NXP Semiconductors logic in automotive applications

by Michael Lyons, Product Marketing, BL Logic

As a leading supplier of logic products to the automotive industry, NXP Semiconductors focuses on quality: quality of product, quality of supply and quality of support. Quality that is perfectly represented by our Q100 logic range — proven either by decades of reliable use in automotive applications or by exceeding the levels of reliability outlined in the automotive industry's AEC-Q100 standard. Amongst other things, this standard outlines:

- Rigorous stresses such as high temperature operating life (HTOL) and highly accelerated stress testing (HAST) that, when combined, simulate the aging of a device in an automotive environment
- Manufacturing practices to limit the potential for non-typical outlier products to be delivered to automotive customers

NXP's logic products are used in a wide variety of automotive applications including instrument clusters, body control modules and engine control units.

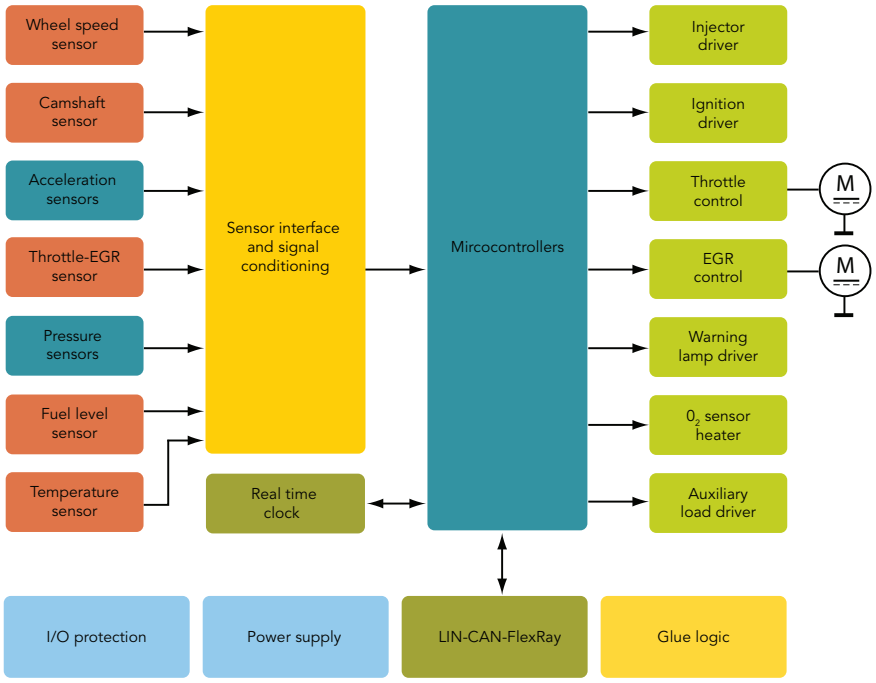
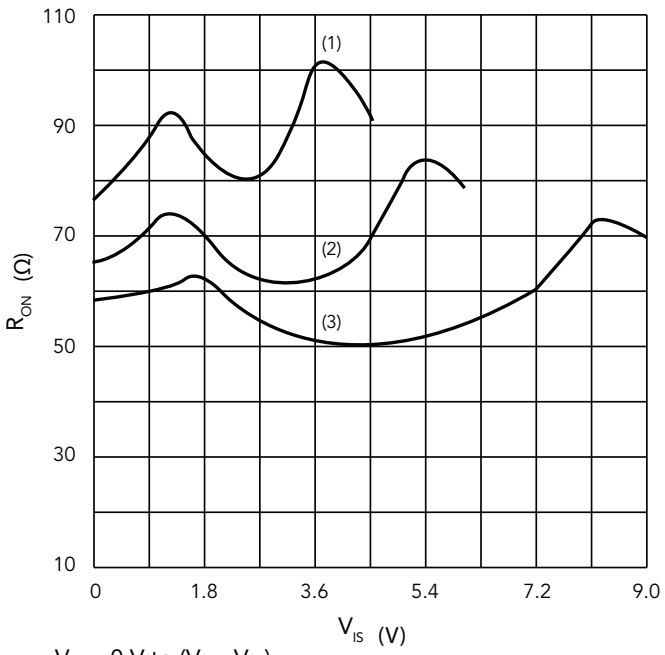


