<HVIC>

M81777FP

600V HIGH VOLTAGE HALF BRIDGE DRIVER

DESCRIPTION

M81777FP is high voltage Power MOSFET and IGBT gate driver for half bridge applications.

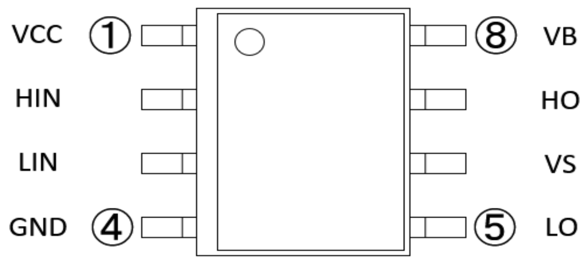
FEATURES

- ●Floating Supply Voltage ····· 600V
- ●Output Current ········· ···· +200mA/-350mA
- ●Half Bridge Driver
- ●Built in BSD function
- ●Protect supply voltage drop
- ●SOP-8 Package

APPLICATIONS

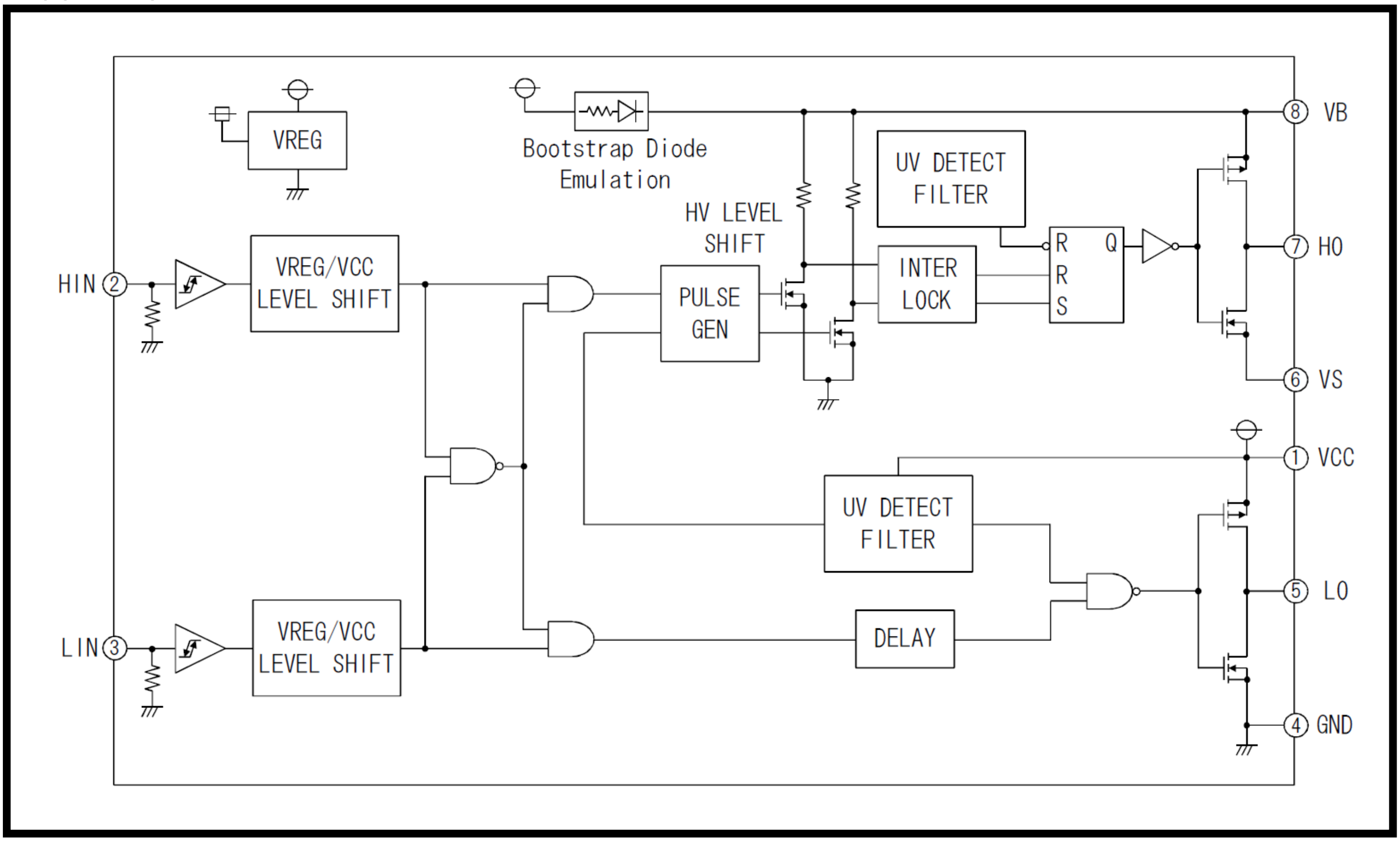
MOSFET and IGBT module driver.

