Automatic Correction Scheme of RS-485 Communication Bus Cross-Wire Fault

In the rapidly developing intelligent power distribution system, data needs to be transmitted remotely. RS485, as an internationally general serial communication standard, is widely used in intelligent power distribution systems due to its simple structure, strong anti-interference, appropriate transmission distance, and data transmission rate.

The E-meter communication network is a typical master-slave communication system, where the master node communicates with multiple slave nodes through a bus. The network has a long transmission distance and multiple nodes, making it easy for the bus in the equipment interconnection to be connected incorrectly. As a result, it is inconvenient for debugging and maintenance, and increases the cost for repair and maintenance.

To solve this problem, 3PEAK has introduced the TPT485N, a bus (A/B) polarity self-correcting RS-485 transceiver.

1.

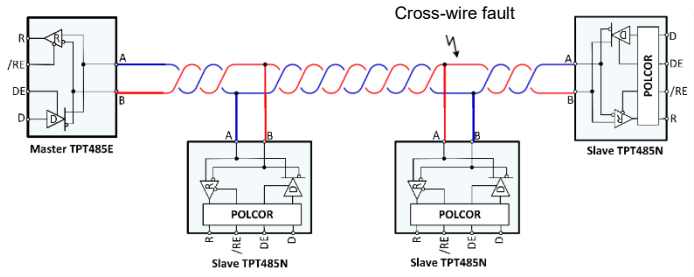


Figure 1. Electric Meter RS-485 Communication Network with Polarity Self-Calibration Function

In the system shown in Figure 1, the master node broadcasts a determined bit pattern to all slave nodes, and then the slave nodes compare the bit pattern initially stored in the processor during power-up with the pattern sent by the master node.

- If the patterns match, the slave node will keep its signal polarity unchanged.
- In the case of a mismatch, the processor in the slave node will use the "XOR" function to reverse the signal polarity of the input and output data, ensuring the normal operation of the transceiver without any hardware changes.

Figure 1 shows a typical system framework using the 3PEAK TPT485N bus polarity correction transceiver. The master node contains a safety bias resistor network that keeps the signal polarity on the bus determined by default. Both the master and slave nodes need to integrate polarity correction units to match the signal polarity of the

bus during idle state. This correction unit consists of a debouncing filter, which distinguishes between long data strings of the same polarity and the bus idle state based on the duration of the debouncing time.

Since the TPT485N must work over a wide temperature range, the debouncing time can vary between t_{FS} (min)=44 ms and t_{FS} (max)=100 ms, meaning that polarity correction may be triggered by a constant bus voltage lasting a minimum of 44 ms. Therefore, a continuous 0-bit data string must be shorter than 44 ms to avoid triggering polarity correction by mistake.

In contrast, the expected polarity correction requirement typically requires the bus idle voltage to last longer than 100 ms after network power-on or after installing new bus nodes to ensure that polarity correction can be completed.

Therefore, a constant bus signal shorter than 44 ms is considered valid data, and a duration exceeding 100 ms is considered as a bus idle state.

Only when the negative differential input voltage is lower than the negative input threshold (V_{IT-}) of the receiver within a few times of idle state, the correction unit will reverse the signal polarity. Otherwise, the transceiver will maintain its original polarity state.

2.

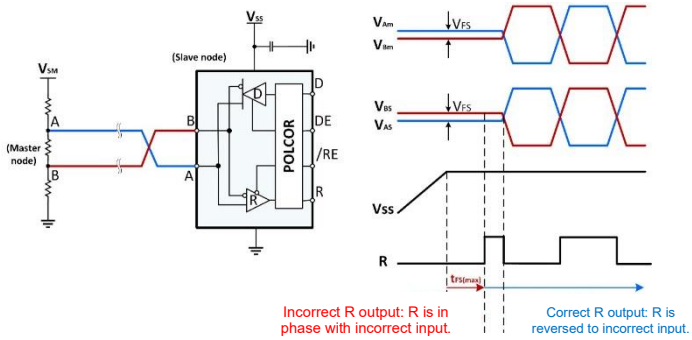
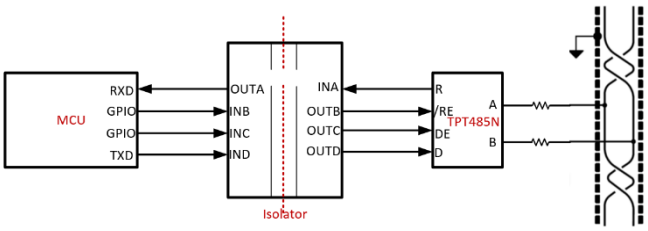


Figure 2. Polarity Self-calibration Sequence after Power-on and Stabilization

Figure 2 shows an example of polarity correction after power-on stabilization.

During power-up, the output of the receiver (R) is undefined, and the default output is low. Once the slave node power supply (V_{SS}) is stable, the bus must be idle for at least t_{FS} (max) to ensure that the polarity correction is completed. Due to a bus cross-wire fault, the positive bus voltage ($V_{AB(M)}$) output by the master node is detected as negative at the input of the slave node.

Therefore, after t_{FS} (max), the internal polarity of the slave node transceiver is reversed, and the slave node realizes automatic correction of bus cross-wire fault.



Typical Applications with Isolation

3.

The TPT485N provides polarity correction for cross-wired bus cables with debouncing filtering. The minimum debounce time (t_{FS} (min)) of the filter determines the maximum duration of the same polarity data string, and the maximum debounce time (t_{FS} (max)) of the filter determines the minimum bus idle time for signal polarity correction.

The TPT485N only starts polarity correction after power stabilization. After correction, the polarity state is stored in the transceiver and is consistently applied to receive and transmit data. Switching the transceiver between transmit and receive modes does not change the polarity state.

4.

The TPT485N is an RS-485/-422 transceiver that supports 3 V/5 V, half-duplex, and polarity-free operation, designed by 3PEAK. The TPT485N contains one driver and one receiver, with hot-swapping capability, which can eliminate transient fault signals on the bus during power-up or hot-plugging. The slew-rate-limited driver provided by the RS-485 can reduce EMI and reflections caused by improper cable termination, achieving error-free data transmission at rates of up to 500 kbps. At the same time, the input impedance of the chip receiver is 1/8 unit load, allowing up to 256 transceivers to be connected to the bus for half-duplex communication. The output provides HBM ESD protection of ±18 kV or more, ensuring normal operation in harsh environments such as video surveillance, power electronics, and industrial instrumentation.

- The polarity-free TPT485N can be compatible with most half-duplex RS485 on the market with high performance.
- The polarity-free TPT485N has a built-in bus adaptive polarity recognition circuit and can be connected to an A/B bus arbitrarily.