

Application Bulletin

Wafer-Level Chip-Scale Package Sensors from NVE Corporation

NVE's wafer-level chip-scale package (WLCSP) provides flip-chip-compatible miniaturized sensors for industrial, wearable, and medical applications. Packages as small as 0.57×0.57 mm feature sensor-side solder bumps with an array of 120 μ m diameter SAC305 balls. The sensors are surface-mount technology (SMT) solderable with JEDEC standard reflows, and no underfill is required. Compared to wirebonded bare die, NVE's WLCSP sensors are smaller and form more reliable electrical connections.

This application note provides a mechanical description of the WLCSP and NVE's recommendations for printed circuit board (PCB) layout and soldering reflow. Example WLCSP sensors are shown in Figure 1:



Figure 1. NVE's solder-bumped nanopower switch sensors (left) and high-speed linear sensors (right).

Mechanical Dimensions

NVE's WLCSP sensors are shown top-down in Figures 2 and 3. The solder bumps are arranged symmetrically to furnish reliable SMT assembly. The direction of magnetic sensitivity is from Pin A1 to Pin A2, or vertical in the figures.

Marking

Pin A1 is marked on both sides of the WLCSP. Each chip-scale device is marked with a five-digit number from the solder ball side of the part. This marking is shown in Figures 1-3. The size of the marking is approximately 15 x 20 μ m per character. Pin A1 is also laser marked on the topside of the package. The circular marking is approximately 75 μ m in diameter.





Figure 2. The mechanical dimension and marking for NVE's AHL- and ADL-series WLCSP switch sensors. Dimensions in μ m, $\pm 10 \mu$ m unless otherwise specified.

Table 1 shows the electrical connections for NVE's AHL- and ADL-series WLCSP sensors. Datasheets for these sensors are available at <u>nve.com</u>. They can also be obtained by request from <u>sensor-apps@nve.com</u>.

Pin	AHL-Series	ADL-Series
A1	Vdd	Vdd
A2	GND	GND
B1	NC	Out
B2	OUT	NC

Table 1. Electrical connections to NVE's AHL- and ADL-series WLCSP devices.



Figure 3. The mechanical dimension and marking for NVE's ALT-series WLCSP linear sensors. Dimensions in μ m, ±10 μ m unless otherwise specified.

Table 2 shows the electrical connections for NVE's ALT-series WLCSP sensors. Datasheets for these sensors are available at <u>nve.com</u>. They can also be obtained by request from <u>sensor-apps@nve.com</u>.

Pin	ALT-Series
A1	Out-
A2	GND
B1	Vdd
B2	Out+

Table 2. Electrical connections to NVE's ALT-series WLCSP devices.



Figure 4 is an illustrated cross-section of NVE's WLCSP. The 120 µm diameter solder balls are attached to the chip through a redistribution layer (RDL) that reroutes interconnects from the bare-die wirebond pads to a symmetric solder ball array. The underbump metal (UBM) forms the metal interface to the SAC305 solder ball to ensure reliable adhesion after SMT assembly. In some cases, UBM directly covers the bare-die wirebond pad. Multiple passivation layers beyond the pad-level passivation protect the device from environmental degradation and provide interlayer adhesion and additional chip rigidity to withstand SMT assembly.



Figure 4. WLCSP cross-section showing redistribution layers (RDL), underbump metal (UBM), and solder ball.

Parameter	Dimension	Tolerance
Ball diameter	120 µm	±20 μm
Ball stand-off	80 µm	±25 μm
Total thickness before assembly	230 µm	±40 μm
Total thickness after assembly	210 µm	±40 μm

Table 3. WLCSP stand-off dimensions.

Assembly Recommendations

Proper definition of the PCB footprint optimizes the natural self-alignment of the WLCSP during SMT assembly.

PCB Layout

NVE recommends non-solder mask defined (NSMD) pads for the solder ball interface. These pad geometries are more tightly controlled by PCB manufacturers. The pads should be undersized, approximately 20 μ m less than the solder ball diameter. This allows solder to flow around the pad for maximum interfacial contact and adhesion. The solder stencil opening should be a square and centered over the pad. Optimum dimensions are summarized in Table 4 below. An example PCB landing pattern is shown in Figure 5.

PCB Feature	Configuration
Pad layout	Non solder mask defined (NSMD)
Pad Size	80 – 100 μm
Solder mask clearance to pad	20 µm (minimum)
Pad metal	Cu OSP (Organic Solderability Preservative) or ENIG (Cu Ni 2 – 6 µm
	Au <0.1 μm)
Solder Paste Stencil	Square opening with sides equal to pad diameter and 100 μ m thick

Table 4. Recommended PCB layout for NSMD pad configuration.





Figure 5. Recommended AHL- and ADL-series WLCSP footprint for NSMD pad configuration in µm.

Some PCB manufacturers have difficulty with these small circular pads. An alternate recommendation is given in Figure 6:



Figure 6. Alternate WLCSP footprint for NSMD pad configuration in µm. We tried this footprint on several boards ordered from JLCPCB, and they worked fine for all AHL-, ADL-, and ALT-series WLCSP sensors. 150 µm traces should exit all pads and route tucked under the surrounding soldermask to ensure the stability of copper exposed in the soldermask opening.

Solder Profile

NVE's WLCSP devices are rated to MSL1, and the solder bumps have a Pb-free alloy composition of 96.5% Sn, 3% Ag, and 0.5% Cu (SAC305) that provides a near-eutectic melting point of 217 °C. We recommend standard Pb-free reflow profiles, such as JEDEC J-STD-020. Assembly experiments will determine the ideal reflow profile for your PCB. Please contact NVE support at <u>sensor-apps@nve.com</u> for answers to specific questions.



Rework

SMT rework is not recommended for NVE's WLCSP. The ultrafine microbumps and limited space on dense PCBs make rework difficult. The best chance for success is obtained with automated tools – hot air or laser heating tools for component removal and vacuum tools for solder removal. Replacing a component requires a stencil and solder paste. Using no-clean flux on the PCB is also recommended. Resoldering should be done with the same tools as removal, but careful temperature control is required.

Underfill

NVE's WLCSP sensors do not require underfill.



	Tape Dimensions (mm)							
Tape Width	D ₀	Ε	F	Po	P 1	P 2	W	Т
8 mm	1.5 ± 0.10	1.75 ± 0.10	3.5±0.05	4.0±0.10	4.0±0.10	2.0±0.05	8.0±0.30	0.30 max.

Pocket Dimensions (mm)			Pin A1	Standard	Quantities
AO	B0	KO	Orientation	7'' Reel	13" Reel
0.86 ± 0.1	0.86±0.1	0.40 ± 0.1	Lower Left	2500	5000

NVE engineers are happy to provide design assistance and troubleshooting advice. Please contact <u>sensor-apps@nve.com</u> to discuss your application.



An ISO 9001 Certified Company

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SB-SA-03 Rev. A

January 2025