

Is the TMUX405x Logic Compatible with the CD405xB and CD74HCx405x Family of Devices?



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ABSTRACT

The [TMUX405x](#) family of multiplexers are pin to pin to with the CD405xB and CD74HCx405x families. The multiplexers support 24 V single-sided supply or ± 12 V in dual-sided supply and feature 1.8 V logic compatibility, fail-safe logic, and the industries smallest ([SOT-23](#)) package.

Seeing the performance and features of the TMUX405x family, many designers will add the TMUX405x to enhance their systems currently using CD405xB and CD74HCx405x. When designing the new device into the system, one considerations that must be made is the logic compatibility between the previous and new devices. Legacy CD405xB and CD74HCx405x devices will typically require legacy Transistor-Transistor Logic (TTL) or CMOS logic drivers to control the logic inputs of the mux. Due to the architecture of these drivers, they will each have different output voltage levels which impacts how devices interact with these drivers. This application note's objective is to expand on this logic compatibility and show how to evaluate whether the TMUX405x 1.8 V logic compatibility feature is compatible with the legacy TTL or CMOS logic drivers currently in use.

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1 Logic Compatibility

The fundamental concept of the threshold levels (V_{IH} , V_{IL} , V_{OH} , V_{OL}) are expanded on in this TI Precision Labs training video - [Output/input logic levels \(\$V_{OH}\$, \$V_{OL}\$, \$V_{IH}\$, \$V_{IL}\$ \)](#). The following information builds upon the basic understanding of these thresholds based on the information provided in this video.

To check the compatibility between any device's logic inputs and the pre-existing driver, a simple comparison of the V_{OH} and V_{OL} levels of the driver versus the V_{IH} and V_{IL} thresholds of the multiplexer in question can be done. The following is a more in-depth explanation on how to check the V_{IH} and V_{IL} compatibility of your TMUX405x when used in a system that has a pre-existing CD405x or CD74HCx405x designed in.

1.1 V_{IH} Compatibility

To illustrate the V_{OH}/V_{IH} logic compatibility use an example case where the CD74HCT405x, with a V_{IH} minimum equal to 3.5 V, is driven by either a 5-V CMOS or 5-V TTL driver. [Figure 1-1](#), shows that the 5-V CMOS driver can work because the minimum V_{OH} of 4.44 V is greater than the 3.5 V V_{IH} minimum of multiplexer. However, the 5-V TTL driver minimum V_{OH} of 2.4 V is less than the 3.5 V V_{IH} minimum and might not be high enough to register a logic *HIGH* on the mux's logic control inputs under certain conditions.

Alternatively, by selecting the TMUX405x, a device with 1.8-V logic compatible inputs, we can see from the following how this V_{OH}/V_{IH} compatibility issue is resolved and the logic threshold required to register a *HIGH* on the mux's inputs is met under all conditions. See [1.8-V Logic for Multiplexers and Signal Switches](#) application note, for additional information on 1.8-V logic compatible inputs.

