

RS-485 Introduction

TI Precision Labs – RS-485

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What is RS-485?

- “Recommended Standard” jointly published by Telecommunications Industry Association (TIA) and Electronic Industries Alliance (EIA).
- Defines the electrical characteristics of interface circuits (line drivers/transmitters and receivers) used for serial communications over a multipoint network.

Examples:

Signal amplitude

Input sensitivity

Input impedance

Does not define:

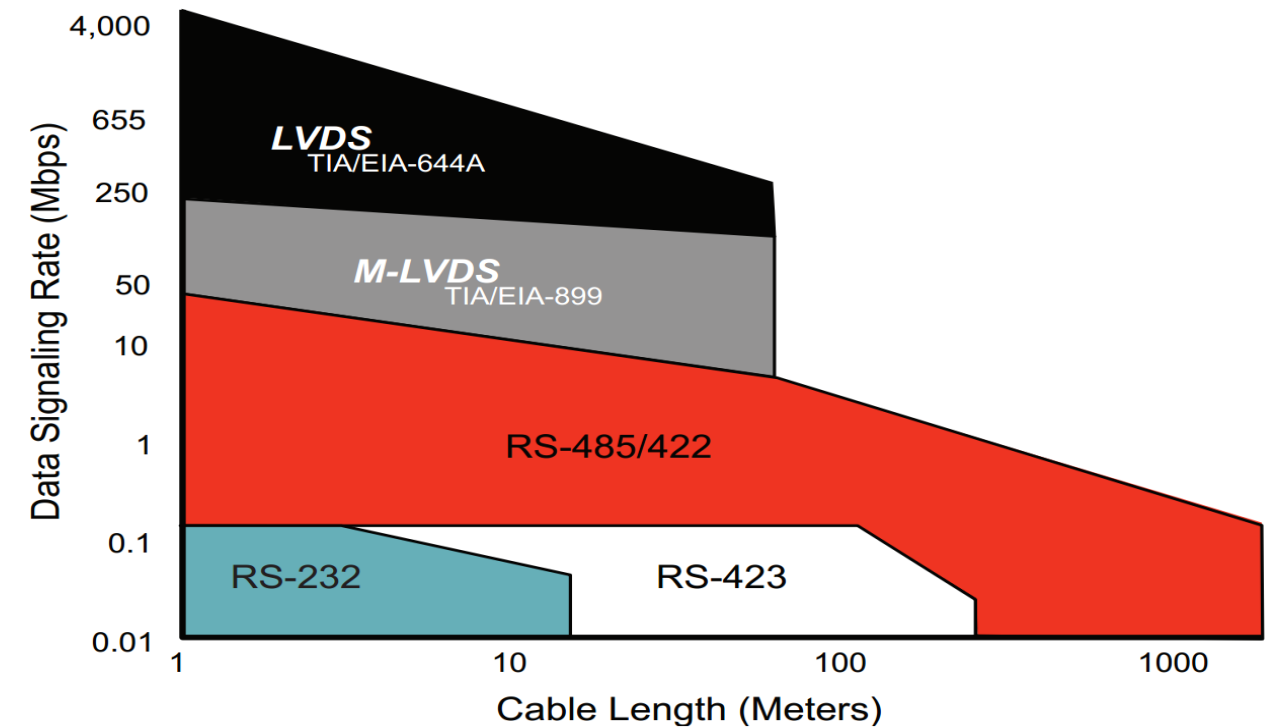
Cabling

Connectors

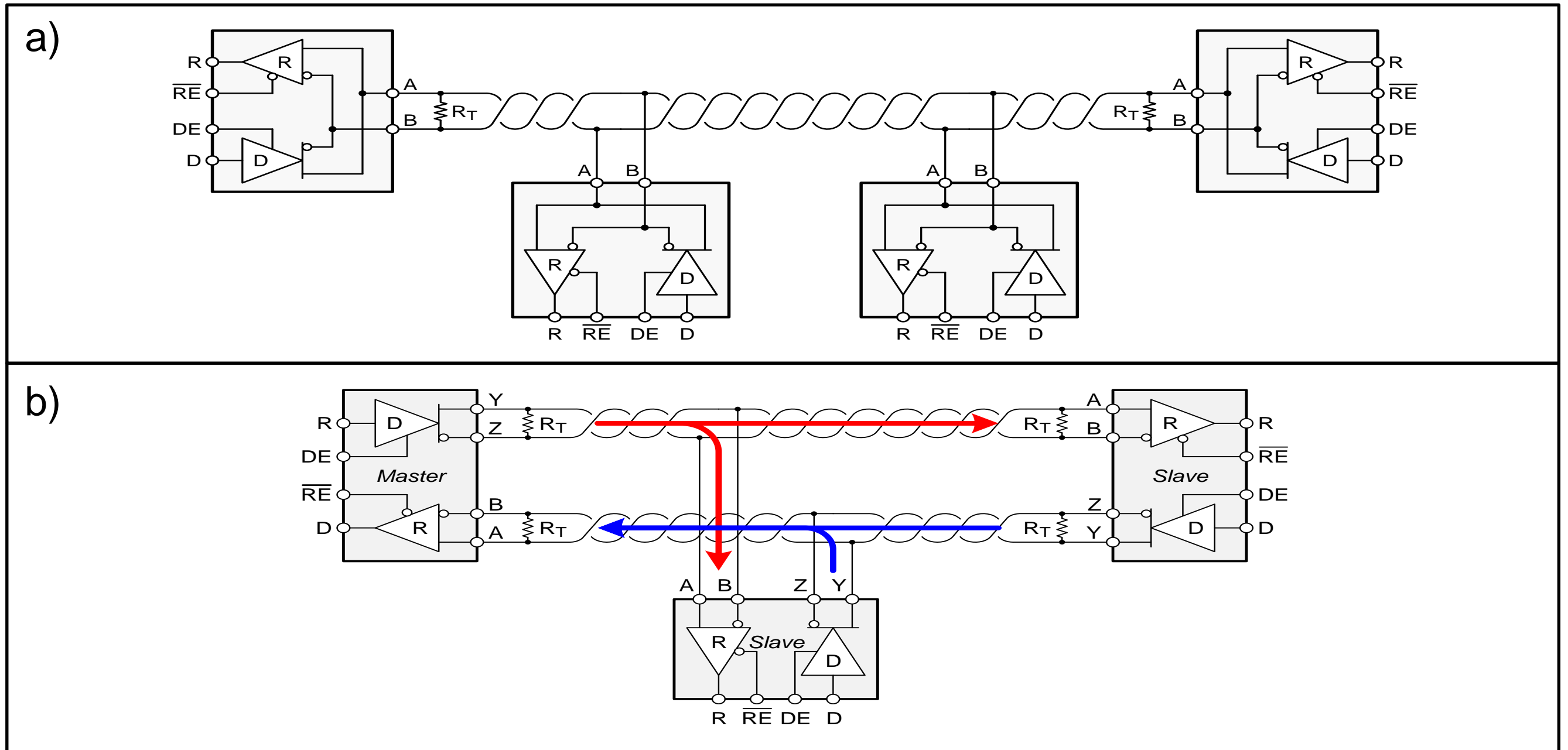
Data protocol

Why RS-485?

