Protection

A suitable overcurrent and short circuit protection is important to prevent the SiC MOSFET and IGBT modules from catastrophic break down. Because the output characteristics of SiC MOSFET and IGBT are different. Compared to the IGBT, SiC MOSFET has a larger linear region. The transition point from linear region to saturation region is far higher than the IGBT's. The drain current keeps increasing with the increasing drain to source voltage, which means it may be destroyed before the transition point. So, the OC protection is more suitable in the SiC application.

The SiC/IGBT module with mirror current source is preferred in OC protection because of the smaller noise and lower power dissipation. The mirror current source is used to scale down the device current. The scaled-down current can be measured by an external high precision shunt resistor R_s and the device current can be calculated based on the ratio. To further improve the noise immunity, a low pass filter can be added. A filter capacitor from 100pF to 10nF and a resistance from 10ohm to 100ohm can be added. The typical application circuit is shown below.

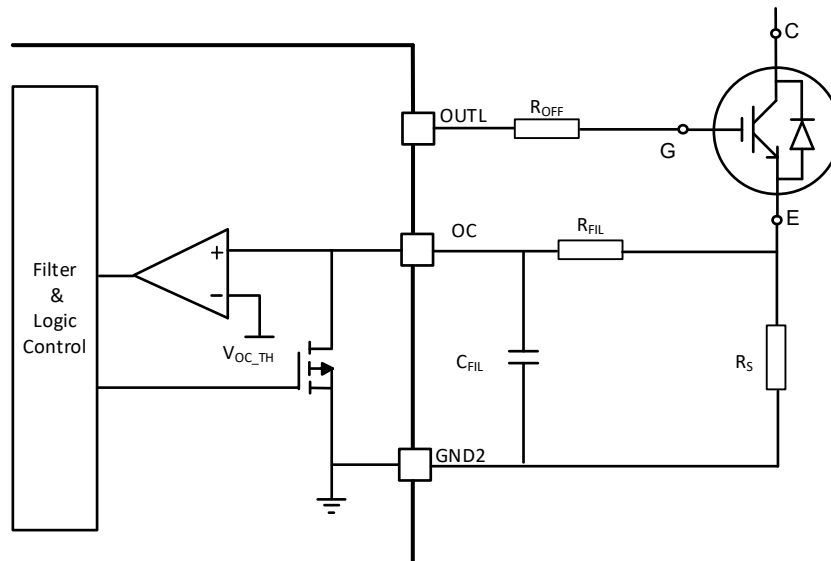


Figure10.6 OC protection

10.9. Design for AIN and APWM

The analog input pin is used to detect analog signal on the secondary side like temperature, bus voltage and so on. The voltage detected in the AIN pin can be transformed to the PWM duty at the APWM pin. NSI6730 provides an internal current source,

which is used to forward bias the thermal diode or create a voltage drop on a temperature sensing resistor. To be mentioned, the NSI6770 does not have the internal current source therefore requires add external current source to NTC or Thermal diode in the system. The duty cycle of the PWM changes linearly from 8% to 94% when the voltage of AIN pin changes from 4.6v to 0.3v. The relationship between voltage and duty refer to the Equation below.

$$D_{APWM} (\%) = -20 \times V_{AIN} + 100$$

There is a low pass filter recommended in the AIN pin to filter the noise caused by the switching of the external power transistor. The APWM pin can be connected to the MCU directly and the AIN voltage can be calculated by the PWM duty cycle. A typical application is shown below.

