NCP338

2A Ultra-Small Controlled Load Switch with Auto-discharge Path

The NCP338 is very low Ron MOSFET controlled by external logic pin, allowing optimization of battery life, and portable device autonomy.

Indeed, due to a current consumption optimization with PMOS structure, leakage currents are eliminated by isolating connected IC on the battery when not used.

Output discharge path is also embedded to eliminate residual voltages on the output rail.

Proposed in a wide input voltage range from 1.0 V to 3.6 V, in a small 0.8 x 1.2 mm WLCSP6, pitch 0.4 mm.

Features

- 1.0 V − 3.6 V Operating Range
- 16 mΩ P MOSFET at 3.6 V
- DC Current Up to 2 A
- Output Auto−discharge
- Active High EN Pin
- WLCSP6 0.8 x 1.2 mm
- ESD Ratings: 6 kV HBM, 250 V MM
- This is a Pb−Free Device

Typical Applications

- Mobile Phones
- Tablets
- Digital Cameras
- GPS
- Portable Devices

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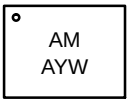
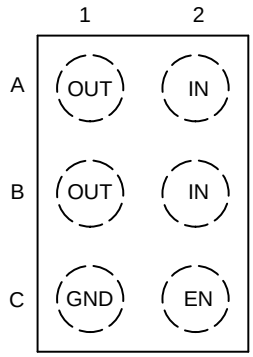
MARKING DIAGRAM

WLCSP6
CASE 567FY



AM = Specific Device Code
A = Assembly Location
Y = Year
W = Work Week

PIN DIAGRAM



ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 7 of this data sheet.

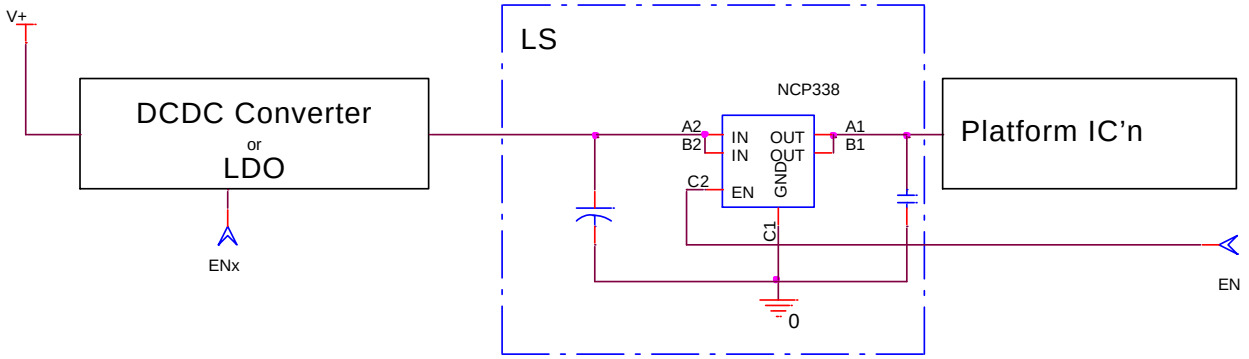


Figure 1. Typical Application Circuit

PIN FUNCTION DESCRIPTION

Pin Name	Pin Number	Type	Description
IN	A2, B2	POWER	Load−switch input voltage; connect a 1 μF or greater ceramic capacitor from IN to GND as close as possible to the IC.
GND	C1	POWER	Ground connection.
EN	C2	INPUT	Enable input, logic high turns on power switch.
OUT	A1, B1	OUTPUT	Load−switch output; connect a 1 μF ceramic capacitor from OUT to GND as close as possible to the IC is recommended.

