

74LVC541A-Q100

Octal buffer/line driver with 5 V tolerant inputs/outputs;
3-state

Rev. 2 — 4 March 2013

Product data sheet

1. General description

The 74LVC541A-Q100 is an octal non-inverting buffer/line driver with 5 V tolerant inputs and outputs. The output enable inputs $\overline{OE}1$ and $\overline{OE}2$ control the 3-state outputs.

This device is fully specified for partial power-down applications using I_{OFF} . The I_{OFF} circuitry disables the output, preventing the damaging backflow current through the device when it is powered down.

Inputs can be driven from either 3.3 V or 5 V devices. When disabled, up to 5.5 V can be applied to the outputs. These features allow the use of these devices as translators in mixed 3.3 V and 5 V applications.

This product has been qualified to the Automotive Electronics Council (AEC) standard Q100 (Grade 1) and is suitable for use in automotive applications.

2. Features and benefits

- Automotive product qualification in accordance with AEC-Q100 (Grade 1)
 - ◆ Specified from $-40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$ and from $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$
- 5 V tolerant inputs for interfacing with 5 V logic
- Wide supply voltage range from 1.2 V to 3.6 V
- CMOS low power consumption
- Direct interface with TTL levels
- Complies with JEDEC standard:
 - ◆ JESD8-7A (1.65 V to 1.95 V)
 - ◆ JESD8-5A (2.3 V to 2.7 V)
 - ◆ JESD8-C/JESD36 (2.7 V to 3.6 V)
- ESD protection:
 - ◆ MIL-STD-883, method 3015 exceeds 2000 V
 - ◆ HBM JESD22-A114F exceeds 2000 V
 - ◆ MM JESD22-A115-A exceeds 200 V ($C = 200\text{ pF}$, $R = 0\text{ }\Omega$)

3. Ordering information

Table 1. Ordering information

| Type number | Package | | | Version |
|------------------|-------------------|----------|--|----------|
| | Temperature range | Name | Description | |
| 74LVC541AD-Q100 | -40 °C to +125 °C | SO20 | plastic small outline package; 20 leads; body width 7.5 mm | SOT163-1 |
| 74LVC541APW-Q100 | -40 °C to +125 °C | TSSOP20 | plastic thin shrink small outline package; 20 leads; body width 4.4 mm | SOT360-1 |
| 74LVC541ABQ-Q100 | -40 °C to +125 °C | DHVQFN20 | plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads; 20 terminals; body 2.5 × 4.5 × 0.85 mm | SOT764-1 |

4. Functional diagram

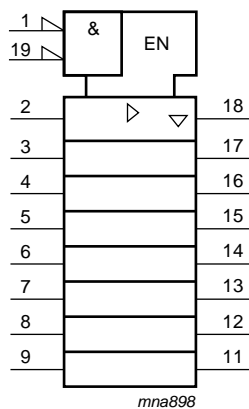


Fig 1. IEC logic symbol

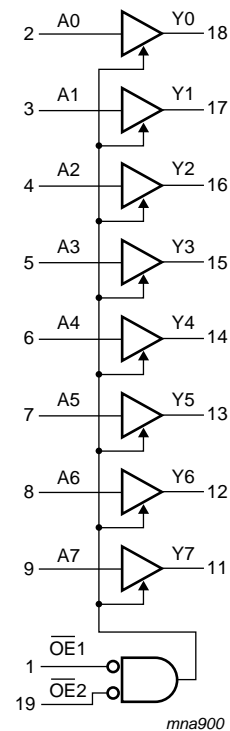
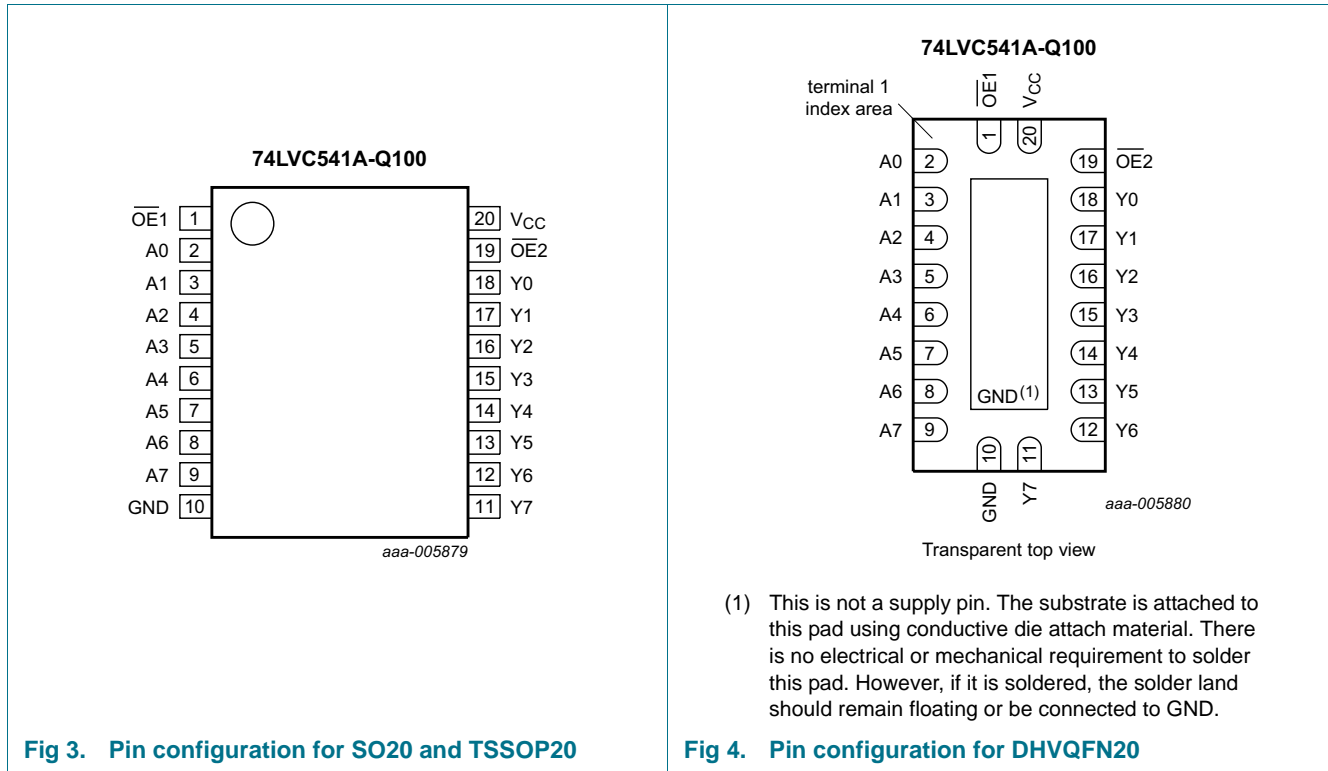


