APPLICATION NOTE

ATA663211 LIN TRX VHDL Model - Level 1 Model Documentation

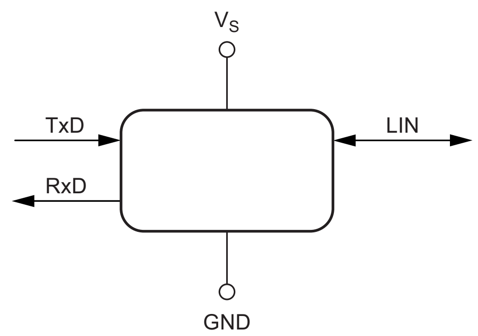
ATAN0099

Introduction - Level 1 Approach Schema

In a level 1 approach, the model is kept as simple as possible with the main characteristics of the device subdivided into blocks. The output ports are shown in Figure 1:

- **VBAT** Supply positive port (VS refers to the same pin, which is used in figures)
- **GND** Ground or negative port supply
- **LIN** Bus connection, LIN input/output
- **TxD** Transmission port
- **RxD** Receiver port, includes a pull-down transistor

Figure 1. Model Inputs and Outputs

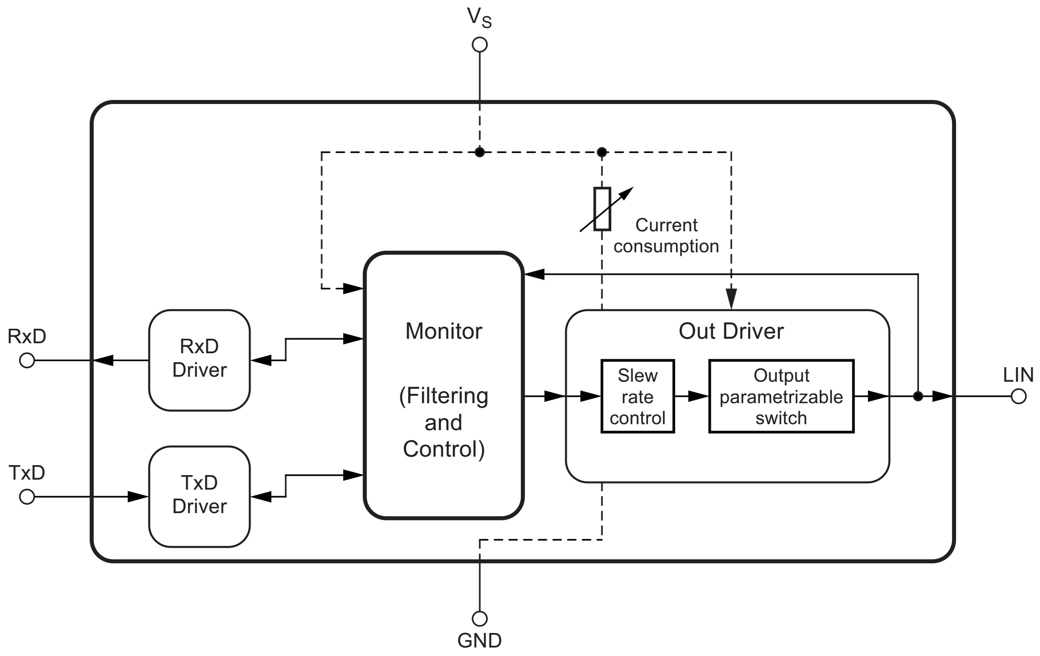


A main block does the signal filtering and general control inside the model (for more information, see Figure 2 on page 2). The monitor is the main control and also specifies when to actuate any switch on the model (pull-down transistor, output switch, etc.). Counters or timing filters are implemented inside this block.

On the RxD driver, the pull-down transistor is implemented characterizing its interface.

The output driver includes a characteristic slew rate control and output interface containing the main switch of the model. Output pull-up circuitry is implemented inside this block.

Figure 2. Level 1 Approach Schema



The current consumption in different modes (normal, sleep, etc.) was modeled in an abstract manner, with an equivalent resistor that changes its value for each scenario.

Reference List

1. ATA6632xx_doc9198.pdf
2. ATA6632-4_36861-ED.xls
3. ATA666x_VHDL_AMS_Modell_v2.pdf
4. LIN OSI Layer1 Physical Layer for LIN Specification V2.2 for devices with RX TX access.pdf
5. LIN OSI Layer1 Physical Layer for LIN Specification V2.2 for devices without RX TX access.pdf
6. C&S ATA663211 Level 2 VHDL-AMS model

1. Model Behavior - Test Bench

A test bench was performed in order to show the behavior of the model and its interaction with external signals. A description is shown in Table 1-1.