BLOCK DIAGRAM

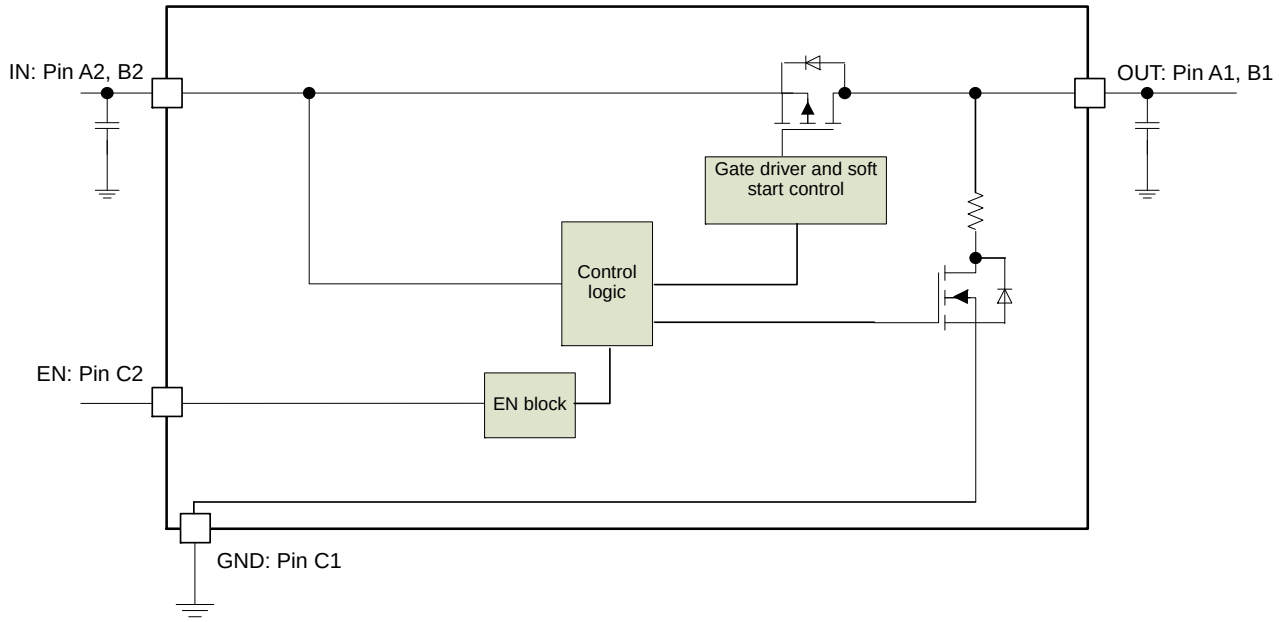


Figure 2. Block Diagram

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
IN, OUT, EN, Pins	V_{EN} , V_{IN} , V_{OUT}	−0.3 to + 4.0	V
From IN to OUT Pins: Input/Output	V_{IN} , V_{OUT}	0 to + 4.0	V
Maximum Junction Temperature	T_J	−40 to + 125	°C
Storage Temperature Range	T_{STG}	−40 to + 150	°C
Human Body Model (HBM) ESD Rating are (Note 1 and 2)	ESD HBM	6000	V
Machine Model (MM) ESD Rating are (Note 1 and 2)	ESD MM	250	V
Moisture Sensitivity (Note 3)	MSL	Level 1	

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. According to JEDEC standard JESD22−A108.
2. This device series contains ESD protection and passes the following tests:
   Human Body Model (HBM) ±2.0 kV per JEDEC standard: JESD22−A114 for all pins.
   Machine Model (MM) ±200 V per JEDEC standard: JESD22−A115 for all pins.
3. Moisture Sensitivity Level (MSL): 1 per IPC/JEDEC standard: J−STD−020.

OPERATING CONDITIONS

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V_{IN}	Operational Power Supply			1.0		3.6	V
V_{EN}	Enable Voltage			0		3.6	
T_A	Ambient Temperature Range			−40	25	+85	°C
T_J	Junction Temperature Range			−40	25	+125	°C
C_{IN}	Decoupling input capacitor			1			μF
C_{OUT}	Decoupling output capacitor			1			μF
$R_{\theta JA}$	Thermal Resistance Junction to Air	WLCSP package (Note 5)			100		°C/W
I_{OUT}	Maximum DC current					2	A
P_D	Power Dissipation Rating (Note 6)	$T_A \le 25°C$	WLCSP package			1	W
		$T_A = 85°C$	WLCSP package			0.4	W

4. Latch up Current Maximum Rating: ±100 mA per JEDEC standard: JESD78 class II.
5. The $R_{\theta JA}$ is dependent of the PCB heat dissipation and thermal via.
6. The maximum power dissipation ($_{PD}$) is given by the following formula:

$$P_D = \frac{T_{JMAX} - T_A}{R_{\theta JA}}$$

ELECTRICAL CHARACTERISTICS Min and Max Limits apply for $_{TA}$ between −40°C to +85°C for $_{VIN}$ between 1.0 V to 3.6 V (Unless otherwise noted). Typical values are referenced to T_A = +25°C and V_{IN} = 3.6 V (Unless otherwise noted).

