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# LF2104N

## *Half-Bridge Gate Driver*

## Features

- **Floating high-side driver in bootstrap operation to 600V**
- **Drives two N-channel MOSFETs or IGBTs in a half bridge configuration**
- **Designed for enhanced performance in noisy motor applications**
- **290mA source/600mA sink output current capability**
- **Outputs tolerant to negative transients**
- **Internal dead time to protect MOSFETs**
- **Wide low side gate driver supply voltage: 10V to 20V**
- **Logic input (IN and SD*) 3.3V capability**
- **Schmitt triggered logic inputs**
- **Under Voltage Lockout (UVLO) for $V_{CC}$ and $V_{BS}$**
- **Extended temperature range: -40°C to +125°C**

## Description

The LF2104N is a high voltage, high speed gate driver capable of driving N-channel MOSFETs and IGBTs in a half bridge configuration. The high voltage technology enables the LF2104N's high side to switch to 600V in a bootstrap operation.

LF2104N logic inputs are compatible with standard TTL and CMOS levels (down to 3.3V) to interface easily with controlling devices. The driver outputs feature high pulse current buffers designed for minimum driver cross conduction.

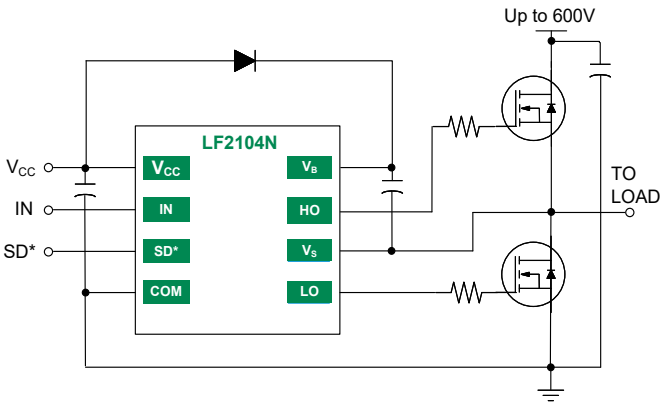
LF2104N is offered in SOIC(N)-8 package and operate over the extended temperature range of -40 °C to +125 °C .

## Applications

- Motor Controls
- DC-DC Converters
- AC-DC Inverters
- Motor Drives


**SOIC(N)-8**

## Typical Application



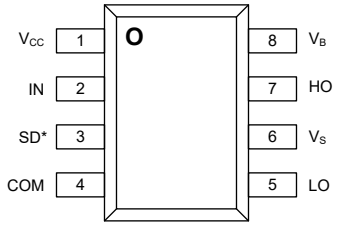

## Ordering Information

Year Year Week Week

| Part# | Package | Pack / Qty | Mark |
|---|---|---|---|
| LF2104NTR | SOIC(N)-8 | T&R / 2500 | YYWW<br>LF2104N<br>LOT ID |

# 1 Specifications

## 1.1 Pin Diagrams




**Top View:** SOIC(N)-8

**LF2104N**

## 1.2 Pin Descriptions

| Pin# | Pin Name | Pin Type | Pin Description |
|---|---|---|---|
| 1 | $V_{CC}$ | Power | Logic and low side supply |
| 2 | IN | Input | Logic input for high-side and low-side gate driver outputs (HO and LO), in phase with HO |
| 3 | SD* | Input | Logic input for shutdown, active low |
| 4 | COM | Power | Low-side and logic return |
| 5 | LO | Output | Low-side gate drive output |
| 6 | $V_S$ | Power | High-side floating supply return |
| 7 | HO | Output | High-side gate drive output |
| 8 | $V_B$ | Power | High-side floating supply |

## 1.3 Absolute Maximum Ratings

| Parameter | Symbol | Min | Max | Unit |
|---|---|---|---|---|
| High side floating supply voltage | $V_B$ | -0.3 | +624 | V |
| High side floating supply offset voltage | $V_S$ | $V_B$-24 | $V_B$+0.3 | V |
| High side floating output voltage | $V_{HO}$ | $V_S$-0.3 | $V_B$+0.3 | V |
| Offset supply voltage transient | $dV_S/dt$ | -- | 50 | V/ns |
| Low side fixed supply voltage | $V_{CC}$ | -0.3 | +24 | V |
| Low side output voltage | $V_{LO}$ | -0.3 | $V_{CC}$+0.3 | V |
| Logic input voltage (IN and SD*) | $V_{IN}$ | -0.3 | $V_{CC}$+0.3 | V |
| Package power dissipation | $P_D$ | -- | 0.625 | W |
| Junction Operating Temperature | $T_J$ | -- | +150 | °C |
| Storage Temperature | $T_{STG}$ | -55 | +150 | ° C |

