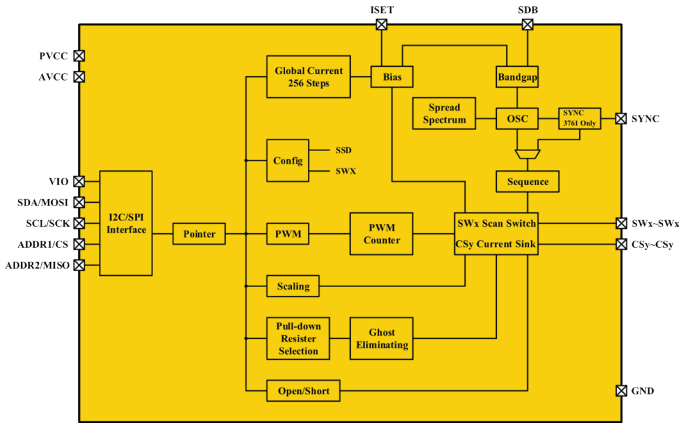
IS3xFL376x Family: Maximum LED Coverage, Minimal Power Waste

One of the main challenges in driving a large number of LEDs in a multiplexed or Charlieplexed configuration is managing the refresh rate. The refresh rate refers to how many times per second each LED is updated during the scan cycle. In simpler terms, the refresh rate is directly proportional to the PWM frequency and inversely proportional to the number of scan lines. So, increasing the number of scan lines lowers the refresh rate unless the PWM frequency is also increased. To avoid flickering and ensure compatibility with high-speed cameras, the LED driver must support a refresh rate well above typical camera frame rates. The IS3xFL376x family addresses this by supporting PWM frequencies up to 312 kHz in 6+2-bit mode, which is more than sufficient for smooth, flicker-free performance. Another key consideration is power efficiency. Especially in battery-operated applications, keeping quiescent current low is critical. The IS3xFL376x family performs well here too, with a typical quiescent current under 0.28 mA when all LEDs are off, helping extend battery life and reduce heat.

PWM Frequency Perception Comparison

The IS3xFL376x family supports up to 2.0V to 5.5V input range, which makes it well-suited for systems powered from a single lithium-ion cell. It can drive up to 396 LEDs, and this becomes especially useful in RGB applications where forward voltages vary, Red typically sits around 2.2V, while Green and Blue are closer to 3.4V. When driving these together, some LED drivers struggle to maintain proper current regulation due to insufficient voltage drop across the switch (SWx) and sink (CSy) paths. That's where the IS3xFL376x stands out. It's designed to operate with very low headroom voltage across its current switches and sinks, so it regulates accurately even in tight voltage conditions. These drivers can also be cascaded to scale beyond 396 LEDs, depending on the application.

These drivers support both SPI (12MHz) and I2C(1MHz) interfaces for programming and reading device registers. LED current is set using a single external resistor (ISET). For accurate RGB blending, the IS3xFL376x family supports both analog and PWM dimming. Analog dimming allows individual LED current control with 256 levels, while the integrated PWM generators support 8 or 12-bit resolution for smooth digital dimming. The block diagram below provides an overview of the integrated technologies in the IS3xFL376x family.



IS3xFL376x Block Diagram

To meet the demands of evolving lighting applications, the IS3xFL376x family includes built-in features that give designers flexibility in creating a wide range of lighting effects.

MATRIX SCANNING

These drivers use a 12-scan architecture, allowing individual control of LEDs arranged in a matrix array. The process works by sequentially activating each column (SWx) to power all the current sink rows (CSy). For each active column, the PWM timing for each CSy is applied individually. Once a full PWM cycle is completed, the driver moves to the next column, updates the PWM values, and repeats the process. After the final column (SW12), the sequence loops back to the first column (SW1). See Fig. 1 for reference.

This matrix scanning combined with PWM dimming on each LEDs is what enables Full Array Local Dimming (FALD), a key feature for improving image contrast especially in darker scenes by achieving deeper blacks and more precise control across the display.