PIN CONFIGURATION (TOP VIEW)



Outline:SOP8

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS (Ta = 25°C unless otherwise specified)

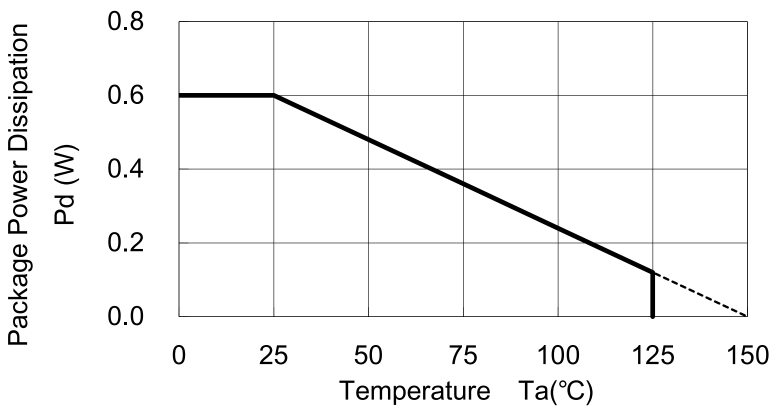
Symbol	Parameter	Test conditions	Ratings	Unit
V_B	High Side Floating Supply Absolute Voltage		- 0.5 ~ 624	V
V_S	High Side Floating Supply Offset Voltage		V_B - 24 ~ V_B + 0.5	V
V_{BS}	High Side Floating Supply Voltage	$V_{BS} = V_B - V_S$	- 0.5 ~ 24	V
V_{HO}	High Side Output Voltage		V_S - 0.5 ~ V_B + 0.5	V
V_{CC}	Low Side Fixed Supply Voltage		- 0.5 ~ 24	V
V_{LO}	Low Side Output Voltage		- 0.5 ~ Vcc + 0.5	V
V_{IN}	Logic Input Voltage	HIN,LIN Terminal	- 0.5 ~ Vcc + 0.5	V
Pd	Package Power Dissipation	Ta = 25°C ,On Board	0.6	W
$K\theta$	Linear Derating Factor	Ta > 25°C ,On Board	4.8	mW/℃
Rth(j-c)	Junction-Case Thermal Resistance		50	℃/W
Tj	Junction Temperature		- 40 ~ 150	℃
Topr	Operation Temperature		- 40 ~ 125	℃
Tstg	Storage Temperature	On Board	- 40 ~ 150	℃
TL	Solder Reflow Condition	Pb-free	255:10s, max 260	℃

RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Test conditions	Limits			Unit
			Min.	Typ.	Max.	
V_B	High Side Floating Supply Absolute Voltage		V_S + 10	—	V_S + 20	V
V_S	High Side Floating Supply Offset Voltage		0	—	500	V
V_{BS}	High Side Floating Supply Voltage	$V_{BS} = V_B - V_S$	10	—	20	V
V_{HO}	High Side Output Voltage		V_S	—	V_B	V
V_{CC}	Low Side Fixed Supply Voltage		10	—	20	V
V_{LO}	Low Side Output Voltage		0	—	V_{CC}	V
V_{IN}	Logic Input Voltage	HIN,LIN Terminal	0	—	V_{CC}	V