*Unless otherwise specified all voltages are referenced to COM . All electrical ratings are at $T_A$= 25 °C*

*Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.*

## 1.4 Thermal Characteristics

| Parameter | Symbol | Rating | Unit |
|---|---|---|---|
| Junction to ambient | $\emptyset_{JA}$ | 200 | °C/W |

*When mounted on a standard JEDEC 2-layer FR-4 board - JESD51-3*

## 1.5 Recommended Operating Conditions

| Parameter | Symbol | Min | Max | Unit |
|---|---|---|---|---|
| High side floating supply absolute voltage | $V_B$ | $V_S$ + 10 | $V_S$ + 20 | V |
| High side floating supply offset voltage | $V_S$ | ***NOTE1*** | 600 | V |
| High side floating output voltage | $V_{HO}$ | $V_S$ | $V_B$ | V |
| Low side fixed supply voltage | $V_{CC}$ | 10 | 20 | V |
| Low side output voltage | $V_{LO}$ | 0 | $V_{CC}$ | V |
| Logic input voltage (IN and SD*) | $V_{IN}$ | 0 | 5 | V |
| Ambient temperature | $T_A$ | -40 | 125 | °C |

*Unless otherwise specified all voltages are referenced to COM*

***NOTE1*** *High-side driver remains operational for $V_S$ transients down to -5V*

## 1.6 DC Electrical Characteristics

$V_{CC}$ =$V_{BS}$ = 15V, $T_A$ = 25 °C and $V_{COM}$ = 0V , unless otherwise specified.

*The $V_{IN}$ and $I_{IN}$ parameters are applicable to both logic input pins: IN and SD*. The $V_O$ and $I_O$ parameters are applicable to the respective output pins: HO and LO and are referenced to COM*

| Parameter | Symbol | Conditions | MIn | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Logic "1" input voltage | $V_{IH}$ | $V_{CC}$ = 10V to 20V **NOTE 2** | 2.5 | -- | -- | V |
| Logic "0" input voltage | $V_{IL}$ | | -- | -- | 0.8 | |
| Logic input voltage hysteresis | $V_{IN(HYS)}$ | -- | -- | 0.3 | -- | |
| High level output voltage, $V_{BIAS}$ - $V_O$ | $V_{OH}$ | $I_O$ = 2mA | -- | 0.05 | 0.2 | |
| Low level output voltage, $V_O$ | $V_{OL}$ | $I_O$ = 2mA | -- | 0.02 | 0.1 | |
| Offset supply leakage current | $I_{LK}$ | VB = VS = 600V | -- | -- | 50 | µA |
| Quiescent $V_{BS}$ supply current | $I_{BSQ}$ | $V_{IN}$ = 0V or 5V | -- | 60 | 100 | |
| Quiescent $V_{CC}$ supply current | $I_{CCQ1}$ | IN =0V or 5V, SD*=5V | -- | 350 | 500 | |
| Quiescent $V_{CC}$ supply current in shutdown | $I_{CCQ2}$ | IN=0V or 5V, SD*=0V | -- | 590 | 750 | |
| Logic "1" input bias current | $I_{IN+}$ | $V_{IN}$ = 5V | -- | 3 | 10 | |
| Logic "0" input bias current | $I_{IN-}$ | $V_{IN}$ = 0V | -- | -- | 5 | |
| $V_{CC}$ UVLO off positive going threshold | $V_{CCUV+}$ | -- | 8.0 | 8.9 | 9.8 | V |
| $V_{CC}$ UVLO enable negative going threshold | $V_{CCUV-}$ | -- | 7.4 | 8.2 | 9.0 | |
| $V_{CC}$ UVLO hysteresis | $V_{CCUV(HYS)}$ | -- | -- | 0.7 | -- | |
| $V_{BS}$ UVLO off positive going threshold | $V_{BSUV+}$ | -- | 4.5 | 5.5 | 6.5 | |
| $V_{BS}$ UVLO enable negative going threshold | $V_{BSUV-}$ | -- | 4.2 | 5.2 | 6.2 | |
| $V_{BS}$ UVLO hysteresis | $V_{BSUV(HYS)}$ | -- | -- | 0.3 | -- | |
| Output high short circuit pulsed current | $I_{O+}$ | $V_O$ = 0V, t ≤ 10 µs | 130 | 290 | -- | mA |
| Output low short circuit pulsed current | $I_{O-}$ | $V_O$ = 15V, t ≤ 10 µs | 270 | 600 | -- | |