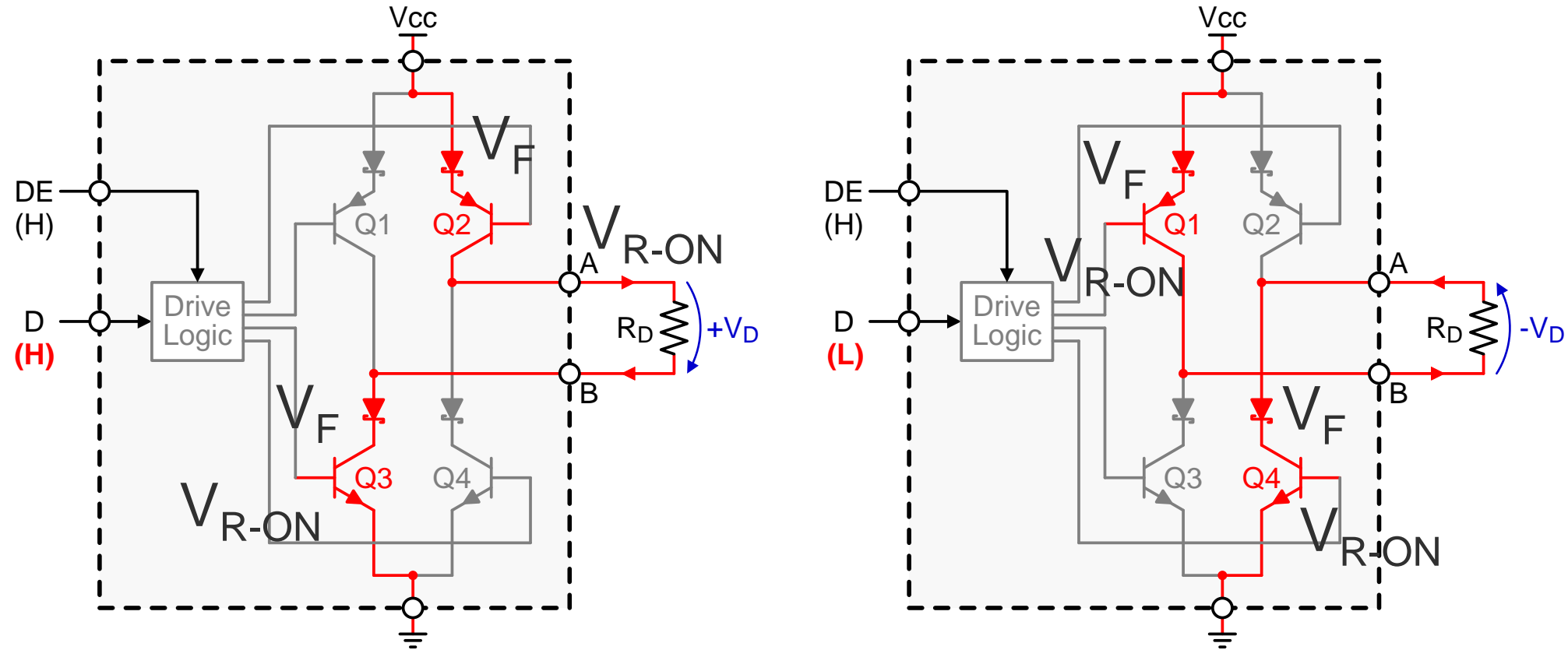
1. Balanced interface
 - increases noise immunity and decreases emissions
2. Multipoint, bi-directional communication on a single pair of wires
 - lower cabling costs
3. Large differential signal, large common-mode range
 - allows for communication over long distances and with large ground potential differences
4. Can achieve signaling rates up to 50 Mbps
 - suitable for a wide array of applications



