



Keywords: Bus Buffer, I²C, IES5501, Bus switches, LED drivers

Summary: The I²C bus has a drive capability limitation, if a bus switch feeding a large number of branches needs to select all branches, for example when driving a large number of slave LED drivers in large display panels, the total loading on the input I²C bus will almost certainly exceed the allowed loading on the input I²C bus, the bus switch, or both. The solution can be simply using a bus buffer with I²C compliant logic switching levels on each bus switch output, or on as many outputs as required to remain within the I²C bus loading limits.

The I²C bus often has a drive capability limitation, when it is required to select all branches, for example when driving a large number of slave LED drivers in large display panels. The total loading on the input I²C bus will almost certainly exceed the allowed loading on the input I²C bus, the bus switch, or both. This problem is easily solved via using an I²C compliant logic switching levels on each bus switch output, or on as many outputs as required to remain within the I²C bus loading limits

The IES5501 has compliant switching levels and therefore places no restrictions on joining multiple buffer I/Os as happens when the bus switch enables multiple

outputs in parallel. The true buffering of IES5501 means the loading at each bus switch output can be just a few pF. The pull-up resistors marked as R2 on each buffer input are only required to hold the buffer inputs high when they are de-selected by the bus switch. A suitable value will be 100k - 470k so even when 8 outputs are selected the bus loading at the input is greater than 12k. The total capacitance can be estimated as 10pF per buffer, 3pF per switch output, 20pF switch input plus allowance for tracks. 20pF per switch output should provide a conservative estimate, so just 160pF for 8 branches. Each buffer output can drive at least 400pF per branch, allowing a total I²C system loading of 3200pF in this example.

DI001: Buffering I²C bus switches to create larger I²C systems

Resistors R3 are selected to achieve the required rise time on each branch. Resistors R1 are selected to provide the required rise time when ALL switch outputs are selected. Switch and buffers will contribute less than 160pF, well below the I²C allowed 400pF maximum. The overloading situation is solved.

- I²C rise time = $0.85 \times R \times \text{bus capacitance}$ (R in ohms, Capacitance in Farads).
- R minimum = Bus supply / 3mA provides the fastest rise time.

The IES5501 allows bus logic level shifting, if required, but keep in mind its logic switching levels are set by its Vcc. If the supply Vcc2 is chosen as 5V then the I/O (and slave bus) switching level for a bus low is set at $33\% \times 5V = 1.65V$. Because the IES5501 has tightly controlled switching levels that remains compatible with the use of 3.3V logic on the bus switch, it is not necessary to reach the usual switching level of $70\% \times 5V = 3.5V$ but it's always wise to check these points.

The IES5501 datasheet shows that it is possible to simply parallel all IES5501 inputs then use a lower cost GPIO, or even a simple logic decoder, to control the 'Enable' inputs of each IES5501 and achieve the same functionality.

If necessary, each IES5501 output could be buffered using a P82B715 so the distribution lines could be run at 30mA Fast-mode Plus (Fm+) bus levels to allow long cabling with large numbers of Fm+ slaves directly connected to that cable. A total wiring plus device loading of at least 4000pF per branch (32nF total) could be supported.

See [AN102 Simplifying extended I²C design with the IES5501 and P82B715](#) for details from Hendon Semiconductors official bus buffer website.

Ordering Information

Part Number	Package	Package Type
IES5501T	SO8	Tube
IES5501D	MSOP8	Tube
IES5501TR	SO8	Tape and Reel
IES5501DR	MSOP8	Tape and Reel

Other Hendon Semiconductors related parts

Part Number	Description
IES5502	Fast dual-bidirectional bus buffer with hot insertion logic
IES5505	Simple two wire bus buffer
IES5515	Simple two wire bus buffer

Designing an I²C system? Email the bus buffer experts at hendon.info@hendonsemiconductors.com for suggestions to optimize your system. For more information please visit www.bus-buffer.com

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