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Matrix LED and Where They Are Used

People today come in contact with a wide range of consumer electronics (CE) devices in their daily lives. CE devices have become increasingly complex with added functionality enabled by MCU's which provide the intelligence for automating functions. Control panels used in appliances and other equipment leverage MCUs and several integrated circuits to enable functions, such as sensing, process control and user interface (UI).

The user interface consists of input controls, visual and audio feedback used to configure the product to perform complex tasks. An aesthetically pleasing UI (Fig. 1) is a major differentiating feature for home appliances such as ovens, washing machines and refrigerators. Home appliance UIs commonly use capacitive or inductive touch sensing to provide an easy to clean interface unmatched by mechanical buttons. In addition to touch sensing, a UI has to provide audio and visual feedback in response to the user selection. The UI may not be the most important factor in determining the commercial success of CE devices. However, once parity is established on the major functions such as washing capacity, energy efficiency, etc, the UI becomes a key differentiator. Today, parity has been established on most of the important factors making the UI a product differentiating factor.

As the trend continues to move away from purely mechanical switches to a fully electronic interface expect to see demand for LEDs and drivers to continue increasing. ISSI is in a position to offer cost effective audio and LED driver solutions to address today's UI requirements.

Fig. 1: Samsung Refrigerator Control Panel

LED user interface

There are many types of LED displays available based on the target price of the appliance and end user preference. One can use 7 segment LED, dot matrix LED or strategically placed individual LEDs for a cost effective display. Typically the design engineer would use the onboard MCU to drive the LEDs. However MCU-based LED driving consumes valuable CPU cycles and the display refresh can be uneven or unreliable, depending on the firmware. For this reason designers of complex control panels turn to an I2C programmable LED driver to offload the MCU resulting in simplified firmware and a stable LED output.

Consider an appliance control panel such as in Fig. 2 with a variety of LEDs providing appliance operation feedback. In this application the panel supports many individual LEDs as well as 7 segment display; impossible to support with the limited number of MCU GPIOs. In the example shown below, a matrix LED driver such as the IS31FL3731 with support for up to 144 LEDs can easily drive each individual LED in addition to the 7 segment display.

Fig 2: Example Control panel Application

Controlling a large number of LEDs

For a matrix format (Fig. 3), LEDs are arranged in rows and columns. In this matrix arrangement LEDs are driven in a multiplex fashion which is more efficient compared to individually driving each LED. A matrix architecture results in fewer PCB traces requiring less PCB area with lower power consumption while controlling a large number of LEDs. The IS31FL373x family of matrix LED drivers integrate many advanced features such as a configurable matrix (row/column) architecture, individual LED control registers, individual LED open/short fault detection, support for a mix of monochrome and RGB LEDs; all accessible via a fast 1MHz I2C compatible bus interface (see table below).

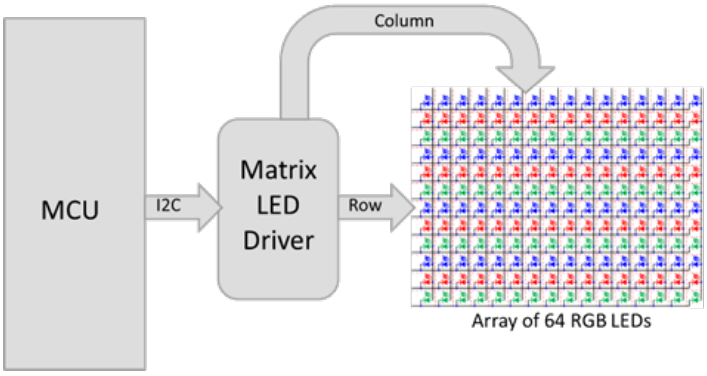

Fig. 3: Example Control panel Application

Diversity of Applications

Typical applications for ISSI's matrix LED driver are unlimited; as shown in the examples below:

Control panel for music mixer

In the example below, a single matrix LED driver can be used to drive the 7 segment display as well as backlighting the RGB buttons. A music mixing panel has many functionalities such as control of the level and position for each individual audio signal, their equalization and filtering, grouping, routing to a recording device or effect processor, etc. Therefore the button function will vary depending on the user's preference. For maximum flexibility the matrix LED driver is used to change the button backlight color to convey a specific function and grouping.

Fig. 4: Driving LEDs in music mixer

Backlight for small LCD screens

Home medical devices such as blood glucose meters are small, portable, and relatively easy to use. These medical devices sometimes incorporate a small LCD panel to display instantaneous test results, so patients can make decisions about taking necessary medications. Since patients rely on properly viewing and interpreting the LCD results, it is imperative the display be visible under all lighting conditions.

In the application of Fig. 5, the IS31FL3733 is used to drive an array of white LEDs to provide the optimum illumination for the medical device display. Proper visibility and interpretation of the displayed results is very critical to avoid patient misinterpreting the LCD display due to poor lighting conditions or from the failure of an LED. Not only does the IS31FL3733/36/37 family drive up to 192 LEDs (enough to cover any small LCD display) but they also detect and report LED open/short conditions. Upon detecting a failed LED, the medical device can decide to disable itself to avoid a patient incorrectly reading test results due to poor lighting. This open/short detection function enables an added level of safety for medical devices.

