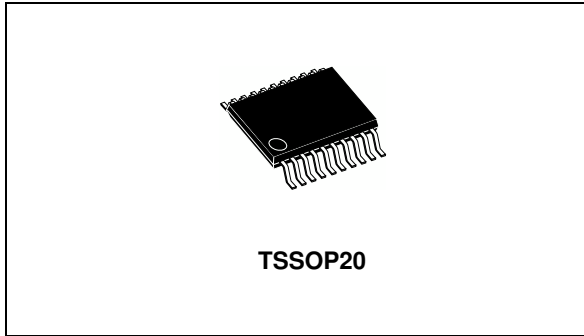


8-bit dual supply 1.71 V to 5.5 V level translator with I/O $V_{CC} \pm 15$ kV ESD protection

Datasheet - production data



Description

The ST2378E device is an 8-bit, dual supply, bidirectional level translator with ± 15 kV ESD protection on I/Os at V_{CC} side. It is designed to interface data transfer between low voltage ASICs/PLDs and higher voltage systems. Externally applied voltage, V_{CC} and V_L , set logic levels at both sides with the range specified as $1.71 \text{ V} \leq V_L \leq 5.5 \text{ V}$ and $V_L \leq V_{CC} \leq 5.5 \text{ V}$. For proper operation, V_{CC} should be set higher than V_L .

Utilizing a transmission-gate-based design, this device allows bidirectional asynchronous data transfer, which means each channel is allowed to have either V_{CC} to V_L or V_L to V_{CC} data transfer direction independently and no direction pin is required. The ST2378E device operates at a guaranteed data rate of 13 Mbps over the entire specified operating voltage range.

Among the other features, the OE pin allows disable mode operation whereby current consumption is reduced to less than $1 \mu\text{A}$.

Features

- High speed
 - $t_{PD} = 15 \text{ ns}$ (max.) at $T_A = 85 \text{ }^\circ\text{C}$
 - $V_L = 1.8 \text{ V}$
 - $V_{CC} = 5.5 \text{ V}$
- Guaranteed data rate
 - 13 Mbps ($1.8 \text{ V} \leq V_L \leq V_{CC} \leq 5.5 \text{ V}$)
- Low power dissipation
 - $I_{TS-VL} = I_{TS-VCC} = 1 \mu\text{A}$ (max.) at $T_A = 85 \text{ }^\circ\text{C}$
 - $I_{QVL} = 100 \mu\text{A}$ (max.) at $T_A = 85 \text{ }^\circ\text{C}$
 - $I_{QCC} = 10 \mu\text{A}$ (max.) at $T_A = 85 \text{ }^\circ\text{C}$
- Output impedance
 - $|I_{OHA}| = 20 \mu\text{A}$ (min.) at $V_L = 1.8 \text{ V}; V_{CC} = 5.5 \text{ V}$
 - $I_{OLA} = 1.0 \mu\text{A}$ (min.) at $V_L = 1.8 \text{ V}; V_{CC} = 5.5 \text{ V}$
- Bidirectional level translation
- Totem pole and open drain driving for I²C communications
- 5 V tolerant on enable pin
- Wide operating voltage range
 - V_L (opr.) = 1.71 V to V_{CC}
 - V_{CC} (opr.) = 1.71 V to 5.5 V
- ESD performance
- HBM > 15 kV ESD protection on I/O V_{CC} lines
- TSSOP package

Table 1. Device summary

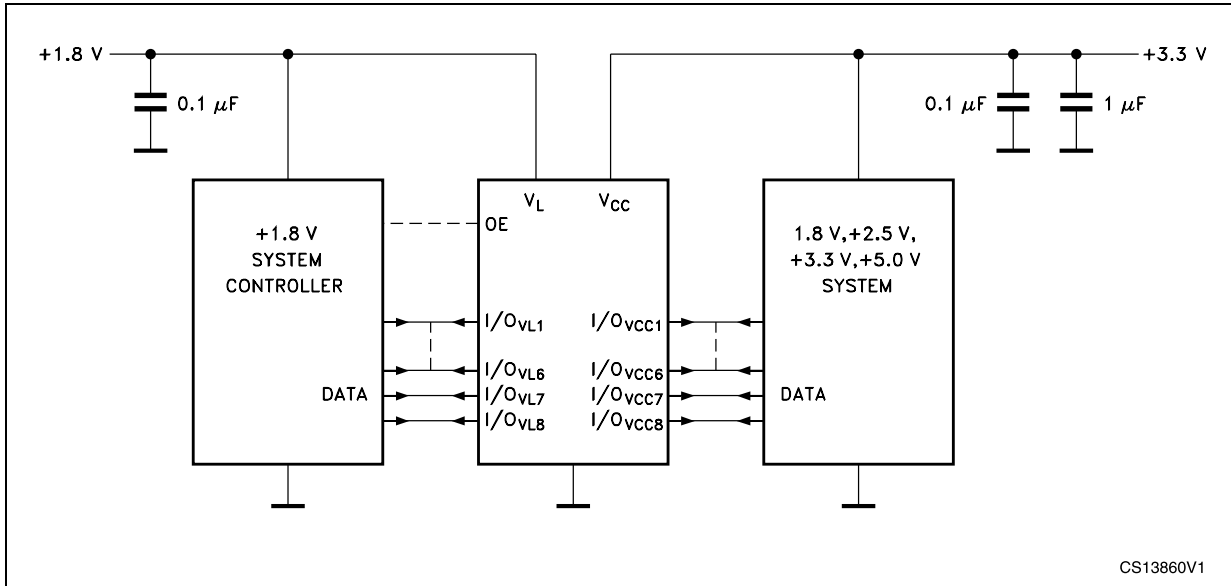
| Part number | Temp. range (°C) | Package | Marking |
|-------------|------------------|---------|---------|
| ST2378ETTR | -40 to 85 | TSSOP20 | ST2378E |