***NOTE2*** *For optimal operation, it is recommended the input pulse to IN should have a minimum amplitude of 2.5V a minimum pulse width of 840ns .*

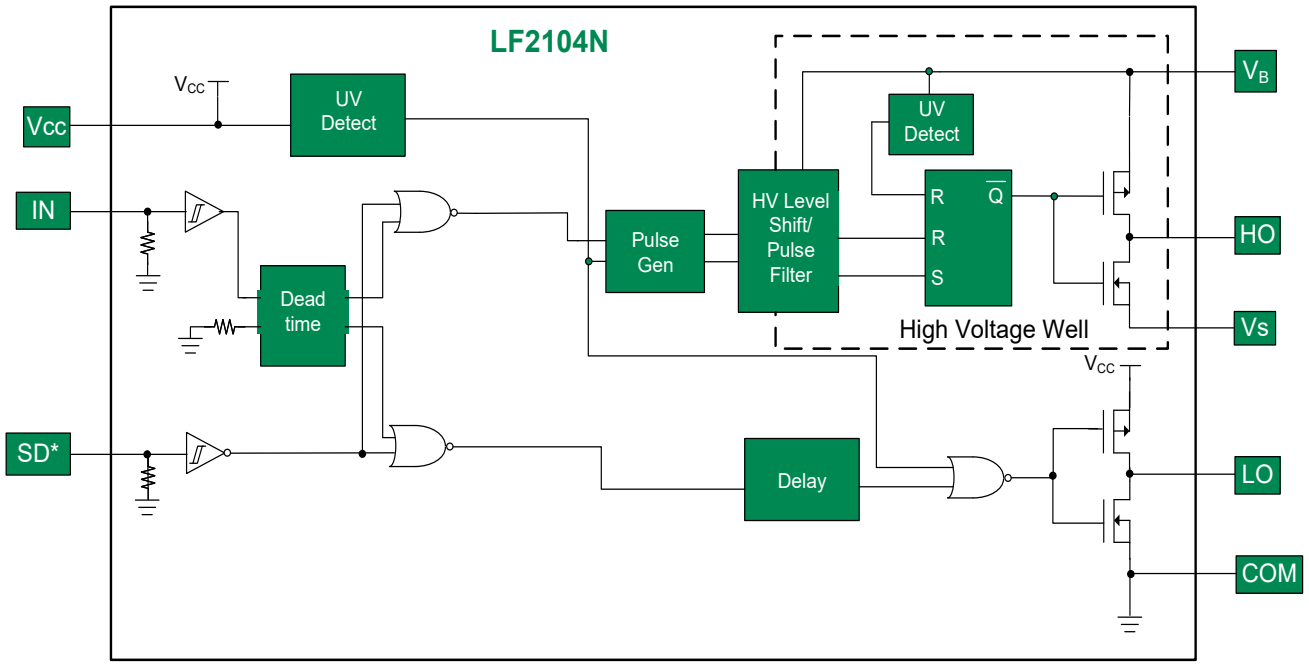
## 1.7 AC Electrical Characteristics

$V_{CC=}$ $V_{BS}$ = 15V, $C_L$ = 1000pF, and $T_A$ = 25 °C , unless otherwise specified.

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Turn-on propagation delay | $t_{on}$ | $V_S$ = 0V | -- | 680 | 820 | ns |
| Turn-off propagation delay | $t_{off}$ | $V_S$ = 600V | -- | 150 | 220 | |
| Shutdown propagation delay | $t_{SD}$ | -- | -- | 160 | 220 | |
| Propagation delay matching, HO & LO turn-on/turn-off | $t_{DM}$ | -- | -- | -- | 60 | |
| Turn-on rise time | $t_r$ | $V_S$ = 0V | -- | 70 | 170 | |
| Turn-off fall time | $t_f$ | | -- | 35 | 90 | |
| Deadtime: $t_{DT\ LO\text{-}HO}$ & $t_{DT\ HO\text{-}LO}$ | $t_{DT}$ | -- | 300 | 420 | 650 | |
| Deadtime Matching | $t_{DT\ MT}$ | -- | -- | -- | 60 | |

