L9988

Data brief

12V Li-Ion Battery Management System Solution

Product status link

L9988

Product label

Features

- AEC-Q100 grade 1 qualified
- [4 V÷28 V] Power supply operating range
- Voltage measurement:
  - 15-bit Sigma Delta ADC with programmable filter time with cut-off down to 30 Hz
  - Measures 4 single cell voltage, with over/under voltage detection and balance timeout protection
  - Measures stack voltage, with over/under voltage detection and plausibility check vs. sum of cells
  - Full 0÷5 V measurement range, with total error < ±2 mV in the [1.8 V÷4.5 V] range with -40°C ≤ T_J ≤ +105°C
- Current measurement:
  - 20-bit Current Sense ADC for battery current measurement (range ± 1500A), with overcurrent protection
    - Total error < 0.23% for ±200A, considering 100 µΩ R_{SHUNT} typical value (no spread contribution)
  - 20-bit Coulomb Counting ADC for SoC estimation
    - Total error < 3.9% for ±100 mA in STANDBY MODE, considering 100 µΩ R_{SHUNT} typical value (no spread contribution)
    - Total error < 0.7% for ±50A in NORMAL MODE, considering 100 µΩ R_{SHUNT} typical value (no spread contribution)
  - Continuously short-circuit detection
- Passive cell balancing: Max 200 mA, supporting time-continuous and PWM modes, with synchronized odd-even channels balance
- 4 analog inputs measure pack temperature via NTCs, with OT/UT detection; 2 GPIOs are available
- Ultra-low power consumption of 190 µA in STANDBY MODE and 50 µA in SLEEP MODE
- Integrated PMIC with configurable regulators:
  - Boost pre-regulator to support system full operation at low battery level
  - VCORE regulator for MCU supply [1.125 V÷5 V]
  - VCC regulator for MCU ADCs supply [3.3 V/5 V]
  - Fixed 5 V regulator for external CAN power supply
  - VSTBY regulator for external RTC supply [3.3 V/5 V]
  - Fixed 5 V VTREF regulator to bias external NTCs
- Integrated dual high-side VGS pre-driver:
  - Drive 2 independent groups back-to-back MOSFETs
  - Switch OFF MOSFETs in case of SC during NORMAL and STANDBY MODE.
- Standard 4-wire, 4 MHz, 40-bit SPI interface for device configuration and diagnostics data read-out
- Watchdogs: Configurable double watchdog (Q&A WD and time windowed WD)
- Real-time clock: Selectable timer from 1s to 180 days
- Configurable wakeup monitoring OV/UV/OT/OVC/SC
- Hardware wakeup module: IGN level triggered and WAKE edge triggered

- Embedded NVM for configuration parameters storage and runtime configuration integrity check
- Full ISO26262 compliant, up to ASIL-D systems ready
- Hot plug robustness

Application

- 12 V vehicle starter and backup battery

Description

The L9988 is a multicell battery stack monitor that measures up to 4 series-connected battery cells with a total measurement error of less than 2 mV. The IC has one battery stack current measurement channel, which can support synchronous current and voltage measurement, performing coulomb counting for SoC estimation. The L9988 includes both timed and PWM-based odd-even passive balancing for each cell. 4 analog inputs for external NTC thermistor connection and 2 general-purpose I/O are available. The L9988 can be powered directly from the battery stack. Programmable voltage regulators can supply all the system components, including the MCU, CAN and NTCs. The IC also integrates a dual pre-driver for driving 2 independent groups of circuit breaker (CB) back-to-back MOSFETs to manage battery pack connection. IC configuration and information exchange with the MCU is performed via 4 MHz, 40-bit SPI. Relevant configurations stored in the internal NVM allow quick wakeup without reprogramming the IC. The L9988 has dedicated alert output pins to indicate fault state, which makes the system more robust. A comprehensive set of safety mechanisms has been implemented to achieve up to ASIL-D targets.

1 Overview

The L9988 BMIC device provides all the functions needed to manage battery pack configurations up to 4s. It features a comprehensive set of cell/pack monitoring, balancing, and protection functions designed to achieve up to ASIL-D targets in demanding systems.