Contents

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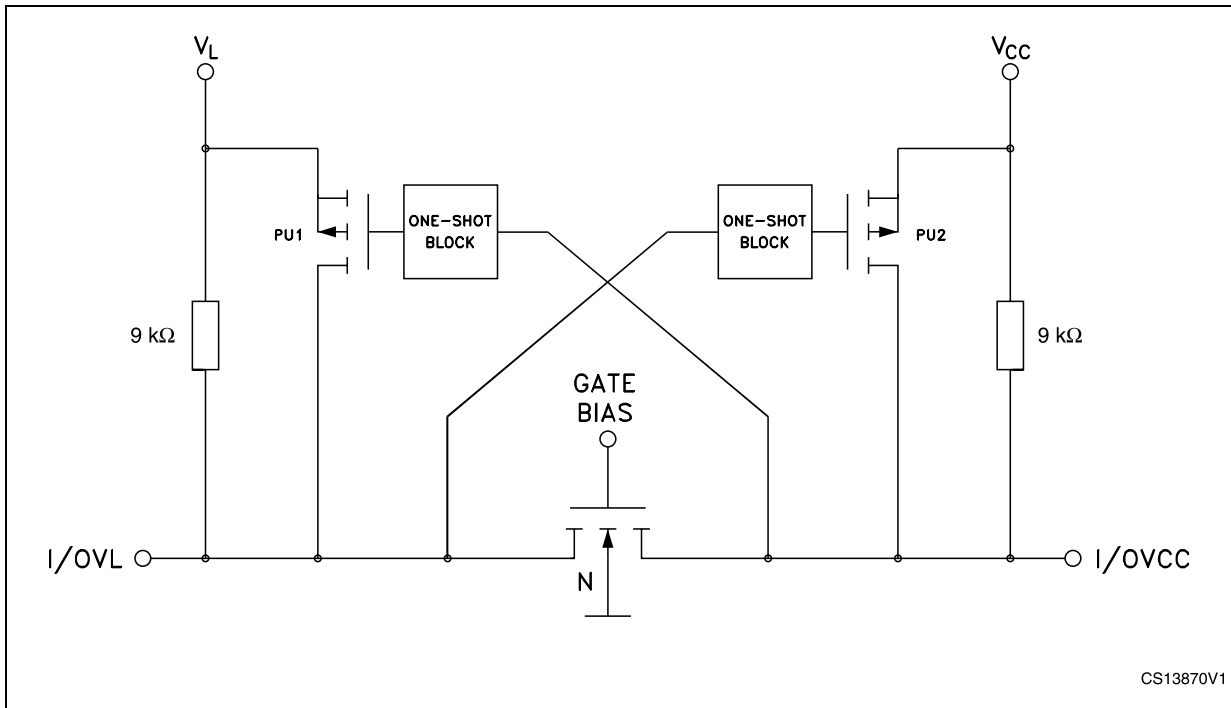
1 Block diagram

Figure 1. Block diagram



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Figure 2. Functional diagram (1 I/O line)

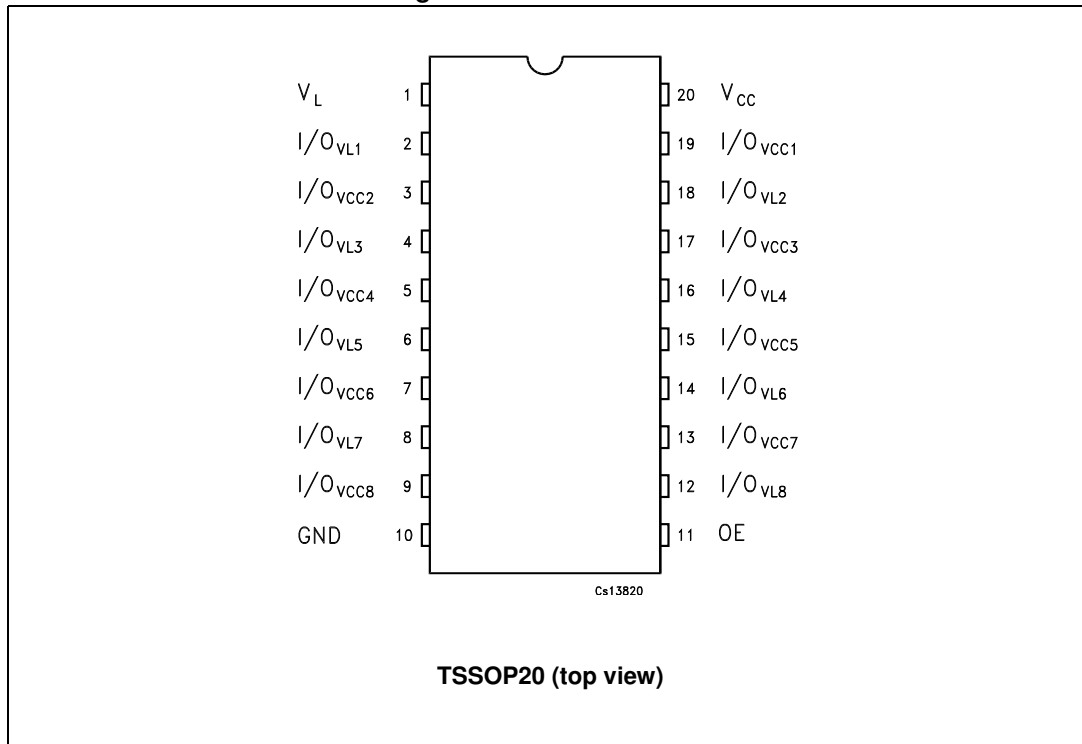


CS13870V1

2 Pin settings

2.1 Pin connection

Figure 3. Pin connection



2.2 Pin description

Table 2. Pin description

| TSSOP20 pin N° | Symbol | Name and function |
|----------------------------|--|-------------------------|
| 2, 18, 4, 16, 6, 14, 8, 12 | I/O _{VL1} to I/O _{VL8} | Data inputs/outputs |
| 19, 3, 17, 5, 15, 7, 13, 9 | I/O _{VCC1} to I/O _{VCC8} | Data inputs/outputs |
| 11 | OE | Output enable inputs |
| 10 | GND | Ground (0 V) |
| 1 | V _L | Positive supply voltage |
| 20 | V _{CC} | Positive supply voltage |