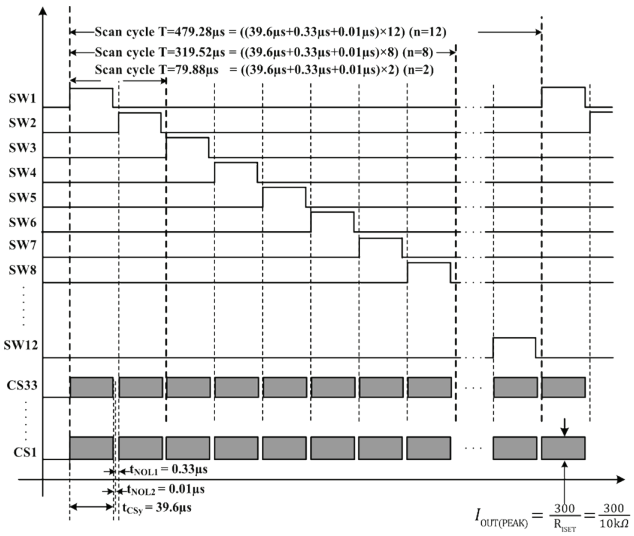


Figure 1: Scan Cycle Timing for *IS31FL3761

PWM FREQUENCY AND SCAN FREQUENCY

As mentioned earlier, The IS3xFL376x drivers support a high PWM frequency up to 312kHz. In short, PWM frequency determines how fast each LED's brightness is modulated during a single scan cycle, while the scan frequency defines how fast the entire matrix is refreshed.

Since scan frequency is directly tied to PWM frequency, when using a 12-scan configuration (n = 12 for SWx), the effective scan frequency reaches around 26kHz. That's a very high refresh rate, more than sufficient for most display and lighting applications.

This performance is achieved in the (6+2-bit) PWM mode, which balances resolution and speed. There are also other PWM modes available that offer higher resolution, though at the cost of lower scan frequency.

PWM DITHERING AND SPREAD SPECTRUM

Dithering and Spread Spectrum are the latest additions to the feature set in our LED drivers. These technologies help designers manage clock speed more efficiently. For example, in IS31FL3761 standard 12-bit PWM mode, the PWM frequency drops to around 6kHz. However, when using the 8+4-bit dithering mode, the PWM frequency increases to 92kHz while still running at the same clock speed as a conventional 8-bit mode. The benefit is clear: you get higher resolution without needing a higher clock.

Spread Spectrum support is also built-in and can be configured through the SSR (Spread Spectrum Registers). Designers can enable or disable the feature, or select a specific modulation range mode, directly from the register settings.
Both Dithering and Spread Spectrum are useful for reducing EMI and improving signal integrity especially in automotive environments.

DE-GHOSTING

In matrix-configured LED setups, ghosting can be a common issue where unintended LEDs light up dimly along with the intended ones. This is typically caused by parasitic capacitance in the matrix, especially when multiple scan lines and current sinks are active. To address this, the IS3xFL376x family includes integrated pull-down resistors on each SWx line and pull-up resistors on each CSy line. These resistors help discharge any residual voltage on the lines and prevent false triggering of LEDs during the scan cycle. What's worth noting is that these resistors are only active for a small portion of the scan period. This means they effectively reduce ghosting without adding unnecessary power loss to the system giving designers cleaner visual output without compromising efficiency.

SHUTDOWN MODES AND FAULT DETECTION

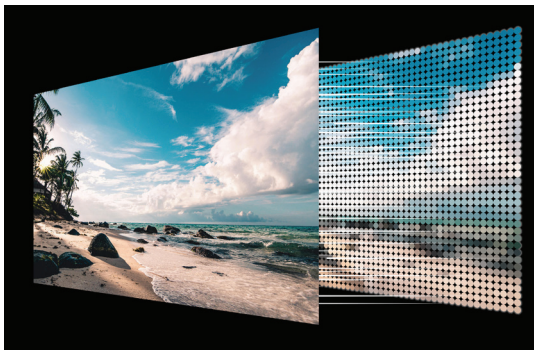
The IS3xFL376x Family support shutdown through both software and hardware control. From the MCU side, shutdown can be triggered by accessing the SSD register. Alternatively, a hardware shutdown is available by pulling the SDB pin low. Both methods disable all outputs and bring the driver into a low-power state, achieving quiescent currents as low as 0.6µA.

