

74HC688

8-bit magnitude comparator

Rev. 4 — 16 July 2021

Product data sheet

1. General description

The 74HC688 is an 8-bit magnitude comparator. It performs comparisons of two 8-bit binary or BCD words. Inputs include clamp diodes. This enables the use of current limiting resistors to interface inputs to voltages in excess of V_{CC} .

2. Features and benefits

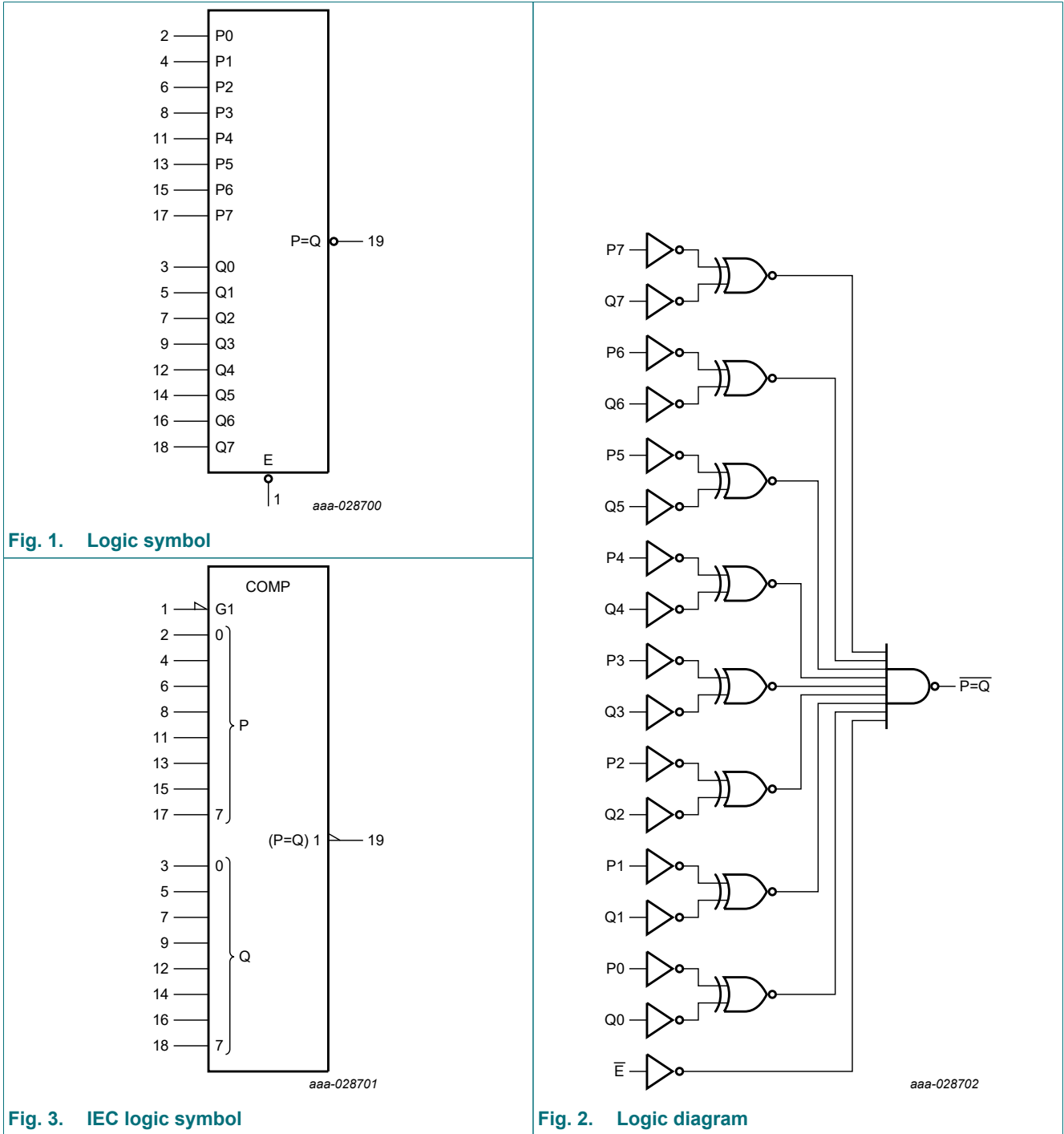
- Compare two 8-bit words
- Wide supply voltage range from 2.0 to 6.0 V
- CMOS input levels
- CMOS low power dissipation
- High noise immunity
- Latch-up performance exceeds 100 mA per JESD 78 Class II Level B
- Complies with JEDEC standards
 - JESD8C (2.7 V to 3.6 V)
 - JESD7A (2.0 V to 6.0 V)
- ESD protection:
 - HBM JESD22-A114-F exceeds 2000 V
 - MM JESD22-A115-A exceeds 200 V
- Specified from -40 °C to +85 °C and from -40 °C to +125 °C

