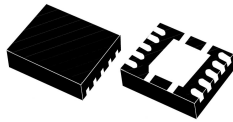


3.3 V RS485 compatible with 1.8 V I/Os and selectable speed 20 Mbps or 250 kbps



DFN10 3 x 3

Features

- Half-duplex RS485 transceiver
- 1.65 V to 3.6 V supply for data and enable signals
- 3 V to 3.6 V supply for bus supply
- High speed: up to 20 Mbps data rate
- Low speed selected by SLR pin : 250 kbps
- Up to 256 transceivers on the bus
- Fail safe receiver (bus open, idle and shorted)
- Thermal shutdown protection
- Low quiescent current in shutdown mode
- Extended temperature range : -40 °C to +105 °C
- Available in industry standard DFN10
- Bus-pin protection more than:
 - ±4 kV HBM protection
 - ±8 kV IEC61000-4-2 contact discharge
 - ±16 kV IEC61000-4-2 air discharge
 - Compliant IEC61000-4-4 fast transient burst Class B

Description

The [STR485](#) is a low power differential line transceiver for data transmission standard RS485 applications in half-duplex mode. Data and enable signals are compatible with 1.8 V or 3.3 V supplies.

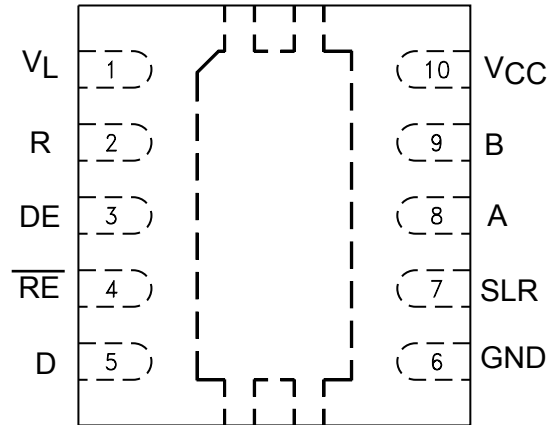
Two speeds are selectable through SLR pin: fast data rate up to 20 Mbps or slow data rate for extended cable running to 250 kbps.

Excessive power dissipation caused by bus contention or faults is prevented by thermal shutdown circuit that forces the driver outputs into a high impedance state. The receiver has a fail-safe feature, which guarantees a high output state when the inputs are left open, shorted or idle.

Product status link

[STR485](#)

1 Pin connections

Figure 1. Pin connections

Table 1. Pin description

| Name | Pin | I/O | Description |
|------|-----|----------------|---|
| VL | 1 | Logic supply | 1.65 V to 3.6 V supply for logic I/O signals |
| R | 2 | Digital output | Receiver data output |
| DE | 3 | Digital input | Driver enable input |
| nRE | 4 | Digital input | Receiver enable input |
| D | 5 | Digital input | Transmission data input |
| GND | 6 | Ground | |
| SLR | 7 | Digital input | Slew rate select: low = 20 Mbps, high = 250 kbps. Default to 20 Mbps if SLR is left floating |
| A | 8 | Bus I/O | Digital bus I/O, A |
| B | 9 | Bus I/O | Digital bus I/O, B |
| VCC | 10 | Bus supply | 3 V to 3.6 V supply for A and B bus lines |

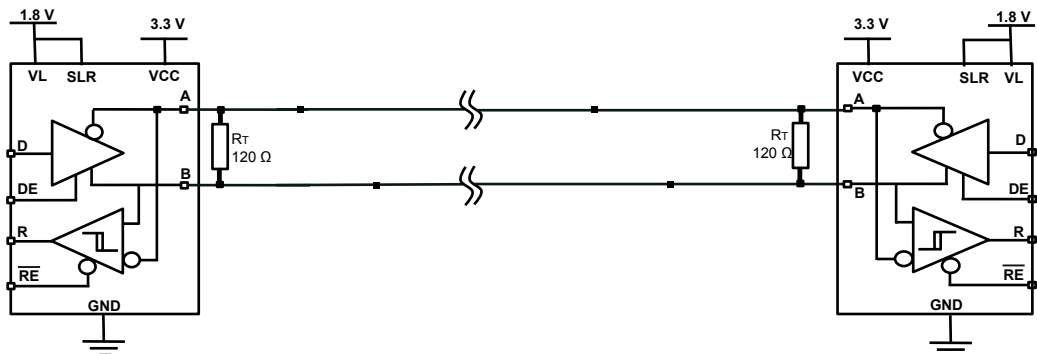
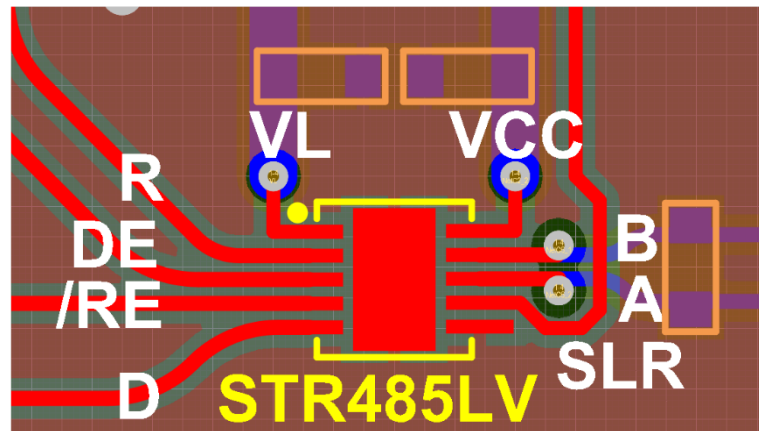
Figure 2. Typical application schematic


Figure 3. Example of implementation in a PCB



Adding an ESDA14V2BP6 or ETP01-2821 ST Microelectronics protection device can help the product to sustain an EFT perturbation level up to 4 kV.