Note：For proper operation, the device should be used within the recommended conditions

THERMAL DERATING FACTOR CHARACTERISTIC (MAXIMUM RATING)



ELECTRICAL CHARACTERISTICS (Ta=25℃, VCC=VBS (=VB–VS)=15V, unless otherwise specified)

Symbol	Parameter	Test conditions	Limits			Unit
			Min.	Typ.*	Max.	
I_{FS}	Floating Supply Leakage Current	$V_B = V_S = 600V$	—	—	1.0	uA
I_{BS}	V_{BS} Standby Current	HIN = LIN = 0V	—	0.2	0.5	mA
I_{CC}	V_{CC} Standby Current	HIN = LIN = 0V	—	1.0	2.0	mA
R_{BS}	Boot strap limiting resistance	**	—	100	200	Ω
V_{OH}	High Level Output Voltage	I_O = -20mA HO,LO Terminal	13.6	14.2	—	V
V_{OL}	Low Level Output Voltage	I_O = 20mA HO,LO Terminal	—	0.3	0.6	V
V_{IH}	High Level Input Threshold Voltage	HIN,LIN Terminal(***)	2.7	—	—	V
V_{IL}	Low Level Input Threshold Voltage	HIN,LIN Terminal(****)	—	—	0.8	V
I_{IH}	High Level Input Bias Current	V_{IN} = 5V, HIN,LIN Terminal	—	25	100	uA
I_{IL}	Low Level Input Bias Current	V_{IN} = 0V, HIN,LIN Terminal	—	—	2	uA
V_{BSuvr}	V_{BS} Supply UV Reset Voltage		7.0	8.4	9.8	V
V_{BSuvt}	V_{BS} Supply UV Trip Voltage		6.5	7.85	9.0	V
V_{BSuvh}	V_{BS} Supply UV Hysteresis Voltage		0.3	0.55	—	V
t_{VBSuv}	V_{BS} Supply UV Filter Time		—	7.5	—	us
V_{CCuvr}	V_{CC} Supply UV Reset Voltage		7.0	8.4	9.8	V
V_{CCuvt}	V_{CC} Supply UV Trip Voltage		6.5	7.85	9.0	V
V_{CCuvh}	V_{CC} Supply UV Hysteresis Voltage		0.3	0.55	—	V
t_{VCCuv}	V_{CC} Supply UV Filter Time		—	7.5	—	us
I_{OH}	Output High Level Short Circuit Pulsed Current	V_O = 0V, V_{IN} = 5V, PW < 10ms	120	200	—	mA
I_{OL}	Output Low Level Short Circuit Pulsed Current	V_O = 15V, V_{IN} = 0V, PW < 10ms	250	350	—	mA
R_{OH}	Output High Level On Resistance	I_O = -20mA, $R_{OH} = (V_{CC}(\text{or } V_{BS}) - V_{OH}) / I_O$	—	40	70	Ω
R_{OL}	Output Low Level On Resistance	I_O = 20mA, $R_{OL} = V_{OL} / I_O$	—	15	30	Ω
t_{dLH}(HO)	High Side Turn-On Propagation Delay	CL = 1000pF between HO - V_S	—	150	300	ns
t_{dHL}(HO)	High Side Turn-Off Propagation Delay	CL = 1000pF between HO - V_S	—	130	230	ns
t_{rH}	High Side Turn-On Rise Time	CL = 1000pF between HO - V_S	—	130	220	ns
t_{fH}	High Side Turn-Off Fall Time	CL = 1000pF between HO - V_S	—	50	80	ns
t_{dLH}(LO)	Low Side Turn-On Propagation Delay	CL = 1000pF between LO - GND	—	150	300	ns
t_{dHL}(LO)	Low Side Turn-Off Propagation Delay	CL = 1000pF between LO - GND	—	130	230	ns
t_{rL}	Low Side Turn-On Rise Time	CL = 1000pF between LO - GND	—	130	220	ns
t_{fL}	Low Side Turn-Off Fall Time	CL = 1000pF between LO - GND	—	50	80	ns
DtdLH	Turn-On Propagation Delay Matching	|tdLH(HO) - tdLH(LO)|	—	0	30	ns
DtdHL	Turn-Off Propagation Delay Matching	|tdHL(HO) - tdHL(LO)|	—	0	30	ns