Typical half- and full- duplex RS-485 networks



RS-485 driver

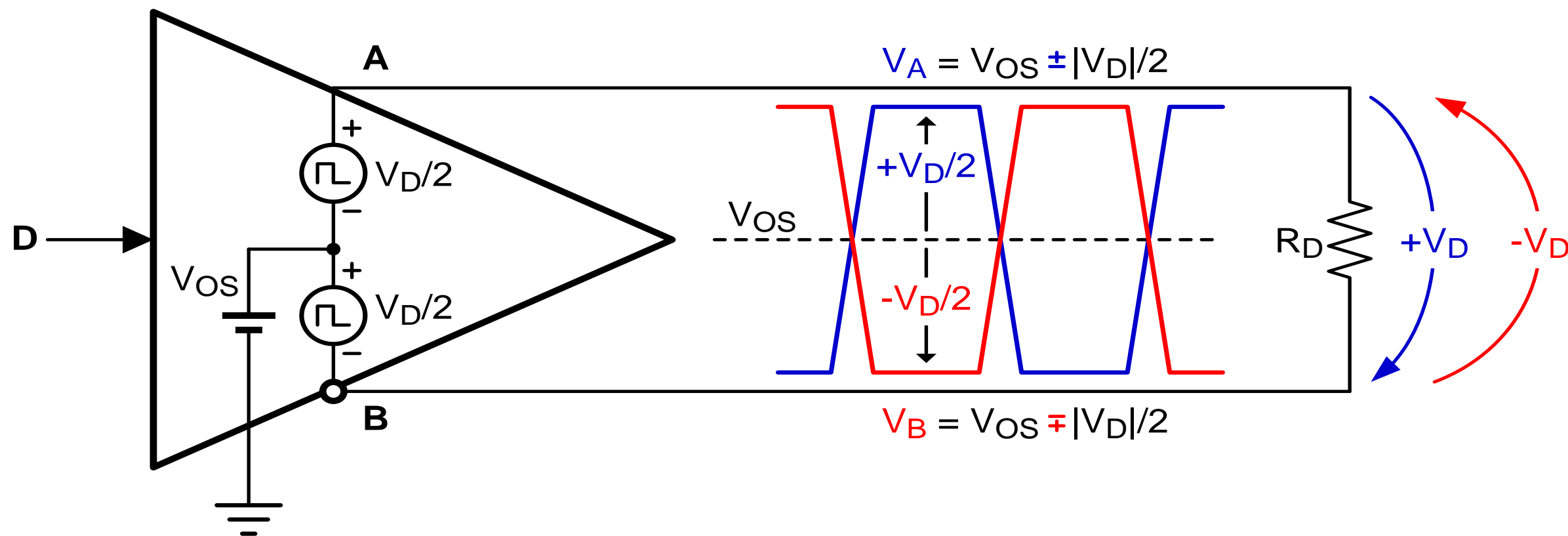


$$V_D = V_A - V_B$$

$$|V_D| = V_{CC} - 2(V_F + V_{R-ON})$$