The L9988 uses dedicated high precision ADCs synchronously acquiring cells and pack voltage. The cell measurement ranges from 0 V to 5 V, making the L9988 suitable for most battery chemistries.

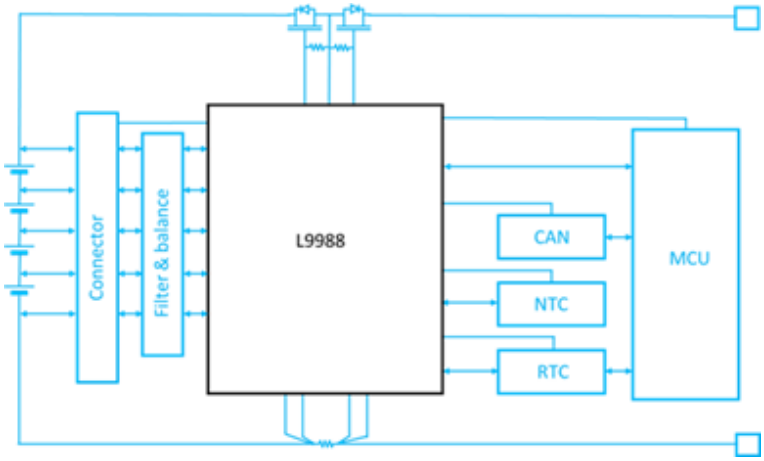
The L9988 measures pack current with redundant acquisition and including coulomb counter calculation.

The BMIC is supplied via an efficient buck preregulator, thus optimizing energy consumption, and heat dissipation. It also integrates a full set of configurable LDOs available