# 2 Functional Description

## 2.1 Functional Block Diagram



## 2.2 Timing Waveforms

**Figure 1.** Input / Output Logic Diagram

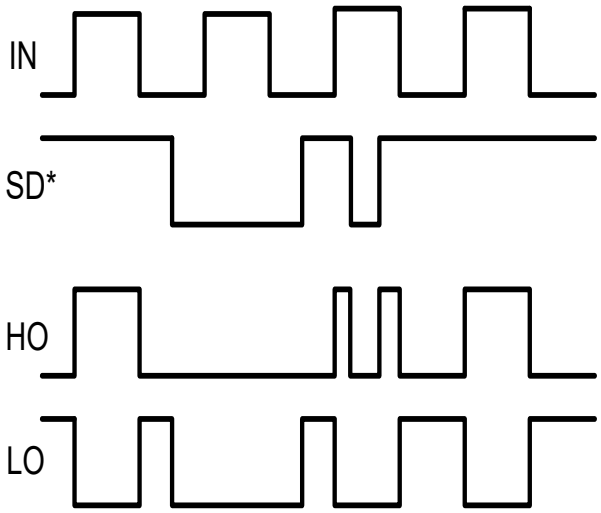



**Figure 2.** Shutdown Waveform Diagram

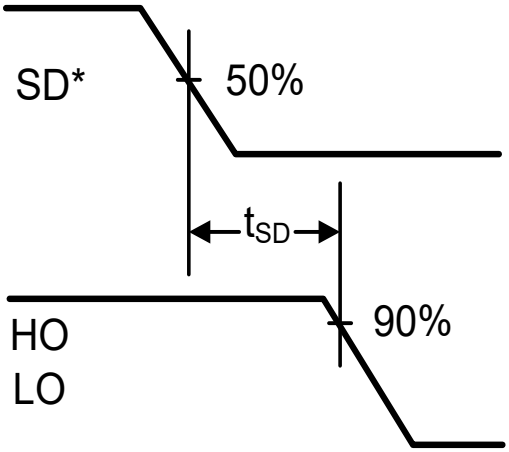
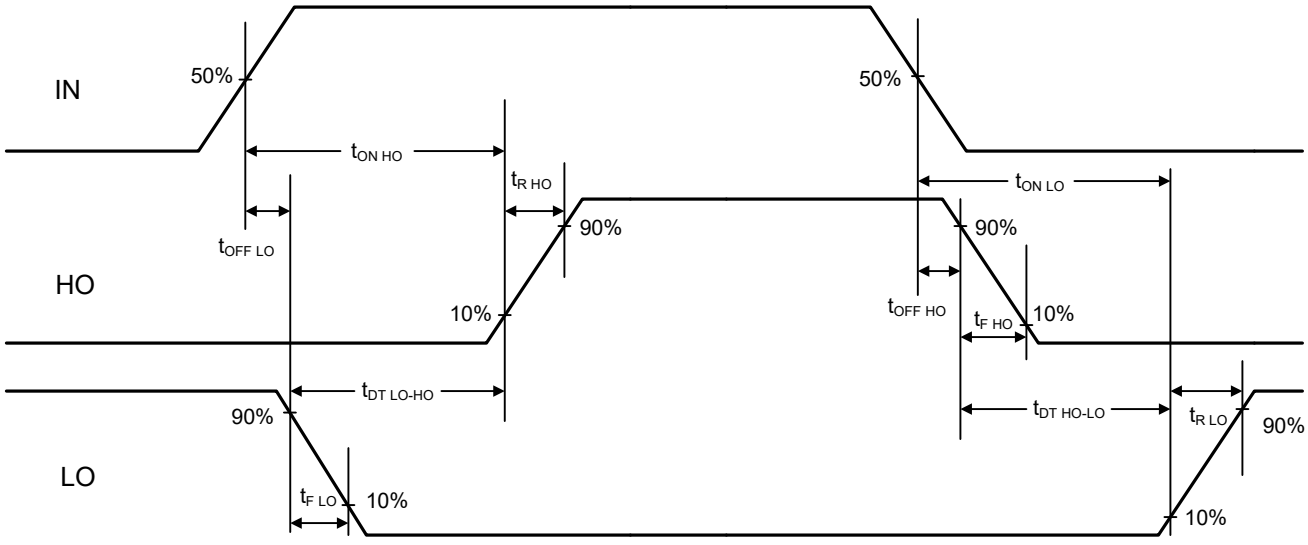