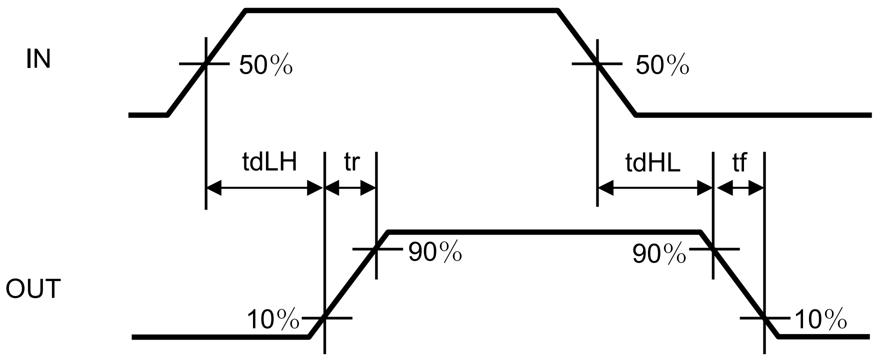
* Typ is not specified.

**R_{BS} formula:

$$R_{BS} = \frac{V_B(I_O@10mA) - V_B(I_O@20mA)}{10mA}$$

***Please set High level input voltage more than the minimum value of limits.
****Please set Low level input voltage less than the maximum value of limits.

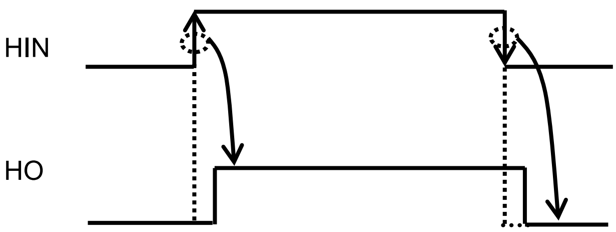
INPUT/OUTPUT TIMING DIAGRAM



FUNCTION TABLE (X:H or L)

HIN	LIN	V_{BS}UV	V_{CC}UV	HO	LO	Behavioral state
H→L	L	H	H	L	L	HO = L, LO = L
H→L	H	H	H	L	H	LO = H
L→H	L	H	H	H	L	HO = H
L→H	H	H	H	L	L	HO = L, LO = L
X	L	L	H	L	L	LO=L,HO=L when V_{BS}UV is detected
X	H	L	H	L	H	LO=H,HO=L when V_{BS}UV is detected
H→L	X	H	L	L	L	LO=L,HO=L when V_{CC}UV is detected
L→H	X	H	L	L	L	LO=L,HO=L when V_{CC}UV is detected

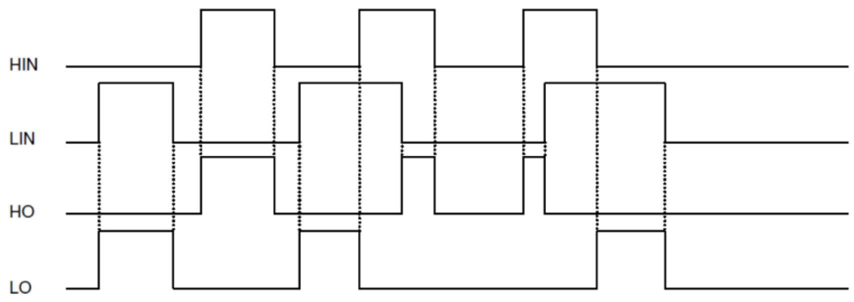
Note1 : "L" state of V_{BS} UV, V_{CC} UV means that V_{CC} (V_{BS}) Supply become under UV trip voltage.
Note2 : In the case of both input signals (HIN and LIN) are "H", output signals (HO and LO) become "L".
Note3 : X(HIN):L→H or H→L X(LIN):H or L
Note3 : Output Signal (HO) is triggered by the edge of input signal.