Fig 2. Functional diagram

5. Pinning information

5.1 Pinning



5.2 Pin description

Table 2. Pin description

| Symbol | Pin | Description |
|-------------------------|--------------------------------|----------------------------------|
| $\overline{\text{OE}}1$ | 1 | output enable input (active LOW) |
| A[0:7] | 2, 3, 4, 5, 6, 7, 8, 9 | data input |
| GND | 10 | ground (0 V) |
| Y[0:7] | 18, 17, 16, 15, 14, 13, 12, 11 | bus output |
| $\overline{\text{OE}}2$ | 19 | output enable input (active LOW) |
| V _{CC} | 20 | supply voltage |

6. Functional description

Table 3. Functional table^[1]

| Input | | | Output | |
|-------|-----|----|--------|--|
| OE1 | OE2 | An | Yn | |
| L | L | L | L | |
| L | L | H | H | |
| X | H | X | Z | |
| H | X | X | Z | |

- [1] H = HIGH voltage level
 L = LOW voltage level
 X = don't care
 Z = high-impedance OFF-state

7. Limiting values

Table 4. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to GND (ground = 0 V).

| Symbol | Parameter | Conditions | Min | Max | Unit |
|-----------|-------------------------|-------------------------------|----------|----------------|------|
| V_{CC} | supply voltage | | -0.5 | +6.5 | V |
| I_{IK} | input clamping current | $V_I < 0$ V | -50 | - | mA |
| V_I | input voltage | | [1] -0.5 | +5.5 | V |
| I_{OK} | output clamping current | $V_O > V_{CC}$ or $V_O < 0$ V | - | ±50 | mA |
| V_O | output voltage | output HIGH or LOW state | [2] -0.5 | $V_{CC} + 0.5$ | V |
| | | output 3-state or power-down | [2] -0.5 | +6.5 | V |
| I_O | output current | $V_O = 0$ V to V_{CC} | - | ±50 | mA |
| I_{CC} | supply current | | - | 100 | mA |
| I_{GND} | ground current | | -100 | - | mA |
| T_{stg} | storage temperature | | -60 | +150 | °C |
| P_{tot} | total power dissipation | $T_{amb} = -40$ °C to +125 °C | [3] - | 500 | mW |

- [1] The minimum input voltage ratings may be exceeded if the input current ratings are observed.
 [2] The output voltage ratings may be exceeded if the output current ratings are observed.
 [3] For SO20 packages: above 70 °C the value of P_{tot} derates linearly with 8 mW/K.
 For TSSOP20 packages: above 60 °C the value of P_{tot} derates linearly with 5.5 mW/K.
 For DHVQFN20 packages: above 60 °C the value of P_{tot} derates linearly with 4.5 mW/K.