for biasing external MCU, CAN, RTC as well as NTC resistors for temperature monitoring. An optional boost can be used to improve robustness versus pulses like crank.

SPI controller peripherals allow interfacing the device with the MCU.

Passive balancing is available in both continuous and PWM mode.

Figure 1. L9988 battery monitor in 12 V BMS system



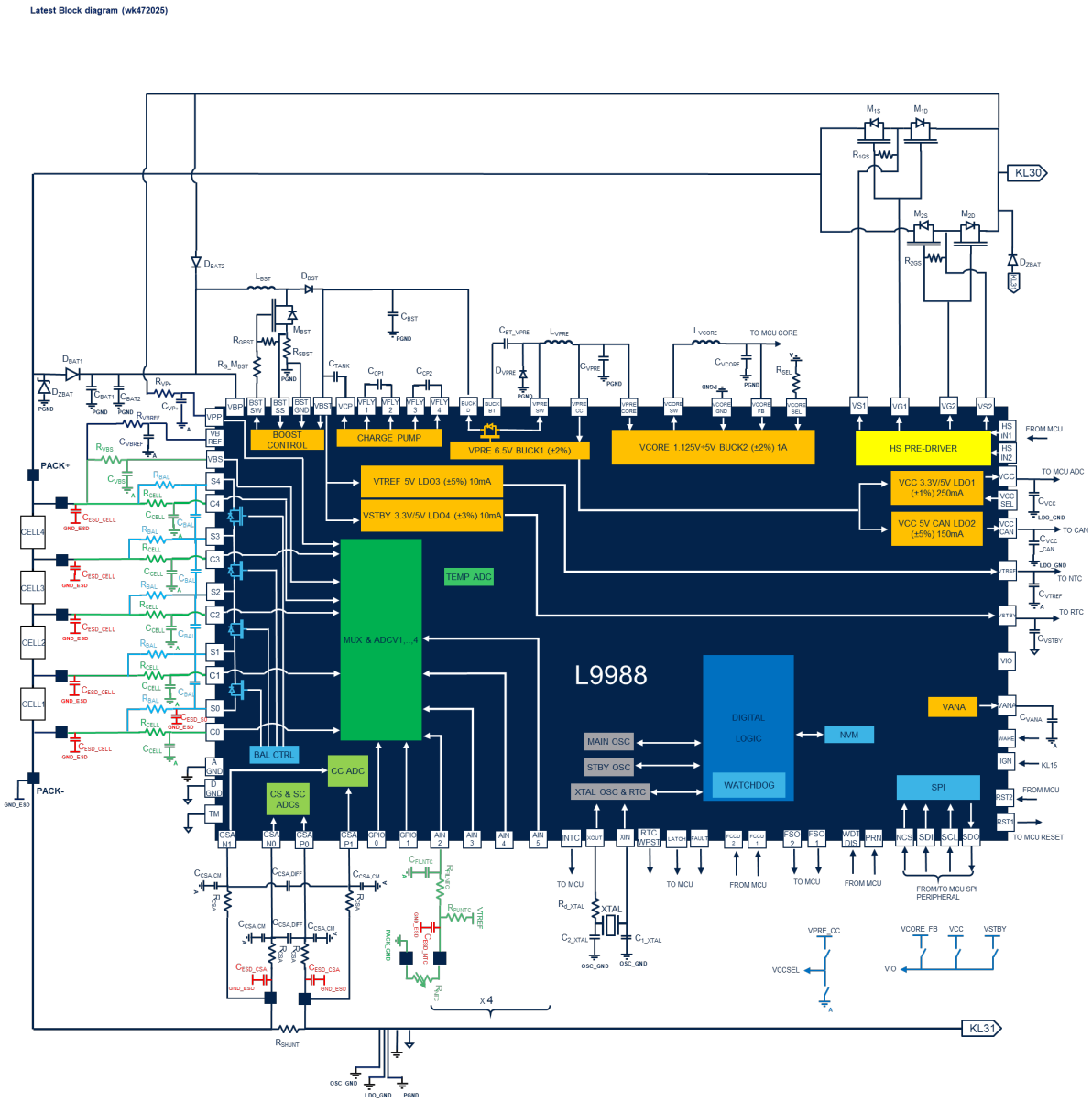
The L9988 embeds a functional state machine to optimize system power consumption without compromising safety functions:

- NORMAL: full operation mode.
- STANDBY MODE: low-power state for managing battery idle state, including long balancing periods. Active functions in this state, (cell voltage/current/temperature diagnostics…), can be configured by the MCU during NORMAL MODE, with a reduced power consumption according to the enabled resources.
- SLEEP MODE: ultra-low power state for managing long inactive periods. In this state, the device is sensitive to wake-up tones both from the IGN and WAKE pins.

The L9988 is able to drive 2 independent HSD circuit breaker MOSFETs, including a diagnosis of main faults.

2 Block and typical application diagrams

Figure 2. L9988 Block and typical application



3 Package information

To meet environmental requirements, ST offers these devices in different grades of ECOPACK packages, depending on their level of environmental compliance. ECOPACK specifications, grade definitions, and product status are available at: www.st.com. ECOPACK is an ST trademark.

Figure 3. Package TQFP80

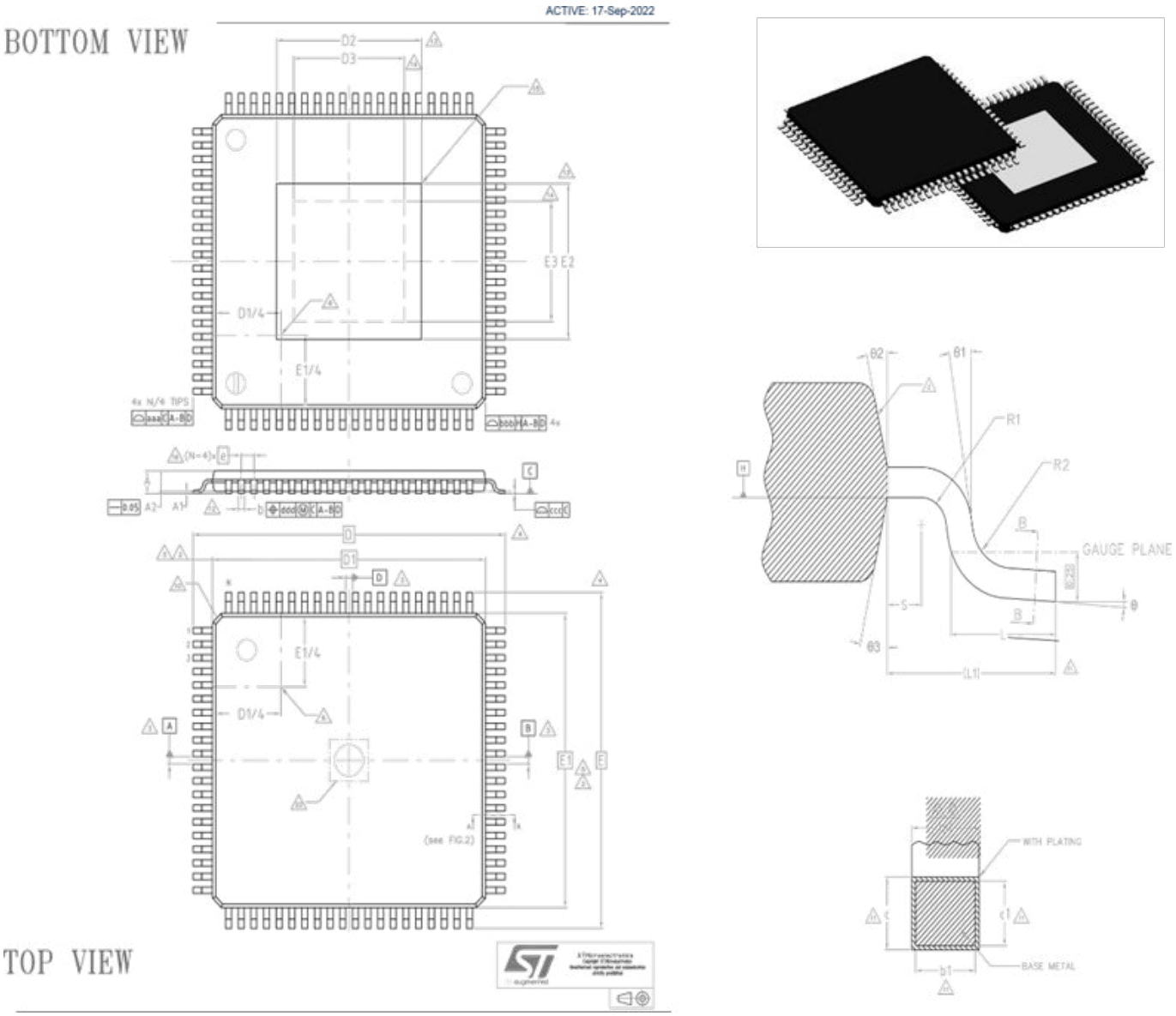


Table 1. **TQFP80 14x14 80L exposed pad down package dimensions**

ST DATABOOK				
Symbol	**Min**	**Typ**	**Max**	**Note**
Θ	0°	3.5°	7°	-
Θ1	0°	-	-	-
Θ2	10°	12°	14°	-
Θ3	10°	12°	14°	-
A	-	-	1.20	15
A1	0.05	-	0.15	12
A2	0.95	1.00	1.05	15
b	0.22	0.32	0.38	9,11
b1	0.22	0.30	0.33	11
c	0.09	-	0.20	11
c1	0.09	-	0.16	11
D		16.00 BSC		4
D1		14.00 BSC		2,5
D2		VARIATIONS		13
D3		VARIATIONS		14
e		0.65 BSC		
E		16.00 BSC		4
E1		14.00 BSC		2,5
E2		VARIATIONS		13
E3		VARIATIONS		14
L	0.45	0.60	0.75	
L1		1.00 REF		
N		80		16
R1	0.08	-	-	
R2	0.08	-	0.20	
S	0.20	-	-	