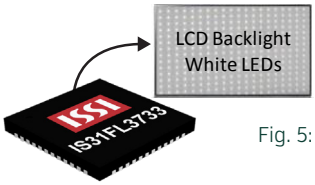

Fig. 5: Driving LCD backlight

Automotive Applications

The application for LED lighting in automobiles is never ending, LEDs are replacing incandescent lighting resulting in less battery consumption and greater fuel efficiency. Recognizing the need for ever greater automotive LED content, ISSI has introduced our first AEC-Q100 LED driver, the IS32FL3738. As shown below the IS32FL3738 can drive 48 monochrome or 16 RGB LEDs. For applications requiring a LIN bus interface, the block diagram below (Fig. 6) shows how a LIN micro can be used to interface the LIN bus with the I2C bus of the IS32FL3738 and drive a multitude of LEDs; not possible with the LIN micro alone.

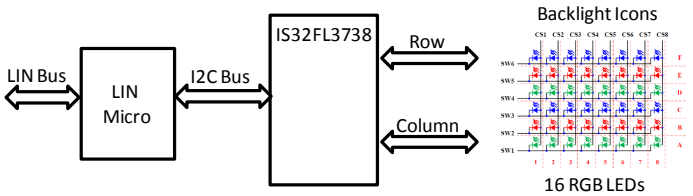

Fig. 6: Block diagram of LIN to LED matrix

Automotive instrument clusters provide an attractive and well-defined automotive status information to keep the driver informed. They combine various pieces of information centrally in the driver's primary viewing range, LED lighting helps to emphasize status and importance of an event. The diagram (Fig. 7) below shows the possible ISSI analog devices available to designers of automotive instrument clusters. The IS32FL3738 can be used to individually light the cluster backlight icons or provide illumination lighting.

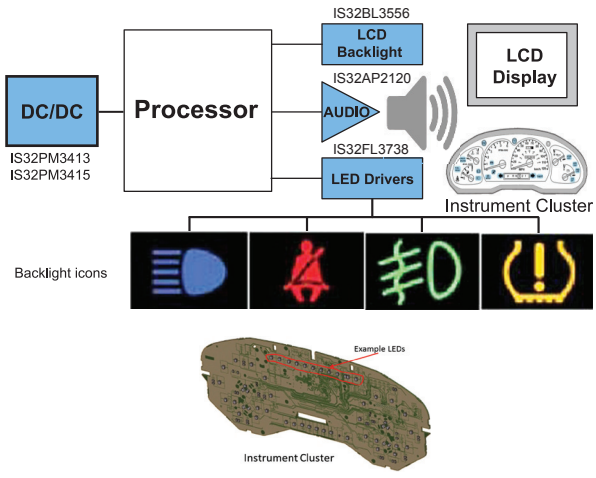

Fig. 7: Instrument cluster block diagram

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Family of matrix LED drivers

The ISSI family of matrix LED drivers has been evolving to meet ever expanding customer requirements. The first generation matrix driver evolved to the second generation by incorporating an enhanced I2C bus interface. The third generation built on the success of Gen 1 and 2 support even more LEDs, include detection/reporting of LED open or short faults and simplifies RGB LED support.

Part Number	3rd Gen			2nd Gen	1st Gen		
	IS31FL3733	IS31FL3737	IS31FL3736	IS31FL3732	IS31FL3728	IS31FL3730	IS31FL3731
Maximum LED Dot	**192(16x12)**	**144(12x12)**	**96(8x12)**	144(8x9x2)	64(8x8)	128(8x8x2)	144(8x9x2)
RGB LED	**64**	**48**	**32**	48	NA	NA	48
Scan Technology	**Single scan**	**Single scan**	**Single scan**	Multi-scan	Single scan	Dual scan	Multi-scan
I2C Speed	**1MHz**	**1MHz**	**1MHz**	1MHz	400KHz	400KHz	400KHz
I2C Address Programmable	**16**	**16**	**16**	16	4	4	4
Sync in Multi Chip Application	**Yes**	**Yes**	**Yes**	Yes	No	No	No
Integrated RAM Loop	**No**	**No**	**No**	Yes	No	No	Yes
Audio Modulated	**No**	**No**	**No**	Yes	Yes	No	Yes
Auto Breath Control	**3 Pattern group**	**3 Pattern group**	**3 Pattern group**	Global	No	No	Global
Register Lock	**Yes**	**Yes**	**Yes**	No	No	No	No
Anti-Ghost Function	**Yes**	**Yes**	**Yes**	No	No	No	No
Open/Short Detect	**Yes**	**Yes**	**Yes**	No	No	No	No
Each Dot PWM Control	**256 steps**	**256 steps**	**256 steps**	256 steps	No	No	256 steps
Global PWM control	**256**	**256**	**256**	256	15	15x128	No
Separate Analog/ Digital Vcc	**Yes**	**Yes**	**Yes**	Yes	No	No	No
Package	**QFN48(6x6), LQFP48**	**QFN40(5x5)**	**QFN40(5x5)**	QFN40(5x5)	QFN24(4x4)	QFN24(4x4)	QFN28(4x4), SSOP28

Table 1 of ISSI matrix LED drivers

Summary

ISSI's family of matrix LED drivers have been a success in the RGB gaming keyboard space, where we own a major share of this market. We are expanding the matrix LED market by introducing its advantages and features to the control panel segment; white goods appliances, mixer panel, small backlight and automotive applications.

Contact ISSI analog marketing for help with your customer LED driver applications, IC samples and evaluation boards.