3. Ordering information

Table 1. Ordering information

| Type number | Package | | | |
|-------------|-------------------|---------|---|----------|
| | Temperature range | Name | Description | Version |
| 74HC688D | -40 °C to +125 °C | SO20 | plastic small outline package; 20 leads; body width 7.5 mm | SOT163-1 |
| 74HC688PW | -40 °C to +125 °C | TSSOP20 | plastic thin shrink small outline package; 20 leads; body width 4.4 mm | SOT360-1 |

4. Functional diagram



5. Pinning information

5.1. Pinning

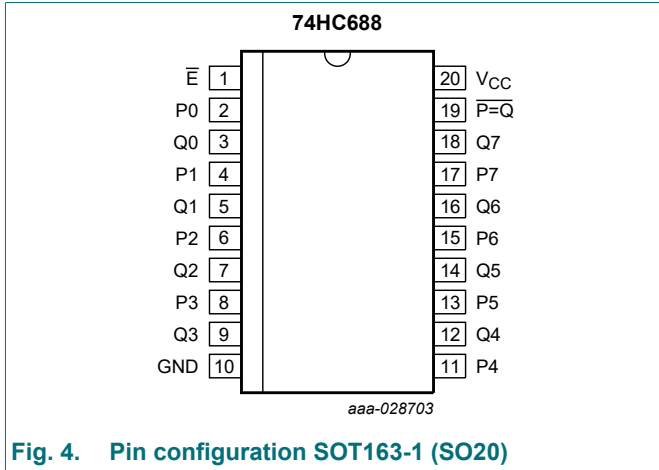


Fig. 4. Pin configuration SOT163-1 (SO20)

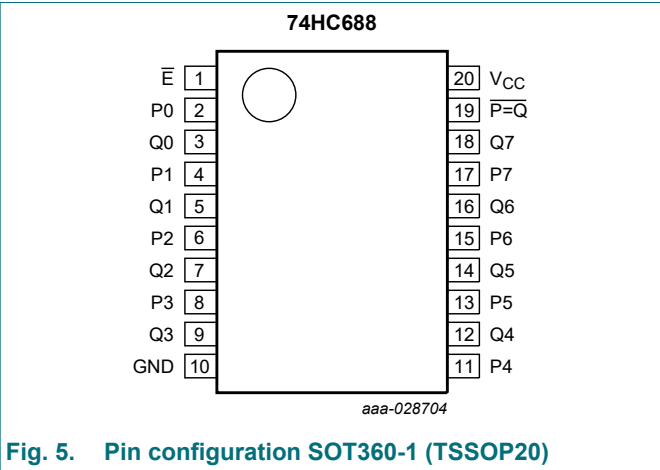


Fig. 5. Pin configuration SOT360-1 (TSSOP20)

5.2. Pin description

Table 2. Pin description

| Symbol | Pin | Description |
|--------------------------------|----------------------------|---------------------------|
| \bar{E} | 1 | enable input (active LOW) |
| P0, P1, P2, P3, P4, P5, P6, P7 | 2, 4, 6, 8, 11, 13, 15, 17 | word P inputs |
| Q0, Q1, Q2, Q3, Q4, Q5, Q6, Q7 | 3, 5, 7, 9, 12, 14, 16, 18 | word Q inputs |
| GND | 10 | ground (0 V) |
| $P=Q$ | 19 | equal to output |
| V_{CC} | 20 | supply voltage |

6. Functional description

Table 3. Function table

H = HIGH voltage level; L = LOW voltage level; X = don't care.

| inputs | | output |
|-------------|-----------|--------|
| data Pn, Qn | \bar{E} | $P=Q$ |
| P=Q | L | L |
| P>Q | L | H |
| P<Q | L | H |
| X | H | H |

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 | +7 | V |
| I_{IK} | input clamping current | $V_I < -0.5\text{ V}$ or $V_I > V_{CC} + 0.5\text{ V}$ [1] | - | ± 20 | mA |
| I_{OK} | output clamping current | $V_O < -0.5\text{ V}$ or $V_O > V_{CC} + 0.5\text{ V}$ [1] | - | ± 20 | mA |
| I_O | output current | $-0.5\text{ V} < V_O < V_{CC} + 0.5\text{ V}$ | - | ± 25 | mA |
| I_{CC} | supply current | | - | 50 | mA |
| I_{GND} | ground current | | -50 | - | mA |
| T_{stg} | storage temperature | | -65 | +150 | °C |
| P_{tot} | total power dissipation | $T_{amb} = -40\text{ °C}$ to $+125\text{ °C}$ [2] | - | 500 | mW |

[1] The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

[2] For SOT163-1 (SO20) package: P_{tot} derates linearly with 12.3 mW/K above 109 °C.
For SOT360-1 (TSSOP20) package: P_{tot} derates linearly with 10.0 mW/K above 100 °C.