3 Electrical data

3.1 Maximum ratings

Table 3. Absolute maximum rating

| Symbol | Parameter | Value | Unit |
|--------------|--|------------------------|------|
| V_L | Supply voltage | -0.3 to V_{CC} | V |
| V_{CC} | Supply voltage | -0.3 to +7.0 | V |
| V_{OE} | DC control input voltage | -0.3 to +7.0 | V |
| $V_{I/OVL}$ | DC I/O_{VL} input voltage (OE = GND or V_L) | -0.3 to $V_L + 0.3$ | V |
| $V_{I/OVCC}$ | DC I/O_{VCC} input voltage (OE = GND or V_L) | -0.3 to $V_{CC} + 0.3$ | V |
| I_{IK} | DC input diode current (OE control pin) | - 20 | mA |
| I_{IOVL} | DC output current | ± 25 | mA |
| I_{IOVCC} | DC output current | ± 25 | mA |
| I_{SCTOUT} | Short-circuit duration I/O_{VL} , I/O_{VCC} driven from 40 mA source | Continuous | mA |
| I_{CCB} | DC V_{CC} or ground current | ± 100 | mA |
| P_d | Power dissipation ⁽¹⁾ | 500 | mW |
| T_{stg} | Storage temperature | -65 to +150 | °C |
| T_L | Lead temperature (10 sec.) | 300 | °C |

1. 500 mW: \cong 65 °C derated to 300 mW by 10 mW/°C: 65 °C to 85 °C.

3.2 Recommended operating conditions

Table 4. Recommended operating conditions

| Symbol | Parameter | Value | Unit | |
|--------------|---|-----------------------------|---------|------|
| V_L | Supply voltage | 1.71 to V_{CC} | V | |
| V_{CC} | Supply voltage | 1.71 to 5.5 | V | |
| V_I | Input voltage (OE output enable pin, V_L power supply referred) | 0 to 5.5 | V | |
| $V_{I/OVL}$ | I/O_{VL} voltage | 0 to V_L | V | |
| $V_{I/OVCC}$ | I/O_{VCC} voltage | 0 to V_{CC} | V | |
| T_{op} | Operating temperature | -40 to 85 | °C | |
| dt/dv | Input rise and fall time (OE control pin) ⁽¹⁾ | 0 to 10 | ns/V | |
| dt/dv | Input rise and fall time ⁽²⁾ | $1.71 < V_L < V_{CC} < 5 V$ | 0 to 10 | ns/V |
| | | $V_{CC} = V_L = 5 V$ | 0 to 3 | ns/V |

1. V_{OE} from 10% V_L to 90% V_L .

2. V_{IOVL} from 10% V_L to 90% V_L ; V_{IOVCC} from 10% V_{CC} to 90% V_{CC} .

4 Electrical characteristics

Table 5. DC specification

| Symbol | Parameter | Test condition ⁽¹⁾ | | | Value | | | | | Unit |
|--------------------|--|-----------------------------------|------------------------------------|---|------------------------|---------------------|---------------------|----------------------|---------------------|------|
| | | V _L (V) ⁽²⁾ | V _{CC} (V) ⁽²⁾ | | T _A = 25 °C | | | -40 to 85 °C | | |
| | | | | | Min. | Typ. ⁽³⁾ | Max. | Min. | Max. | |
| V _{IHL} | High level input voltage (I/O _{VL}) | 1.8 | V _L to 5.5 | | V _L -0.2 | | | V _L -0.2 | | V |
| | | 2.5 | V _L to 5.5 | | 0.75 V _L | | | 0.75 V _L | | |
| | | 3.3 | V _L to 5.5 | | 0.75 V _L | | | 0.75 V _L | | |
| | | 5.0 | V _L to 5.5 | | 0.75 V _L | | | 0.75 V _L | | |
| V _{ILL} | Low level input voltage (I/O _{VL}) | 1.8 | V _L to 5.5 | | | | 0.15 | | 0.15 | V |
| | | 2.5 | V _L to 5.5 | | | | 0.30 | | 0.30 | |
| | | 3.3 | V _L to 5.5 | | | | 0.30 | | 0.30 | |
| | | 5.0 | V _L to 5.5 | | | | 0.30 | | 0.30 | |
| V _{IHC} | High level input voltage (I/O _{VCC}) | 1.8 | V _L to 5.5 | | V _L -0.2 | | | V _L -0.2 | | V |
| | | 2.5 | V _L to 5.5 | | 0.75 V _{CC} | | | 0.75 V _{CC} | | |
| | | 3.3 | V _L to 5.5 | | 0.75 V _{CC} | | | 0.75 V _{CC} | | |
| | | 5.0 | V _L to 5.5 | | 0.75 V _{CC} | | | 0.75 V _{CC} | | |
| V _{ILC} | Low level input voltage (I/O _{VCC}) | 1.8 | V _L to 5.5 | | | | 0.15 | | 0.15 | V |
| | | 2.5 | V _L to 5.5 | | | | 0.30 | | 0.30 | |
| | | 3.3 | V _L to 5.5 | | | | 0.30 | | 0.30 | |
| | | 5.0 | V _L to 5.5 | | | | 0.30 | | 0.30 | |
| V _{IH-TS} | High level input voltage (OE) | 1.8 | V _L to 5.5 | | V _L -0.2 | | | V _L -0.2 | | V |
| | | 2.5 | V _L to 5.5 | | 0.75 V _L | | | 0.75 V _L | | |
| | | 3.3 | V _L to 5.5 | | 0.75 V _L | | | 0.75 V _L | | |
| | | 5.0 | V _L to 5.5 | | 0.75 V _L | | | 0.75 V _L | | |
| V _{IL-TS} | Low level input voltage (OE) | 1.8 | V _L to 5.5 | | | | 0.15 | | 0.15 | V |
| | | 2.5 | V _L to 5.5 | | | | 0.25 V _L | | 0.25 V _L | |
| | | 3.3 | V _L to 5.5 | | | | 0.25 V _L | | 0.25 V _L | |
| | | 5.0 | V _L to 5.5 | | | | 0.25 V _L | | 0.25 V _L | |
| V _{OHL} | High level output voltage I/O _{VL} | 1.8 to 5.5 | V _L to 5.5 | I _O = -20 μA I/O _{VCC} ≥ V _{CC} - 0.2 | 0.67 V _L | | | 0.67 V _L | | V |
| V _{OLL} | Low level output voltage I/O _{VL} | | | I _O = 1.0 mA I/O _{VCC} ≤ 0.15 V | | | 0.40 | | 0.40 | |