2 Truth tables

The STR485 is a half-duplex differential driver/receiver compliant to the RS485 communication standard (ISO-IEC 8482). This product is perfectly adapted for low voltage application running with a low power supplies VL, generally set to 1.8 V and VCC set to 3.3 V.

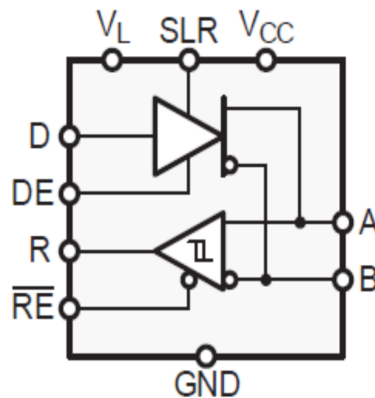
These voltages confer a low power consumption to the product.

SLR is the data rate selection, this pin could be let floating but it is not recommended; in that case the high speed rate is automatically selected.

The SLR pin must be connected to the ground to provide a high speed communication up to 20 Mbps.

When this pin is connected to VL power supply, the data rate is limited to 250 kbps more adapted for very long distance data transmission.

Figure 4. Block diagram



The product is perfectly adapted to run with 256 devices on the same bus thanks to the internal output resistance that is over 96 k Ω up to 105 °C; this resistance follows the RS485 condition that requests a minimum of 12 k Ω for 32 unit loads (UL).

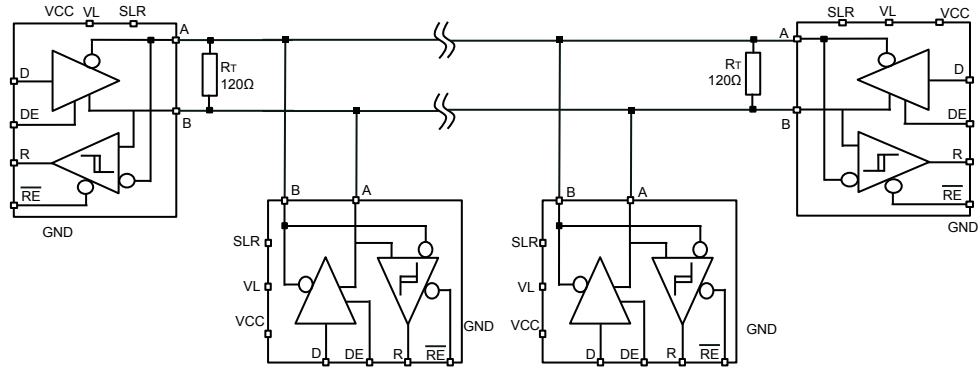
The STR485 has internal protection against ESD that protect each device driver output and receiver input. The limits have been tested up ± 4 kV electrostatic discharge (HBM) and ± 8 kV contact discharge and ± 16 kV air discharge shocks without latch-up.

Another external protections can be used to increase the communication robustness against different perturbation that can be seen on the application.

The power supplies must be well-decoupled by a minimal capacitor of 0.1 μF as closed as possible to the device power supply input. Moreover, the capacitor should be higher on the application with a minimum of 1 μF around the device.

The device operating range is set from VL = 1.65 V to 3.6 V and for VCC = 3.0 V to 3.6 V. In any case VCC must be higher or equal than VL.

The applications should respect this voltage constraints to let the application communication device run to the best conditions.

Figure 5. Example of typical application

Table 2. Driver truth table

| INPUT D | ENABLE DE | OUTPUT A | OUTPUT B | Function |
|---------|-----------|----------|----------|------------------------------------|
| H | H | H | L | Actively drive bus high |
| L | H | L | H | Actively drive bus low |
| X | L | Z | Z | Driver disabled |
| X | Open | Z | Z | Driver disabled by default |
| Open | H | H | L | Actively drive bus high by default |

Table 3. Receiver truth table

| Differential input $V_{ID} = V_A - V_B$ | ENABLE RE | OUTPUT R | Function |
|---|-----------|----------|------------------------------|
| $V_{ID} > V_{IT+}$ | L | H | Receive valid bus high |
| $V_{IT-} < V_{ID} < V_{IT+}$ | L | ? | Indeterminate bus state |
| $V_{ID} < V_{IT-}$ | L | L | Receive valid bus low |
| X | H | Z | Receiver disabled |
| X | OPEN | Z | Receiver disabled by default |
| Open-circuit bus | L | H | Fail safe high output |
| Short-circuit bus | L | H | Fail safe high output |
| Idle (terminated) bus | L | H | Fail safe high output |

Table 4. Speed selection, SLR pin configuration

| SLR | Data rate | Typical t_r / t_f |
|-------------|-----------|---------------------|
| VL | 250 kbps | 200 ns |
| GND or OPEN | 20 Mbps | 7 ns |

3 Absolute maximum ratings and operating conditions

Table 5. Absolute maximum ratings

| Symbol | Parameter | Min. | Max. | Unit |
|-----------|---|------|-----------|------|
| V_L | Control supply voltage | -0.5 | 4 | V |
| V_{CC} | Bus supply voltage | -0.5 | 4.8 | V |
| | Voltage range at A or B inputs | -13 | 13 | V |
| | Input voltage range at any logic pin | -0.3 | $V_L+0.3$ | V |
| | Receiver output current | -12 | 12 | mA |
| T_J | Junction temperature | | 170 | °C |
| T_{stg} | Storage temperature | -65 | 150 | °C |
| ESD | IEC 61000-4-2 ESD (air-gap discharge), bus terminals and GND | | ± 16 | kV |
| | IEC 61000-4-2 ESD (contact discharge), bus terminals and GN | | ± 8 | kV |
| | IEC 61000-4-4 EFT (fast transient or burst) bus terminals and GND | | ± 2 | kV |
| | JEDEC standard 22, test method A114, HBM, all terminals | | ± 4 | kV |
| | JEDEC standard 22, test method C101, (charged device model), all pins | | ± 1.5 | kV |

Note: All voltage values, except the differential voltage, are with respect to network ground terminal.