8. Recommended operating conditions

Table 5. Recommended operating conditions

Voltages are referenced to GND (ground = 0 V)

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---------------------|-------------------------------------|-------------------------|-----|------|----------|------|
| V_{CC} | supply voltage | | 2.0 | 5.0 | 6.0 | V |
| V_I | input voltage | | 0 | - | V_{CC} | V |
| V_O | output voltage | | 0 | - | V_{CC} | V |
| T_{amb} | ambient temperature | | -40 | - | +125 | °C |
| $\Delta t/\Delta V$ | input transition rise and fall rate | $V_{CC} = 2.0\text{ V}$ | - | - | 625 | ns/V |
| | | $V_{CC} = 4.5\text{ V}$ | - | 1.67 | 139 | ns/V |
| | | $V_{CC} = 6.0\text{ V}$ | - | - | 83 | ns/V |

9. Static characteristics

Table 6. Static characteristics

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

| Symbol | Parameter | Conditions | 25 °C | | | -40 °C to +85 °C | | -40 °C to +125 °C | | Unit |
|-----------------|---------------------------|--|-------|------|------|------------------|------|-------------------|------|------|
| | | | Min | Typ | Max | Min | Max | Min | Max | |
| V _{IH} | HIGH-level input voltage | V _{CC} = 2.0 V | 1.5 | 1.2 | - | 1.5 | - | 1.5 | - | V |
| | | V _{CC} = 4.5 V | 3.15 | 2.4 | - | 3.15 | - | 3.15 | - | V |
| | | V _{CC} = 6.0 V | 4.2 | 3.2 | - | 4.2 | - | 4.2 | - | V |
| V _{IL} | LOW-level input voltage | V _{CC} = 2.0 V | - | 0.8 | 0.5 | - | 0.5 | - | 0.5 | V |
| | | V _{CC} = 4.5 V | - | 2.1 | 1.35 | - | 1.35 | - | 1.35 | V |
| | | V _{CC} = 6.0 V | - | 2.8 | 1.8 | - | 1.8 | - | 1.8 | V |
| V _{OH} | HIGH-level output voltage | V _I = V _{IH} or V _{IL} | | | | | | | | |
| | | I _O = -20 μA; V _{CC} = 2.0 V | 1.9 | 2.0 | - | 1.9 | - | 1.9 | - | V |
| | | I _O = -20 μA; V _{CC} = 4.5 V | 4.4 | 4.5 | - | 4.4 | - | 4.4 | - | V |
| | | I _O = -20 μA; V _{CC} = 6.0 V | 5.9 | 6.0 | - | 5.9 | - | 5.9 | - | V |
| | | I _O = -4.0 mA; V _{CC} = 4.5 V | 3.98 | 4.32 | - | 3.84 | - | 3.7 | - | V |
| | | I _O = -5.2 mA; V _{CC} = 6.0 V | 5.48 | 5.81 | - | 5.34 | - | 5.2 | - | V |
| V _{OL} | LOW-level output voltage | V _I = V _{IH} or V _{IL} | | | | | | | | |
| | | I _O = 20 μA; V _{CC} = 2.0 V | - | 0 | 0.1 | - | 0.1 | - | 0.1 | V |
| | | I _O = 20 μA; V _{CC} = 4.5 V | - | 0 | 0.1 | - | 0.1 | - | 0.1 | V |
| | | I _O = 20 μA; V _{CC} = 6.0 V | - | 0 | 0.1 | - | 0.1 | - | 0.1 | V |
| | | I _O = 4.0 mA; V _{CC} = 4.5 V | - | 0.15 | 0.26 | - | 0.33 | - | 0.4 | V |
| | | I _O = 5.2 mA; V _{CC} = 6.0 V | - | 0.16 | 0.26 | - | 0.33 | - | 0.4 | V |
| I _I | input leakage current | V _I = V _{CC} or GND; V _{CC} = 6.0 V | - | - | ±0.1 | - | ±1 | - | ±1 | μA |
| I _{CC} | supply current | V _I = V _{CC} or GND; I _O = 0 A; V _{CC} = 6.0 V | - | - | 8.0 | - | 80 | - | 160 | μA |
| C _I | input capacitance | | - | 3.5 | - | - | - | - | - | pF |

10. Dynamic characteristics

Table 7. Dynamic characteristics

At recommended operating conditions; voltages are referenced to GND (ground = 0 V);