Table 5. DC specification (continued)

| Symbol | Parameter | Test condition ⁽¹⁾ | | | Value | | | | | Unit |
|---------------------|--|-----------------------------------|------------------------------------|--|------------------------|---------------------|------|----------------------|------|------|
| | | V _L (V) ⁽²⁾ | V _{CC} (V) ⁽²⁾ | | T _A = 25 °C | | | -40 to 85 °C | | |
| | | | | | Min. | Typ. ⁽³⁾ | Max. | Min. | Max. | |
| V _{OHC} | High level output voltage I/O _{VCC} | 1.8 to 5.5 | V _L to 5.5 | I _O = -20 μA I/O _{VL} ≥ V _L - 0.2 | 0.67 V _{CC} | | | 0.67 V _{CC} | | V |
| V _{OLC} | Low level output voltage I/O _{VCC} | | | I _O = 1.0 mA I/O _{VL} ≤ 0.15 V | | | 0.40 | | 0.40 | |
| I _{TSL} | Control input leakage current (OE) | 1.8 to 5.5 | V _L to 5.5 | V _I = GND or 5.5 | | | 1 | | 1 | μA |
| I _{TS-LKG} | High impedance input leakage current (I/O _{VL} , I/O _{VCC}) | 1.8 to 5.5 | V _L to 5.5 | OE = GND | | | 1 | | 1 | μA |
| I _{QVCC} | Quiescent supply current V _{CC} | 1.8 to 5.5 | V _L to 5.5 | I/O _{VL} , I/O _{VCC} unconnected | | 0.1 | 1 | | 10 | μA |
| I _{QVL} | Quiescent supply current V _L | 1.8 to 5.5 | V _L to 5.5 | I/O _{VL} , I/O _{VCC} unconnected | | 13 | 20 | | 100 | μA |
| I _{TS-VL} | High impedance mode quiescent supply current V _L | 1.8 to 5.5 | V _L to 5.5 | OE = GND I/O _{VL} = GND to V _L I/O _{VCC} = GND to V _{CC} | | | 1 | | 1 | μA |

1. For normal operation, ensure V_L < (V_{CC} + 0.3 V). During power-up, V_L > (V_{CC} + 0.3 V) will not damage the device.
2. Power supply range: V_L, V_{CC} 1.8 V ± 5%, 2.5 ± 0.2 V, 3.3 ± 0.3 V, 5.0 ± 0.5 V.
3. Typical values are referred to T_A = 25 °C.

Table 6. AC electrical characteristics (totem pole driving)

| Symbol | Parameter | Test condition ⁽¹⁾ | | Value | | | Unit | |
|-----------------------|---|---|------------------------------------|---------------|---------------------|------|------|----|
| | | C _L = 15 pF, t _r = t _f ≤ 6 ns ⁽²⁾ Driver output R _T ≤ 50 Ω | | -40 to +85 °C | | | | |
| | | V _L (V) ⁽³⁾ | V _{CC} (V) ⁽³⁾ | Min. | Typ. ⁽⁴⁾ | Max. | | |
| t _{RVCC} | Rise time I/O _{VCC} ⁽⁵⁾ | 1.8 | 1.8 | | 11 | 15 | ns | |
| | | 1.8 | 2.5 | | 11 | 15 | | |
| | | 1.8 | 3.3 | | 10 | 15 | | |
| | | 1.8 | 5.0 | | 9 | 15 | | |
| | | 2.5 | 3.3 | | 8 | 15 | | |
| t _{FVCC} | Fall time I/O _{VCC} ⁽⁵⁾ | 1.8 | 1.8 | | 6 | 15 | ns | |
| | | 1.8 | 2.5 | | 7 | 15 | | |
| | | 1.8 | 3.3 | | 8 | 15 | | |
| | | 1.8 | 5.0 | | 10 | 15 | | |
| | | 2.5 | 3.3 | | 6 | 15 | | |
| t _{RVL} | Rise time I/O _{VL} ⁽⁵⁾ | 1.8 | 1.8 | | 12 | 15 | ns | |
| | | 1.8 | 2.5 | | 10 | 15 | | |
| | | 1.8 | 3.3 | | 9 | 15 | | |
| | | 1.8 | 5.0 | | 10 | 15 | | |
| | | 2.5 | 3.3 | | 7 | 15 | | |
| t _{FVL} | Fall time I/O _{VL} ⁽⁵⁾ | 1.8 | 1.8 | | 7 | 15 | ns | |
| | | 1.8 | 2.5 | | 6 | 15 | | |
| | | 1.8 | 3.3 | | 6 | 15 | | |
| | | 1.8 | 5.0 | | 7 | 15 | | |
| | | 2.5 | 3.3 | | 4 | 15 | | |
| t _{IOVL-VCC} | Propagation delay time ⁽⁶⁾ I/O _{VL-LH} to I/O _{VCC-LH} I/O _{VL-HL} to I/O _{VCC-HL} | t _{PLH} | 1.8 | 1.8 | | 6 | 15 | ns |
| | | | 1.8 | 2.5 | | 7 | 15 | |
| | | | 1.8 | 3.3 | | 7 | 15 | |
| | | | 1.8 | 5.0 | | 7 | 15 | |
| | | | 2.5 | 3.3 | | 4 | 15 | |
| | | t _{PHL} | 1.8 | 1.8 | | 5 | 15 | |
| | | | 1.8 | 2.5 | | 5 | 15 | |
| | | | 1.8 | 3.3 | | 6 | 15 | |
| | | | 1.8 | 5.0 | | 8 | 15 | |
| | | | 2.5 | 3.3 | | 4 | 15 | |