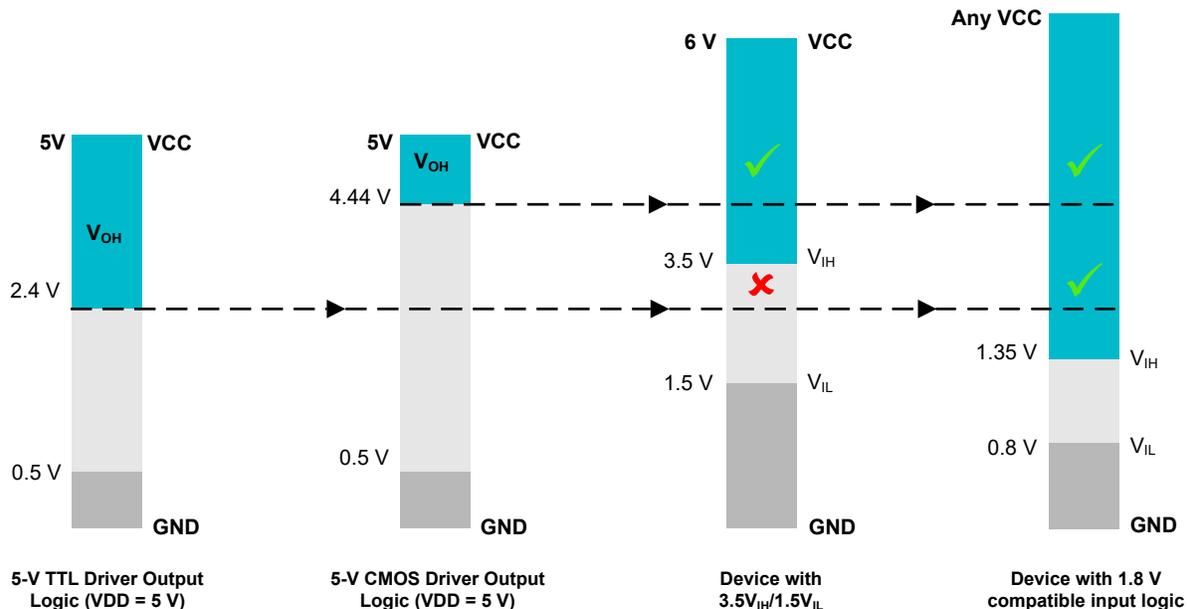


Figure 1-1. 5-V CMOS and 5-V TTL Drivers Output High Compatibility

1.2 V_{IL} Compatibility

Similarly, the low-level logic compatibility can be determined the same way through an understanding of the system and a side by side comparison of the V_{OL}/V_{IL} thresholds. To examine the V_{IL} thresholds of the multiplexer, we will first need to discuss the V_{OL} output voltage that comes from the driver. The V_{OL} voltage is the voltage that is output by the driver when a low logic state is the desired outcome. Typically, there will be some maximum value provided in the driver’s data sheet and will be associated with certain conditions to achieve these output levels (for example, current). The voltage driven to produce a logic *Low* is ideally close to 0 V, but due to leakage currents, 0 V won’t necessarily be achieved. The leakage and actual voltage level on the node will be determined based on the architecture of the output driver. In a well-designed system, this V_{OL} level will be close to 0 V varying only by mV’s. Because of this, often times system designers will overlook the V_{IL} threshold and mainly focus on the V_{OH}/V_{IH} levels instead with the understanding that the V_{IL} threshold compatibility will not play a significant role when it comes to the overall logic compatibility of the device in most scenarios.

To illustrate the V_{OL}/V_{IL} logic compatibility, use the TMUX405x with 1.8 V logic compatible feature with the minimum V_{IL} equal to 0.8 V driven by a 5-V CMOS or 5 V TTL driver. Figure 1-2 shows that both the 5-V CMOS and 5-V TTL driver works because the maximum 0.5 V V_{OH} is less than the maximum 0.8 V V_{IL} . The TMUX405x read this as a *low* input, indicating that the old driver used with the existing CD405xB or CD74HCx405x are logic-low compatible with the new TMUX405x