Figure 1 Gasoline engine control unit block diagram

I/O expansion

Input and output (I/O) expansion devices such as analog and digital multiplexers are used extensively to reduce the complexity, pin count, and ultimately cost of any microcontroller-based solution. The sensor interface of a gasoline engine control unit, shown in Figure 1, is often an analog multiplexer function such as the 4051. It selects one of eight inputs to be passed to the single output. Using such a device enables eight analog sensors to be interfaced sequentially to a single analog to digital converter (ADC) of a microcontroller. Important parameters to consider when selecting an analog multiplexer are the ON resistance, variation of ON resistance with input voltage, or ON resistance flatness, and the ON-state leakage current. The ON resistance determines how much the sensed signal is attenuated. Any variation of ON resistance with input voltage will lead to signal distortion while high ON-state leakage will result in additional signal loss. The combined effect of these parameters on the sensed signal determines the required accuracy of the microcontroller's ADC.



V_{IS} = 0 V to (V_{CC} -V_{EE})

(1) V_{CC} = 4.5 V

(2) V_{CC} = 6 V

(3) V_{CC} = 9 V

Figure 2 R_{ON} v V_{IS} 74HC4051

NXP's 5 V range of 8:1 analog multiplexers includes the 74HC4051-Q100 and 74HC4851-Q100. The 74HC4051-Q100 has 4 µA maximum ON-state leakage current at 125° C and the R_{ON} v VIS characteristic shown in Figure 2. This results in 0.04% total harmonic distortion (THD). The 74HC4851-Q100 has a similar R_{ON} v VIS characteristic to that of the 74HC4051-Q100, but only 1 µA ON-state leakage current at 125° C. It also has an added injection current control feature which enables the user to apply signals of amplitude greater than the supply voltage to the switch terminals.

NXP's next generation 3.3 V range of 8:1 analog multiplexers includes the NX3L4051-Q100. This has 2 µA maximum ON-state leakage current at 125° C, and the combination of the sub 1 ohm ON resistance and sub 0.35 ohm ON resistance flatness leads to a typical THD of just 0.02%. The 74HC4051-Q100, 74HC4851-Q100 and NX3L4051-Q100 are all available in the industry standard 16-pin TSSOP package, as well as NXP's innovative smaller footprint leadless DHQFN and HXQFN packages.

Display drivers

Display drivers integrate serial-in parallel-out shift registers, which are common I/O expansion devices, with MOSFET LED drivers. They reduce the size, complexity, pin count and ultimately

cost of any microcontroller based solution. The display driver shown in the instrument cluster block diagram in Figure 3 is often a logic LED driver such as the 596 or 4894 functions. They allow the microcontroller to enter 8-bit data serially using just two of its I/O pins — one connected to the input clock, the other connected to the serial input. Once the 8-bit data has been loaded into the LED driver's shift register a third microcontroller I/O pin is used to clock the