Table 6. Operating conditions

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|----------|---|------------------|------|------------------|------|
| V_L | Control supply voltage | 1.65 | | 3.6 | V |
| V_{CC} | Bus supply voltage | 3 | 3.3 | 3.6 | |
| V_I | Input level at any bus terminal (separately or common mode) | -7 | | 12 | |
| V_{IH} | High level input voltage (driver, driver enabled, receiver enable inputs, and slew rate select) | $0.7 \times V_L$ | | V_L | |
| V_{IL} | Low level input voltage (driver, driver enable, receiver enable inputs, and slew rate select) | 0 | | $0.3 \times V_L$ | |
| V_{ID} | Differential input voltage | -12 | | 12 | |
| IO | Output current / driver | -80 | | 80 | mA |
| | Output current / receiver | - 2 | | 2 | |
| R_L | Differential load resistance | 54 | 60 | | Ω |
| C_L | Differential load capacitance | | 50 | | pF |
| D_R | Signaling rate / SLR = '0' | | | 20 | Mbps |
| | Signaling rate / SLR = '1' | | | 250 | kbps |
| T_A | Operating free-air temperature | -40 | | 105 | °C |

Operation is specified for internal (junction temperature) up to 150 °C. Self-heating due to internal power dissipation should be considered for each application. Maximum junction temperature is internally limited by the thermal shut-down circuit which disables the driver outputs when the junction temperature reaches 165 °C.

Table 7. Thermal information

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|-------------|---|------|------|------|------|
| R_{th-ja} | Thermal resistance, junction-to-ambient | | 40 | | °C/W |
| R_{th-jc} | Thermal resistance, junction-to-case | | 5.2 | | |

4 Electrical characteristics

Table 8. Receiver: over recommended operating conditions (unless otherwise specified. Please, see "Operating conditions" table)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|--|---------------------|-------------------|--------------------|---------------|
| Receiver/DC | | | | | | |
| V_{IT+} | Positive-going receiver differential input voltage threshold | | (1) | -60 | -20 | mV |
| V_{IT-} | Negative-going receiver differential input voltage threshold | | -200 | -130 | (1) | |
| V_{HYS} | Receiver differential input voltage threshold hysteresis ($V_{IT+} - V_{IT-}$) ⁽¹⁾ | | 40 | 70 | | |
| V_{OH} | Receiver high-level output voltage | $V_L = 1.65\text{ V}, I_{OH} = -2\text{ mA}$ | 1.25 | 1.45 | | V |
| | | $V_L = 3\text{ V}, I_{OH} = -2\text{ mA}$ | 2.75 | 2.9 | | |
| V_{OL} | Receiver low-level output voltage | $V_L = 1.65\text{ V}, I_{OL} = 2\text{ mA}$ | | 0.2 | 0.45 | |
| | | $V_L = 3\text{ V}, I_{OL} = 2\text{ mA}$ | | 0.1 | 0.25 | |
| C_{OD} | Differential output capacitance | | | 15 | | pF |
| I_{OZ} | Receiver output high-impedance current | $V_O = 0\text{ V}$ or V_L, nRE at V_L | -1 | | 1 | μA |
| R_{in} | Receiver input impedance | $-7\text{ V} \leq V_{inCM} \leq +12\text{ V}$ $-40\text{ }^\circ\text{C} \leq \text{Temp} \leq 105\text{ }^\circ\text{C}$ | 96 ⁽²⁾ | | | k Ω |
| I_I | Receiver input current (disabled driver) | $1V65 < V_L < 3.3\text{ V}, V_{CC} = 3.3\text{ V}$ | | 85 ⁽²⁾ | | μA |
| | | $V_I = 12\text{ V}, -40\text{ }^\circ\text{C} \leq \text{Temp} \leq 105\text{ }^\circ$ | | | 125 ⁽²⁾ | |
| | | $V_I = -7\text{ V}, -40\text{ }^\circ\text{C} \leq \text{Temp} \leq 105\text{ }^\circ$ | -100 ⁽²⁾ | | | |
| Receiver / switching characteristics, SLR = 'X' | | | | | | |
| t_r, t_f | Receiver output rise/fall time | | | 5 | 15 | ns |
| t_{PHL}, t_{PLH} | Receiver propagation delay time | $C_L = 15\text{ pF}$ | 15 | 25 | 60 | |
| $t_{SK(P)}$ | Receiver pulse skew, $t_{PHL} - t_{PLH}$ | | | | 15 | |
| t_{PLZ}, t_{PHZ} | Receiver disable time | | | 12 | 20 | |
| $t_{PLZ}, t_{PZH}, t_{PZL}, t_{PZH}$ | Receiver enable time | Driver enabled $C_L = 15\text{ pF}$ with $1\text{ k}\Omega$ | | 15 | 80 | |
| | | Driver disabled $C_L = 15\text{ pF}$ with $1\text{ k}\Omega$ | | 2 | 8 | μs |

1. Under any specific conditions, V_{IT+} is specified to be at least V_{HYS} higher than V_{IT-} .
2. Guaranteed by design simulation in temperature.