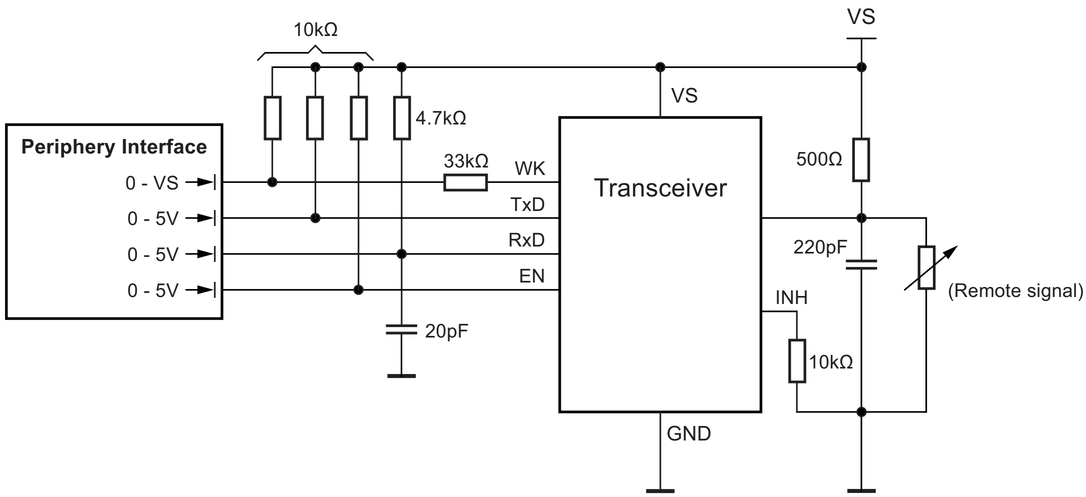
Table 1-1. Test Bench

Test Bench	Description
TB_a	Normal behavior while transmitting

1.1 Test Circuit

To compare the required behavior of the model (Figure 2 on page 2) with the simulation outputs, the circuit shown in Figure 1-1 was used. This circuit can be analyzed using the top-level "test bench" or "demo" file. Please also note that the signal generated from the periphery of the model are TxD and a LIN (remote signal emulation) and that they are stimulus signals. The LIN control signal comes from an imaginary node (remote signal) and is modeled as a load for the LIN pin.

Figure 1-1. Test Bench Circuit

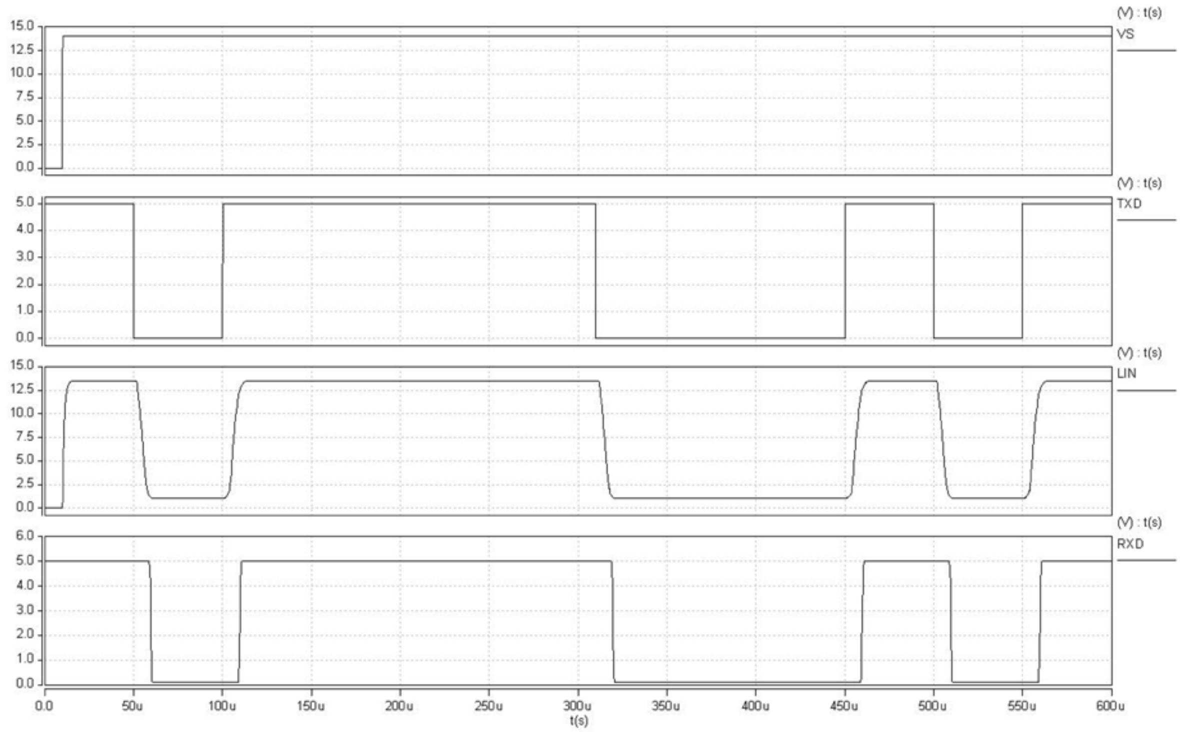


1.2 Logic Behavior

1.2.1 Initialization of the Model and Typical Transmission

Figure 1-2 on page 4 shows the behavior of the test bench "TB_a" of Table 1-1 on page 3. The device is enabled for normal operation from the first instance and a TXD signal can be applied to transmit data to the bus. It runs in normal mode (N), with LIN following TxD and RxD following LIN.