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
POWER SWITCH							
$R_{DS(on)}$	Static drain−source on−state resistance at −200 mA	V_{IN} = 3.6 V	T_A = 25°C		16	27	mΩ
			−40°C < T_A < 85°C			30	
		V_{IN} = 2.5 V	T_A = 25°C		21	36	
			−40°C < T_A < 85°C			40	
		V_{IN} = 1.8 V	T_A = 25°C		27	40	
			−40°C < T_A < 85°C			45	
		V_{IN} = 1.2 V	T_A = 25 °C		52	87	
			−40°C < T_A < 85°C			99	
	Static drain−source on−state resistance at −100 mA	V_{IN} = 1.1 V	T_A = 25°C		67		
Rdis	Output discharge path	EN = low	Vin = 3.3 V		65	90	Ω
V_{IH}	High−level input voltage	Vin = 1.8 V		0.95			V
V_{IL}	Low−level input voltage					0.5	V
I_{EN}	EN leakage current				20		nA
CURRENT CONSUMPTION							
Istd	Standby current	V_{OUT} = open, EN = low, V_{IN} = 3.6 V			20	300	nA
		V_{OUT} = open, EN = low, V_{IN} = 1.8 V			4		
Iq	Quiescent current	V_{OUT} = open, EN = high, V_{IN} = 3.6 V			200	600	
		V_{OUT} = open, EN = high, V_{IN} = 1.8 V			80	300	

7. Parameters are guaranteed for C_{LOAD} and R_{LOAD} connected to the OUT pin with respect to the ground.
8. Guaranteed by design and characterization.

ELECTRICAL CHARACTERISTICS Min and Max Limits apply for $_{TA}$ between −40°C to +85°C for $_{VIN}$ between 1.0 V to 3.6 V (Unless otherwise noted). Typical values are referenced to T_A = +25°C and V_{IN} = 3.6 V (Unless otherwise noted).

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
TIMINGS							
T_{ON}	Turn on time	V_{IN} = 1.2 V	C_{LOAD} = 0.1 μF, R_{LOAD} = 500 Ω (Note 7)		40		μs
			C_{LOAD} = 1 μF, R_{LOAD} = 500 Ω (Note 7)		40		
T_R	V_{OUT} rise time		C_{LOAD} = 0.1 μF, R_{LOAD} = 500 Ω (Note 7)		20		
			C_{LOAD} = 1 μF, R_{LOAD} = 500 Ω (Note 7)		25		
T_{OFF}	Turn off time		C_{LOAD} = 0.1 μF, R_{LOAD} = 500 Ω (Note 7)		10		
			C_{LOAD} = 1 μF, R_{LOAD} = 500 Ω (Note 7)		10		
T_{FALL}	V_{OUT} fall time		C_{LOAD} = 0.1 μF, R_{LOAD} = 500 Ω (Note 7)		20		
			C_{LOAD} = 1 μF, R_{LOAD} = 500 Ω (Note 7)		200		
TIMINGS							
T_{ON}	Turn on time	V_{IN} = 1.8 V	C_{LOAD} = 0.1 μF, R_{LOAD} = 500 Ω (Note 7)		40		μs
			C_{LOAD} = 1 μF, R_{LOAD} = 500 Ω (Note 7)		40		
T_R	V_{OUT} rise time		C_{LOAD} = 0.1 μF, R_{LOAD} = 500 Ω (Note 7)		30		
			C_{LOAD} = 1 μF, R_{LOAD} = 500 Ω (Note 7)		35		
T_{OFF}	Turn off time		C_{LOAD} = 0.1 μF, R_{LOAD} = 500 Ω (Note 7)		10		
			C_{LOAD} = 1 μF, R_{LOAD} = 500 Ω (Note 7)		10		
T_{FALL}	V_{OUT} fall time		C_{LOAD} = 0.1 μF, R_{LOAD} = 500 Ω (Note 7)		15		
			C_{LOAD} = 1 μF, R_{LOAD} = 500 Ω (Note 7)		150		

7. Parameters are guaranteed for C_{LOAD} and R_{LOAD} connected to the OUT pin with respect to the ground.
8. Guaranteed by design and characterization.

