

Active Matrix 4-CH Current Mode Mini-LED Driver

1. Features

- Supply Voltage
- VDD 3.0V ~ 5.5V
- Active Mode Current: 450uA (Typ.)

- Internal OSC up to 16MHz
- Frequency Multiplication
 - AM (Direct Driving) w/ x1, x2, x4, x8, x16, x32, x64

- 4 high precision current sinks (I-sinks)
- Breakdown voltage > 40V
- Driving current range, (0.5~5mA), (1.0~10mA), (2.0~20mA) and (3.0~30mA)
- Individual 7 bit I-DAC for each I-sink
- 0.4V saturation voltage @25mA for each I-sink
- 12-Bit true brightness control resolution with PWM dimming at 32kHz (with dither)
- PWM output frequency support (direct driving mode):
60/120/144/240/480/960/1920/3840 Hz
- PWM output frequency accuracy: +/-2%
- DC I-sink accuracy: +/-2%
- 2 Bit programmable slew rate control for EMI reduction from 0.3us to 2us
- 2+2 bit PWM output skew control
- Centre/Forward PWM waveform alignment

- Dimming mode control scheme
 - PWM - 12 bits

- Interface
 - Brightness control input (Dip)
 - Dynamic headroom status output
 - Fault reporting output (Dis/Dos)

- Diagnostics:
 - LED short detection
 - LED open detection
 - Input UVLO
 - Thermal shutdown at 165°C w/ 30°C Hysteresis

- Chip internal status readback
 - Vch measurement
 - OTP trigger event
 - LED Open/Short status

- Package:
 - CSP-10 Bumps
 - DFN3x3-10L

2. Description

The WH5097D is a 4 channel Mini LED driver designed for driving 2D-Backlight displays and it can support 12 bit PWM. With the appropriate timing control, the WH5097D can implement direct drive or scanning type driving methodologies. This device can deliver up to 30mA of continuous current per channel. The WH5097D utilizes a proprietary interface protocol and self-addressing algorithm so that each WH5097D on the BLU (Backlight Unit) is given a unique address with which to communicate with the backlight timing controller (BCON).

Full protections are included, such as built-in LED open/short detection and thermal shutdown.

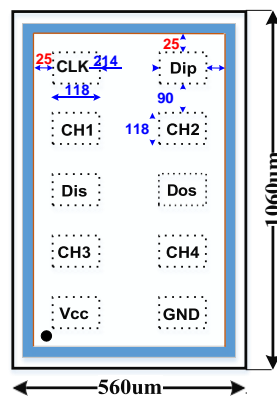
3. Applications

- Control Panel Illumination
- Local Dimming LED Backlight System

4. Ordering Information

Part Number	Package
WH5097D	CSP

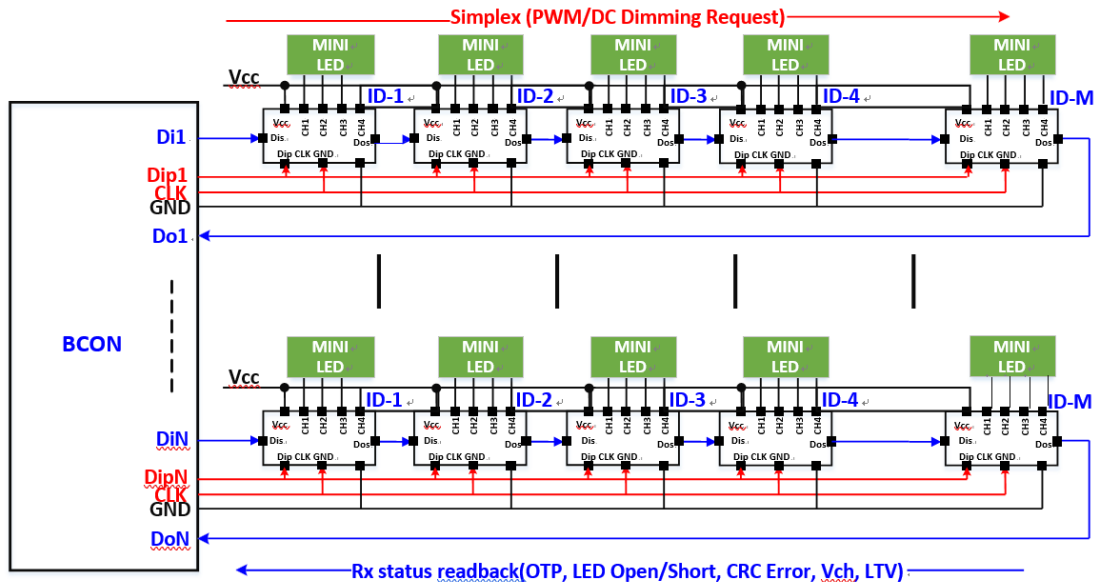
5. CSP Outline(Top View)