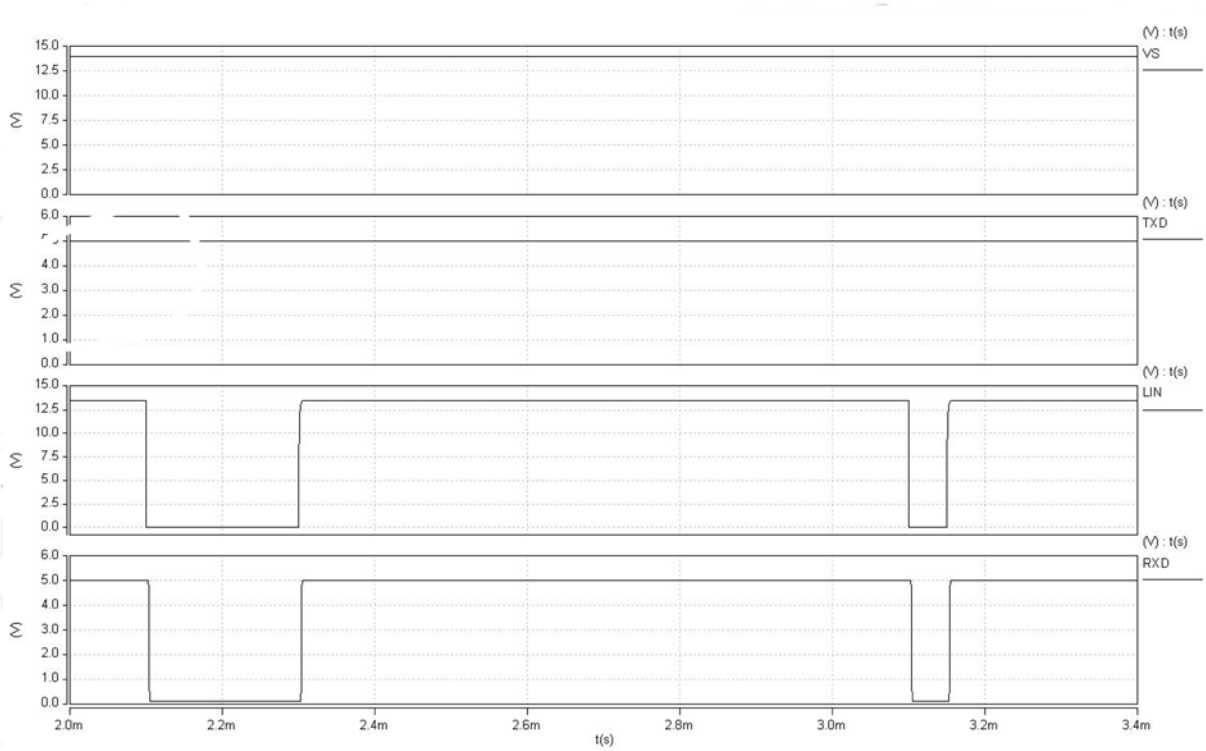
Figure 1-2. TXD Signal is Stimulus



1.2.2 LIN as Receiver

In Figure 1-3 the model is shown as receiver.

Figure 1-3. LIN as Receiver



1.3 Analogous Behavior

This section shows measured LIN versus model output LIN signals in order to show the results of the slew rate control and analog output behavior. The test bench circuit is shown in Figure 1-2.

The analog behavior mainly depends on two factors: *Supply level* and *temperature*. This model is designed with a wide range of parameters, some of which are mainly temperature-dependent, while others depend on supply level and some on both factors. In order to achieve a more accurate model while maintaining the most simplicity, the main structure of the parameterization depends on the temperature influence. On the other hand, to reflect dependency on the supply level an internal monitor to the supply level is performed, creating a correction factor to be added to the parameters.

1.3.1 Supply Variation

Many analog behavior parameters depend on the supply level. A test of the model was performed in order to compare the output signals with the measured signals. The model uses a monitor that is able to detect the supply level. With this level a proportional factor is calculated which is linear regarding the supply variation and used to apply a correction factor to the parameters that are affected by the supply level.

In the special case of the slew rate control, it is not possible to implement a linear factor correction as described above. The correlation between the signal shapes and the supply level is not linear. The solution to this special case is to use one value of the parameters involved in the slew rate control portion of the model for each of five different levels of supply. When the supply changes over time, the model is able to compute a linear interpolation between the two nearest points of the actual supply level.

The measuring process was completed with the same load condition as the test bench circuitry shown in Figure 1-1 on page 3. The supply source was changed in five increments: 5V, 7V, 14V, 18V and 28V. In the following section the characteristic of the model for different supplies and the measured signals are shown, however while varying the temperature parameter, i.e. the three possible scenarios low, type and high are described.

1.3.2 Temperature Variation

This model is parameterized into three different modes (high, room and low temperature). Many of the parameters depend on the temperature level. With the high level parameter “Temp,” it is possible to change among the three modes. The parameter is an integer value which can be set to 0 (room temperature and typical values), 1 (high temperature) and -1 (low temperature). In the setup used, 120°C was the high, –40°C the low, and 24°C the room temperature.

A comparison of the measurements and the parameterized model is shown in the following section. The measured LIN signal vs. model output LIN signal is shown in Figure 1-4 to Figure 1-13 on page 11 as a broad comparison overview. Each figure corresponds to a fixed supply level and only one edge of the signal (falling or rising). In this way it is possible to see the figures for five different levels of supply (5V to 28V), the falling and rising edge for each supply level and the three temperatures (or parameter sets) for each edge. The test bench circuit is shown in Figure 1-1 on page 3 and described in section Section 1.1 “Test Circuit” on page 3.

1.3.2.1 Supply = 5V

The three temperature scenarios are shown with a supply level of 5V in the following figures. The model output (SIM LIN) overwrites the measured signals (MSR LIN) with a dashed line.