Table 9. Driver: over recommended operating conditions (unless otherwise specified. Please, see "Operating conditions" table)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|--|--|---|------------------|------------|-------|---------------|
| DC driver/ DC | | | | | | |
| I_I | Driver input, driver enable, and receiver enable input current | | -2 | | 2 | μA |
| $ V_{OD} $ | Driver differential output voltage magnitude | $R_L = 60 \Omega, 375 \Omega$ on each output to -7 V to 12 | 1.5 | 2 | | V |
| | | $R_L = 54 \Omega$ (RS-485) | 1.5 | 2 | | |
| | | $R_L = 100 \Omega$ (RS-422) $T_J \geq 0 \text{ }^\circ\text{C}, V_{CC} \geq 3.2$ | 2 | | | |
| $\Delta V_{OD} $ | Change in magnitude of driver differential output voltage | $R_L = 54 \Omega, C_L = 50 \text{ pF}$ | -50 | 0 | 50 | mV |
| $V_{C(SS)}$ | Steady-state common-mode output voltage | Center of two 27- Ω load resistors | 1 | $V_{CC}/2$ | 3 | V |
| ΔV_C | Change in differential driver output common-mode voltage | | -50 | 0 | 50 | mV |
| $V_{C(PP)}$ | Peak-to-peak driver common-mode output voltage | | | 500 | | |
| Driver/switching characteristics, SLR='1', 250 kbps, bit time $\geq 4 \mu\text{s}$ | | | | | | |
| t_r, t_f | Driver differential output rise/fall time | $R_L=54 \Omega, C_L=50 \text{ pF}$ | 0.05 | 0.2 | 1 | μs |
| t_{PHL}, t_{PLH} | Driver propagation delay time | | 0.4 | 1 | 1.5 | |
| $t_{SK(P)}$ | Driver pulse skew, $ t_{PHL} - t_{PLH} $ | | | | 0.3 | |
| t_{PLZ}, t_{PHZ} | Driver disable time | | | 0.017 | 0.035 | |
| t_{PLZ}, t_{PZH} | Driver enable time | Receiver enabled $C_L=50 \text{ pF}$ with 110 k Ω | | 0.7 | 1.2 | μs |
| | | Receiver disabled $C_L=50 \text{ pF}$ with 110 k Ω | | 1.64 | 2.4 | |
| Driver/switching characteristics, SLR= '0', 20 Mbps, bit time $\geq 50 \text{ ns}$ | | | | | | |
| t_r, t_f | Driver differential output rise/fall time | $R_L=54 \Omega, C_L=50 \text{ pF}$ | 4 | 7 | 15 | ns |
| t_{PHL}, t_{PLH} | Driver propagation delay | | 6 | 12 | 25 | |
| $t_{SK(P)}$ | Driver pulse skew, $ t_{PHL} - t_{PLH} $ | | | | 4 | |
| t_{PLZ}, t_{PHZ} | Driver disable time | | | 17 | 40 | |
| t_{PZL}, t_{PZH} | Driver enable time | | Receiver enabled | | 9 | |
| | | Receiver disabled | | 1 | 2.4 | μs |

Table 10. Supply current and protections: over recommended operating conditions (unless otherwise specified. Please, see "Operating conditions" table)

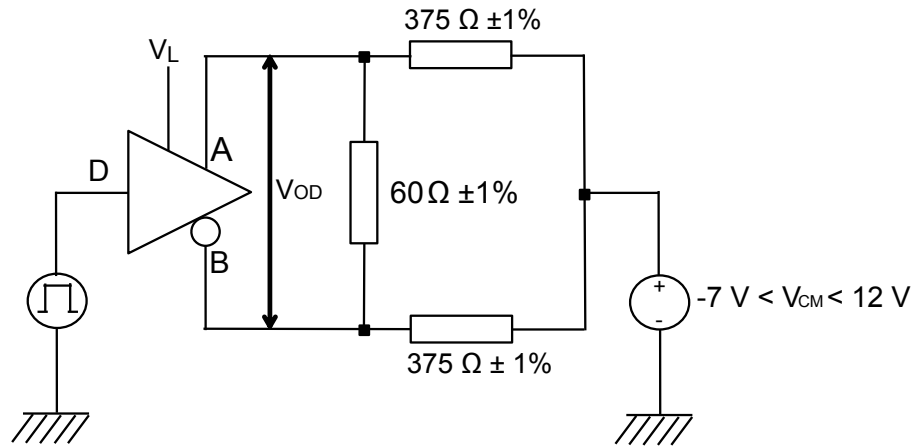
| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|----------------------|-------------------------------------|---|------|------|--------------------|--------------------|
| Supply current | | | | | | |
| I _{CC} | Supply current (quiescent) | Driver and receiver enabled DE = V _L , RE = GND, no load, T _{amb} | | 625 | | μA |
| | | Driver and receiver enabled DE = V _L , RE = GND, no load, T < 105 °C | | | 900 ⁽¹⁾ | |
| | | Driver enabled, receiver disabled DE = V _{CC} , =V _L , No load, T _{amb} | | 315 | | |
| | | Driver enabled, receiver disabled DE = V _{CC} , =V _L , No load, T < 105 °C | | | | 550 ⁽¹⁾ |
| | | Driver disabled, receiver enabled DE = GND, =GND, No Load | | 515 | 700 | |
| | | Driver and receiver disabled DE = GND, =V _L , no load [-40 °C, 105 °C] | | 0.5 | 3 | |
| T _{TSD} | Thermal shutdown threshold | | | 165 | | °C |
| T _{TSD_HYS} | Thermal shutdown hysteresis | | | 15 | | |
| I _{OS} | Driver short-circuit output current | -7 V < V _{SHORT} < + 12 V | -250 | | 250 | mA |

1. Guaranteed by simulation.

5 Test circuits and typical characteristics

In the schematics below, C_L includes fixture and instrumentation capacitance.

Figure 6. Driver differential output voltage with common-mode load



Input generator rate is 100 kbps, 50% duty cycle, rise and fall times less than 6 ns.