ELECTRICAL CHARACTERISTICS Min and Max Limits apply for T_A between −40°C to +85°C for V_{IN} between 1.0 V to 3.6 V (Unless otherwise noted). Typical values are referenced to T_A = +25°C and V_{IN} = 3.6 V (Unless otherwise noted).

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
TIMINGS							
T_{ON}	Turn on time	V_{IN} = 3.6 V	C_{LOAD} = 0.1 μF, R_{LOAD} = 500 Ω (Note 7)		30		μs
			C_{LOAD} = 1 μF, R_{LOAD} = 500 Ω (Note 7)	0	32	80	
T_R	V_{OUT} rise time		C_{LOAD} = 0.1 μF, R_{LOAD} = 500 Ω (Note 7)		20		
			C_{LOAD} = 1 μF, R_{LOAD} = 500 Ω (Note 7)	0	20	50	
T_{OFF}	Turn off time		C_{LOAD} = 0.1 μF, R_{LOAD} = 500 Ω (Note 7)		10		
			C_{LOAD} = 1 μF, R_{LOAD} = 500 Ω (Note 7)	0	10	40	
T_{FALL}	V_{OUT} fall time		C_{LOAD} = 0.1 μF, R_{LOAD} = 500 Ω (Note 7)		10		
			C_{LOAD} = 1 μF, R_{LOAD} = 500 Ω (Note 7)	0	100	300	

7. Parameters are guaranteed for C_{LOAD} and R_{LOAD} connected to the OUT pin with respect to the ground.
8. Guaranteed by design and characterization.