FUNCTION TIMING DIAGRAM

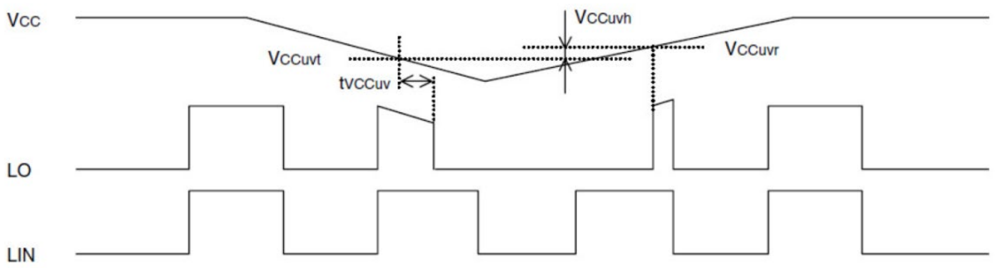
1. Input/Output Timing Diagram

High Active (When input signal (HIN or LIN) is "H", then output signal (HO or LO) is "H".)
In the case of both input signal (HIN and LIN) are "H", output signals (HO and LO) become "L".

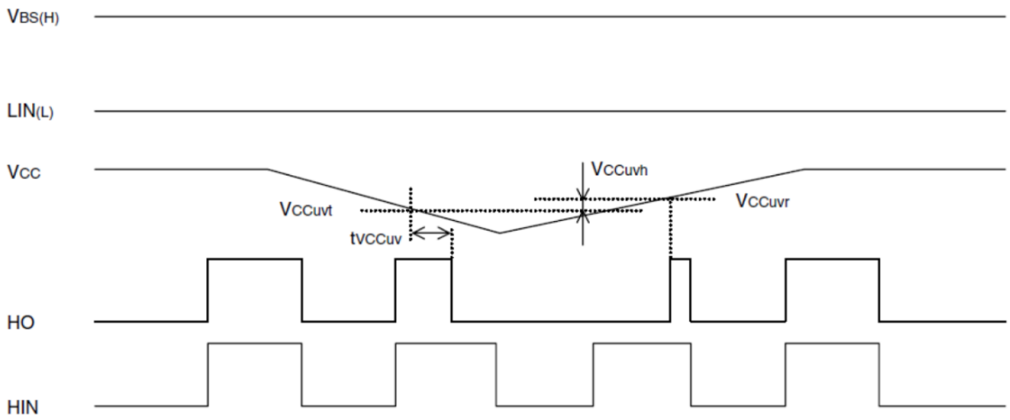


2. V_{CC} (V_{BS}) Supply Under Voltage (UV) Lockout Timing Diagram

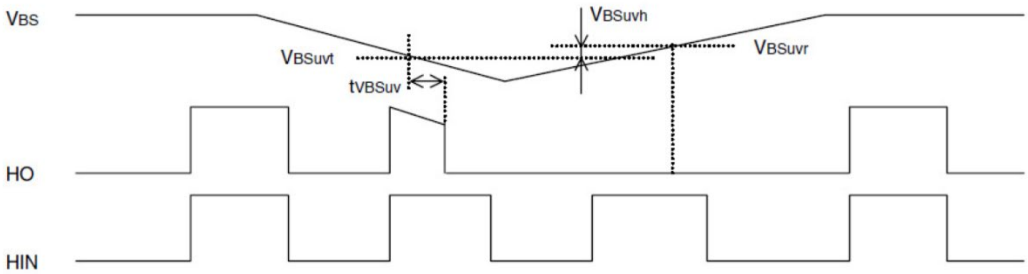
If V_{CC} supply voltage drops below UV trip voltage ($V_{CC}uvt$) for V_{CC} supply UV filter time, LO output signal is shut down. And then, if V_{CC} supply voltage rises over UV reset voltage, LO will return to the usual operation mode.