Figure 1-4. Fall for VS = 5V

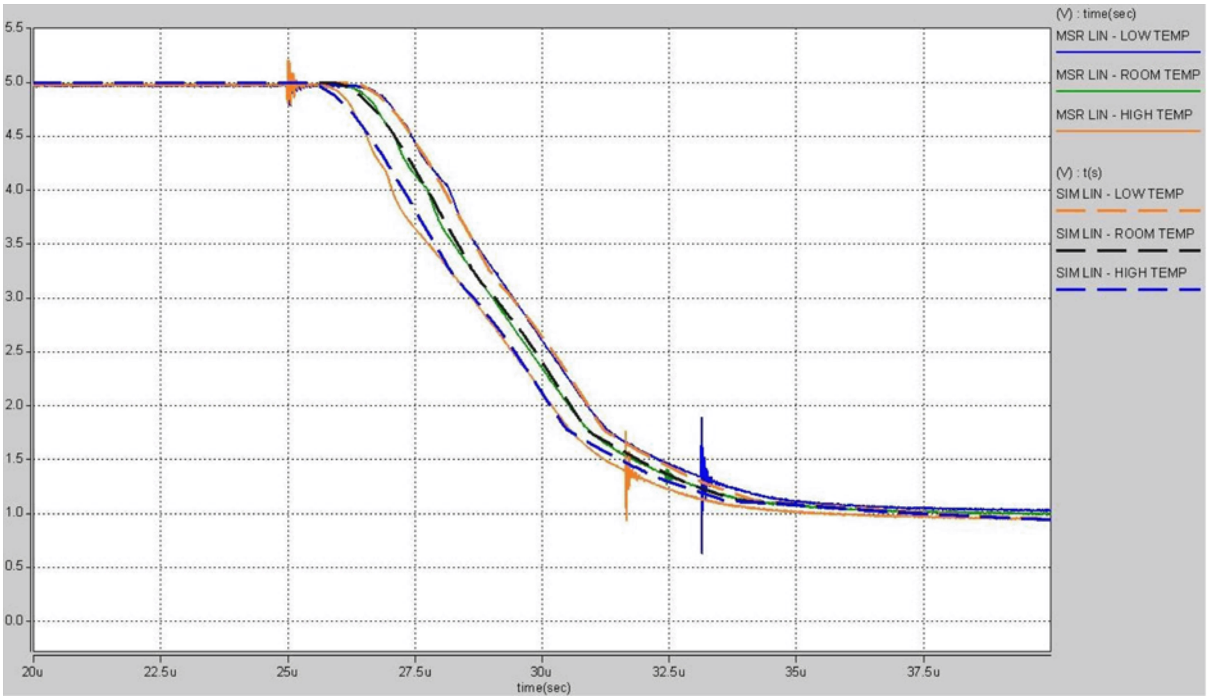
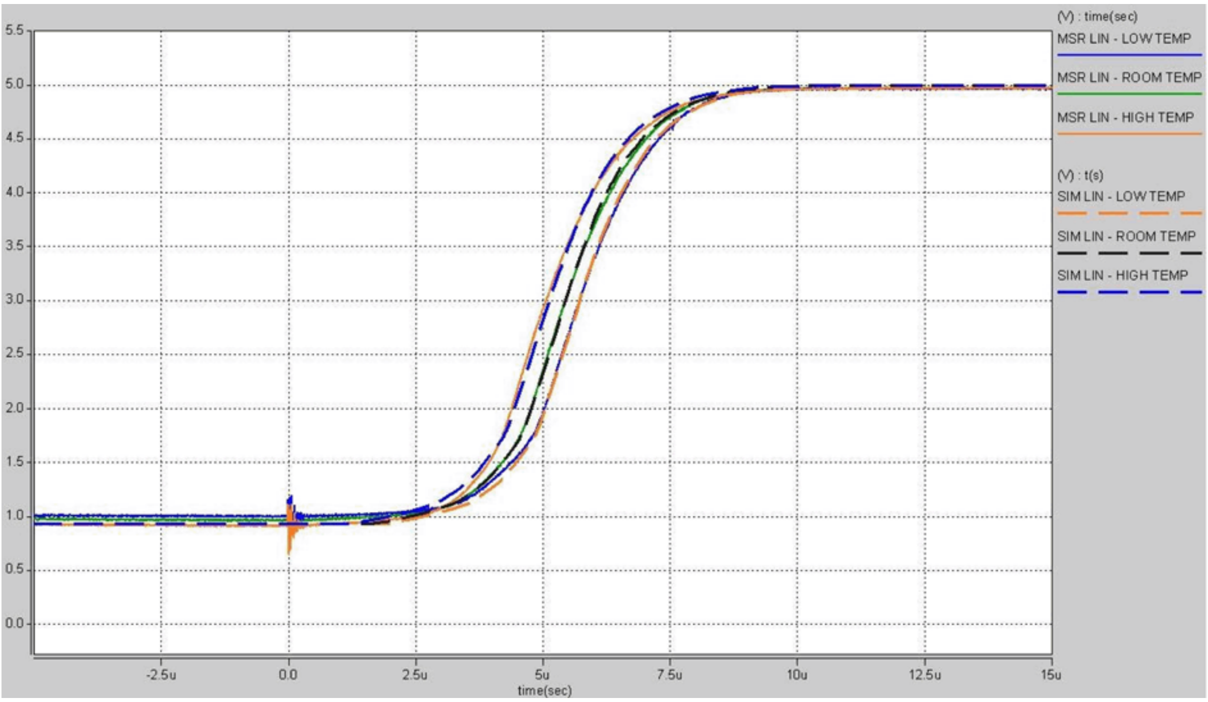


Figure 1-5. Rise for VS = 5V



1.3.2.2 Supply = 7V

The three temperature scenarios are shown with a supply level of 7V in the following figures. The model output (SIM LIN) overwrites the measured signals (MSR LIN) with a dashed line.