$C_L = 50$ pF unless otherwise specified; for test circuit, see Fig. 8

| Symbol | Parameter | Conditions | 25 °C | | | -40 °C to +85 °C | | -40 °C to +125 °C | | Unit |
|------------------|-------------------------------|--|-------|-----|-----|------------------|-----|-------------------|-----|------|
| | | | Min | Typ | Max | Min | Max | Min | Max | |
| t_{pd} | propagation delay | Pn, Qn to $\overline{P=Q}$; see Fig. 6 [1] | | | | | | | | |
| | | $V_{CC} = 2.0$ V | - | 55 | 170 | - | 215 | - | 255 | ns |
| | | $V_{CC} = 4.5$ V | - | 20 | 34 | - | 43 | - | 51 | ns |
| | | $V_{CC} = 5.0$ V; $C_L = 15$ pF | - | 17 | - | - | - | - | - | ns |
| | | $V_{CC} = 6.0$ V | - | 16 | 29 | - | 37 | - | 43 | ns |
| | | E to $\overline{P=Q}$; see Fig. 7 | | | | | | | | |
| | | $V_{CC} = 2.0$ V | - | 28 | 120 | - | 150 | - | 180 | ns |
| | | $V_{CC} = 4.5$ V | - | 10 | 24 | - | 30 | - | 36 | ns |
| | | $V_{CC} = 5.0$ V; $C_L = 15$ pF | - | 8 | - | - | - | - | - | ns |
| $V_{CC} = 6.0$ V | - | 8 | 20 | - | 26 | - | 31 | ns | | |
| t_t | transition time | see Fig. 7 [2] | | | | | | | | |
| | | $V_{CC} = 2.0$ V | - | 19 | 75 | - | 95 | - | 110 | ns |
| | | $V_{CC} = 4.5$ V | - | 7 | 15 | - | 19 | - | 22 | ns |
| | | $V_{CC} = 6.0$ V | - | 6 | 13 | - | 16 | - | 19 | ns |
| C_{PD} | power dissipation capacitance | per package; $V_I = \text{GND to } V_{CC}$ [3] | - | 30 | - | - | - | - | - | pF |

[1] t_{pd} is the same as t_{PHL} and t_{PLH} .

[2] t_t is the same as t_{THL} and t_{TLH} .

[3] C_{PD} is used to determine the dynamic power dissipation (P_D in μW).

$P_D = C_{PD} \times V_{CC}^2 \times f_i + \Sigma (C_L \times V_{CC}^2 \times f_o)$ where:

f_i = input frequency in MHz;

f_o = output frequency in MHz;

$\Sigma (C_L \times V_{CC}^2 \times f_o)$ = sum of outputs;

C_L = output load capacitance in pF;

V_{CC} = supply voltage in V.