6. Pin Description

Pin Name	Type	Description
Dip	Input	Data input
CLK	Input	Clock for Dip data strobe
VCC	Power	Power supply
Dis	Input	Serial input
GND	Ground	Ground
Dos	Output	Serial output
CH1	Output	Driver Channel 1
CH2	Output	Driver Channel 2
CH3	Output	Driver Channel 3
CH4	Output	Driver Channel 4

7. Typical Application Diagram



*Patents Pending

8. Absolute Maximum Ratings

Input Supply Voltage, VCC	-0.3V to 6V
Voltage on CH1, CG2, CH3, CH4	-0.3V to 36V
Storage temperature range	-65°C to 150°C
ESD, Human body mode (HBM)	2kV
ESD, Machine mode (MM)	200V

9. Electrical Specifications

(VCC=3.3V, T_A=25°C, unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
System Supply						
Input Supply Voltage	VCC		3.0	3.3	5.5	V
Active Current	IOP_VCC	Normal Operation w/ OSC=16MHz	-	450	-	uA
Undervoltage Lockout Threshold	VUVLO	Vpwr rising	-	2.7	-	V
	VUVLO_HYS	Vpwr rising – Vpwr falling	-	0.2	-	V
IO Voltage Level						
Logic Input Low Level	VIL		-	-	0.8	V
Logic Input High Level	VIH		1	-	-	
Logic Output Low Level	VOL		-	-	0.67	V
Logic Output High Level	VOH		1.44	-	-	
LED Current Regulation						
CH1,CH2,CH3, CH4, Leakage Current	ILEAK	Vout=20V, Iout=0mA	-	< 0.1	-	uA
LED Current	ILED	4 ranges	0.5	-	5	mA
			1.0	-	10	mA
			2.0	-	20	mA
			3.0	-	30	mA
I_LED DC Accuracy		PWM Duty = 100%	-	+/-2	-	%
LED Current Slew Rate		ICHx = 30mA		2.5/1.3/0.7/0.45/ 0.35/0.2/0.125/0.1		us
Minimum CHx Reg	VCH_MIN	I_LED=25mA		0.4		V

PWM Dimming						
PWM Output Frequency Range	FPWM	Direct Driving Mode	60		3840	Hz
Dither		Dither function		1/2/4/8		
PWM Resolution	HTPWM			12		bit
PWM Output Delay Step				0~3		step
Delay Time Unit				4 / 8 / 16 / 32		us
VSYNC						
Frequency Range of Vsync	FBSYN	Direct Driving Mode	60		960	Hz
Multiplier of Vsync Frequency	KVSYN	3840Hz/FBSYN, Vsync=60/120/240/480/960Hz AM mode only		4/8/16/32/64		
Fault Detection& Protection						
Threshold for Short LED Detection	VVD_SLP	3-Bit selection		2/3/4/5/6/7/9/12		V
Threshold for Open LED Detection	VVD_ONP			0.2		V
Thermal Shutdown Protection Threshold	TTSP		-	165	-	°C
	TTSP_HYST		-	30	-	°C

10. Functional Description

10.1. WH5097D Functionality

The WH5097D is a 4 channel LED driver designed for driving locally dimmed displays. The WH5097D may be placed near (or even within) its corresponding LED zone in order to implement an active matrix structure. Coupled with an appropriate BCON (Backlight Timing Controller) chip, this all new backlight solution topology has many benefits, such as a slim mechanical design, simplified PCB/BLU routing and much simpler connections between the control board and the BLU.

Both direct driving and scanning LED driving methods are available by using the appropriate commands initiated by the BCON. In scanning mode, the number of scanning rows may be adjusted by the BCON. A frequency multiplication feature is supported as well. In direct driving mode, a maximum multiplication of 64x is available, based on the 16Mhz internal oscillator and the backlight frame rate.

The WH5097D has four user selectable current driving ranges, (0.5mA~5mA), (1mA~10mA), (2mA~20mA) and (3mA~30mA). Each range has the same 7-bit resolution current control. For pure PWM dimming, a 12-bit PWM duty cycle is available.

The dimming data, for all of the dimming methods, is sent over the single wire Dip interface.

In order to minimize EMI, the 4 current sinks include a 2-bit slew rate control. In order to control inrush current, the phase of the PWM current sink outputs may be delayed or shifted for each individual WH5097D in the BLU.

For better power efficiency control, the WH5097D is able to measure the channel voltage at each current sink output. That channel voltage information can be sent back to the BCON on the readback status line. The BCON can then appropriately adjust the voltage (VLED) at the common anode connection of each LED zone in the BLU so that the voltage at each current sink output does not exceed the value that is just enough to ensure accurate LED current control. This adaptive technique constantly finds the most efficient operating point for the BLU.

The WH5097D also provides LED open/short protection and over temperature protection (OTP) to ensure system reliability. The sustained voltage on the CH1/CH2/CH3/CH4 pin can reach up to 36V.

In order to satisfy different customer's BLU substrate choice, the mini IC Driver comes in two package types, a 10 ball chip scale package (CSP) and another is a 10 pin DFN package.