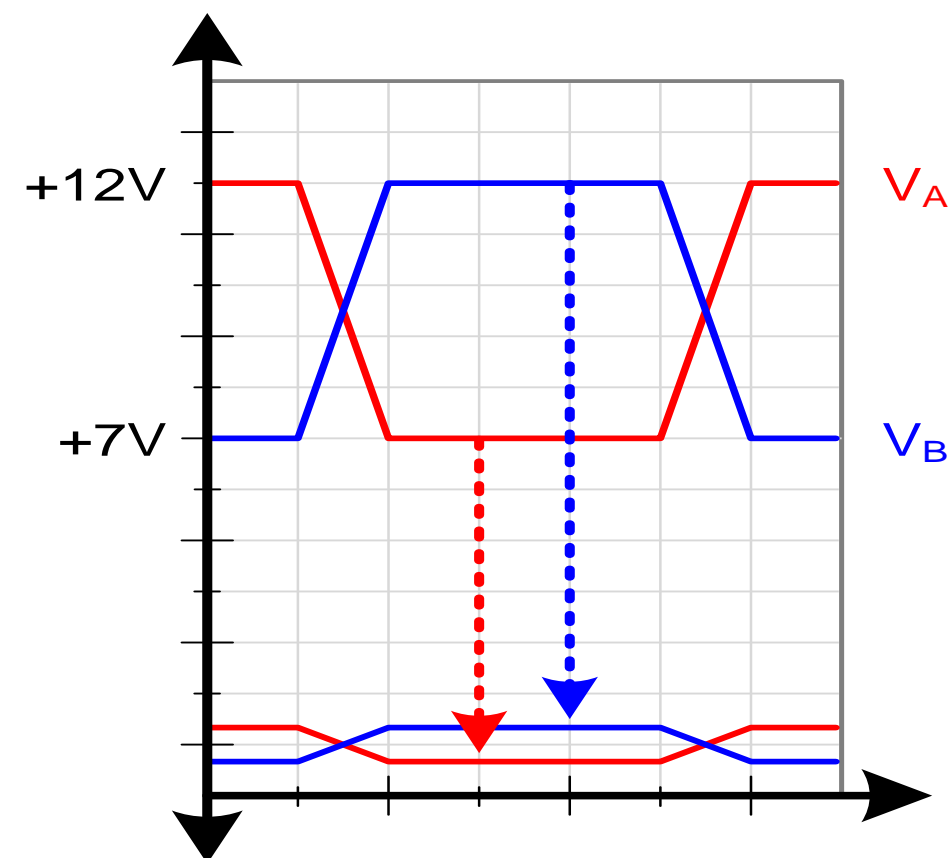
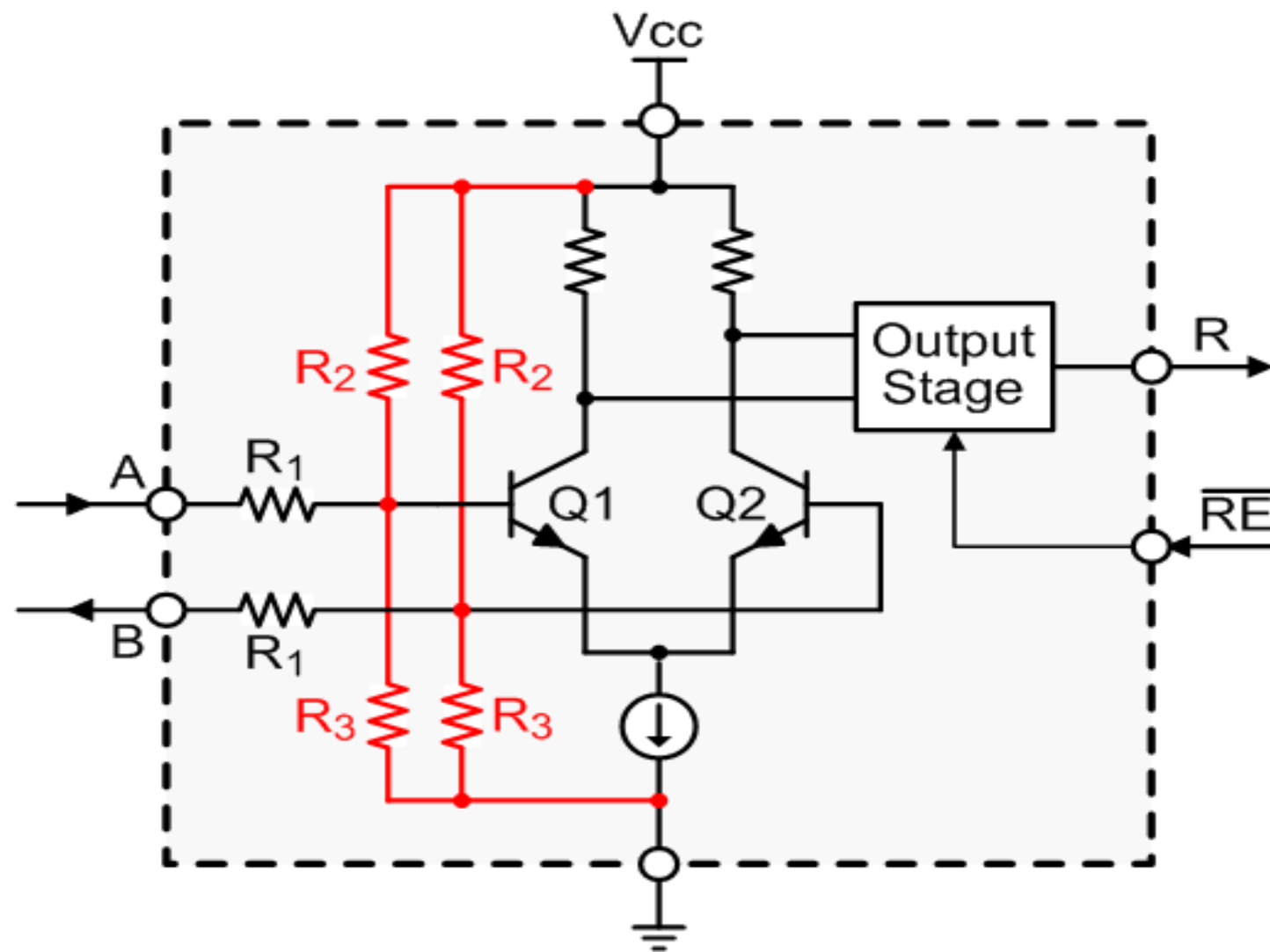
A RS-485 compliant driver must produce at least 1.5 V across a 54Ω load.