10.1. Waveforms and test circuit

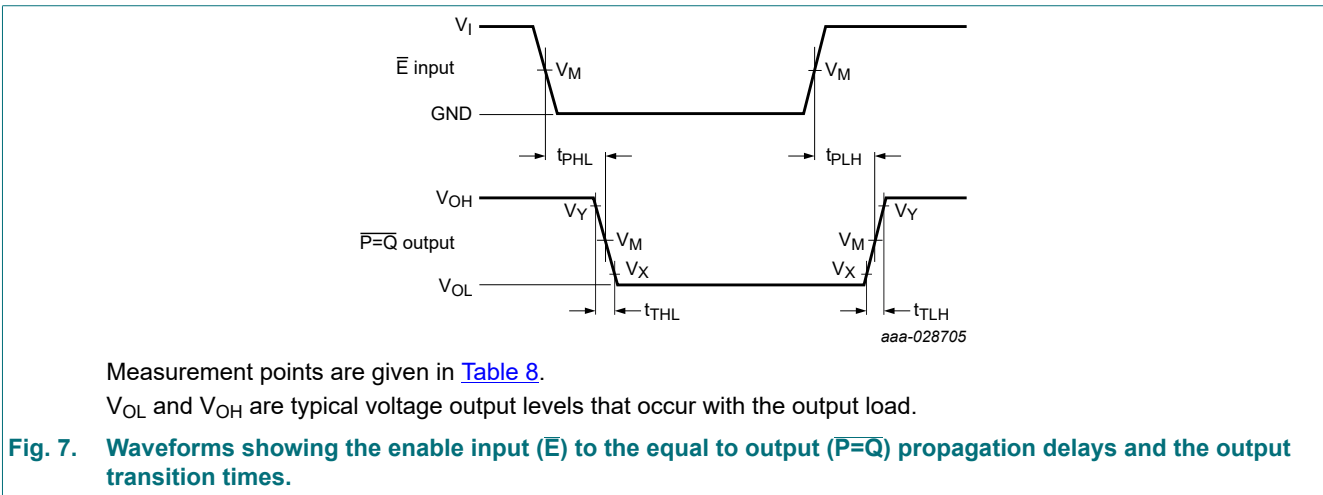
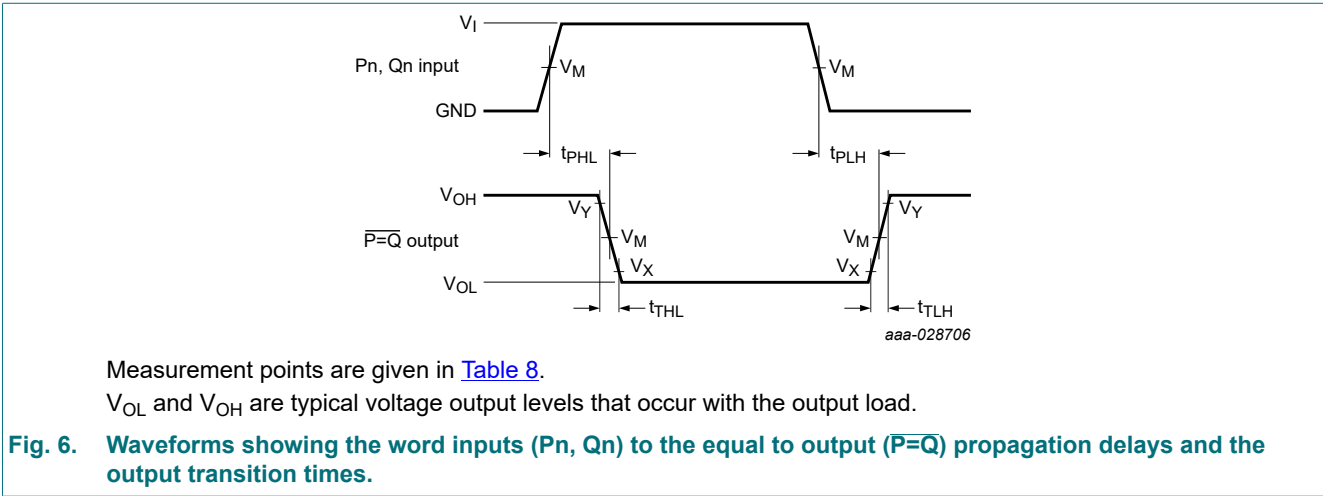


Table 8. Measurement points

| Input | | Output | | |
|-----------------|-------------|-------------|-------------|-------------|
| V_I | V_M | V_M | V_X | V_Y |
| GND to V_{CC} | $0.5V_{CC}$ | $0.5V_{CC}$ | $0.1V_{CC}$ | $0.9V_{CC}$ |