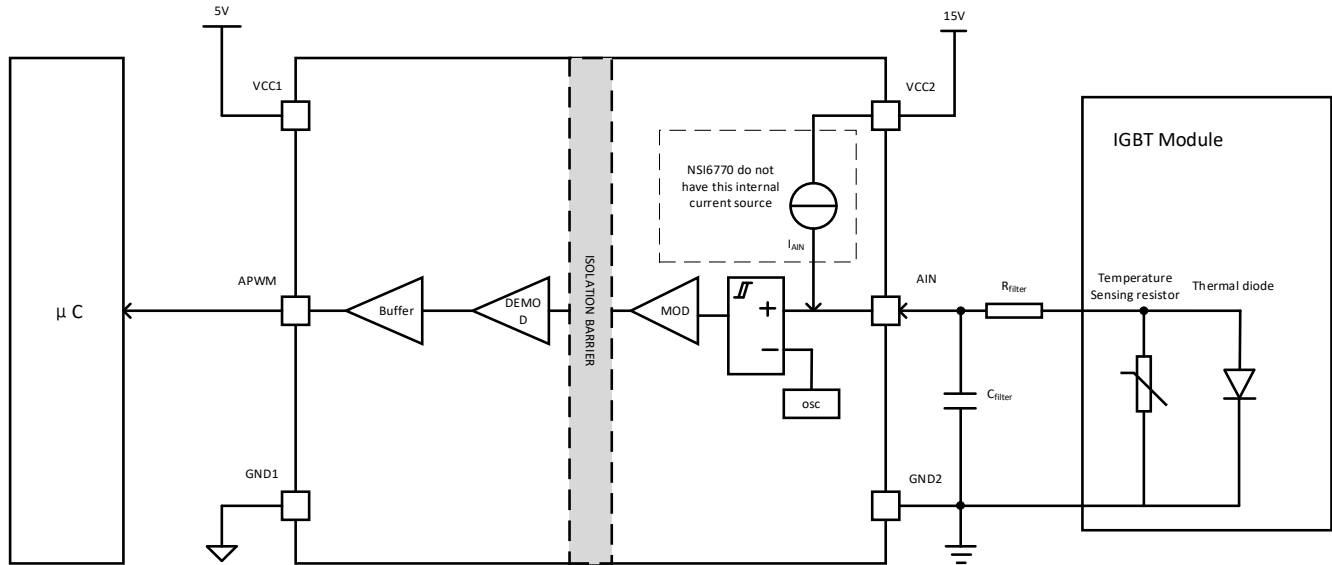


Figure10.7 Design for the IGBT temperature sensing

10.10. PCB Layout

Careful PCB layout is essential for optimal performance. Some key guidelines are:

- The bypass capacitors should be placed close to NSI67x0, between V_{CC1} to GND1, V_{CC2} to GND2 and V_{EE2} to GND2.
- The decoupling capacitors of the input power supply should be connected to pin15 and pin9 through a dependent trace. The voltage spike on the parasitic inductance may affect the internal control logic.
- There is high switching current that charges and discharges the gate of external power transistor, leading to EMI and ring issues. The parasitic inductance of this loop should be minimized, by decreasing loop area and placing NSI67x0 close to power transistor.
- Place a large amount of copper connecting to V_{EE2} pin and V_{CC2} pin for thermal dissipation, with priority on V_{EE2} pin. If the system has multi-layers of V_{EE2} or V_{CC2} , use multiple vias of adequate size for connection.
- To ensure isolation performance between primary and secondary side, the space under the chip should keep free from planes, traces, pads or via.