8. Recommended operating conditions

Table 5. Recommended operating conditions

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---------------------|-------------------------------------|--|------|-----|----------|------|
| V_{CC} | supply voltage | | 1.65 | - | 3.6 | V |
| | | functional | 1.2 | - | - | V |
| V_I | input voltage | | 0 | - | 5.5 | V |
| V_O | output voltage | output HIGH or LOW state | 0 | - | V_{CC} | V |
| | | output 3-state | 0 | - | 5.5 | V |
| T_{amb} | ambient temperature | | -40 | - | +125 | °C |
| $\Delta t/\Delta V$ | input transition rise and fall rate | $V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$ | 0 | - | 20 | ns/V |
| | | $V_{CC} = 2.7 \text{ V to } 3.6 \text{ V}$ | 0 | - | 10 | ns/V |

9. Static characteristics

Table 6. Static characteristics

At recommended operating conditions. Voltages are referenced to GND (ground = 0 V).

| Symbol | Parameter | Conditions | -40 °C to +85 °C | | | -40 °C to +125 °C | | Unit |
|----------|---------------------------|---|----------------------|--------------------|----------------------|----------------------|----------------------|------|
| | | | Min | Typ ^[1] | Max | Min | Max | |
| V_{IH} | HIGH-level input voltage | $V_{CC} = 1.2 \text{ V}$ | 1.08 | - | - | 1.08 | - | V |
| | | $V_{CC} = 1.65 \text{ V to } 1.95 \text{ V}$ | $0.65 \times V_{CC}$ | - | - | $0.65 \times V_{CC}$ | - | V |
| | | $V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$ | 1.7 | - | - | 1.7 | - | V |
| | | $V_{CC} = 2.7 \text{ V to } 3.6 \text{ V}$ | 2.0 | - | - | 2.0 | - | V |
| V_{IL} | LOW-level input voltage | $V_{CC} = 1.2 \text{ V}$ | - | - | 0.12 | - | 0.12 | V |
| | | $V_{CC} = 1.65 \text{ V to } 1.95 \text{ V}$ | - | - | $0.35 \times V_{CC}$ | - | $0.35 \times V_{CC}$ | V |
| | | $V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$ | - | - | 0.7 | - | 0.7 | V |
| | | $V_{CC} = 2.7 \text{ V to } 3.6 \text{ V}$ | - | - | 0.8 | - | 0.8 | V |
| V_{OH} | HIGH-level output voltage | $V_I = V_{IH} \text{ or } V_{IL}$ | | | | | | |
| | | $I_O = -100 \mu\text{A}; V_{CC} = 1.65 \text{ V to } 3.6 \text{ V}$ | $V_{CC} - 0.2$ | - | - | $V_{CC} - 0.3$ | - | V |
| | | $I_O = -4 \text{ mA}; V_{CC} = 1.65 \text{ V}$ | 1.2 | - | - | 1.05 | - | V |
| | | $I_O = -8 \text{ mA}; V_{CC} = 2.3 \text{ V}$ | 1.8 | - | - | 1.65 | - | V |
| | | $I_O = -12 \text{ mA}; V_{CC} = 2.7 \text{ V}$ | 2.2 | - | - | 2.05 | - | V |
| | | $I_O = -18 \text{ mA}; V_{CC} = 3.0 \text{ V}$ | 2.4 | - | - | 2.25 | - | V |
| | | $I_O = -24 \text{ mA}; V_{CC} = 3.0 \text{ V}$ | 2.2 | - | - | 2.0 | - | V |
| V_{OL} | LOW-level output voltage | $V_I = V_{IH} \text{ or } V_{IL}$ | | | | | | |
| | | $I_O = 100 \mu\text{A}; V_{CC} = 1.65 \text{ V to } 3.6 \text{ V}$ | - | - | 0.2 | - | 0.3 | V |
| | | $I_O = 4 \text{ mA}; V_{CC} = 1.65 \text{ V}$ | - | - | 0.45 | - | 0.65 | V |
| | | $I_O = 8 \text{ mA}; V_{CC} = 2.3 \text{ V}$ | - | - | 0.6 | - | 0.8 | V |
| | | $I_O = 12 \text{ mA}; V_{CC} = 2.7 \text{ V}$ | - | - | 0.4 | - | 0.6 | V |
| | | $I_O = 24 \text{ mA}; V_{CC} = 3.0 \text{ V}$ | - | - | 0.55 | - | 0.8 | V |

Table 6. Static characteristics ...continued

At recommended operating conditions. Voltages are referenced to GND (ground = 0 V).