Figure 1-6. Fall for VS = 7V

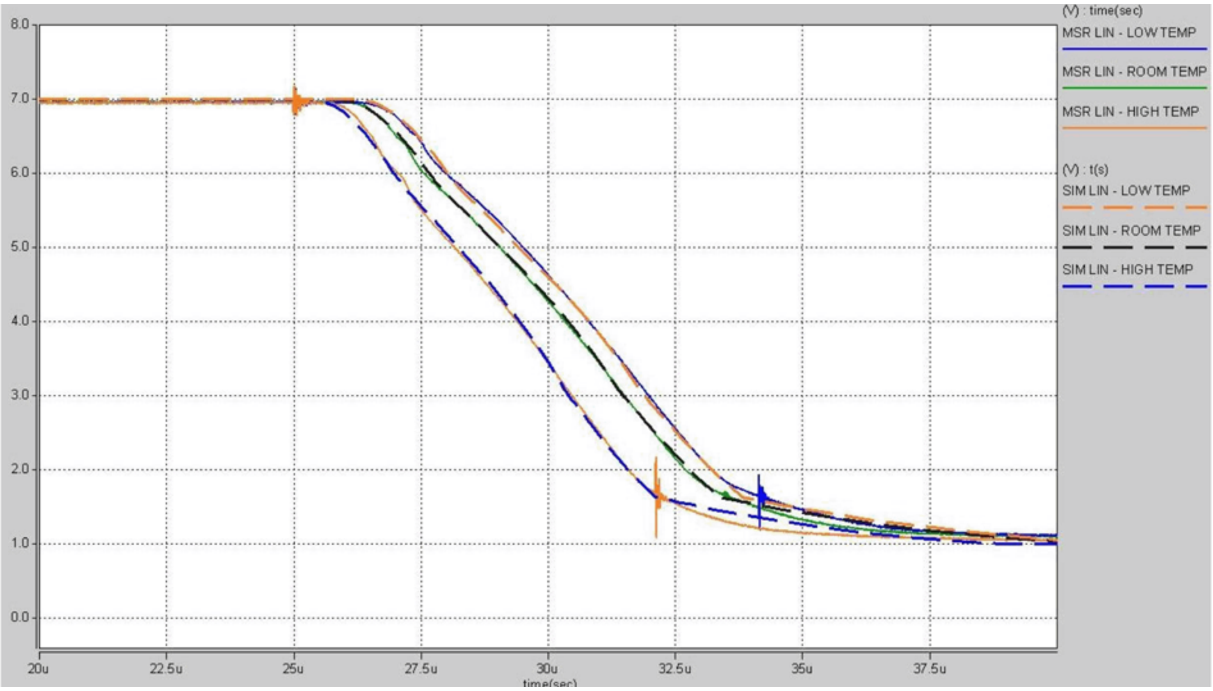
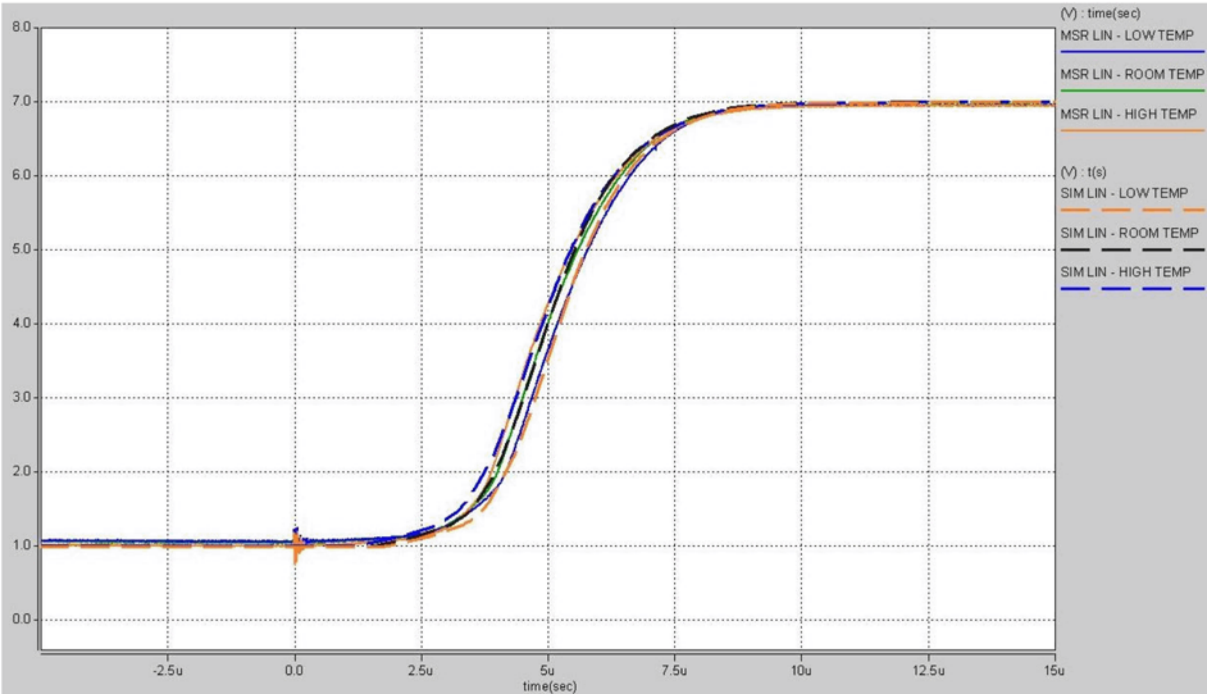


Figure 1-7. Rise for VS = 7V



1.3.2.3 Supply = 14V

The three temperature scenarios are shown with a supply level of 14V in the following figures. The model output (SIM LIN) overwrites the measured signals (MSR LIN) with a dashed line.

