



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

Summary: Driving cables across a very large area will require hundreds of metres of cables for example in application such as driving LED drivers in large architectural lighting. Bus switches are used to resolve address conflicts and using a bus buffer with compliant logic switching levels on each of the outputs such as the IES5501 will place no restrictions on the bus when the bus switch enables multiple outputs in parallel.

Requirement: An I²C bus system is required to cover a very wide area, for example when driving a large number of slave LED drivers in large architectural lighting displays. The cabling is required to cover a very large area and will require hundreds of metres of cable. Bus switches are included to resolve address conflicts, but 'select all' is also a requirement.

Solution: Use buffers with I²C compliant logic switching levels on each bus switch output. Use P82B715 to convert from 3mA to 30mA drives and either use all Fm+ devices on the long cables OR use local buffering with P82B715 or P82B96 to interface back to 3mA bus levels as shown.

(Note: P82B96 cannot be used at the bus switch position because it is not allowed to parallel its Sx/Sy 3mA I/Os and that connection occurs when multiple switch outputs are selected.)

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 and R3 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 that even when 8 outputs are selected the contribution to the bus pull up at the input is still 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 IES5501 output can drive at least 400pF per branch so when directly interfaced to P82B715 the

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Lx/Ly side of P82B715 can drive at least 4000pF. With 8 branches that is allowing 32nF total system loading.

With Cat5 twisted pair cable at 50pF/m that supports hundreds of metres of cabling. In practice, with the 5V logic levels as shown, it is probably wise to restrict each branch to around 30m but that still allows a system with more than 240m of cabling.

330ohm resistors, fitted at the two extreme ends of the cable, combine to provide the lowest allowed pull-up for 5V and, together with the controlled slew of P82B715; control overshoot and ringing on the cable. Faster drivers such as P82B96 and PCA9600 and even the Fm+ parts will cause some ringing and overshoot so it is always a good design rule to include the Schottky diode clamps at every node as shown.

Because FET switches are effectively common base FET amplifiers, a configuration selected for highest frequency RF amplifiers, it may be found necessary to add small capacitors (C) to avoid irregularities on rising bus edges. A suitable value will be around 33-100pF depending on the number of FET switch outputs. Resistors R1 are chosen to provide the required rise time when ALL switch outputs are selected. The 8-output switch and buffers will contribute less than 160pF and the total including Cs should be kept below the I²C allowed 400pF maximum.

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

See [AN102 Simplifying extended I²C design with the IES5501 and P82B715](#) for more details and examples of the clean waveforms for a 20m cable.

Parts 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 Bi-directional 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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