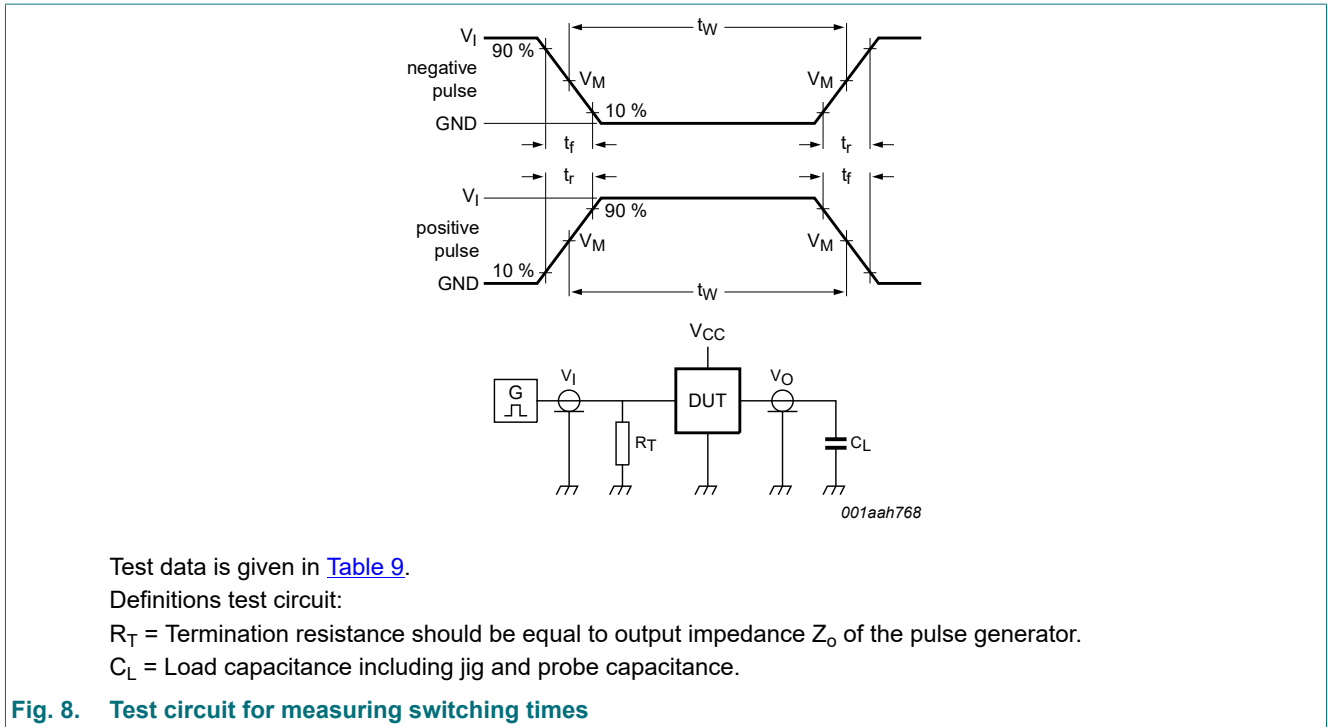
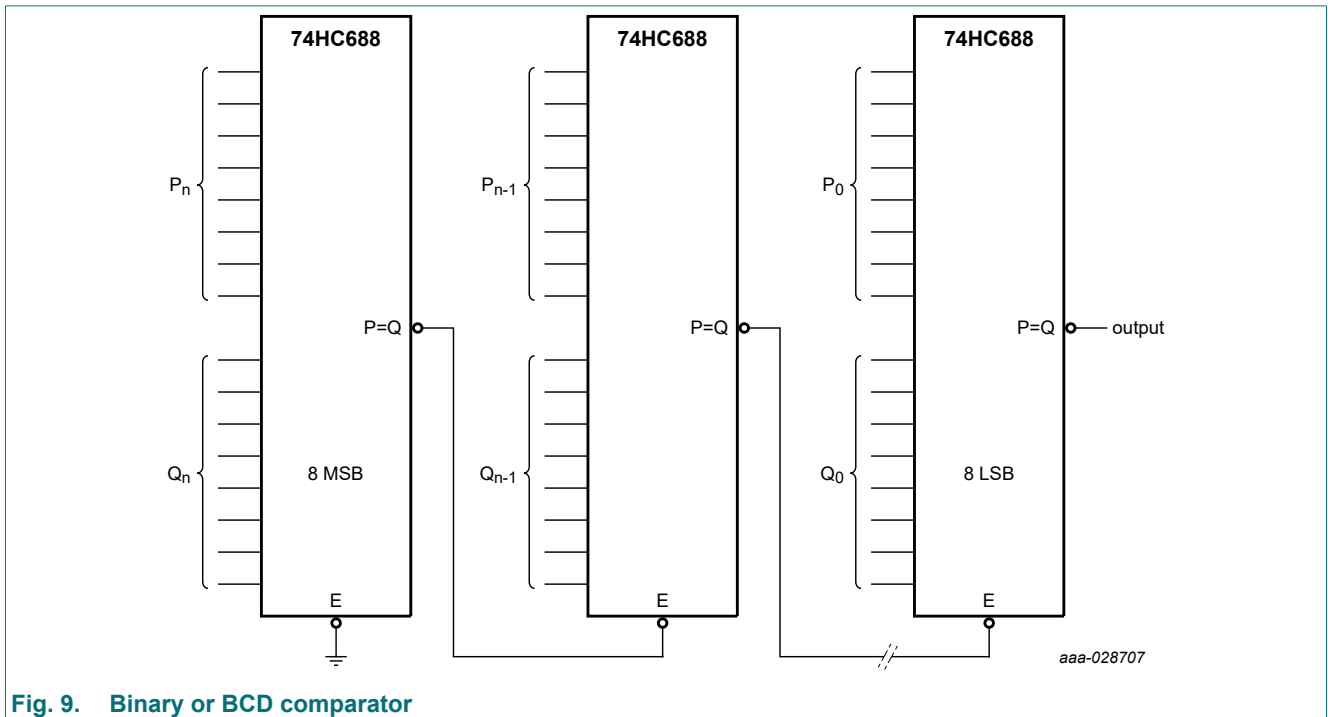


Table 9. Test data

| Input | | Load | Test |
|-----------------|------------|--------------|--------------------|
| V_I | t_r, t_f | C_L | |
| GND to V_{CC} | 6.0 ns | 15 pF, 50 pF | t_{PLH}, t_{PHL} |

11. Application information

Two or more 74HC688 8-bit magnitude comparators may be cascaded to compare binary or BCD numbers of more than 8 bits. An example is shown in [Fig. 9](#).