Figure 1-8. Fall for VS = 14V

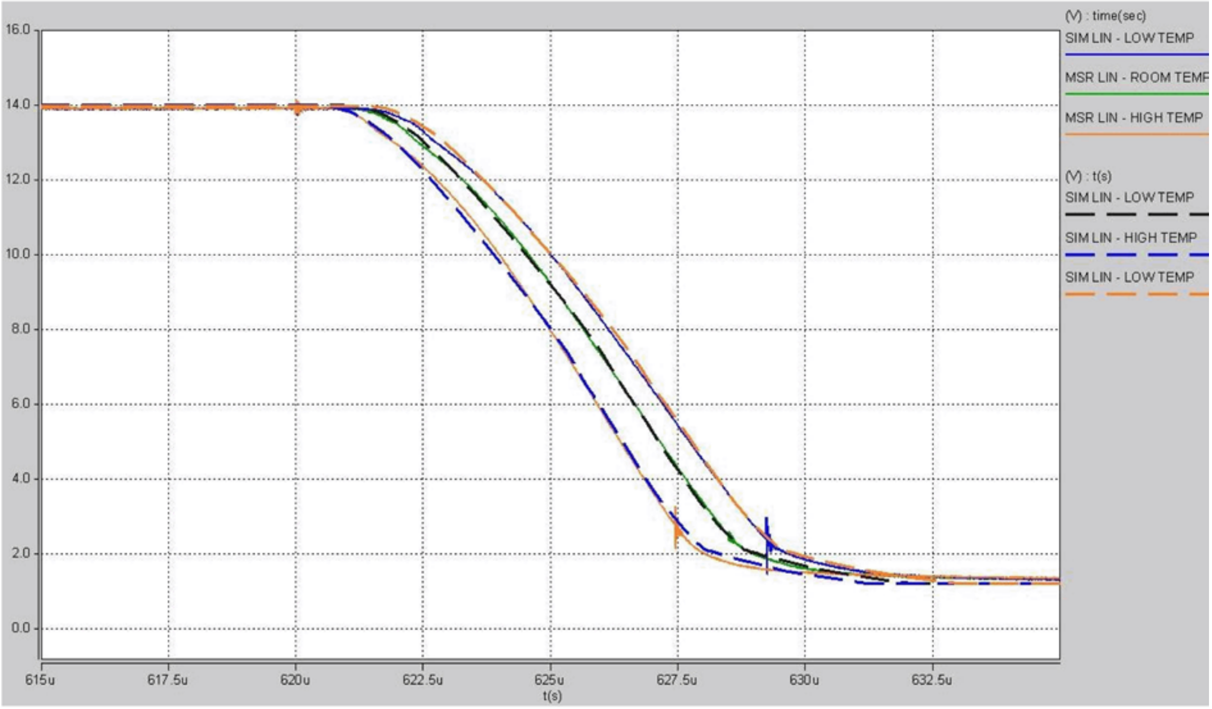
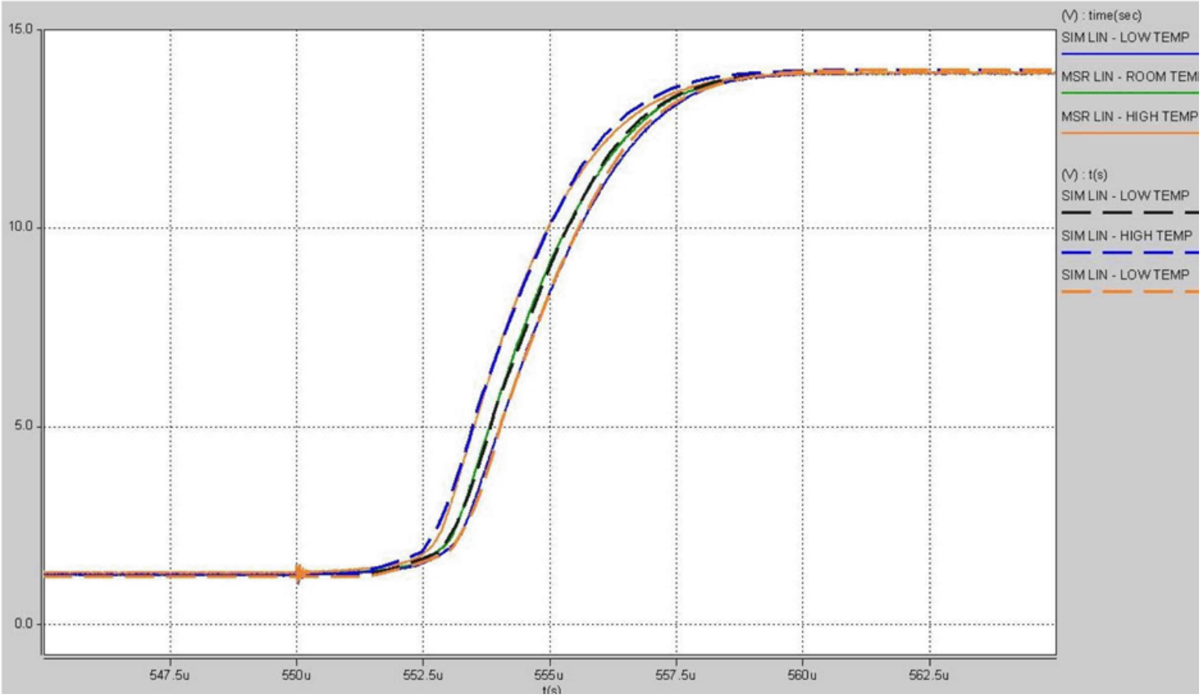


Figure 1-9. Rise for VS = 14V



1.3.2.4 Supply = 18V

The three temperature scenarios are shown with a supply level of 18V in the following figures. The model output (SIM LIN) overwrites the measured signals (MSR LIN) with a dashed line.