| Symbol | Parameter | Conditions | -40 °C to +85 °C | | | -40 °C to +125 °C | | Unit |
|-----------------|---------------------------|---|------------------|--------------------|----------|-------------------|----------|---------------|
| | | | Min | Typ ^[1] | Max | Min | Max | |
| I_I | input leakage current | $V_I = 5.5 \text{ V}$ or GND; $V_{CC} = 3.6 \text{ V}$ | - | ± 0.1 | ± 5 | - | ± 20 | μA |
| I_{OZ} | OFF-state output current | $V_I = V_{IH}$ or V_{IL} ; $V_O = 5.5 \text{ V}$ or GND; $V_{CC} = 3.6 \text{ V}$ | - | ± 0.1 | ± 5 | - | ± 20 | μA |
| I_{OFF} | power-off leakage current | V_I or $V_O = 5.5 \text{ V}$; $V_{CC} = 0.0 \text{ V}$ | - | ± 0.1 | ± 10 | - | ± 20 | μA |
| I_{CC} | supply current | $V_I = V_{CC}$ or GND; $I_O = 0 \text{ A}$; $V_{CC} = 3.6 \text{ V}$ | - | 0.1 | 10 | - | 40 | μA |
| ΔI_{CC} | additional supply current | per input pin; $V_I = V_{CC} - 0.6 \text{ V}$; $I_O = 0 \text{ A}$; $V_{CC} = 2.7 \text{ V}$ to 3.6 V | - | 5 | 500 | - | 5000 | μA |
| C_I | input capacitance | | - | 5.0 | - | - | - | pF |

[1] All typical values are measured at $V_{CC} = 3.3 \text{ V}$ (unless stated otherwise) and $T_{amb} = 25 \text{ }^\circ\text{C}$.

10. Dynamic characteristics

Table 7. Dynamic characteristicsVoltages are referenced to GND (ground = 0 V). For test circuit see [Figure 7](#).

| Symbol | Parameter | Conditions | -40 °C to +85 °C | | | -40 °C to +125 °C | | Unit |
|-----------|-------------------|---|------------------|--------------------|------|-------------------|------|------|
| | | | Min | Typ ^[1] | Max | Min | Max | |
| t_{pd} | propagation delay | An to Yn; see Figure 5 [2] | | | | | | |
| | | $V_{CC} = 1.2 \text{ V}$ | - | 14.0 | - | - | - | ns |
| | | $V_{CC} = 1.65 \text{ V}$ to 1.95 V | 1.5 | 6.5 | 13.8 | 1.5 | 16.0 | ns |
| | | $V_{CC} = 2.3 \text{ V}$ to 2.7 V | 1.0 | 3.5 | 6.8 | 1.0 | 7.9 | ns |
| | | $V_{CC} = 2.7 \text{ V}$ | 1.5 | 3.5 | 5.6 | 1.5 | 7.0 | ns |
| t_{en} | enable time | $\overline{\text{OEn}}$ to Yn; see Figure 6 [2] | | | | | | |
| | | $V_{CC} = 1.2 \text{ V}$ | - | 20.0 | - | - | - | ns |
| | | $V_{CC} = 1.65 \text{ V}$ to 1.95 V | 1.8 | 7.7 | 16.0 | 1.8 | 18.5 | ns |
| | | $V_{CC} = 2.3 \text{ V}$ to 2.7 V | 1.5 | 4.3 | 8.8 | 1.5 | 10.2 | ns |
| | | $V_{CC} = 2.7 \text{ V}$ | 1.5 | 4.4 | 7.5 | 1.5 | 9.5 | ns |
| t_{dis} | disable time | $\overline{\text{OEn}}$ to Yn; see Figure 6 [2] | | | | | | |
| | | $V_{CC} = 1.2 \text{ V}$ | - | 11.0 | - | - | - | ns |
| | | $V_{CC} = 1.65 \text{ V}$ to 1.95 V | 3.0 | 4.9 | 10.3 | 3.0 | 11.9 | ns |
| | | $V_{CC} = 2.3 \text{ V}$ to 2.7 V | 1.0 | 2.7 | 5.9 | 1.0 | 6.8 | ns |
| | | $V_{CC} = 2.7 \text{ V}$ | 1.5 | 3.7 | 7.0 | 1.5 | 9.0 | ns |
| | | $V_{CC} = 3.0 \text{ V}$ to 3.6 V | 1.0 | 3.3 | 6.0 | 1.0 | 7.5 | ns |

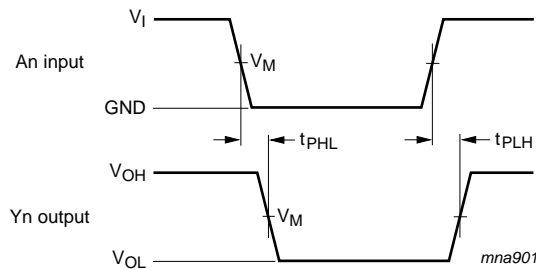
Table 7. Dynamic characteristics ...continued

Voltages are referenced to GND (ground = 0 V). For test circuit see [Figure 7](#).

| Symbol | Parameter | Conditions | -40 °C to +85 °C | | | -40 °C to +125 °C | | Unit |
|-----------------|-------------------------------|--|------------------|--------------------|-----|-------------------|-----|------|
| | | | Min | Typ ^[1] | Max | Min | Max | |
| C _{PD} | power dissipation capacitance | per input; V _I = GND to V _{CC} | | | | | | |
| | | V _{CC} = 1.65 V to 1.95 V | - | 7.7 | - | - | - | pF |
| | | V _{CC} = 2.3 V to 2.7 V | - | 11.3 | - | - | - | pF |
| | | V _{CC} = 3.0 V to 3.6 V | - | 14.4 | - | - | - | pF |