Driver model with V_{OS} and $V_D/2$



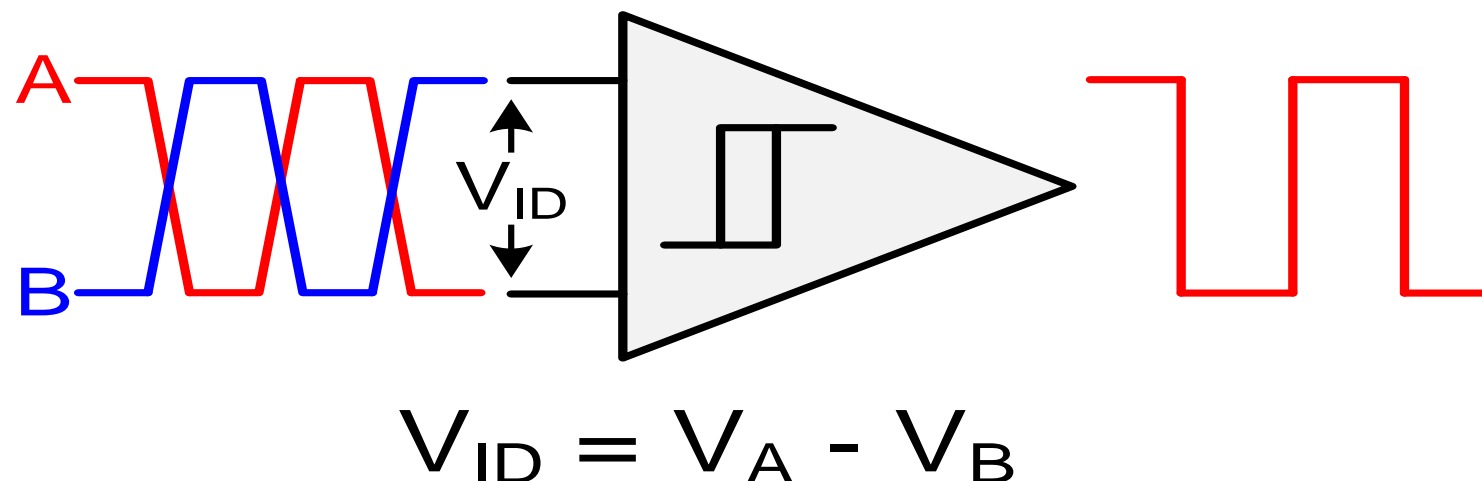
The driver can be modelled with a bias voltage of V_{OS} superimposed by two differential voltages of $V_D/2$