Table 6. AC electrical characteristics (totem pole driving) (continued)

| Symbol | Parameter | Test condition ⁽¹⁾ | | Value | | | Unit | |
|--|---|--|------------------------------------|---------------|---------------------|------|------|----|
| | | C _L = 15 pF, t _r = t _f ≤ 6 ns ⁽²⁾ Driver output R _T ≤ 50 Ω | | -40 to +85 °C | | | | |
| | | V _L (V) ⁽³⁾ | V _{CC} (V) ⁽³⁾ | Min. | Typ. ⁽⁴⁾ | Max. | | |
| t _{IOVCC-VL} | Propagation delay time ⁽⁶⁾ I/O _{VCC-LH} to I/O _{VL-LH} I/O _{VCC-HL} to I/O _{VL-HL} | t _{PLH} | 1.8 | 1.8 | | 2 | 15 | ns |
| | | | 1.8 | 2.5 | | 2 | 15 | |
| | | | 1.8 | 3.3 | | 2 | 15 | |
| | | | 1.8 | 5.0 | | 2 | 15 | |
| | | | 2.5 | 3.3 | | 2 | 15 | |
| | | t _{PHL} | 1.8 | 1.8 | | 5 | 15 | |
| | | | 1.8 | 2.5 | | 5 | 15 | |
| | | | 1.8 | 3.3 | | 5 | 15 | |
| | | | 1.8 | 5.0 | | 6 | 15 | |
| | | | 2.5 | 3.3 | | 4 | 15 | |
| t _{PZL} t _{PZH} t _{PLZ} t _{PZL} | Output enable and disable time | 1.8 | 1.8 | | 60 | 80 | ns | |
| 1.8 | 5.0 | | 150 | 200 | | | | |
| t _{OSLH} t _{OSHL} | Channel to channel skew time ^{(7), (8)} | 1.8 | 1.8 | | 0.1 | 1 | ns | |
| 1.8 | 5.0 | | 0.5 | 1 | | | | |
| DR | Maximum data rate | 1.8 to 5.0 | V _L to 5.0 | 13 | | | Mbps | |

1. For normal operation, ensure V_L < (V_{CC} + 0.3 V). During power-up, V_L > (V_{CC} + 0.3 V) will not damage the device.
2. For V_{CC} = V_L = 1.8 V, t_r = t_f ≤ 4 ns.
3. Power supply range: V_L, V_{CC} 1.8 V ± 5%, 2.5 ± 0.2 V, 3.3 ± 0.3 V, 5.0 ± 0.5 V.
4. Typical values are referred to T_A = 25 °C.
5. Rise time: 10% to 90%, fall time 90% to 10%.
6. Propagation delay time: 50% to 50%.
7. Skew is defined as the absolute value of the difference between the actual propagation delay for any two outputs of the same device switching in the same direction, either HIGH or LOW (t_{OSLH} = |t_{PLHm} - t_{PLHn}|; t_{OSHL} = |t_{PHLm} - t_{PHLn}|).
8. Each translator equally loaded; parameter guaranteed by design.

Table 7. AC characteristic (open drain driving)

| Symbol | Parameter | | Test condition ⁽¹⁾ | | Value | | | Unit | |
|--|---|--|--|------------------------------------|---------------|---------------------|------|------|----|
| | | | C _L = 15 pF, t _r = t _f ≤ 6 ns ⁽²⁾ Driver output R _T ≤ 50 Ω | | -40 to +85 °C | | | | |
| | | | V _L (V) ⁽³⁾ | V _{CC} (V) ⁽³⁾ | Min. | Typ. ⁽⁴⁾ | Max. | | |
| t _{RVCC} | Rise time I/O _{VCC} ⁽⁵⁾ | | 1.8 | 1.8 | | 210 | 300 | ns | |
| | | | 1.8 | 5.0 | | 59 | 150 | | |
| t _{FVCC} | Fall time I/O _{VCC} ⁽⁵⁾ | | 1.8 | 1.8 | | 12 | 30 | ns | |
| | | | 1.8 | 5.0 | | 20 | 30 | | |
| t _{RVL} | Rise time I/O _{VL} ⁽⁵⁾ | | 1.8 | 1.8 | | 210 | 300 | ns | |
| | | | 1.8 | 5.0 | | 96 | 150 | | |
| t _{FVL} | Fall time I/O _{VL} ⁽⁵⁾ | | 1.8 | 1.8 | | 11 | 30 | ns | |
| | | | 1.8 | 5.0 | | 11 | 30 | | |
| t _{IOVL-VCC} | Propagation delay time ⁽⁶⁾ I/O _{VL} -LH to I/O _{VCC} -LH I/O _{VL} -HL to I/O _{VCC} -HL | | t _{PLH} | 1.8 | 1.8 | | 210 | 300 | ns |
| | | | | 1.8 | 5.0 | | 100 | 150 | |
| | | | t _{PHL} | 1.8 | 1.8 | | 7 | 20 | |
| | | | | 1.8 | 5.0 | | 14 | 20 | |
| t _{IOVCC-VL} | Propagation delay time ⁽⁶⁾ I/O _{VCC} -LH to I/O _{VL} -LH I/O _{VCC} -HL to I/O _{VL} -HL | | t _{PLH} | 1.8 | 1.8 | | 210 | 300 | ns |
| | | | | 1.8 | 5.0 | | 57 | 150 | |
| | | | t _{PHL} | 1.8 | 1.8 | | 7 | 20 | |
| | | | | 1.8 | 5.0 | | 8 | 20 | |
| t _{PZL} t _{PZH} t _{PLZ} t _{PZL} | Output enable and disable time | | 1.8 | 1.8 | | 60 | 80 | ns | |
| | | | 1.8 | 5.0 | | 150 | 200 | | |
| t _{OSLH} t _{OShL} | Channel to channel skew time ^{(7), (8)} | | 1.8 | 1.8 | | 10 | 20 | ns | |
| | | | 1.8 | 5.0 | | 2 | 10 | | |
| DR | Maximum data rate | | 1.8 to 5.0 | V _L to 5.0 | 800 | | | kbps | |

- For normal operation, ensure V_L < (V_{CC} + 0.3 V). During power-up, V_L > (V_{CC} + 0.3 V) will not damage the device.
- For V_{CC} = V_L = 1.8 V, t_r = t_f ≤ 4 ns.
- Power supply range: V_L, V_{CC} 1.8 V ± 5%, 2.5 ± 0.2 V, 3.3 ± 0.3 V, 5.0 ± 0.5 V.
- Typical values are referred to T_A = 25 °C.
- Rise time: 10% to 90%, fall time 90% to 10%.
- Propagation delay time: 50% to 50%.
- Skew is defined as the absolute value of the difference between the actual propagation delay for any two outputs of the same device switching in the same direction, either HIGH or LOW (t_{OSLH} = |t_{PLHm} - t_{PLHn}|, t_{OShL} = |t_{PHLm} - t_{PHLn}|).
- Each translator equally loaded; parameter guaranteed by design.