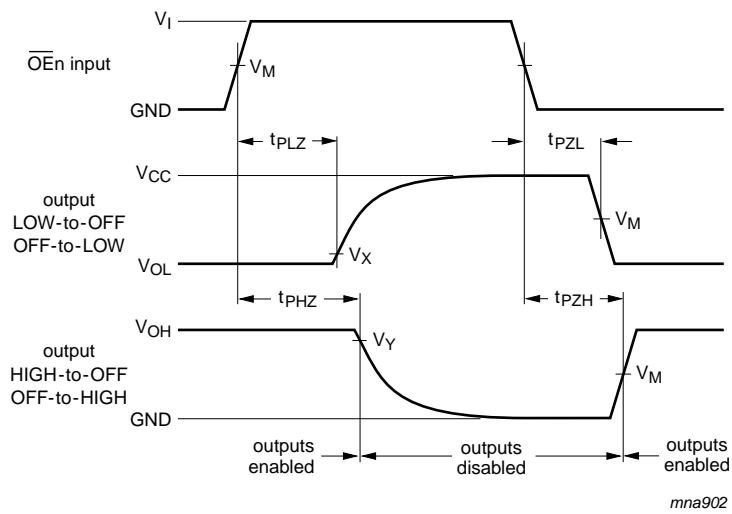
- [1] Typical values are measured at T_{amb} = 25 °C and V_{CC} = 1.2 V, 1.8 V, 2.5 V, 2.7 V, and 3.3 V respectively.
- [2] t_{pd} is the same as t_{PLH} and t_{PHL}.
t_{en} is the same as t_{PZL} and t_{PZH}.
t_{dis} is the same as t_{PLZ} and t_{PHZ}.
- [3] Skew between any two outputs of the same package switching in the same direction. This parameter is guaranteed by design.
- [4] C_{PD} is used to determine the dynamic power dissipation (P_D in μW).
P_D = C_{PD} × V_{CC}² × f_i × N + Σ(C_L × V_{CC}² × f_o) where:
f_i = input frequency in MHz; f_o = output frequency in MHz
C_L = output load capacitance in pF
V_{CC} = supply voltage in Volts
N = number of inputs switching
Σ(C_L × V_{CC}² × f_o) = sum of the outputs.

11. AC waveforms



V_M = 1.5 V at V_{CC} ≥ 2.7 V.
V_M = 0.5 × V_{CC} at V_{CC} < 2.7 V.
V_{OL} and V_{OH} are typical output voltage levels that occur with the output load.

Fig 5. Input (An) to output (Yn) propagation delays



$V_M = 1.5 \text{ V}$ at $V_{CC} \geq 2.7 \text{ V}$.

$V_M = 0.5 \times V_{CC}$ at $V_{CC} < 2.7 \text{ V}$.

$V_X = V_{OL} + 0.3 \text{ V}$ at $V_{CC} \geq 2.7 \text{ V}$.

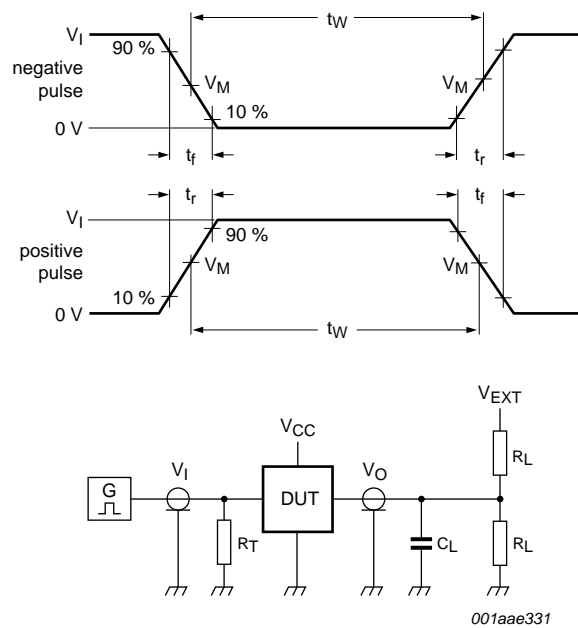
$V_X = V_{OL} + 0.15 \text{ V}$ at $V_{CC} < 2.7 \text{ V}$.

$V_Y = V_{OH} - 0.3 \text{ V}$ at $V_{CC} \geq 2.7 \text{ V}$.

$V_Y = V_{OH} - 0.15 \text{ V}$ at $V_{CC} < 2.7 \text{ V}$.

V_{OL} and V_{OH} are typical output voltage levels that occur with the output load.

Fig 6. 3-state enable and disable times



Test data is given in [Table 8](#).

Definitions for test circuit:

R_L = Load resistance.

C_L = Load capacitance including jig and probe capacitance.