Differential receiver



R2 and R3 attenuate the voltages appearing at the A and B terminal, to ensure that the comparator inputs are not saturated.

Differential receiver output states



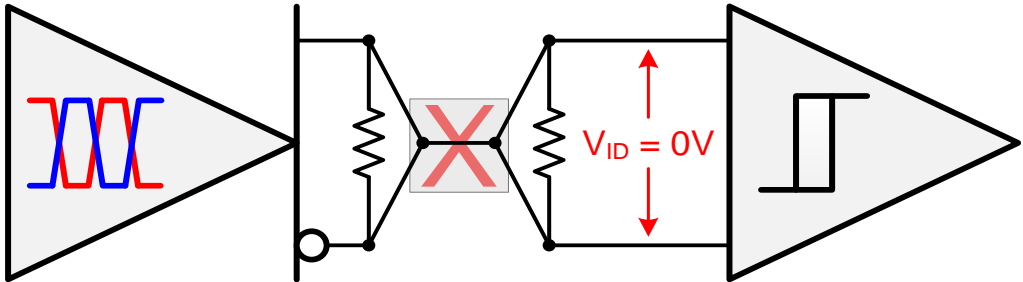
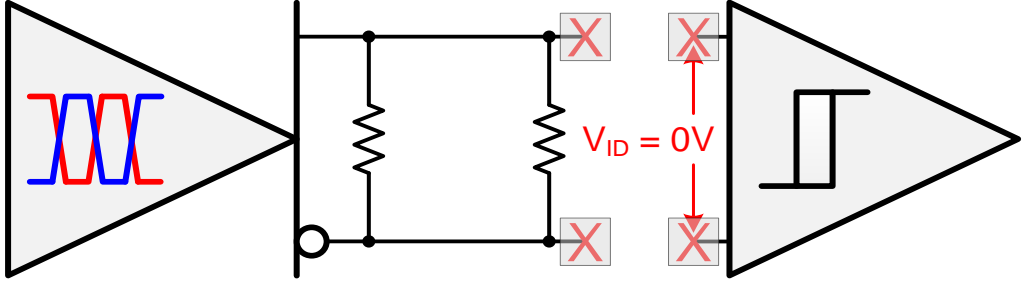
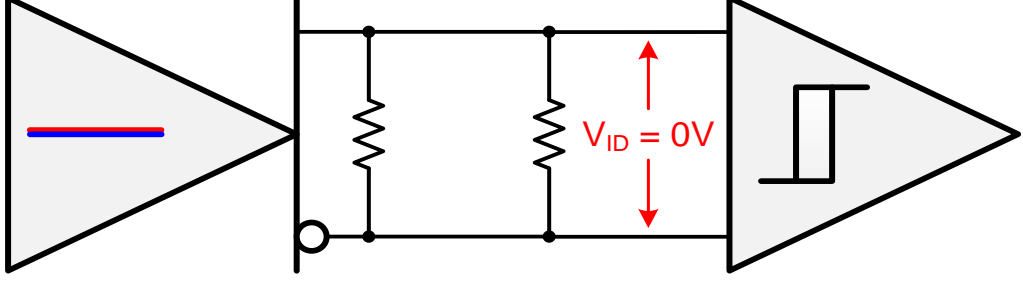
DIFFERENTIAL INPUT	OUTPUT
$V_{ID} = V_A - V_B$	R
$V_{ID} > V_{IT+}$	HIGH
$V_{ID} < V_{IT-}$	LOW
$V_{IT-} < V_{ID} < V_{IT+}$??