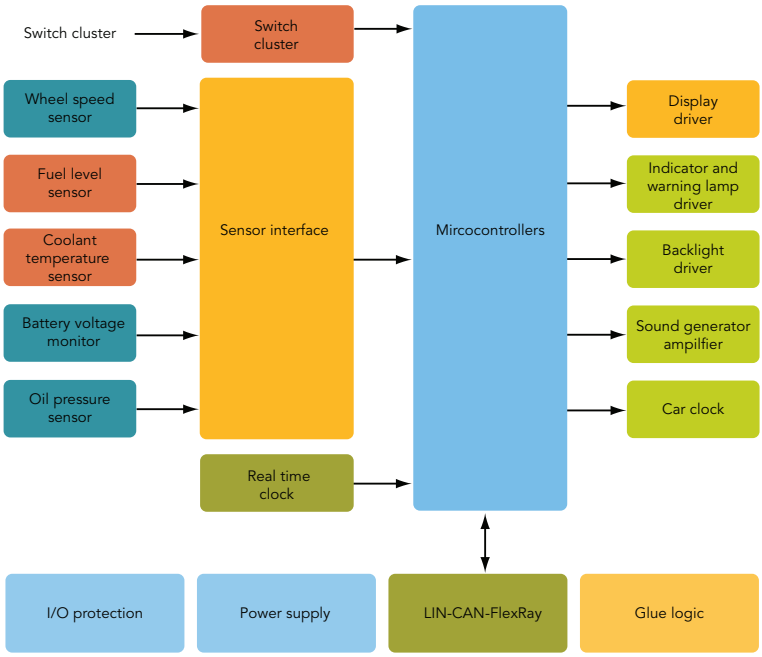


Figure 3 Instrument cluster block diagram

8-bits to the open-drain outputs which drive the LEDs. Logic display drivers include serial outputs which allow the cascading of devices as shown in Figure 4. The result is that three microcontroller I/O pins can be used to control 16-bit, 24-bit, or even higher bit width solutions. As well as bit width, important parameters to consider when selecting a display driver are output current drive and output voltage rating. They determine the suitability of the device for the given display, be it a grid or panel, seven-segment or single indicator.

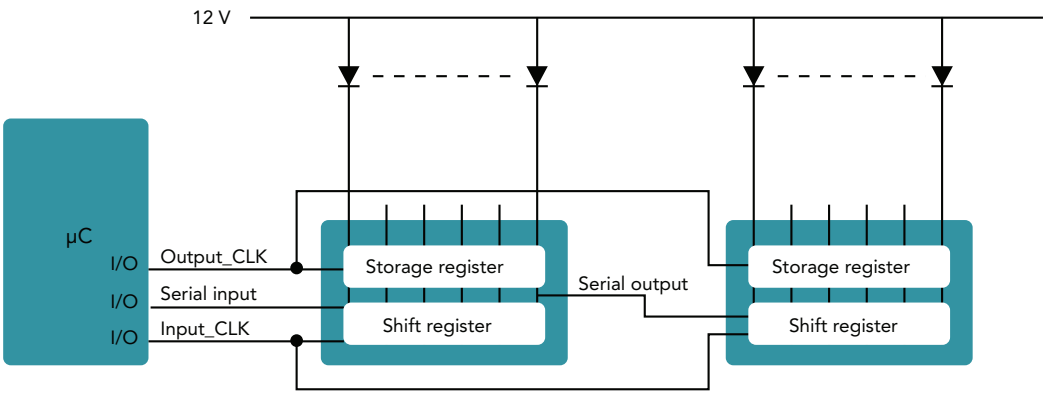


Figure 4 Cascading of 8-bit display drivers

NXP's range of shift register based, open drain output display drivers includes the HEF4894-Q100. It combines a 12-bit shift register with 15 V / 40 mA open-drain outputs. A wide 5 V to 15 V supply range allows it to interface to standard 5 V microcontrollers. For higher current applications NXP has introduced the NPIC6C596-Q100, 8-bit shift register with 33 V / 100 mA open drain outputs which also maintains the standard 5 V control interface. Both devices are available in the industry standard SO and TSSOP packages, while the NPIC6C596-Q100 is also available in NXP's innovative smaller footprint leadless DQFN package.