R_T = Termination resistance should be equal to output impedance Z_o of the pulse generator.

V_{EXT} = External voltage for measuring switching times.

Fig 7. Test circuit for measuring switching times

Table 8. Test data

| Supply voltage | Input | | Load | | V_{EXT} | | |
|------------------|----------|---------------|-------|--------------|--------------------|--------------------|--------------------|
| | V_I | t_r, t_f | C_L | R_L | t_{PLH}, t_{PHL} | t_{PLZ}, t_{PZL} | t_{PHZ}, t_{PZH} |
| 1.2 V | V_{CC} | ≤ 2 ns | 30 pF | 1 k Ω | open | $2 \times V_{CC}$ | GND |
| 1.65 V to 1.95 V | V_{CC} | ≤ 2 ns | 30 pF | 1 k Ω | open | $2 \times V_{CC}$ | GND |
| 2.3 V to 2.7 V | V_{CC} | ≤ 2 ns | 30 pF | 500 Ω | open | $2 \times V_{CC}$ | GND |
| 2.7 V | 2.7 V | ≤ 2.5 ns | 50 pF | 500 Ω | open | $2 \times V_{CC}$ | GND |
| 3.0 V to 3.6 V | 2.7 V | ≤ 2.5 ns | 50 pF | 500 Ω | open | $2 \times V_{CC}$ | GND |

12. Package outline

SO20: plastic small outline package; 20 leads; body width 7.5 mm

SOT163-1

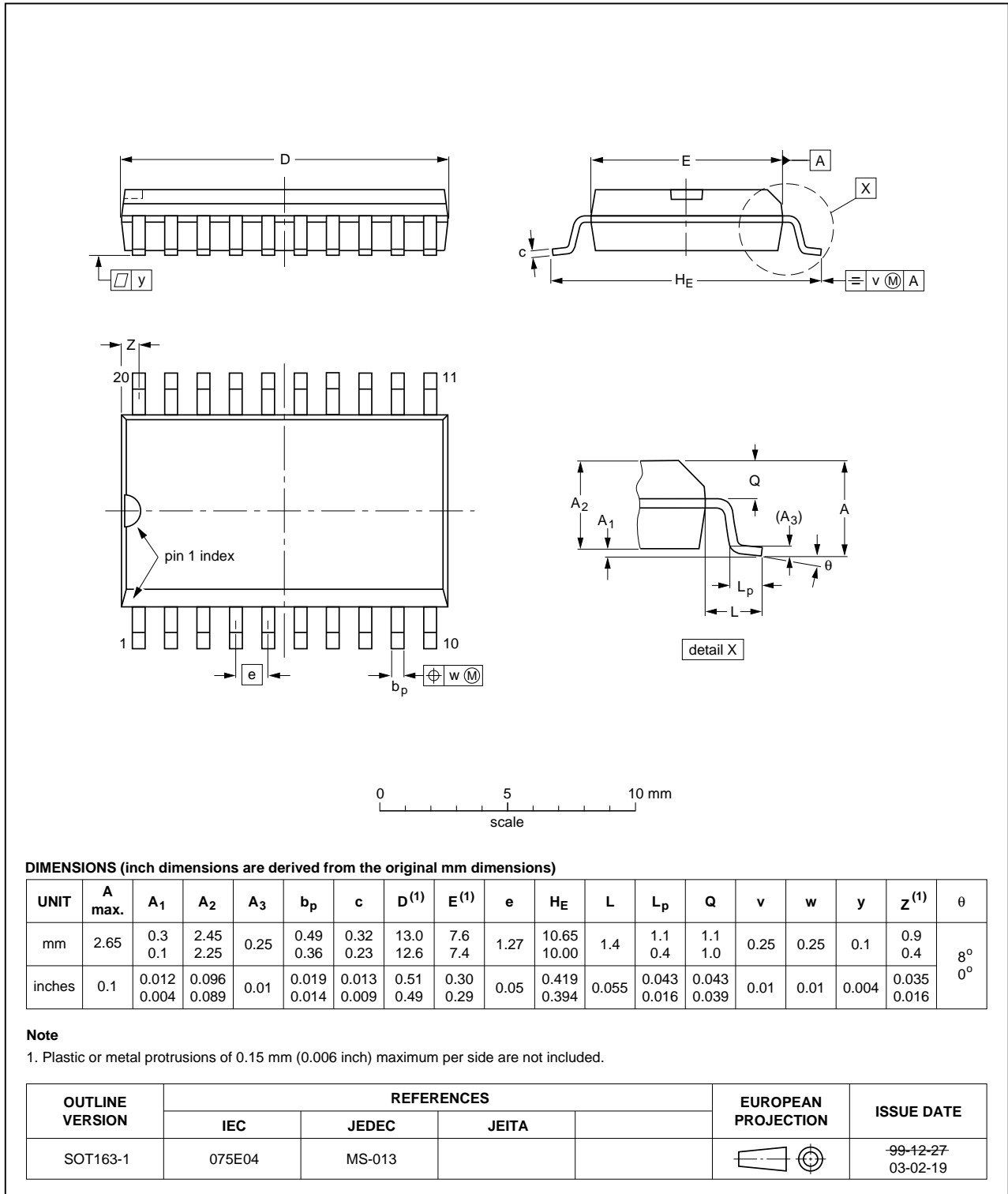


Fig 8. Package outline SOT163-1 (SO20)