Figure 1-10. Fall for VS = 18V

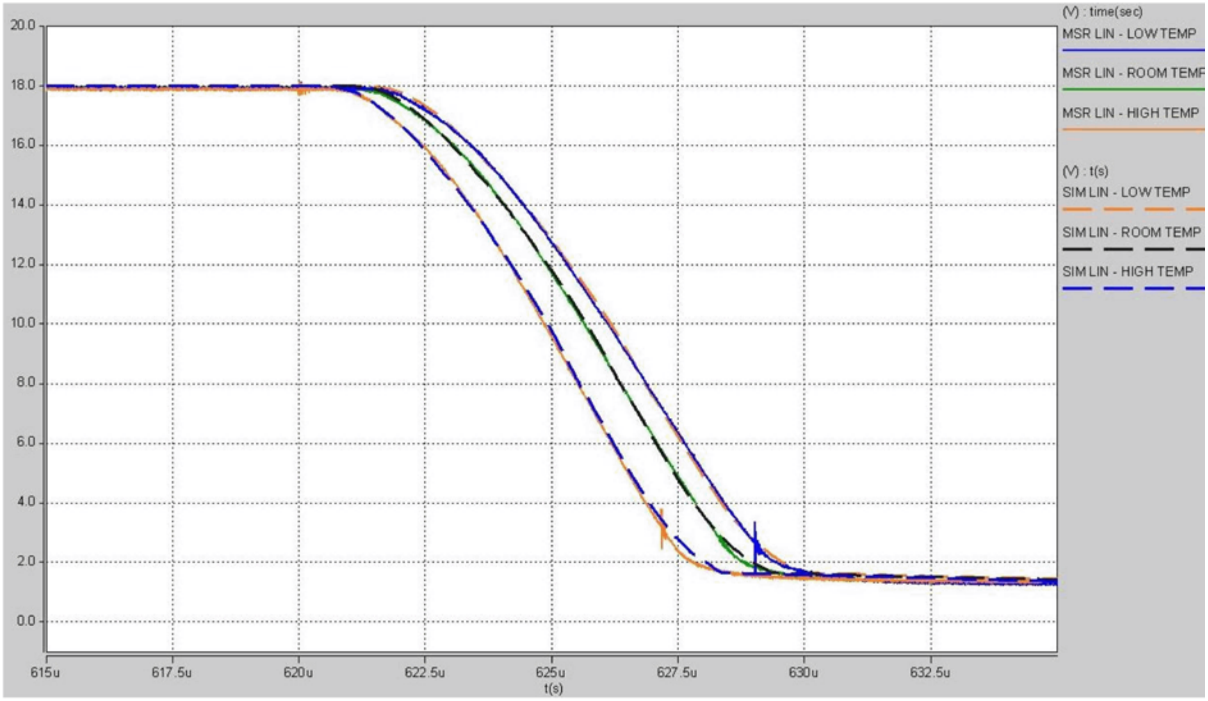
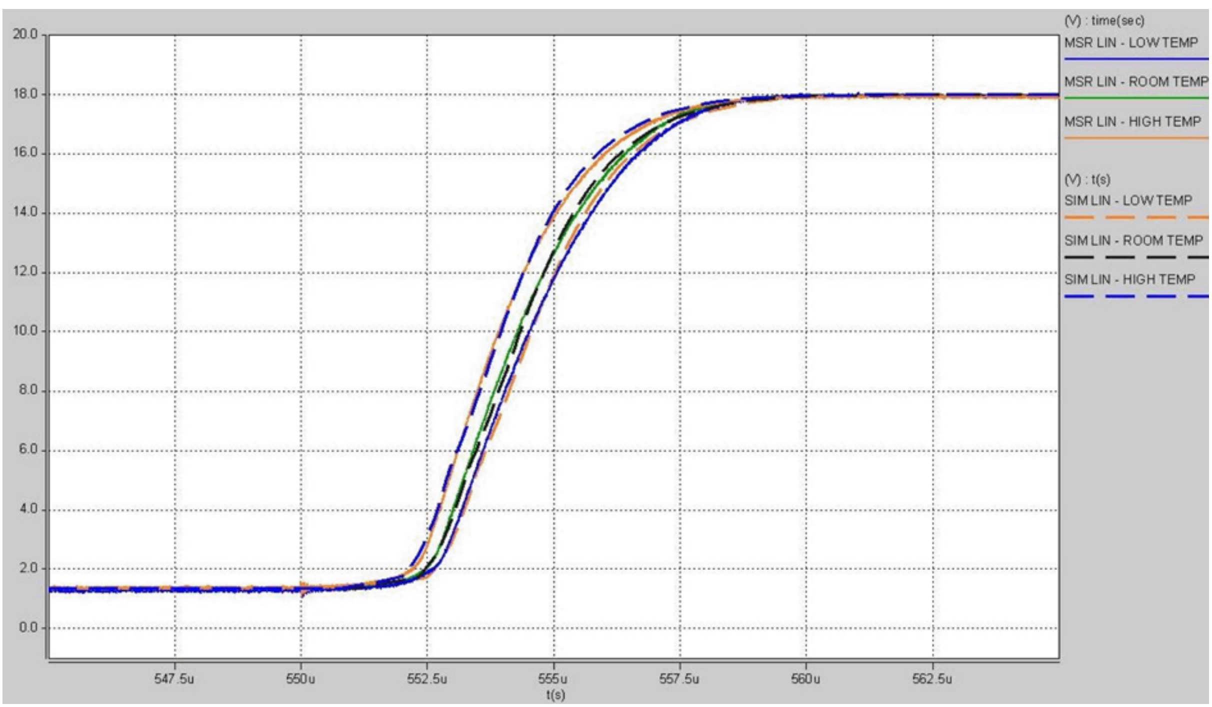


Figure 1-11. Rise for VS = 18V



1.3.2.5 Supply = 28V

The three temperature scenarios are shown with a supply level of 28V in the following figures. The model output (SIM LIN) overwrites the measured signals (MSR LIN) with a dashed line.