12. Package outline

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

SOT163-1

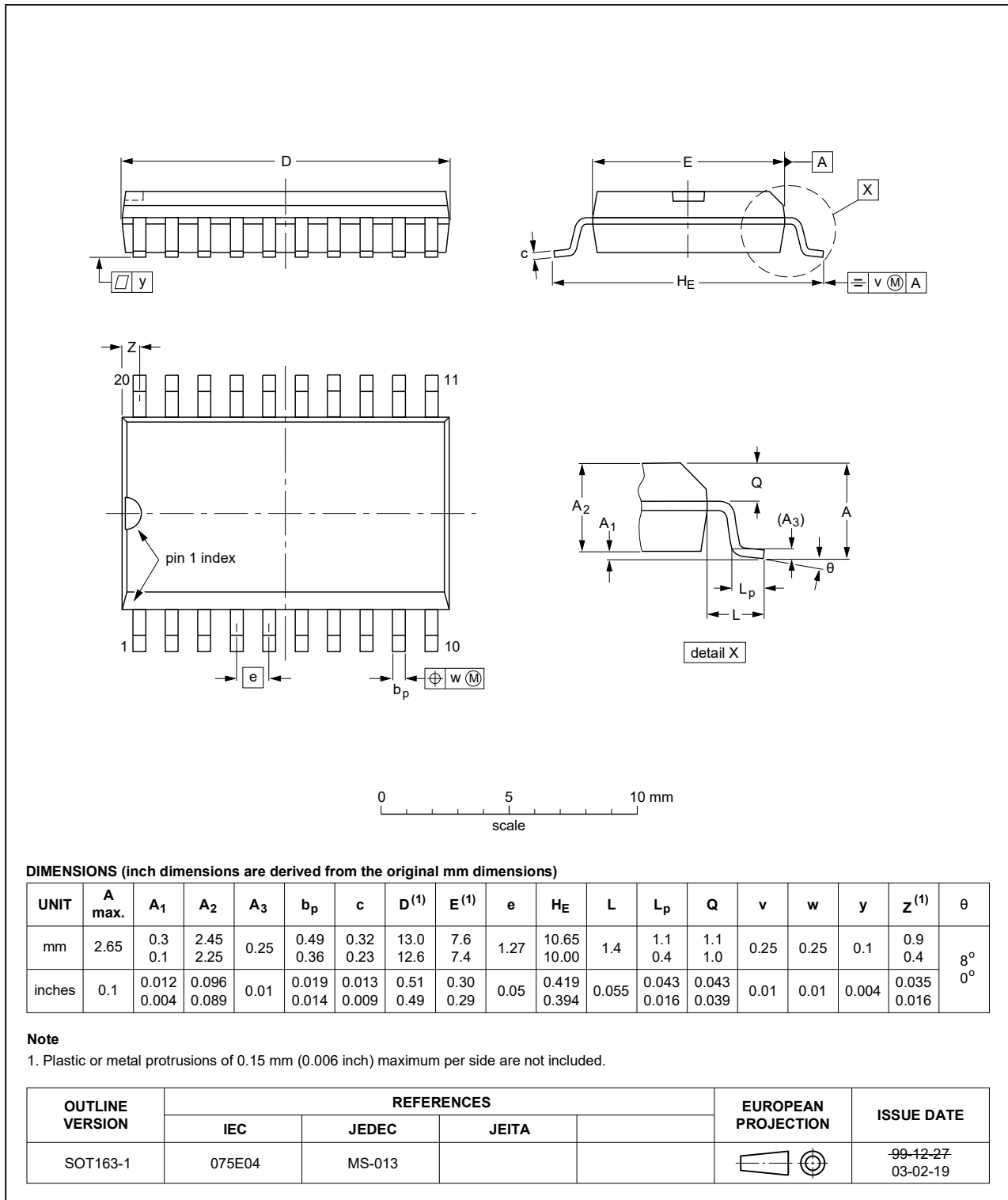


Fig. 10. Package outline SOT163-1 (SO20)