TSSOP20: plastic thin shrink small outline package; 20 leads; body width 4.4 mm

SOT360-1

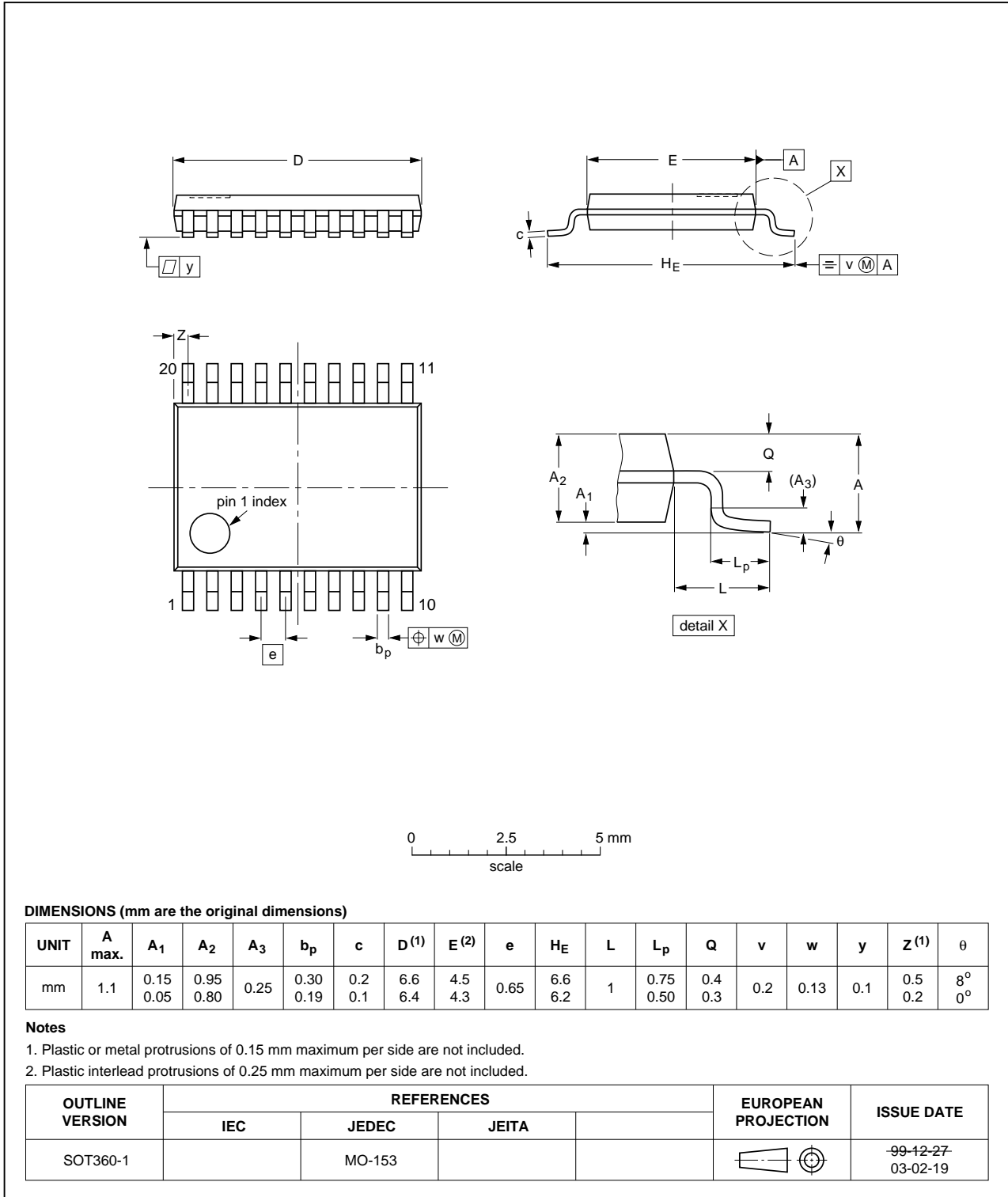


Fig 9. Package outline SOT360-1 (TSSOP20)

DHVQFN20: plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads; 20 terminals; body 2.5 x 4.5 x 0.85 mm