V_{IT+} is the value above which the receiver output must be HIGH when $V_{ID} \geq V_{IT+}$

V_{IT-} is the value below which the receiver output must be LOW when $V_{ID} \leq V_{IT-}$

EIA-485 compliant receivers must have $V_{IT+} \leq +200\text{mV}$ and $V_{IT-} \geq -200\text{mV}$

Offset receiver input thresholds

Bus		R Out
Short		HIGH
Open		HIGH
Idle		HIGH

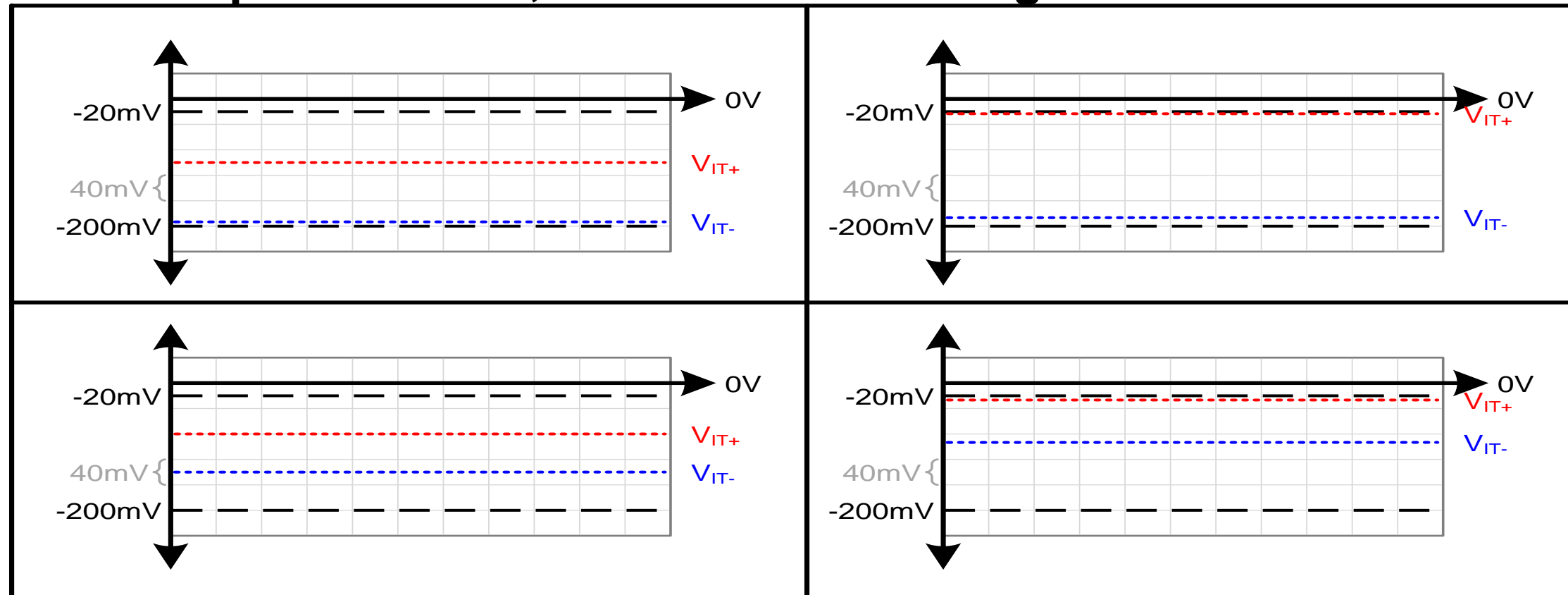
Modern transceivers have $V_{IT+} \leq 0V$ to ensure that the receiver outputs a failsafe HIGH during bus short, open, and idle events.