11. Package Information

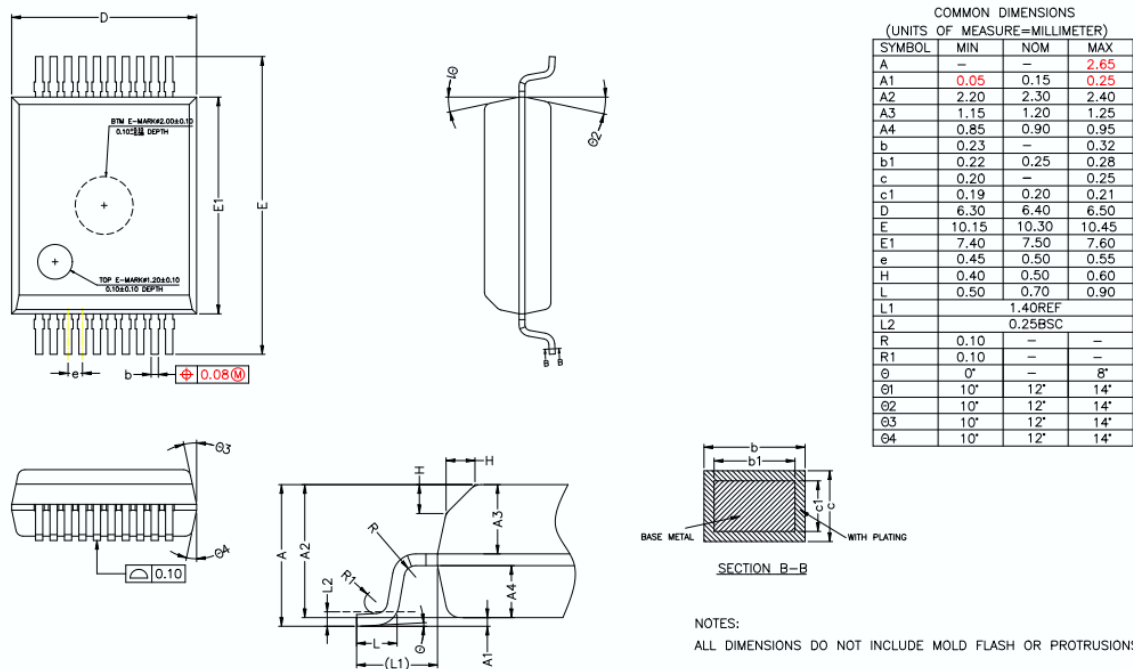
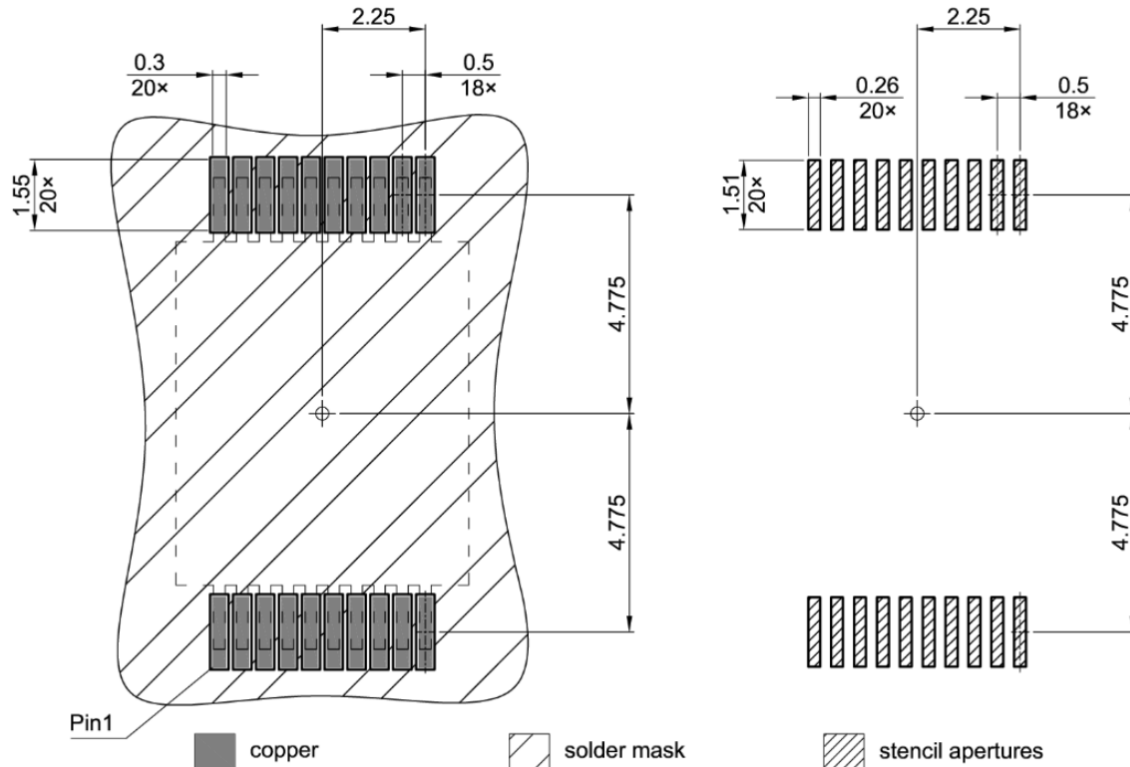


Figure 11.1 SSOW20 Package Shape and Dimension



All dimensions are in units mm

Figure 11.2 Land pattern example

12. Ordering Information

<i>Part Number</i>	<i>Over current Protection</i>	<i>Ambient Temperature</i>	<i>AIN with Internal current source</i>	<i>Soft turn off current</i>	<i>MSL</i>	<i>Category</i>	<i>MPQ</i>	<i>SPQ</i>	<i>Package Type</i>
NSI6730ASA-Q1SSWAR	OC(0.7V)	-40°C to 125°C	YES	I _{STO} =420mA	3	Automotive	1000	1000	SSOW20
NSI6730ASC-Q1SSWAR	DESAT(9V)	-40°C to 125°C	YES	I _{STO} =420mA	3	Automotive	1000	1000	SSOW20
NSI6770ASC-Q1SSWAR	DESAT(9V)	-40°C to 125°C	NO	I _{STO} =420mA	3	Automotive	1000	1000	SSOW20
NSI6770AHC-Q1SSWAR	DESAT(9V)	-40°C to 125°C	NO	I _{STO} =900mA	3	Automotive	1000	1000	SSOW20