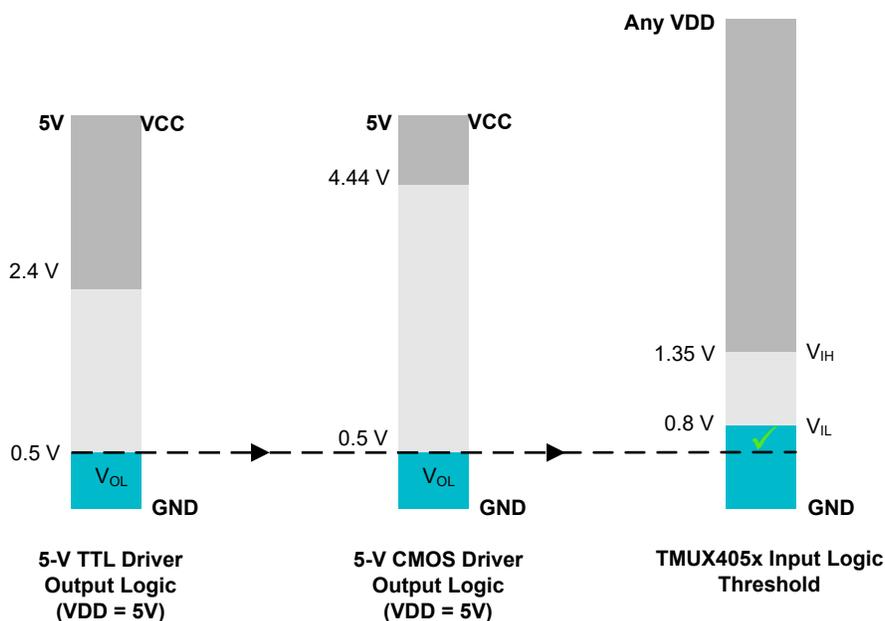


Figure 1-2. TMUX405x Output Low Compatibility with 5-V CMOS and 5-V TTL Drivers

2 Logic Outputs Levels vs. Input Control Logic Thresholds by Family

Figure 2-1 shows the typical standard logic output levels based on the different architecture and supply voltage levels. Now that you know how to evaluate the V_{OH}/V_{OL} and V_{IH}/V_{OH} logic compatibility, you can see the TMUX405x supports all four logic standards. The CD74HC405x, CD74HCT405x, and CD405xB do not support the 1.8-V CMOS drivers.

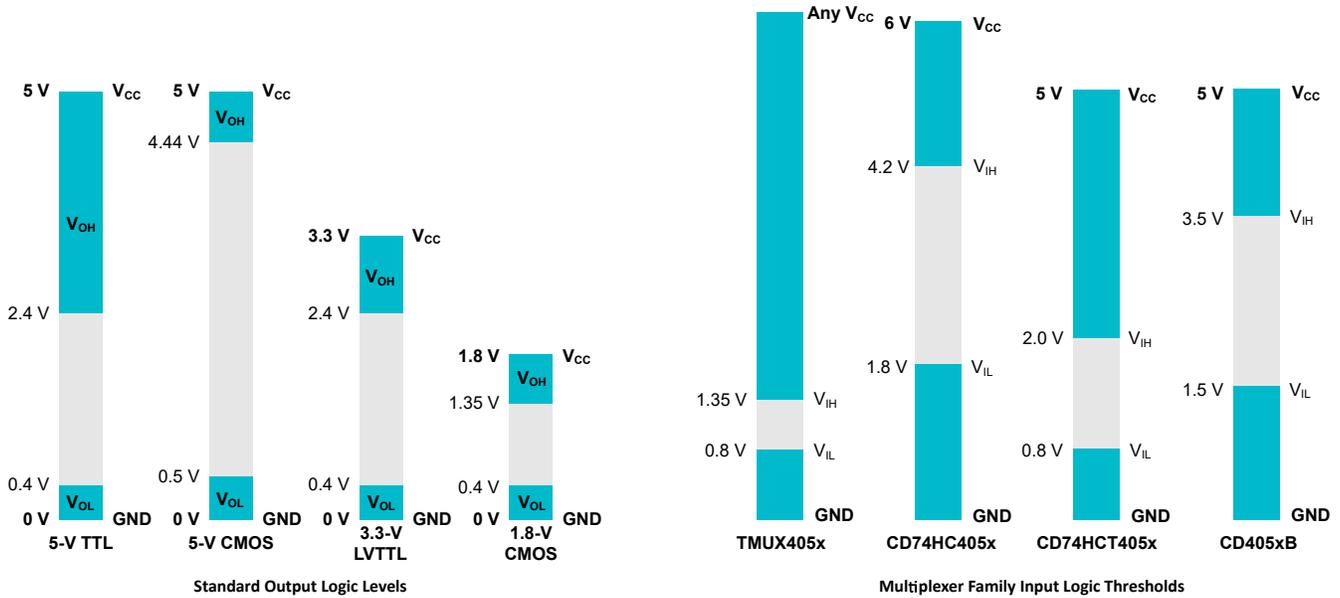


Figure 2-1. Logic Output Levels vs. Input Control Thresholds for TI 405x Multiplexer Families

Table 2-1. Device Family Recommendations

Device	Configuration	Key Features
TMUX4051	1-channel 8:1	±12-V signal range, 1.8-V compatible logic
TMUX4052	2-channel 4:1	
TMUX4053	3-channel 2:1	
CD4051B	1-channel 8:1	±10-V signal range, CMOS compatible inputs
CD4052B	2-channel 4:1	
CD4053B	3-channel 2:1	
CD74HC4051	1-channel 8:1	±5-V signal range, CMOS compatible inputs
CD74HC4052	2-channel 4:1	
CD74HC4053	3-channel 2:1	
CD74HCT4051	1-channel 8:1	±5-V signal range, CMOS, and TTL compatible inputs
CD74HCT4052	2-channel 4:1	
CD74HCT4053	3-channel 2:1	

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