Buffers, line drivers

Buffers and line drivers are used when the output drive capability of a microcontroller is not sufficient to drive the output load. They reduce the size and ultimately cost of any microcontroller based solution. The body control module demux drivers shown in Figure 5 often use a logic line driver such as the 244, 573 or 125 functions. They provide the higher output drive capability that allows the body control module to drive pumps for wiper/washer control, or motors for power window control. In some cases body control modules use multiple line driver circuits. If all these outputs are switched at the same time, it may result in high EMI and system instability due to the high output drive. To avoid this latched drivers are used. In latched drivers the output only changes on a HIGH to LOW transition of the LE (Latch Enable) input, as a result the microcontroller can sequentially enable each driver, or combination of drivers, to reduce EMI. The most important parameter to consider when selecting a buffer-line driver is output drive, which can be used together with the supply voltage to determine if the resultant output voltage will be sufficient to switch the target load.

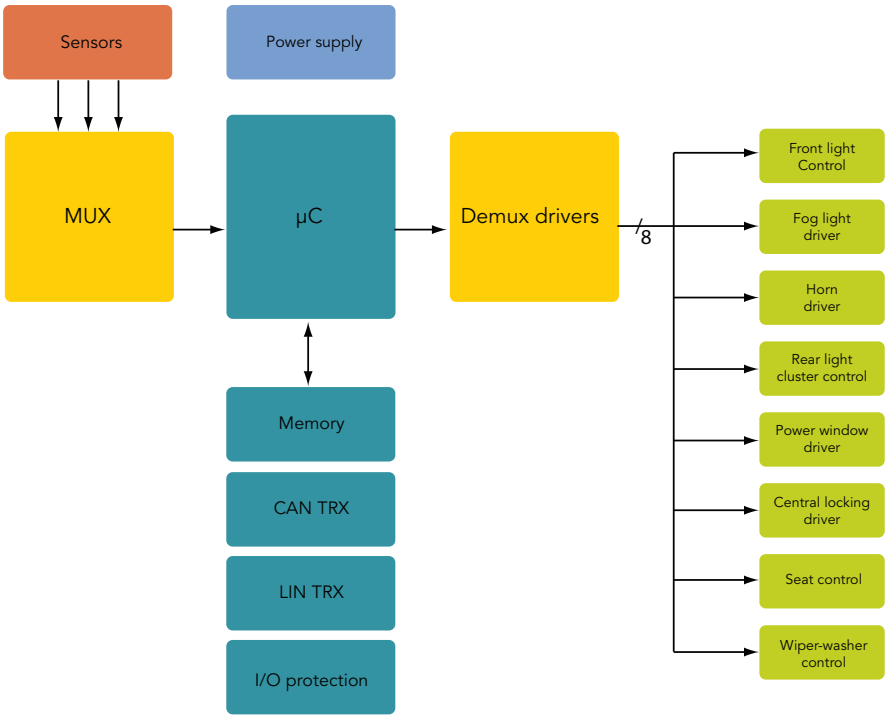


Figure 5 Body control module block diagram

NXP's range of buffers / line drivers includes the 74AHCT244-Q100, 74HC573-Q100 and 74LVC1G125-Q100. The 74AHCT244-Q100 is an 8-bit solution for 5 V applications and has 8 mA drive capability. Also with 8 mA drive at 5 V supply, the 74HC573-Q100 is an 8-bit latched solution for 3.3 V and 5.0 V applications that use multiple devices. It has the additional advantage of having flow through architecture (data inputs opposite data outputs), allowing for easier board layout. For lower voltage, higher drive applications the LVC family can be used. The 74LVC1G125-Q100 is a single driver solution for 1.65 V to 5.5 V applications, with an output drive of 24 mA at 3.3 V and 32 mA at 5.5 V.

8-bit solutions such as the 74AHCT244-Q100 and 74HC573-Q100 can be found in the industry standard SO and TSSOP packages as well as NXP's innovative DQFN leadless package. Single bit solutions such as the 74LVC1G125-Q100 can be found in the industry standard TSSOP5 package as well as NXP's innovative leadless HSON6 package.

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