5 Test circuit

Figure 4. Test circuit

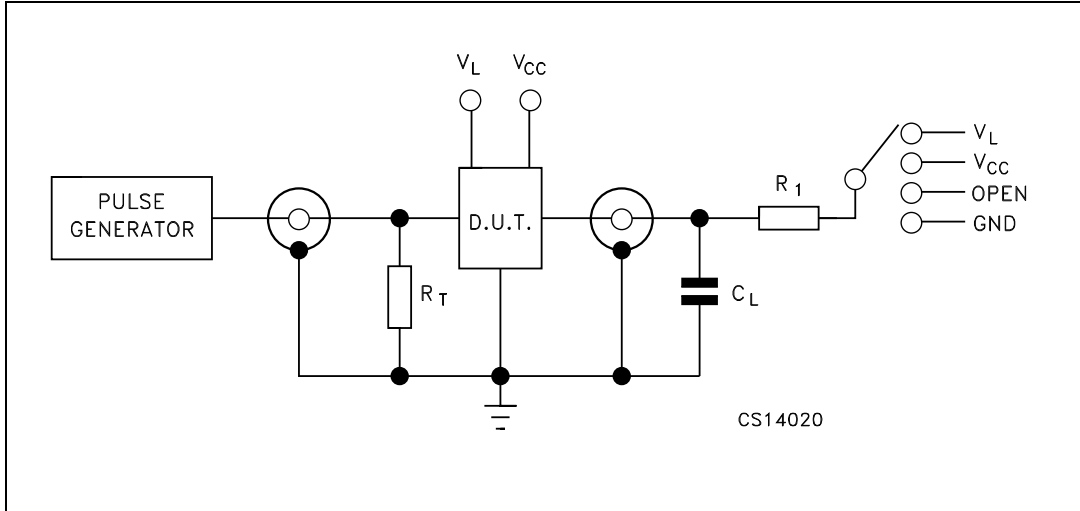


Table 8. Test circuit switches

| Test | Switch | | |
|-------------------------------------|--------------------------------------|---------------------------------------|--------------------|
| | Driving I/O _{V_L} | Driving I/O _{V_{CC}} | Open drain driving |
| t _{PLH} , t _{PHL} | Open | Open | Open |
| t _{PZL} , t _{PLZ} | V _{CC} | V _L | - |
| t _{PZH} , t _{PHZ} | GND | GND | - |

Note: C_L = 15/50 pF or equivalent (includes jig and probe capacitance).
 R₁ = 1 kΩ or equivalent.
 R_T = Z_{OUT} of pulse generator (typically 50 Ω).

Table 9. Truth table

| Control pin | Bidirectional input/outputs | |
|------------------|------------------------------|-------------------------------|
| OE | I/O _{V_L} | I/O _{V_{CC}} |
| H ⁽¹⁾ | H ⁽¹⁾ | H ⁽²⁾ |
| H ⁽¹⁾ | L | L |
| L | Z | Z |

1. High level V_L power supply referred.
2. High level V_{CC} power supply referred.

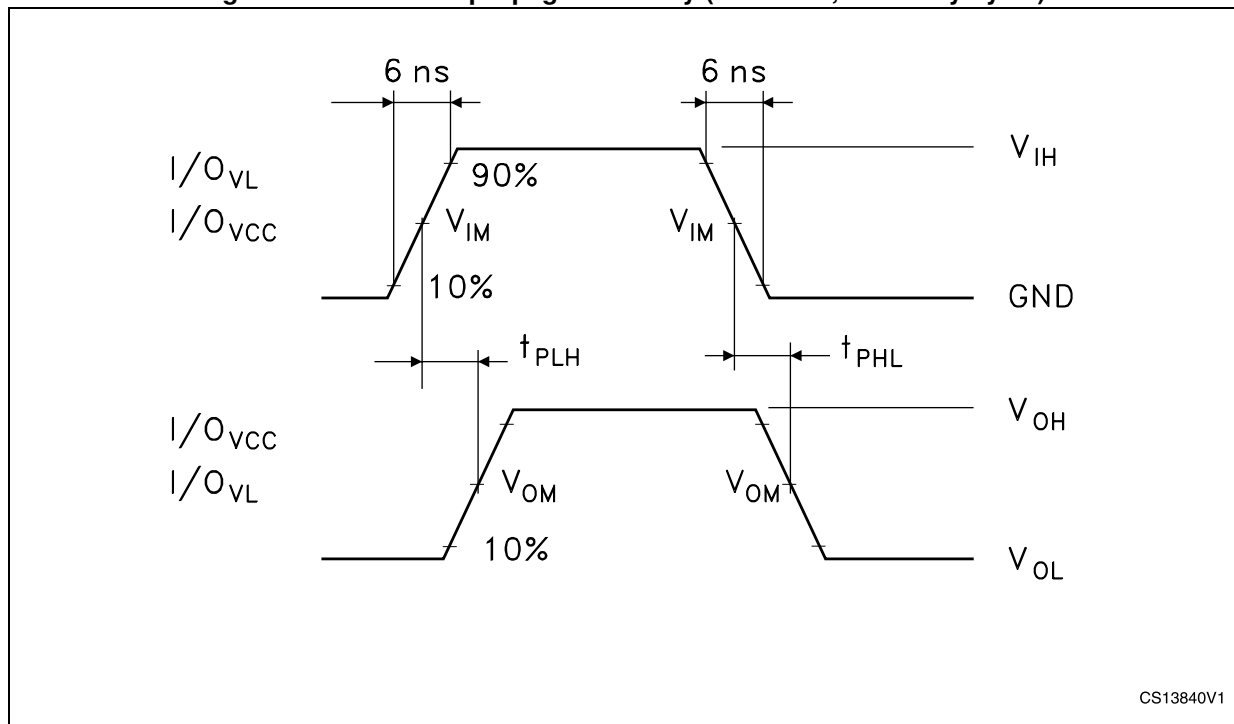
Note: X = do not care; Z = high impedance.