TIMINGS

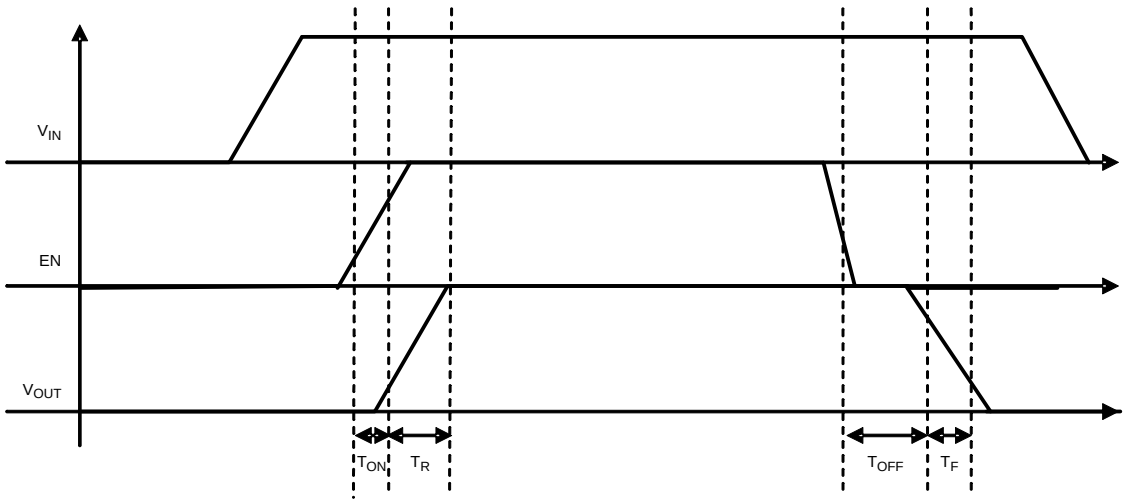


Figure 3. Enable, Rise and Fall Time

TYPICAL CHARACTERISTICS

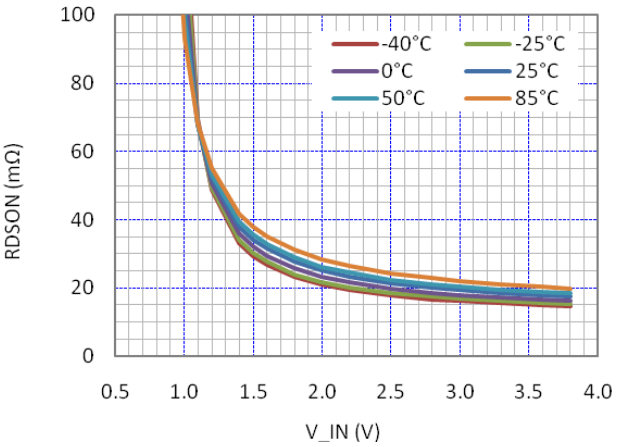


Figure 4. $R_{DS(on)}$ (mΩ) vs. Vin (V) in Temperature

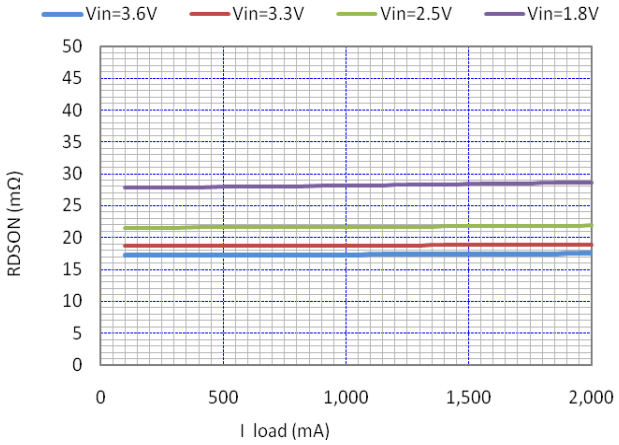


Figure 5. $R_{DS(on)}$ (mΩ) vs. I_{load} at Different Input Voltage

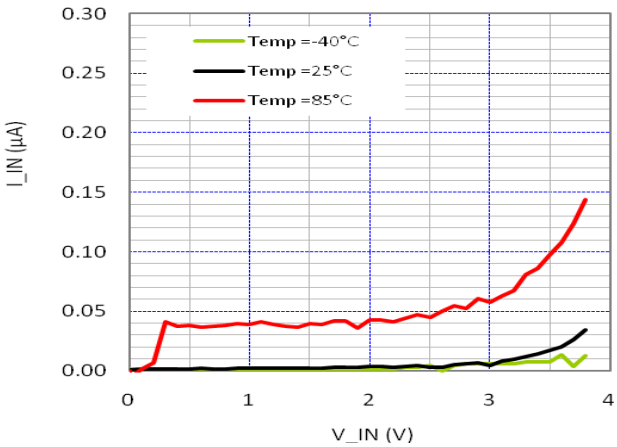


Figure 6. Standby Current (µA) vs. Vin (V)

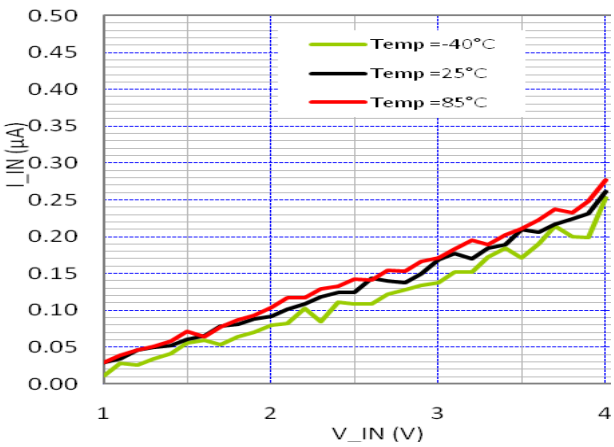


Figure 7. Quiescent Current (µA) vs. Vin (V)

FUNCTIONAL DESCRIPTION

Overview

The NCP338 is a high side P channel MOSFET power distribution switch designed to isolate ICs connected on the battery in order to save energy. The part can be turned on, with a wide range of battery from 1.0 V to 3.6 V.

Enable Input

Enable pin is an active high. The path is opened when EN pin is tied low (disable), forcing P−MOS switch off.

The IN/OUT path is activated with a minimum of Vin of 1.2 V and EN forced to high level.

Auto Discharge

N−MOSFET is placed between the output pin and GND, in order to discharge the application capacitor connected on OUT pin.