Figure 7. Driver differential and common-mode output with RS-485 load

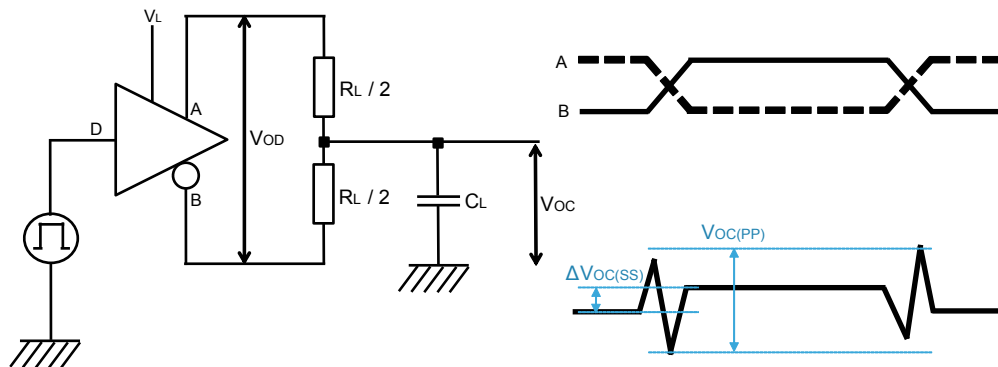


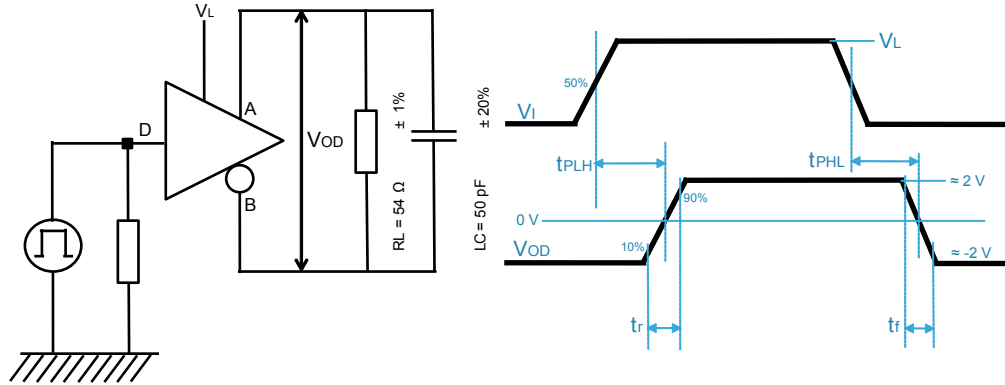
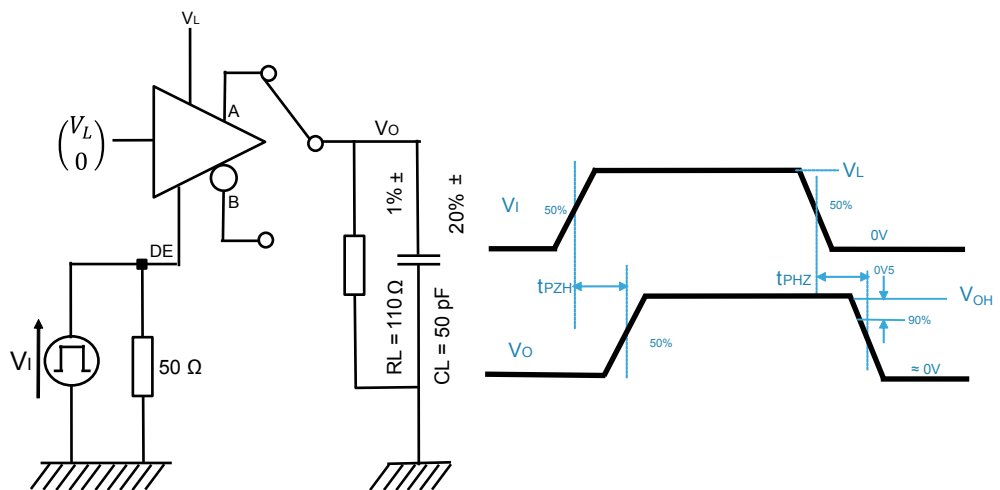
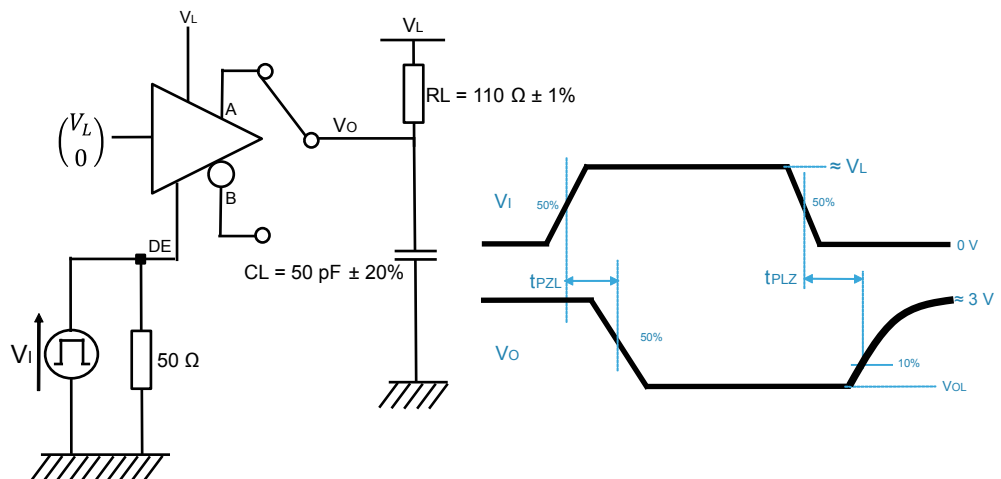
Figure 8. Driver differential output rise and fall times and propagation delays

Figure 9. Driver enable and disable times with active high output and pull-down load

Figure 10. Driver enable and disable times with active low output and pull-up load