6 Waveforms

Table 10. Waveform symbol value

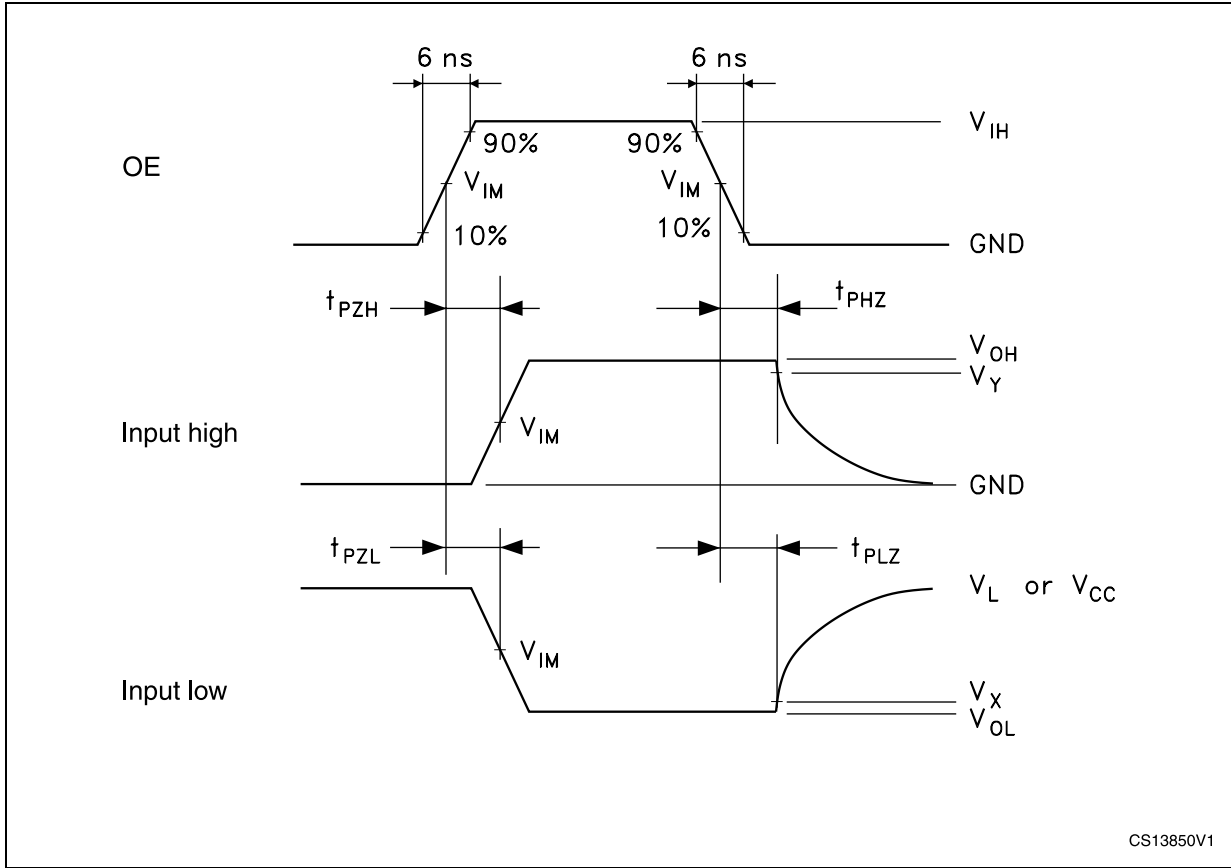
| Symbol | Driving I/O _{VL} | | Driving I/O _{VCC} | |
|-----------------|--|--|--|--|
| | 1.8 V ≤ V _L ≤ V _{CC} ≤ 2.5 V | 3.3 V ≤ V _L ≤ V _{CC} ≤ 5.0 V | 1.8 V ≤ V _L ≤ V _{CC} ≤ 2.5 V | 3.3 V ≤ V _L ≤ V _{CC} ≤ 5.0 V |
| V _{IH} | V _L | V _L | V _{CC} | V _{CC} |
| V _{IM} | 50% V _L | 50% V _L | 50% V _{CC} | 50% V _{CC} |
| V _{OM} | 50% V _{CC} | 50% V _{CC} | 50% V _{CC} | 50% V _{CC} |
| V _X | V _{OL} + 0.15 V | V _{OL} + 0.3 V | V _{OL} + 0.15 V | V _{OL} + 0.3 V |
| V _Y | V _{OH} - 0.15 V | V _{OH} - 0.3 V | V _{OH} - 0.15 V | V _{OH} - 0.3 V |

Figure 5. Waveform - propagation delay (f = 1 MHz; 50% duty cycle)



CS13840V1

Figure 6. Waveform - output enable and disable time (f = 1 MHz; 50% duty cycle)

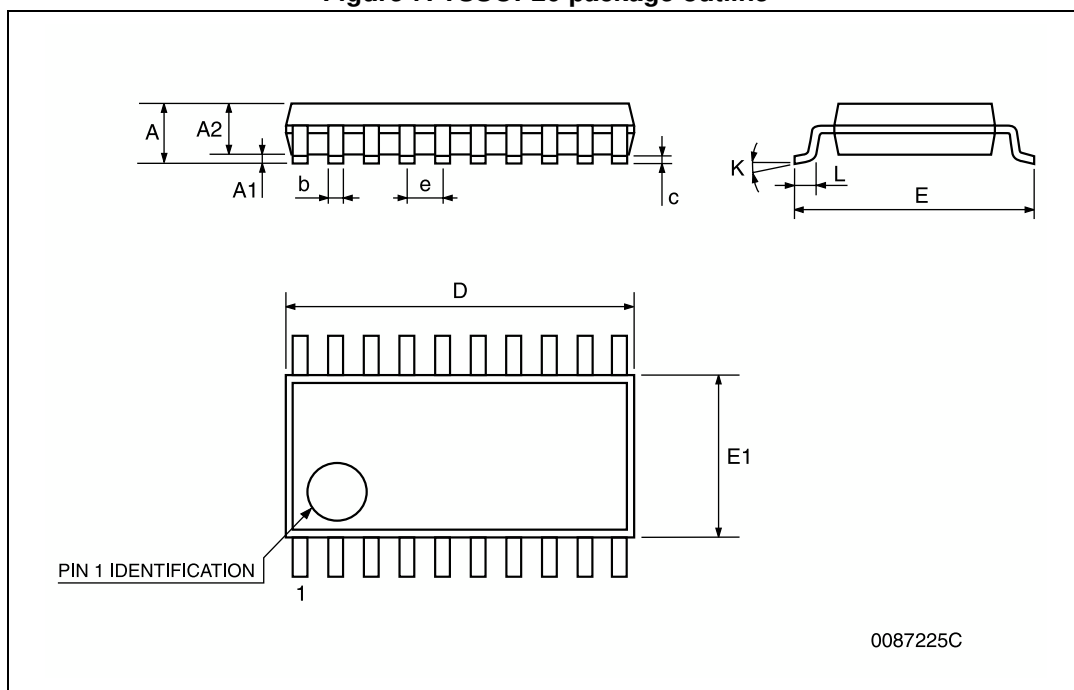


7 Package information

In order 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.