The auto−discharge is activated when EN pin is set to low level (disable state).

The discharge path (Pull down NMOS) stays activated as long as EN pin is set at low level and V_{IN} > 1.0 V.

In order to limit the current across the internal discharge N−MOSFET, the typical value is set at 65 Ω.

C_{IN} and C_{OUT} Capacitors

IN and OUT, 1 μF, at least, capacitors must be placed as close as possible the part to for stability improvement.

APPLICATION INFORMATION

Power Dissipation

Main contributor in term of junction temperature is the power dissipation of the power MOSFET. Assuming this, the power dissipation and the junction temperature in normal mode can be calculated with the following equations:

$$P_D = R_{DS(on)} \times \left(I_{OUT}\right)^2$$

P_D = Power dissipation (W)
$R_{DS(on)}$ = Power MOSFET on resistance (Ω)
I_{OUT} = Output current (A)

$$T_J = P_D \times R_{\theta JA} + T_A$$

T_J = Junction temperature (°C)
$R_{\theta JA}$ = Package thermal resistance (°C/W)
T_A = Ambient temperature (°C)

PCB Recommendations

The NCP338 integrates an up to 2 A rated PMOS FET, and the PCB design rules must be respected to properly evacuate the heat out of the silicon. By increasing PCB area, especially around IN and OUT pins, the $R_{\theta JA}$ of the package can be decreased, allowing higher power dissipation.

ORDERING INFORMATION

Device	Marking	Autodischarge	Package	Shipping†
NCP338FCCT2G	AM	Yes	WLCSP 0.8 x 1.2 mm (Pb−Free)	3000 / Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

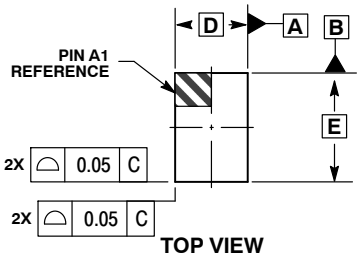
MECHANICAL CASE OUTLINE
PACKAGE DIMENSIONS

ON Semiconductor®

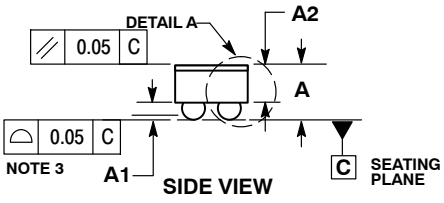
WLCSP6, 0.80x1.20
CASE 567FY
ISSUE B

SCALE 4:1

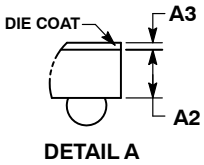
DATE 15 SEP 2016



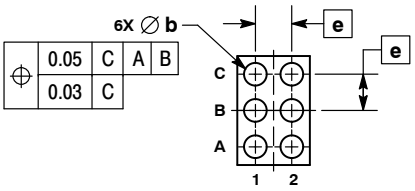
TOP VIEW



SIDE VIEW



DETAIL A

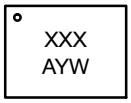


BOTTOM VIEW

NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. COPLANARITY APPLIES TO SPHERICAL CROWNS OF SOLDER BALLS.

	MILLIMETERS	
DIM	MIN	MAX
A	---	0.60
A1	0.17	0.23
A2	0.28 REF	
A3	0.04 REF	
b	0.21	0.25
D	0.80 BSC	
E	1.20 BSC	
e	0.40 BSC	

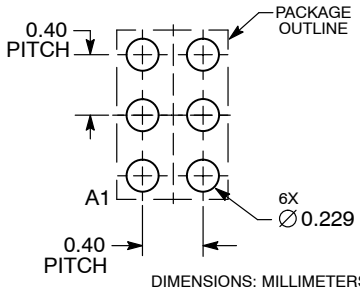
GENERIC MARKING DIAGRAM*



A = Assembly Location
Y = Year
W = Work Week

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, “G” or microdot “ ▪”, may or may not be present.

RECOMMENDED SOLDERING FOOTPRINT*



DIMENSIONS: MILLIMETERS

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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DESCRIPTION:	WLCSP6, 0.80X1.20	PAGE 1 OF 1

PUBLICATION ORDERING INFORMATION

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