Figure 1-12. Fall for VS = 28 V

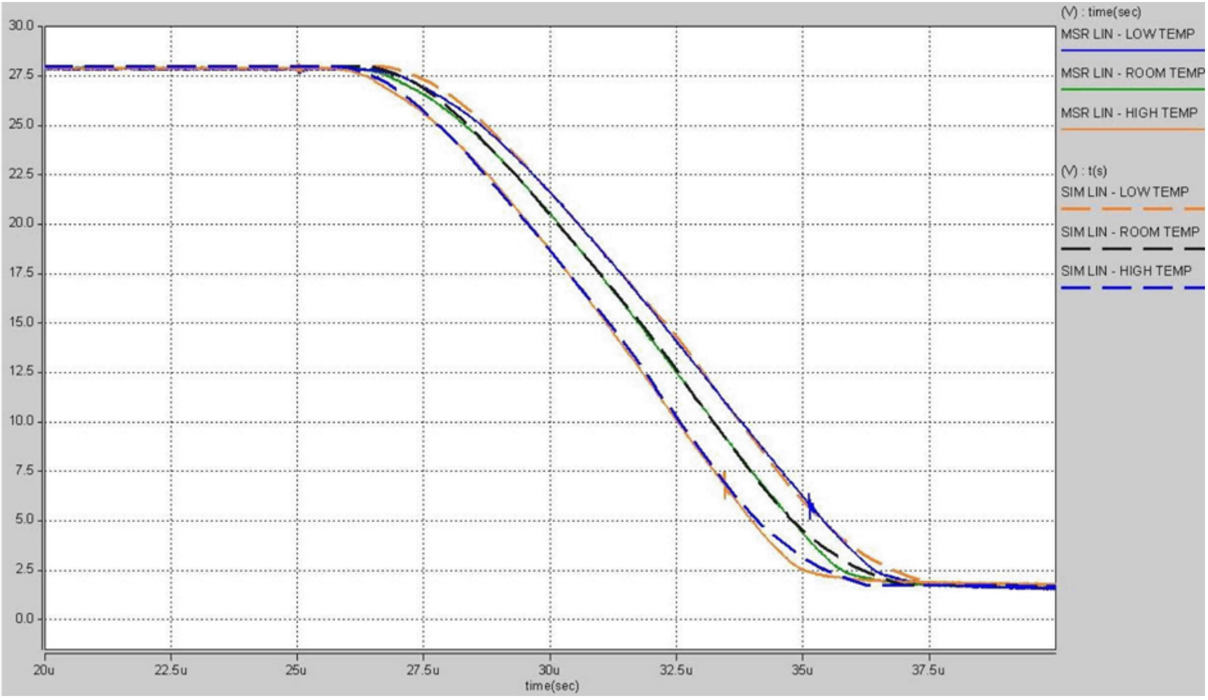
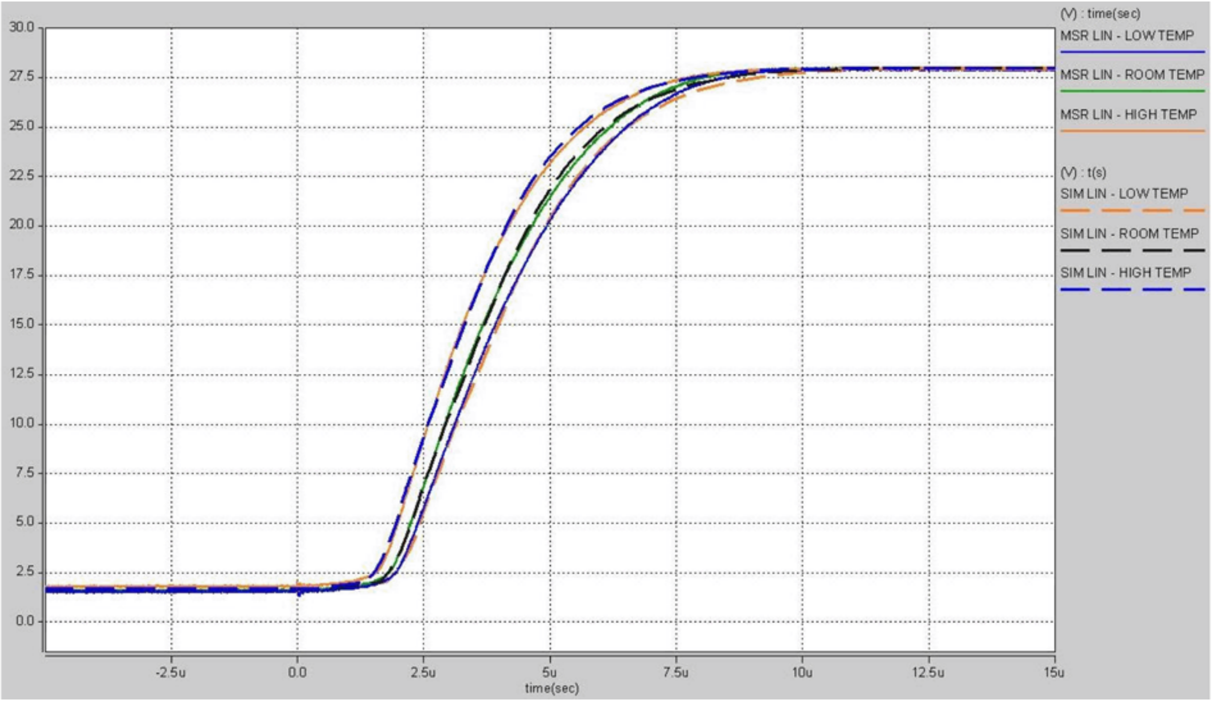


Figure 1-13. Rise for VS = 28V



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