**Figure 3.** Input-to-Output Delay Timing Diagram




Deadtime : $t_{DT\ LO\text{-}HO} = t_{ON\ HO} - t_{OFF\ LO}$

$t_{DT\ HO\text{-}LO} = t_{ON\ LO} - t_{OFF\ HO}$

Delay Matching : $t_{DM\ OFF} = |t_{OFF\ LO} - t_{OFF\ HO}|$

$t_{DM\ ON} = |t_{ON\ LO} - t_{ON\ HO}|$

Deadtime Matching: $t_{DT\ MT} = |t_{DT\ LO\text{-}HO} - t_{DT\ HO\text{-}LO}|$

## 2.3 Application Information

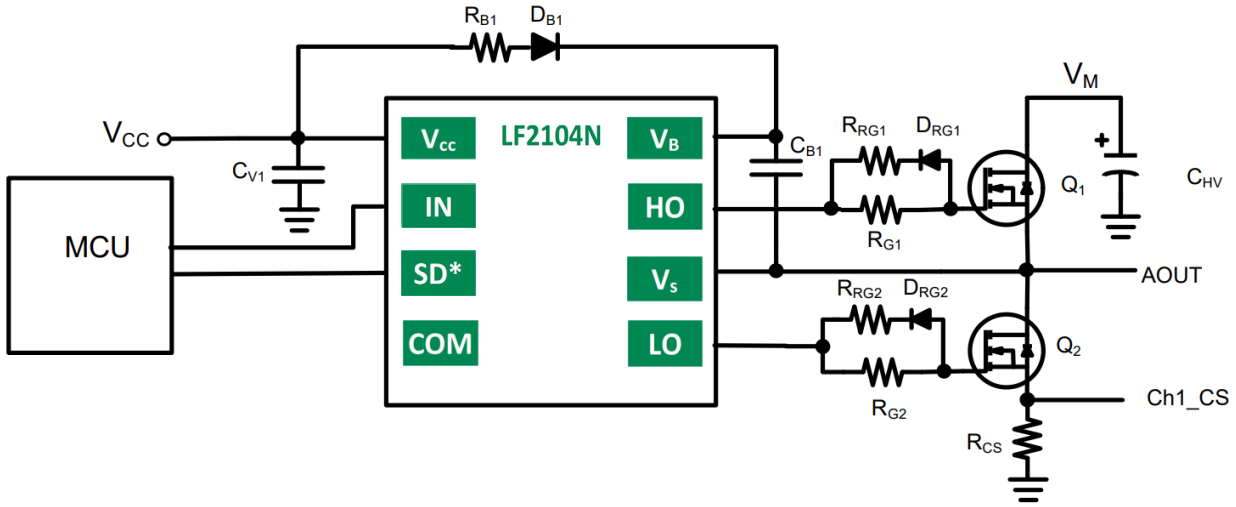



**Figure 4.** Single phase (of four) for Stepper motor driver application using the LF2104N

- RRG1 and RRG2 values are typically between 0Ω and 10Ω, exact value decided by MOSFET junction capacitance and drive current of gate driver; 10Ω is used in this example.

- It is **highly recommended** that the input pulse to IN should have a minimum amplitude of 2.5V (for $V_{CC}$=15V) with a minimum pulse width of 840ns.

- RG1 and RG2 values are typically between 20Ω and 100Ω, exact value decided by MOSFET junction capacitance and drive current of gate driver; 50Ω is used in this example.

- RB1 value is typically between 3Ω and 20Ω, exact value depending on bootstrap capacitor value and amount of current limiting required for bootstrap capacitor charging; 10Ω is used in this example. Also DB should be an ultra fast diode of 1A rating minimum and voltage rating greater than system operating voltage.

# 3 Manufacturing Information

## 3.1 Moisture Sensitivity

All plastic encapsulated semiconductor packages are susceptible to moisture ingression. Littelfuse Integrated Circuits Division classified all of its plastic encapsulated devices for moisture sensitivity according to the latest version of the joint industry standard, **IPC/JEDEC J-STD-020**, in force at the time of product evaluation. We test all of our products to the maximum conditions set forth in the standard, and guarantee proper operation of our devices when handled according to the limitations and information in that standard as well as to any limitations set forth in the information or standards referenced below.