7.1 TSSOP20 package information

Figure 7. TSSOP20 package outline



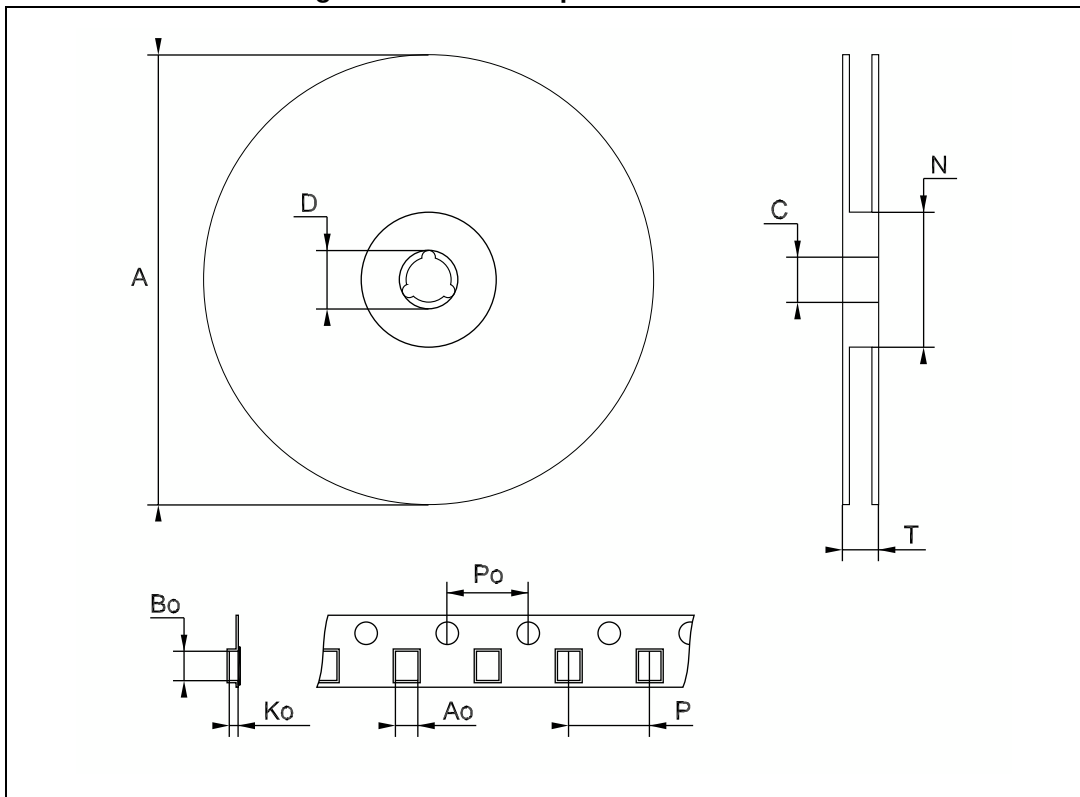
0087225C

Table 11. TSSOP20 package mechanical data

| Symbol | Dimensions | | | | | |
|--------|------------|----------|------|-------|------------|--------|
| | mm | | | inch | | |
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | | 1.2 | | | 0.047 |
| A1 | 0.05 | | 0.15 | 0.002 | 0.004 | 0.006 |
| A2 | 0.8 | 1 | 1.05 | 0.031 | 0.039 | 0.041 |
| b | 0.19 | | 0.30 | 0.007 | | 0.012 |
| c | 0.09 | | 0.20 | 0.004 | | 0.0079 |
| D | 6.4 | 6.5 | 6.6 | 0.252 | 0.256 | 0.260 |
| E | 6.2 | 6.4 | 6.6 | 0.244 | 0.252 | 0.260 |
| E1 | 4.3 | 4.4 | 4.48 | 0.169 | 0.173 | 0.176 |
| e | | 0.65 BSC | | | 0.0256 BSC | |
| K | 0° | | 8° | 0° | | 8° |
| L | 0.45 | 0.60 | 0.75 | 0.018 | 0.024 | 0.030 |

7.2 TSSOP20 packing information

Figure 8. TSSOP20 tape and reel outline



1. Drawing not to scale.

Table 12. TSSOP20 tape and reel mechanical data

| Symbol | Dimensions | | | | | |
|--------|------------|------|------|-------|------|--------|
| | mm | | | inch | | |
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | | 330 | | | 12.992 |
| C | 12.8 | | 13.2 | 0.504 | | 0.519 |
| D | 20.2 | | | 0.795 | | |
| N | 60 | | | 2.362 | | |
| T | | | 22.4 | | | 0.882 |
| Ao | 6.8 | | 7 | 0.268 | | 0.276 |
| Bo | 6.9 | | 7.1 | 0.272 | | 0.280 |
| Ko | 1.7 | | 1.9 | 0.067 | | 0.075 |
| Po | 3.9 | | 4.1 | 0.153 | | 0.161 |
| P | 11.9 | | 12.1 | 0.468 | | 0.476 |

8 Revision history

Table 13. Document revision history

| Date | Revision | Changes |
|-------------|----------|---|
| 10-Apr-2006 | 1 | Initial release. |
| 18-Sep-2012 | 2 | Updated Figure 2 (added resistor values). Updated notes and cross-references of the notes below Table 5 to Table 7, replaced t_{FCC} by t_{FVCC} in Table 6 and Table 7. Updated ECOPACK text in Section 7., reformatted Section 7 (added Table 11 to Table 14, moved note below Figure 8 and Figure 10). Minor corrections throughout document. |
| 18-May-2015 | 3 | Added Table 1: Device summary. Revised presentation of Section 7: Package information. Minor textual updates. |
| 04-Oct-2024 | 4 | Removed the part number ST2378EBJR (flip-chip package) and all its reference throughout the document. |

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