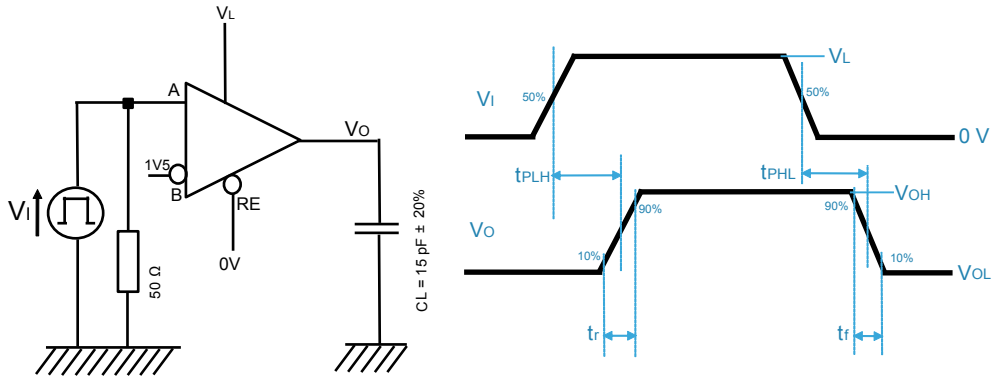
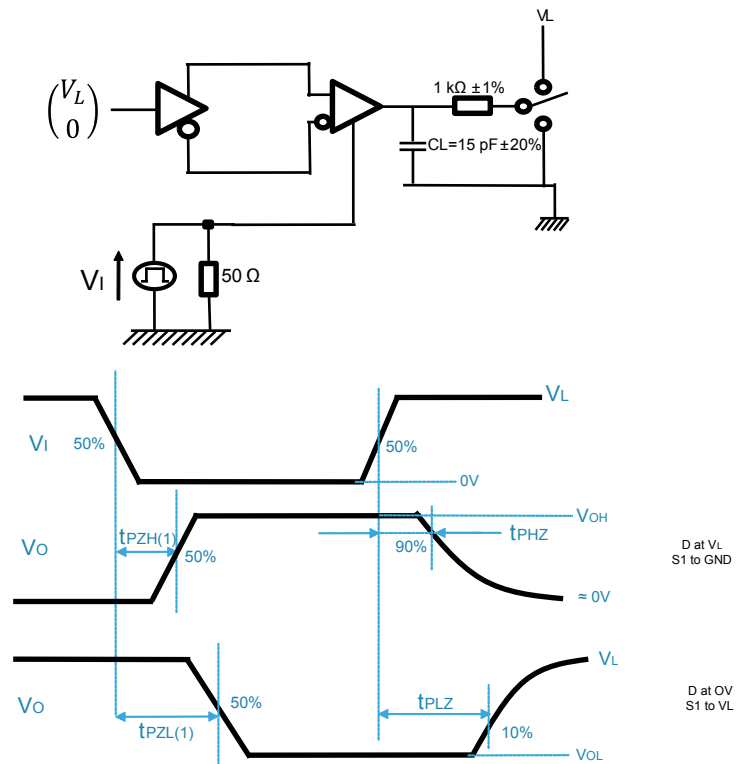
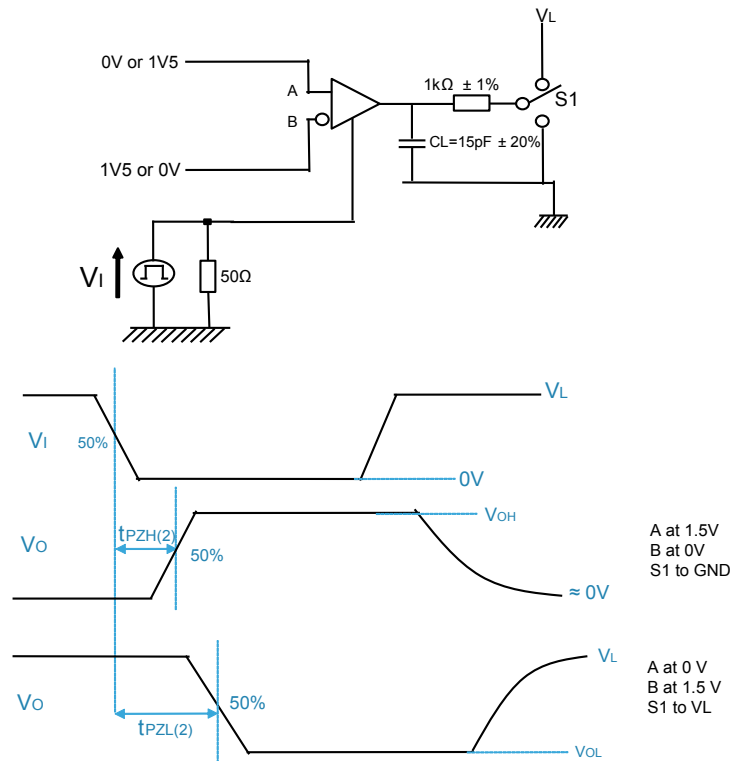
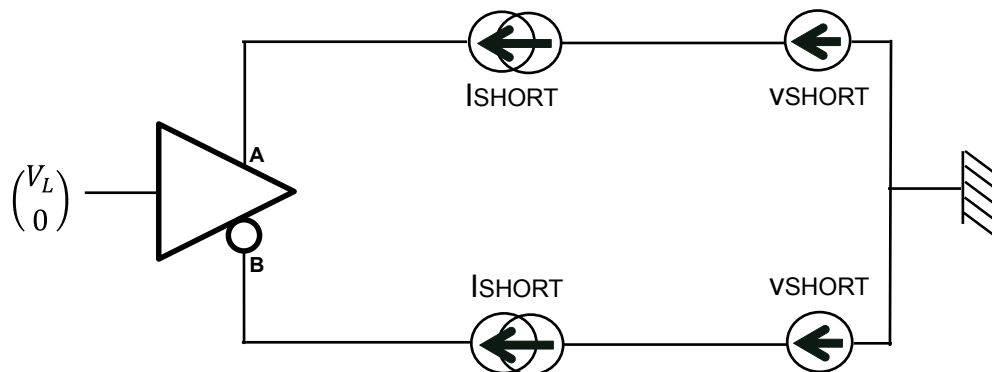
Figure 11. Receiver output rise and fall times and propagation delay

Figure 12. Receiver enable/disable times with driver enabled


Figure 13. Receiver enable/disable times with driver disabled

Figure 14. Short-circuit output current measurement


When one of the driver output is shorted to a voltage source (named V_{SHORT}) between -7 V to +12 V stabilized, the current does not exceed 250 mA and the driver is protected.