Failure to adhere to the warnings or limitations as established by the listed specifications could result in reduced product performance, reduction of operable life, and/or reduction of overall reliability.

This product carries a **Moisture Sensitivity Level (MSL)** rating as shown below, and should be handled according to the requirements of the latest version of the joint industry standard **IPC/JEDEC J-STD-033.**

| Device | Moisture Sensitivity Level (MSL) Classification |
|---|---|
| LF2104N | MSL3 |

## 3.2 ESD Sensitivity

This product is **ESD Sensitive**, and should be handled according to the industry standard **JESD-625**.

## 3.3 Reflow Profile

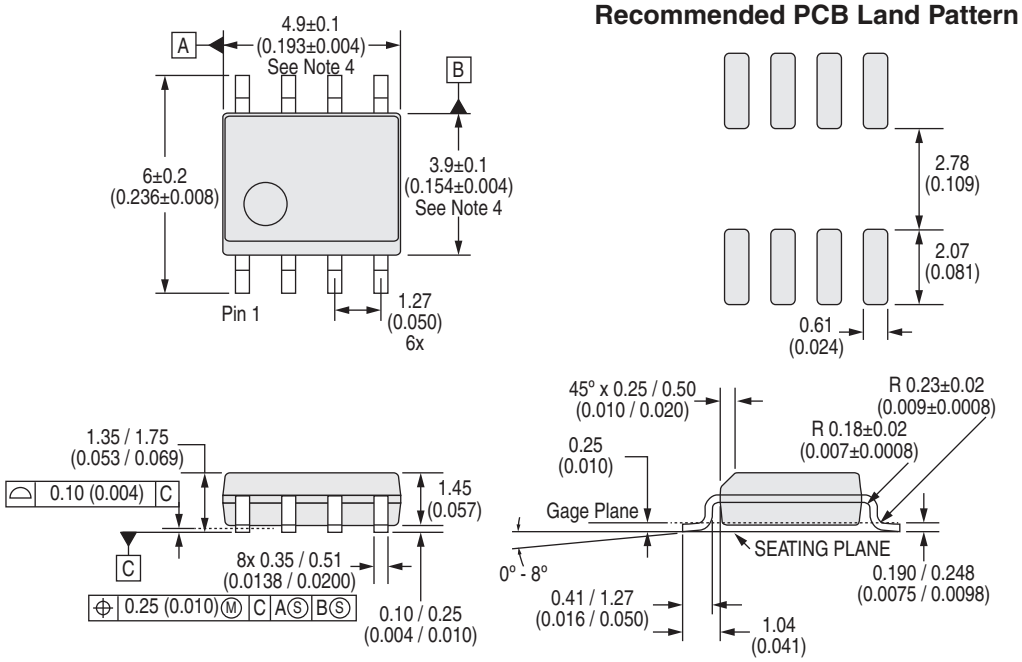
Provided in the table below is the IPC/JEDEC J-STD-020 Classification Temperature ($T_C$) and the maximum dwell time the body temperature of these surface mount devices may be ($T_C$ - 5)°C or greater. The Classification Temperature sets the Maximum Body Temperature allowed for these devices during reflow soldering processes.

| Device | Classification Temperature(Tc) | Dwell Time (tp) | Max Reflow Cycles |
|---|---|---|---|
| LF2104N | 260°C | 30 seconds | 3 |

## 3.4 Board Wash

Littelfuse recommends the use of no-clean flux formulations. Board washing to reduce or remove flux residue following the solder reflow process is acceptable provided proper precautions are taken to prevent damage to the device. These precautions include but are not limited to: using a low pressure wash and providing a follow up bake cycle sufficient to remove any moisture trapped within the device due to the washing process. Due to the variability of the wash parameters used to clean the board, determination of the bake temperature and duration necessary to remove the moisture trapped within the package is the responsibility of the user (assembler). Cleaning or drying methods that employ ultrasonic energy may damage the device and should not be used. Additionally, the device must not be exposed to halide flux or solvents.

## 4 Package Dimensions: SOIC(N)-8




Notes: (Unless otherwise specified)
1. Controlling dimension: millimeters.
2. All dimensions are in mm (inches).
3. Reference JEDEC registration MS-012, variation AA.
4. Not including mold flash, protrusion, or gate burrs
   0.15 (0.006) maximum per end.

Dimensions:
Minimum / Maximum

## Important Notice



Specification: DS-LF2104N-R01

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