If V_{CC} supply voltage drops below UV trip voltage ($V_{CC}uvt$) for V_{CC} supply UV filter time, HO output signal is shut down. And then, if V_{CC} supply voltage rises over UV reset voltage, HO will return to the usual operation mode.

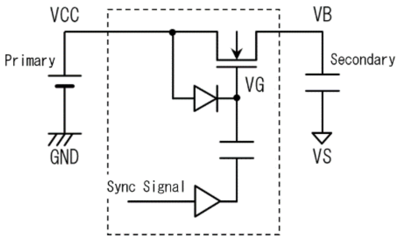


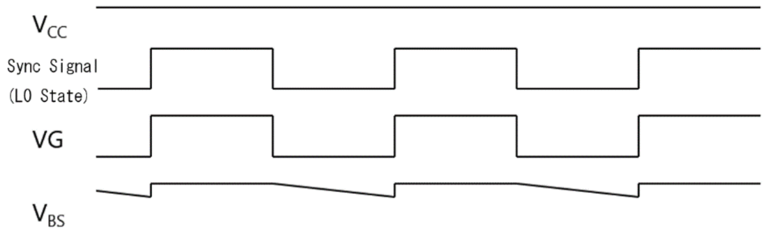
If V_{BS} supply voltage drops below UV trip voltage ($V_{BS}uvt$) for V_{BS} supply UV filter time, HO output signal is shut down. And then, if V_{BS} supply voltage rises over UV reset voltage, HO will respond to the next active HIN signal(L→H).



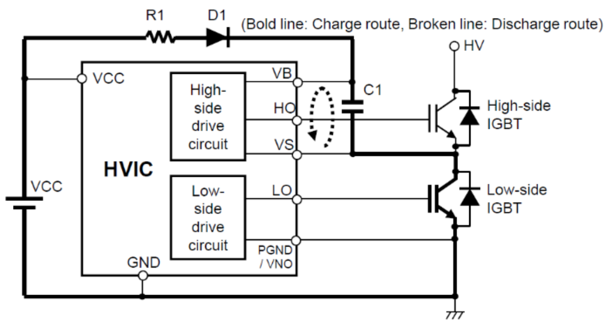
3. Operating BSD Function

The high voltage MOSFET inside HVIC is driven by the sync signal (The signal is LO state at M81777FP) and emulate charging operation by the bootstrap diode. When providing the sync signal, the MOSFET gate is applied the voltage which is boosted V_{CC}, and charge the bootstrap capacitor connected V_B pin. When stopping the sync signal, the MOSFET changes OFF state. The bootstrap capacitor storing electrical charge functions the secondary power supply (V_{BS}).





The setting method of capacitance of the bootstrap capacitor connected V_B pin conform to HVIC Application note [Setting of each constant value (R1, C1, D1) of the bootstrap circuit].



・ Setting of bootstrap capacitor (C1)

To drive high-side IGBT, the bootstrap capacitor is charged by turning on low-side IGBT. The charged voltage V_{C1} is shown below.

(V_F:Voltage between D1 terminals, V_{CE}:Voltage beween collector and emitter of low-side IGBT)

$$V_{C1} = V_{CC} - V_F - V_{CE} \cdots (1)$$

(Note) In case of M81777FP : $V_F \fallingdotseq 0V$

The capacitance value C1 is shown below.

(T1:Maximum on-time of high-side IGBT, I_{BS}:High-side drive circuit consumption current of HVIC, ΔV:Electrical discharge allowance voltage between C1 terminals)

$$C1 = I_{BS} \times T1 / \Delta V + \text{margin} \cdots (2)$$

I_{BS} changes depending on gate capacitance of IGBT and carrier frequency. And (1) and (2) expression are simplified. So please set the capacitance value C1 based on evaluation of your system.
About the kind of capacitor, it recommends that the electrolysis capacitor which has excellent characteristics of temperature and frequency is connected in parallel with the ceramic capacitor for noise removal which has excellent characteristics of temperature and frequency.