6 Typical characteristics

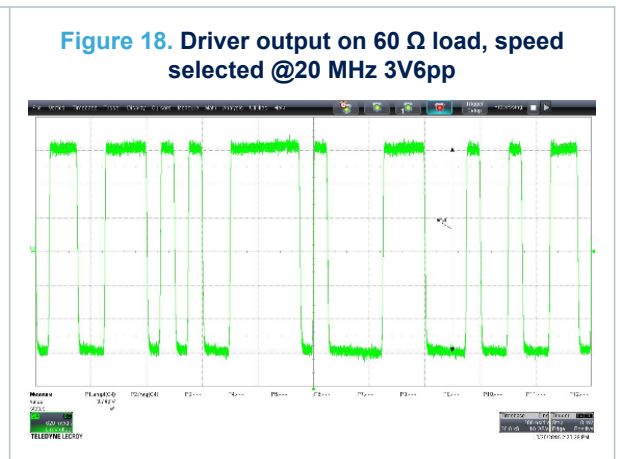
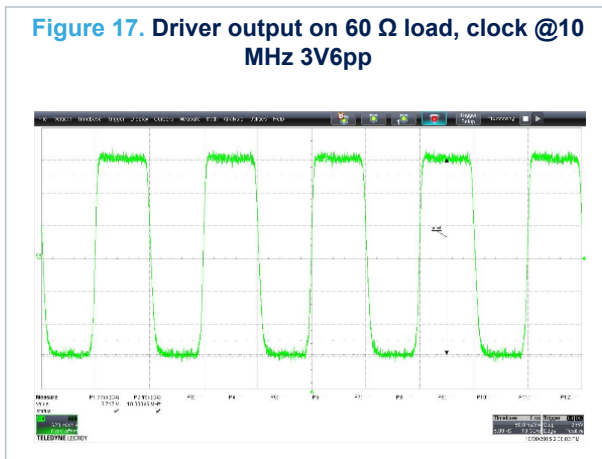
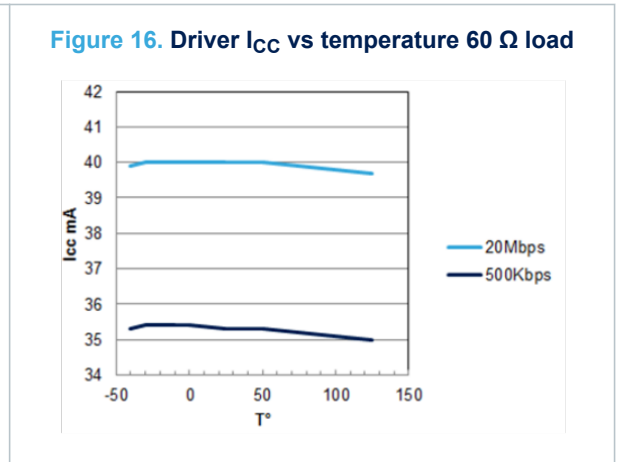
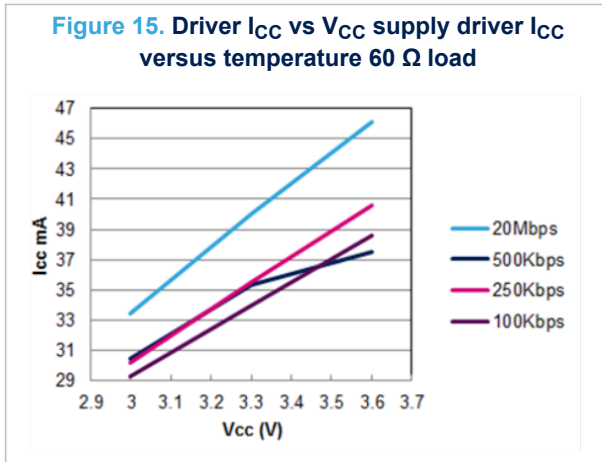
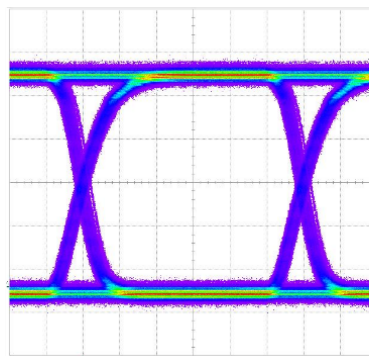
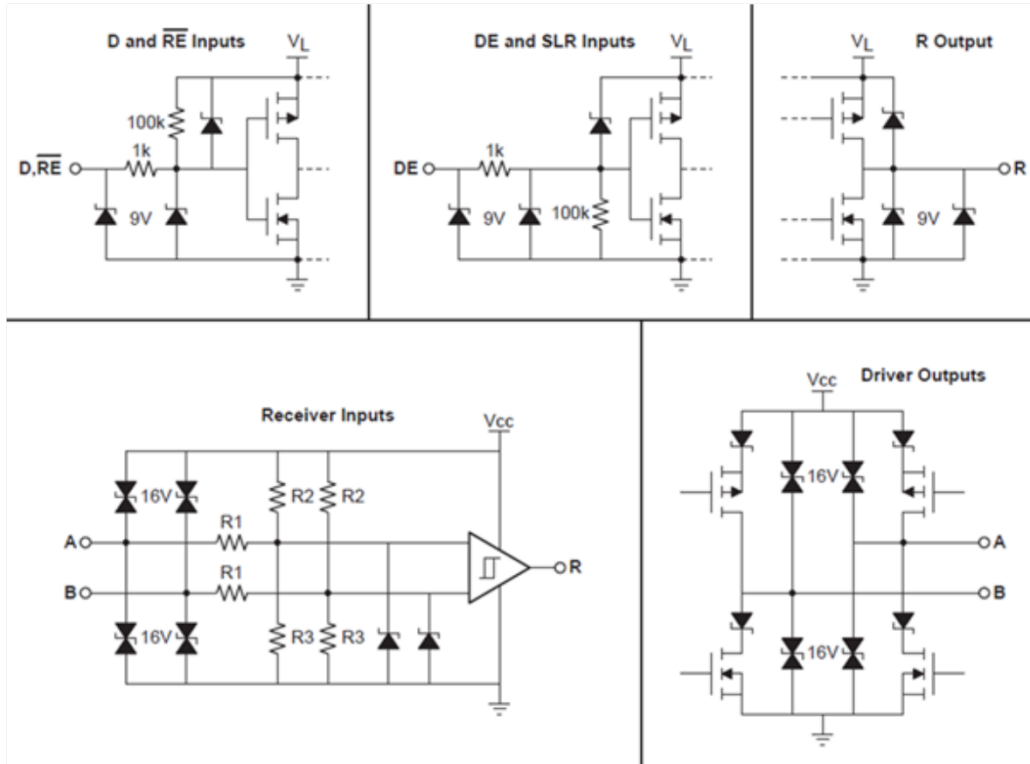