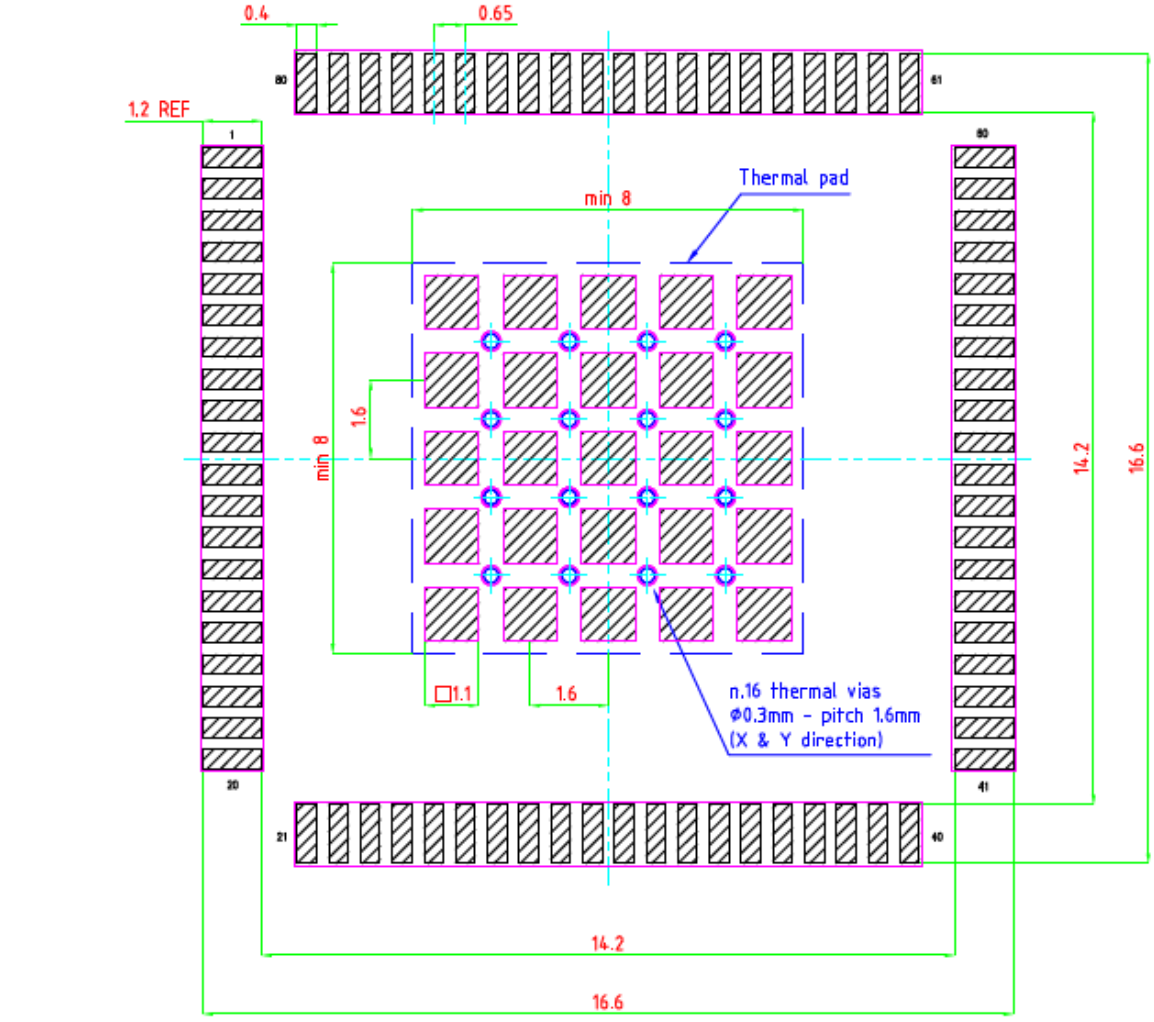
Table 2. **Tolerance of form and position**

Tolerance of form and position		
Symbol	**Databook**	**Note**
aaa	0.20	1,7,20
bbb	0.20	
ccc	0.10	
ddd	0.13	

Table 3. **Variations**

Variations				
Databook				
Symbol	Min	Nom	Max	Pad opt.
D2	-	-	8.27	8.0x8.0 (T1)
E2	-	-	8.27	
D3	6.78	-	-	
E3	6.78	-	-	