・ Setting of resistor (R1)
R1 is necessary to restrict inrush current during initial charge.Time to charge C1 is decided by C1 and R1. Therefore, when the minimum on-time of the low-side IGBT is set to T2, the value of R1 is set so that C1 can be charged by ΔV in the time of T2.
(Note) In case of M81777FP : R1 = R_{BS}

・ Selection of diode (D1)
The high-speed recovery diode whose breakdown voltage is 600V/1200V or more is recommended.
(Note) In case of M81777FP :Diode(D1) is not needed.

NOTES

1) Allowable supply voltage transient
When applying V_{CC} and V_{BS}, power supply should be applied slowly.
If it rises rapidly, output signal (HO or LO) may be malfunction.

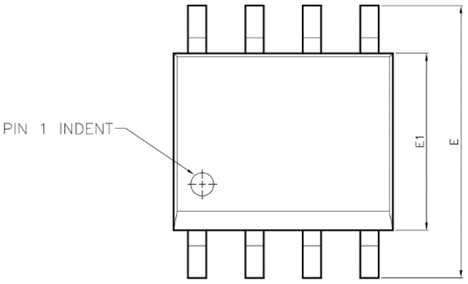
2) Supply voltage start up or restart after shut down
If V_{CC} supply is less than 10V(outside of RECOMMENDED OPERATING CONDITIONS), there is some possibility that output does not change in response to input.
Please evaluate carefully about supply start up or restart after shut down in your application systems.

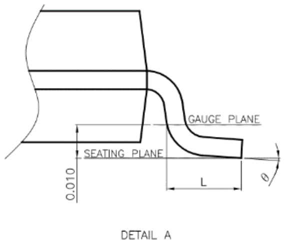
3) V_B supply voltage
Please use V_B supply voltage within RECOMMENDED OPERATING CONDITIONS
(V_S +10V < V_B < V_S + 20V : V_S = 0V minimum)
If V_B supply voltage is used on the other conditions, output signal HO may be malfunction.
Please evaluate carefully about V_B supply voltage in your application systems.

4) Inter-terminal processing
In this product, the terminal of the low voltage part and the high voltage part are adjacent (No.5:V_{CC}, No.6:V_S). There may be cases where there is insufficient insulation clearance distance between the pins.
Please use such as coating between the terminals.

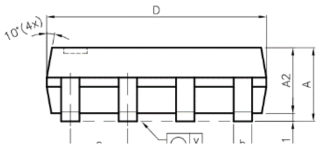
ENVIRONMENTAL CONSCIOUSNESS
M81777FP is compliant with the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) directive 2011/65/EU+(EU)2015/863.

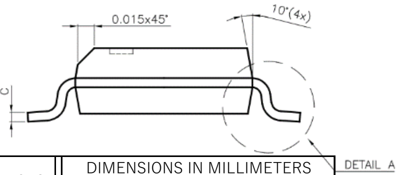
PACKAGE OUTLINE

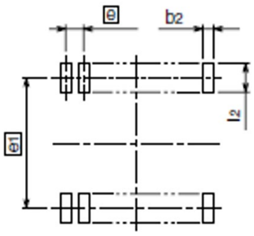




SYMBOLS	DIMENSIONS IN MILLIMETERS		
	MIN	NOM	MAX
A	1.47	1.60	1.73
A1	0.10	——	0.25
A2	——	1.45	——
b	0.33	0.41	0.51
C	0.19	0.20	0.25
D	4.80	4.85	4.95
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	——	1.27	——
L	0.40	0.71	1.27
y	——	——	0.076
θ	0°	——	8°







Recommended Mount Pad

SYMBOLS	DIMENSIONS IN MILLIMETERS		
	MIN	NOM	MAX
e1	—	5.23	—
l2	1.27	—	—
e	—	1.27	—
b2	—	0.76	—

The above is one example.
Please design the mount pad with your evaluation.

Main Revision for this Edition

Rev.	Date	Revision	
		Pages	Points
A	28 Jan. 2022	-	New
B	1 Sep. 2022	-	Delete "PRELIMINARY".

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