Figure 19. Eye diagram 20 Mbps short line



7 Equivalent input and output schematic diagrams

Figure 20. Equivalent input and output schematic diagrams


8 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.

8.1 DFN10 package information

Figure 21. DFN10 package outline

FIGURE.1: VFDFPN 10 3x3x1.0 PITCH 0.5
PACKAGE CODE: WQ

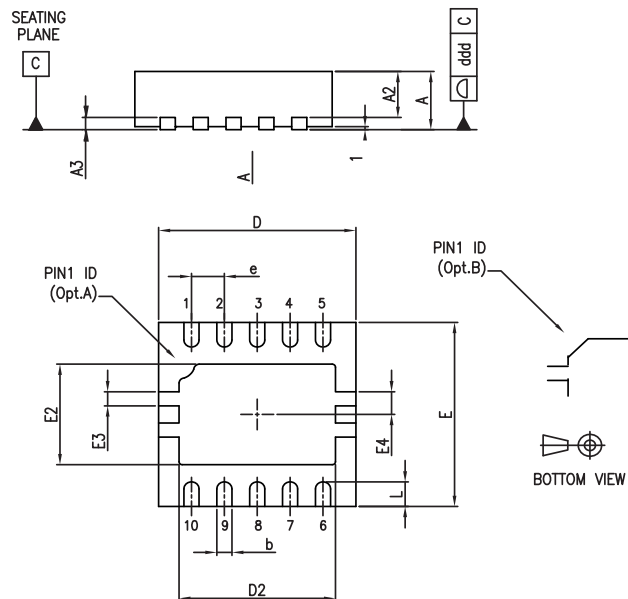
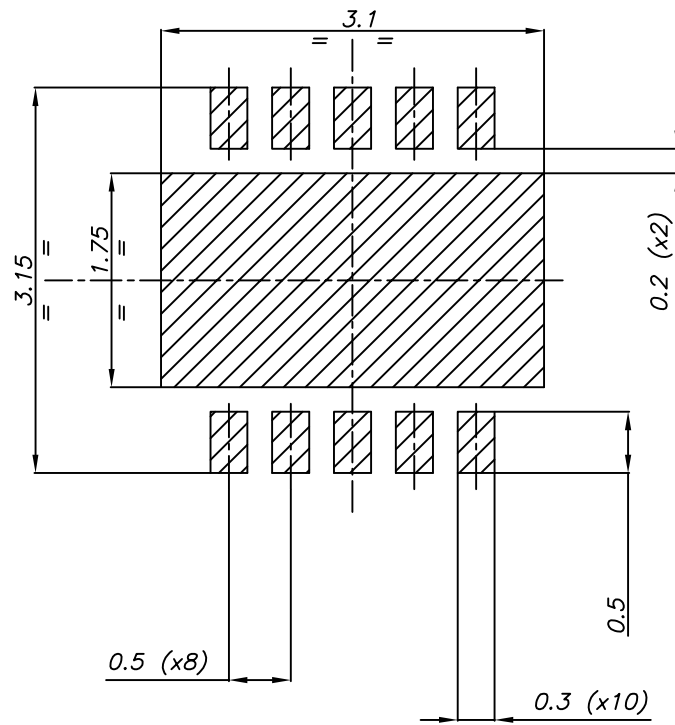


Table 11. DFN10 package mechanical data

| Symbol | mm | | |
|--------|------|------|------|
| | Min. | Typ. | Max. |
| A | 0.80 | 0.90 | 1.00 |
| A1 | | 0.02 | 0.05 |
| A2 | 0.55 | 0.65 | 0.80 |
| A3 | | 0.20 | |
| b | 0.18 | 0.25 | 0.30 |
| D | 2.85 | 3.00 | 3.15 |
| D2 | 2.20 | | 2.70 |
| E | 2.85 | 3.00 | 3.15 |
| E2 | 1.40 | | 1.75 |
| e | | 0.50 | |
| L | 0.30 | 0.40 | 0.50 |
| ddd | | | 0.08 |

Note: VFDFPN stands for thermally enhanced very thin fine pitch dual flat packages. No lead. Very thin: $0.80\text{ mm} < A \leq 1.00\text{ mm}$ / fine pitch: $e < 1.00\text{ mm}$

Figure 22. DFN10 recommended footprint



9 Ordering information

| Order code | Temperature range | Package | Marking |
|------------|-------------------|---------|---------|
| STR485LV | -40 °C to +105 °C | DFN10 | 485L |

Revision history

Table 12. Document revision history

| Date | Version | Changes |
|-------------|---------|---|
| 20-Sep-2018 | 1 | Initial release. |
| 16-Oct-2018 | 2 | Updated Table 10. Supply current and protections: over recommended operating conditions (unless otherwise specified. Please, see "Operating conditions" table). |
| 15-Apr-2019 | 3 | Updated Table 9. Driver: over recommended operating conditions (unless otherwise specified. Please, see "Operating conditions" table). |

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| Figure 22. | DFN10 recommended footprint | 19 |

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