Receiver hysteresis

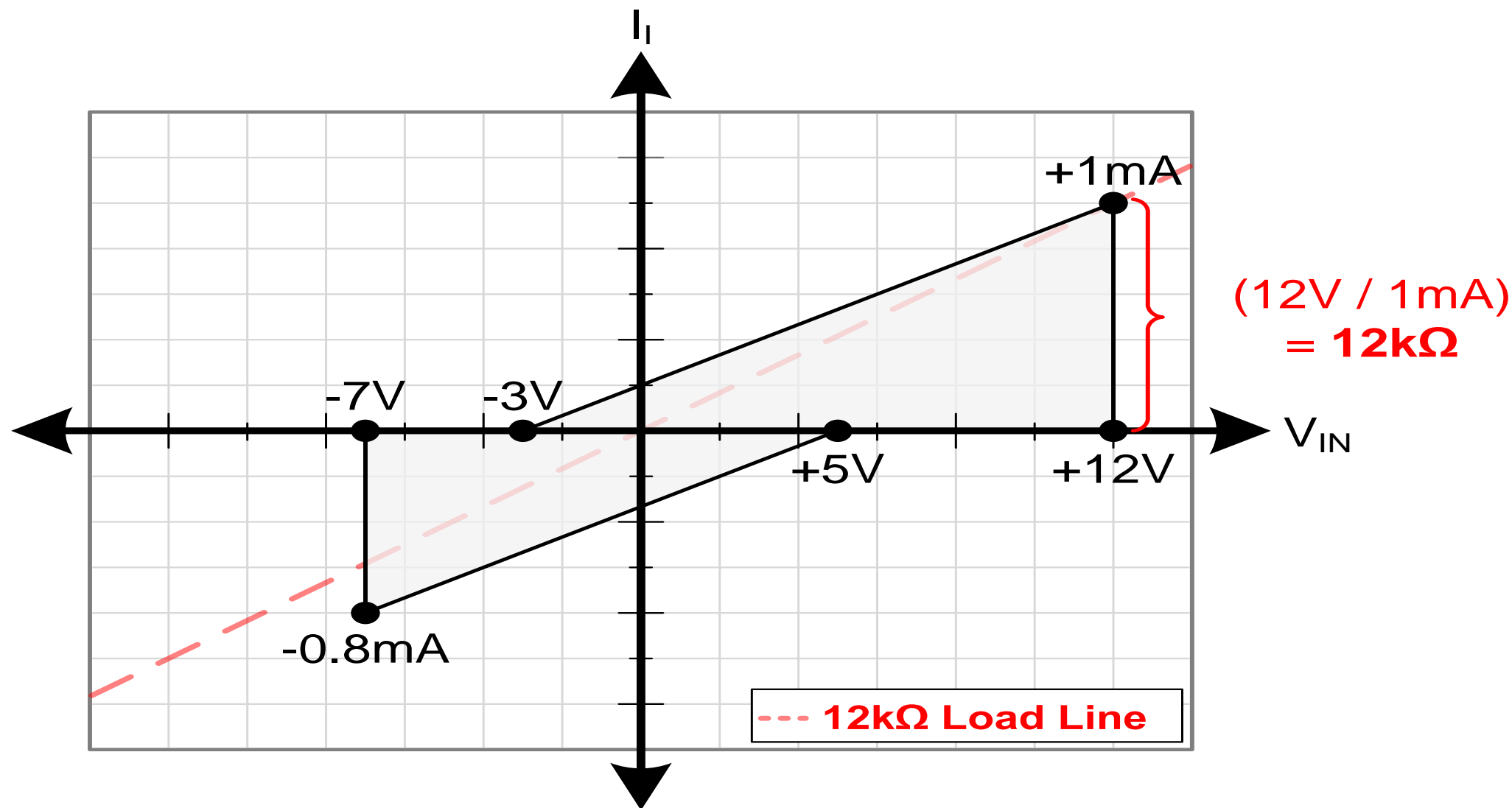
V_{HYS} specifies the minimum value of the difference between V_{IT+} and V_{IT-} .

	PARAMETER	MIN	NOM	MAX	UNIT
V_{IT+}	Positive-going receiver differential input voltage threshold	x	-60	-20	mV
V_{IT-}	Negative-going receiver differential input voltage threshold	-200	-130	x	mV
V_{HYS}	Receiver differential input voltage threshold hysteresis ($V_{IT+} - V_{IT-}$)	40	70	-	mV

For the datasheet specifications, each of the following are valid receiver characteristics



The unit load (how many receivers on the bus?)



The bus input current (I_i) of RS-485 compliant receivers must remain within the shaded region when $-7V \leq V_{IN} \leq 12V$

Unit load table

Unit load	Bus input leakage current at 12 V	Input impedance (Ohms)	Transceivers on the Bus
1	1 mA	12 k	32
1/2	0.5 mA	24 k	64
1/4	0.25 mA	48 k	128
1/8	0.125 mA	96 k	256

**To find more RS485 technical resources
and search products, visit
[ti.com/interface/rs-485-rs-422/overview.html](https://www.ti.com/interface/rs-485-rs-422/overview.html)**