Figure 4. **QFP 14x14 80L - 8x8 EP down - PCB Landpattern**

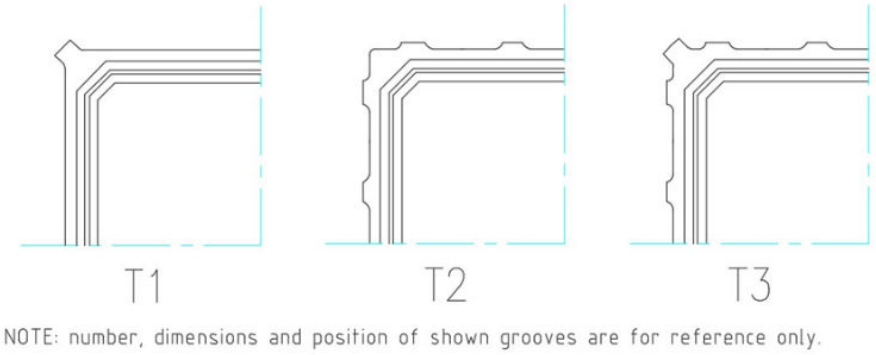


NOTE:
This is a draft proposal only and it might be not in line with customer or pcb supplier design rules.

Note:

1. *Dimensioning and tolerancing schemes conform to ASME Y14.5M-1994.*
2. *The Top package body size may be smaller than the bottom package size by as much as 0.15 mm.*
3. *Datums A-B and D to be determined at datum plane H.*
4. *To be determined at seating datum plane C.*
5. *Dimensions D1 and E1 do not include mold flash or protrusions. Allowable mold flash or protrusions is “0.25 mm” per side. D1 and E1 are Maximum plastic body size dimensions including mold mismatch.*
6. *Details of pin 1 identifier are optional but must be located within the zone indicated.*
7. *All Dimensions are in millimeters.*
8. *No intrusion allowed inwards the leads.*
9. *Dimension “b” does not include dambar protrusion. Allowable dambar protrusion shall not cause the lead width to exceed the maximum “b” dimension by more than 0.08 mm. Dambar cannot be located on the lower radius or the foot. Minimum space between protrusion and an adjacent lead is 0.07 mm for 0.4 mm and 0.5 mm pitch packages.*
10. *Exact shape of each corner is optional.*
11. *These dimensions apply to the flat section of the lead between 0.10 mm and 0.25 mm from the lead tip.*
12. *A1 is defined as the distance from the seating plane to the lowest point on the package body.*
13. *Dimensions D2 and E2 show the maximum exposed metal area on the package surface where the exposed pad is located (if present). It includes all metal protrusions from exposed pad itself. Type of exposed pad is variable depending on lead frame pad design (T1, T2, T3), as shown in the figure below. End user should verify D2 and E2 dimensions according to specific device application.*

Figure 5. ***T1,T2,T3***



14. *Dimensions D3 and E3 show the minimum solderable area, defined as the portion of exposed pad which is guaranteed to be free from resin flashes/bleeds, bordered by internal edge of inner groove.*
15. *The optional exposed pad generally coincides with the top or bottom side of the package and is not allowed to protrude beyond that surface.*
16. *“N” is the number of terminal positions for the specified body size.*
17. *For Tolerance of Form and Position see Table.*
18. *Critical dimensions:*
    a. *Stand-Off*
    b. *Overall Width*
    c. *Lead Coplanarity*
19. *Component cross reference: see DMS spec. 8404938, DM00886812.*
20. *For Symbols, Recommended Values and Tolerances see Table below*
21. *POA FORMAT & CONTENT spec. reference number is CD10033601.*
22. *Notch may be present in this area (MAX 2.0mm square) if center top gate molding technology is applied. Resin gate residually not protruding out of package top surface.*

4 Ordering codes

Table 4. **Ordering codes**

Order code	Package	Packing
L9988	TQFP80	Tray
L9988-TR		Tape&Reel

Revision history

Table 5. **Document revision history**

Date	Version	Changes
09-Dec-2025	1	Initial release.
14-Apr-2026	2	Added: Section 2: Block and typical application diagrams and Section 3: Package information.

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