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

SOT360-1

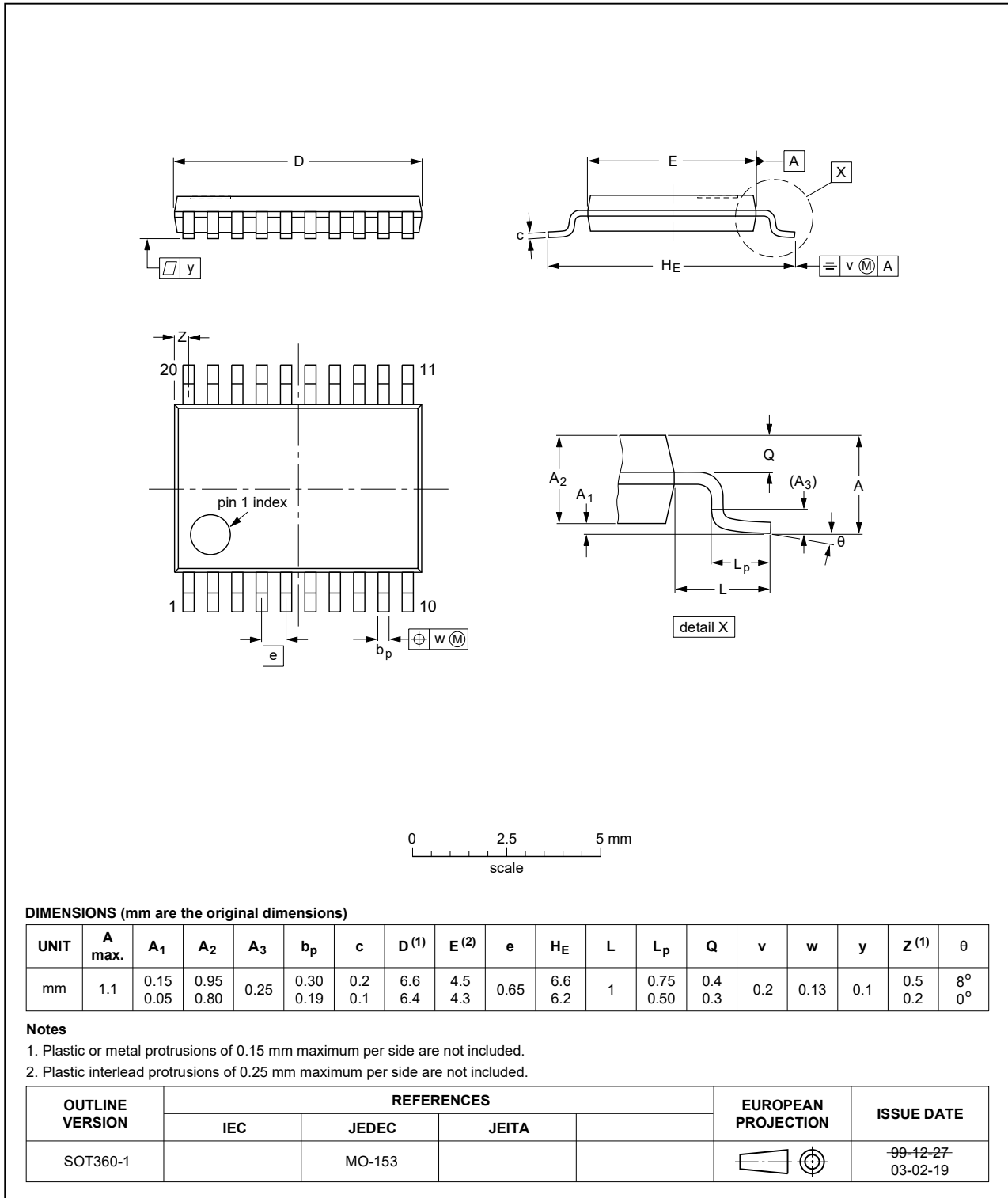


Fig. 11. Package outline SOT360-1 (TSSOP20)

13. Abbreviations

Table 10. Abbreviations

| Acronym | Description |
|---------|---|
| CMOS | Complementary Metal-Oxide Semiconductor |
| DUT | Device Under Test |
| ESD | ElectroStatic Discharge |
| HBM | Human Body Model |
| MM | Machine Model |

14. Revision history

Table 11. Revision history

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|-----------------|--|-----------------------|---------------|-----------------|
| 74HC688 v.4 | 20210716 | Product data sheet | - | 74HC688 v.3 |
| Modifications: | <ul style="list-style-type: none"> Type number 74HC688DB (SOT339-1/SSOP20) removed. Section 2 updated. Section 7: Derating values for P_{tot} total power dissipation updated. | | | |
| 74HC688 v.3 | 20180704 | Product data sheet | - | 74HC_HCT688 v.2 |
| Modifications: | <ul style="list-style-type: none"> The format of this data sheet has been redesigned to comply with the identity guidelines of Nexperia. Legal texts have been adapted to the new company name where appropriate. Type numbers 74HC688N (SOT146-1), 74HCT688N (SOT146-1) and 74HCT688PW (SOT360-1) removed. | | | |
| 74HC_HCT688 v.2 | 19901201 | Product specification | - | 74HC_HCT688 v.1 |

15. Legal information

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. |
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Date of release: 16 July 2021