In addition, the drivers include built-in open/short detection for each LED channel. When an open or short condition occurs, the event is captured and stored in the corresponding OPEN/SHORT status registers. These registers can be read back by the MCU, making it easy to implement diagnostics or system-level fault handling.

USE CASES

A 33×n (n = 2~12) matrix driver like the *IS31FL3761 supports up to 396 individual LEDs or 132 RGB dots. It's a good fit for applications like RGB logo lighting and HMI backlighting, where multiple small seven-segment displays are integrated across a panel.

For designs that require fewer LEDs, the **IS31FL3762** is a practical choice, handling up to 288 LEDs. It's particularly useful in mini-LED backlight applications. The built-in Gamma Correction feature in these drivers helps match linear luminance output to the eye's non-linear perception, which improves the quality of visual effects like breathing or smooth fades. It also supports individual LED dimming, enabling full-array local dimming, a significant feature in backlight displays.



When it comes to keyboard backlighting, the **IS31FL3763** and **IS31FL3766** are strong options. Their output pin configurations are well-matched to TKL and full-size keyboard layouts. Features like de-ghosting and reduced reverse bias on LEDs help minimize visual artifacts caused by parasitic capacitance, improving overall lighting performance and reliability.

The IS3xFL376x family of LED matrix drivers are now in full production, and evaluation kits are available to help get designs up and running quickly. As shown in the table below, the family covers a range of matrix sizes and package types from the high-density 33×12 *IS31FL3761 in a QFN-60, down to the compact 18×6 IS31FL3766 in a QFN-32. All of these parts run between 2.0V to 5.5V, and they're designed with ultra-low quiescent current and shutdown modes to minimize power draw when the LEDs aren't active.

If you're looking for a driver that can handle a lot of LEDs, keep power waste low, and still fit into tight spaces, this family checks all the boxes. Plus, with an operating temperature range from -40°C to +125°C, they're rugged enough for environments like automotive and industrial machines.

KEY FEATURES

Part	Supply Voltage Range	Matrix Ch	Output Current per CSy	PWM Frequency	Interface	Fault reporting	Spread Spectrum	PWM Dithering	Special Features	Recommended Applications
*IS31FL3761	2.7 to 5.5V	33 × n (n=2~12), 12 Scan Timing	30mA	312kHz @ 6+2-bit PWM Mode	1MHz I2C or 12MHz SPI	LED open/ short	YES	YES	De-Ghost, Reduced LED reverse Bias	RGB Keyboard Backlight, Computer Hardware Peripherals, RGB Logo Light
IS31FL3762	2.7 to 5.5V	33 × n (n=2~12), 12 Scan Timing	30mA	312kHz @ 6+2-bit PWM Mode	1MHz I2C or 12MHz SPI	LED open/ short	YES	YES	De-Ghost, Reduced LED reverse Bias	RGB Keyboard Backlight, Computer Hardware Peripherals, RGB Logo Light
IS31FL3763	3.0 to 5.5V	33 × n (n=2~12), 12 Scan Timing	40mA	24kHz @ 6+2-bit PWM Mode	1MHz I2C or 12MHz SPI	LED open/ short	YES	YES	De-Ghost, Reduced LED reverse Bias	RGB Keyboard Backlight, Remote Backlight, LED Matrix Panel
IS31FL3766	3.0 to 5.5V	33 × n (n=2~12), 12 Scan Timing	40mA	288kHz @ 6+2-bit PWM Mode	1MHz I2C	LED open/ short	YES	YES	De-Ghost, Reduced LED reverse Bias	RGB Keyboard Backlight, Gaming Peripherals

*Note: The following parts are also available in [IS32] automotive version