FRONT VIEW

SIDE VIEW

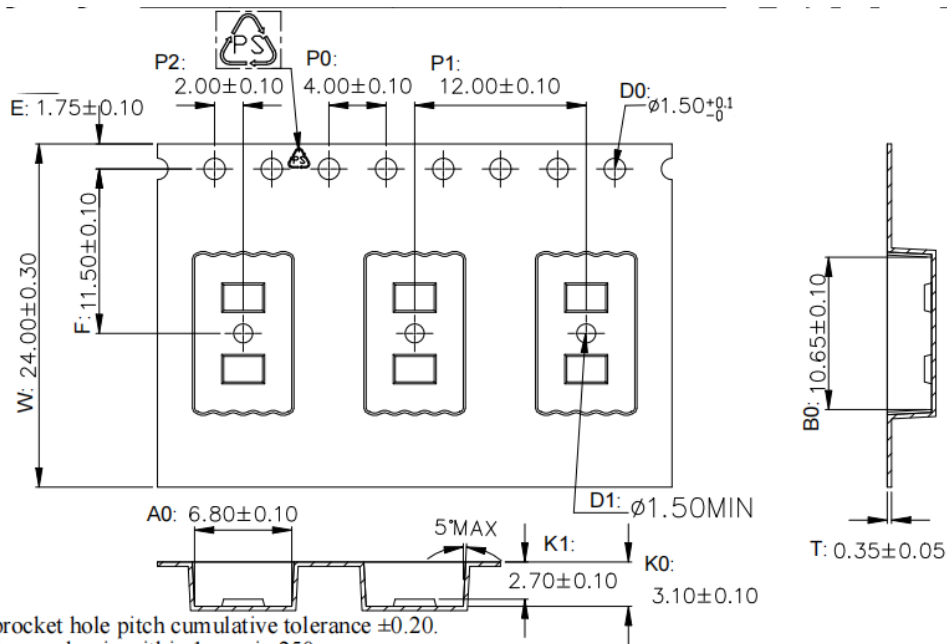
BACK VIEW

ARBOR HOLE DETAIL A
SCALE : 3:1

TAPE WIDTH	øA ±2.0	øN ±2.0	W1	W2 (MAX)	W3	E (MIN)
08MM	330	178	8.4 ^{+1.5} _{-0.5}	14.4	SHALL ACCOMMODATE TAPE WIDTH WITHOUT INTERFERENCE	5.5
12MM	330	178	12.4 ^{+2.0} _{-0.5}	18.4		5.5
16MM	330	178	16.4 ^{+2.0} _{-0.5}	22.4		5.5
24MM	330	178	24.4 ^{+2.0} _{-0.5}	30.4		5.5
32MM	330	178	32.4 ^{+2.0} _{-0.5}	38.4		5.5

LEGEND	SR RANGE	TYPE	COLOUR
A	BELOW 10 ¹²	ANTISTATIC	ALL TYPES
B	10 ⁸ TO 10 ¹¹	STATIC DISSIPATIVE	BLACK ONLY
C	10 ⁸ & BELOW 10 ⁸	CONDUCTIVE (GENERIC)	BLACK ONLY
E	10 ⁸ TO 10 ¹¹	ANTISTATIC (COATED)	ALL TYPES

Figure 13.1 Reel information



1. 10 sprocket hole pitch cumulative tolerance ± 0.20 .
2. Carrier camber is within 1 mm in 250 mm.
3. Material : Black Conductive Polystyrene Alloy.
4. All dimensions meet EIA-481 requirements.
5. Thickness : $0.35 \pm 0.05 \text{ mm}$.
6. Packing length per 19" reel : 168 Meters. (複捲1:9 W122)
7. Component load per 13" reel : 1500 pcs.
8. Surface resistivity : $10^5 \sim 10^{10} \Omega/\text{sq}$.

Figure 13.2 Tape information

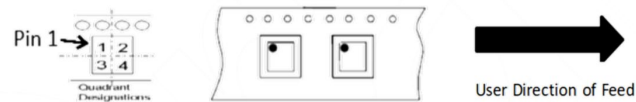


Figure 13.3 Quadrant Designation for Pin1 Orientation in Tape

14. Revision History

Revision	Description	Date
1.0	Initial version	2026/02/25

IMPORTANT NOTICE

The information given in this document (the "Document") shall in no event be regarded as any warranty or authorization of, express or implied, including but not limited to accuracy, completeness, merchantability, fitness for a particular purpose or infringement of any third party's intellectual property rights.

Users of this Document shall be solely responsible for the use of NOVOSENSE's products and applications, and for the safety thereof. Users shall comply with all laws, regulations and requirements related to NOVOSENSE's products and applications, although information or support related to any application may still be provided by NOVOSENSE.

This Document is provided on an "AS IS" basis, and is intended only for skilled developers designing with NOVOSENSE's products. NOVOSENSE reserves the rights to make corrections, modifications, enhancements, improvements or other changes to the products and services provided without notice. NOVOSENSE authorizes users to use this Document exclusively for the development of relevant applications or systems designed to integrate NOVOSENSE's products. No license to any intellectual property rights of NOVOSENSE is granted by implication or otherwise. Using this Document for any other purpose, or any unauthorized reproduction or display of this Document is strictly prohibited. In no event shall NOVOSENSE be liable for any claims, damages, costs, losses or liabilities arising out of or in connection with this Document or the use of this Document.

For further information on applications, products and technologies, please contact NOVOSENSE (www.novosns.com).

Suzhou NOVOSENSE Microelectronics Co., Ltd