SOT764-1

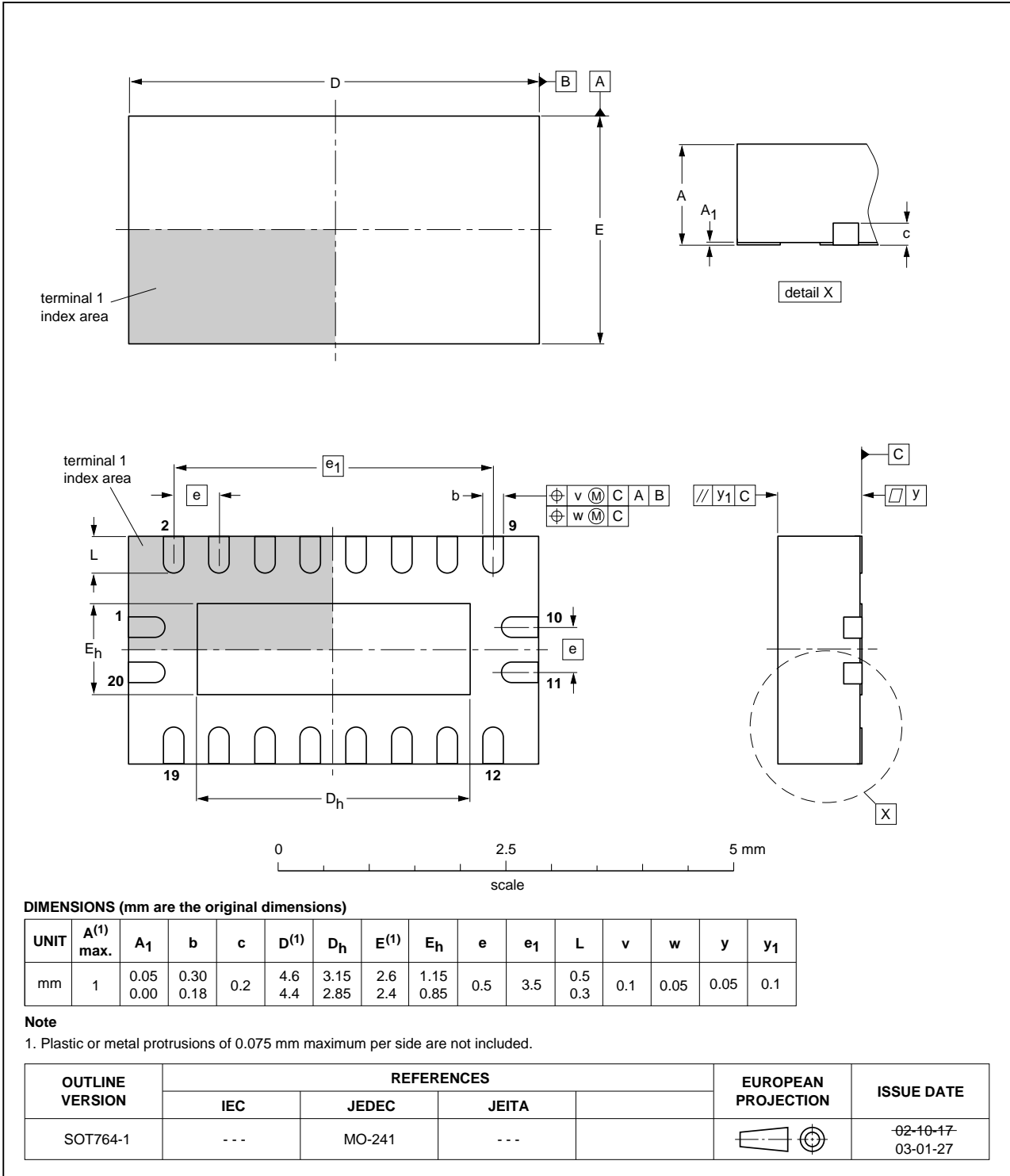


Fig 10. Package outline SOT764-1 (DHVQFN20)

13. Abbreviations

Table 9. Abbreviations

| Acronym | Description |
|---------|-----------------------------|
| CDM | Charged Device Model |
| DUT | Device Under Test |
| ESD | ElectroStatic Discharge |
| MM | Machine Model |
| HBM | Human Body Model |
| TTL | Transistor-Transistor Logic |
| MIL | Military |

14. Revision history

Table 10. Revision history

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|--------------------|---|--------------------|---------------|--------------------|
| 74LVC541A_Q100 v.2 | 20130304 | Product data sheet | - | 74LVC541A_Q100 v.1 |
| Modifications: | • Changed interlacing into interfacing (errata) in features list. | | | |
| 74LVC541A_Q100 v.1 | 20130219 | Product data sheet | - | - |

15. Legal information

15.1 Data sheet status

| Document status ^{[1][2]} | Product status ^[3] | Definition |
|-----------------------------------|-------------------------------|---|
| Objective [short] data sheet | Development | This document contains data from the objective specification for product development. |
| Preliminary [short] data sheet | Qualification | This document contains data from the preliminary specification. |
| Product [short] data sheet | Production | This document contains the product specification. |

[1] Please consult the most recently issued document before initiating or completing a design.

[2] The term 'short data sheet' is explained in section "Definitions".

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