3-Ch Constant Current LED Driver for RGB

FEATURES

- 3 Constant Current-Sinks rated at Max 25V
- 20MHz 4-wire serial interface
- 3V to 5.5V logic supply
- LED current range 2 – 175mA
- LED current set by external RSET resistor
- Minimum 0.3V output operation at 60mA
- Thermal shutdown protection
- 16-lead SOIC package

APPLICATIONS

- Billboard Display
- Marquee Display
- Instrument Display
- General Purpose Display

DESCRIPTION

The CAT4103 is a 3 channel constant current driver for LED signage and other general display applications. LED channel currents are programmed together via an external RSET resistor. Low output voltage operation of min 0.3V (at 60mA) allows for more power efficient designs than competitors.

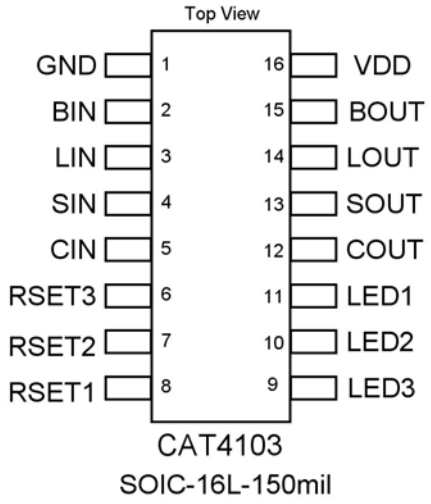
A high speed 4-wire 25MHz serial to parallel interface controls each individual channel using a shift register and latch configuration. Output data pins allow multiple devices to be cascaded and programmed via one serial interface with no meed for external drivers or timing considerations. The device also includes a blanking control pin (BIN) that can be used to disable all channels independently of the interface.

Thermal shutdown protection is incorporated in the device to disable the LED outputs if the die temperature exceeds a set limit.

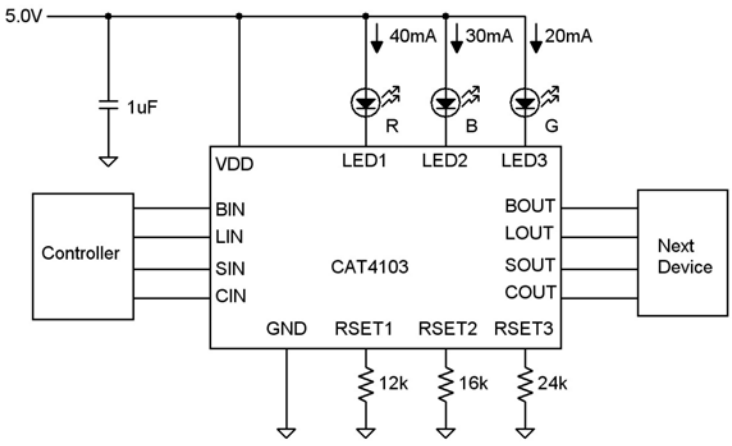
ORDERING INFORMATION

Part Number	Package	Quantity per Reel	Package Marking
CAT4103W	SOIC16		

PIN CONFIGURATION



TYPICAL APPLICATION CIRCUIT



ABSOLUTE MAXIMUM RATINGS

Parameter	Rating	Unit
V_{DD} voltage	6	V
Input voltage range (SIN, BIN, CIN, LIN)	-0.3V to VDD+0.3V	V
Output voltage range (SOUT, BOUT, COUT, LOUT)	-0.3V to VDD+0.3V	V
Peak LED voltage	25	V
DC output current on LED1 to LED16	200	mA
Storage Temperature Range	-55 to +160	°C
Junction Temperature Range	-40 to +125	°C
Lead Soldering Temperature (10sec.)	300	°C
ESD Rating: All Pins Human Body Model Machine Model	 2000 200	V

RECOMMENDED OPERATING CONDITIONS

Parameter	Range	Unit
V_{DD}	3.0 to 5.5	V
Voltage applied to LED1 to LED3	0.3 to 28	V
Output current on LED1 to LED3	2 to 175	mA
Ambient Temperature Range	-40 to +85	°C

ELECTRICAL OPERATING CHARACTERISTICS

DC Characteristics

V_{DD} = 5.0V, -40ºC ≤ T_A ≤ 85 ºC, over recommended operating conditions unless specified otherwise.

Symbol	Name	Conditions	Min	Typ	Max	Units
I_{DD1}	Supply Current outputs off	V_{LED} = 5V R_{SET} = 3kΩ		2	5	mA
I_{DD2}	Supply Current outputs off	V_{LED} = 5V R_{SET} = 750Ω		4	10	mA
I_{DD3}	Supply Current outputs on	V_{LED} = 0.5V R_{SET} = 3kΩ		2	5	mA
I_{DD4}	Supply Current outputs on	V_{LED} = 0.5V R_{SET} = 750Ω		4	10	mA
I_{LKG}	LED output Leakage	V_{LED} = 5V, outputs off	-1		1	µA
R_{LIN}	LIN Pull-down Resistance		140	180	250	kΩ
R_{BIN}	BIN Pull-up Resistance		140	180	250	kΩ
V_{IH} V_{IL}	Logic high input voltage Logic low input voltage		 0.3xV_{DD}		0.7xV_{DD}	V V
I_{IL}	Logic Input leakage current (CIN, SIN)	V_I = V_{DD} or GND	-5	0	5	µA
V_{OH} V_{OL}	xOUT logic high output voltage xOUT logic low output voltage	I_{OH} = -1mA I_{OL} = 1mA	V_{CC}-0.3V		 0.3	V
V_{RSET}	RSETx Regulated Voltage		1.17	1.2	1.23	V

PIN DESCRIPTIONS

Pin #	Name	Function
1	GND	Ground Supply
2	BIN	Blank all LED channels input (Active Low)
3	LIN	Latch serial data to output registers
4	SIN	Serial Data input pin
5	CIN	Serial Clock input pin
6	RSET3	LED current set pin for LED 3
7	RSET2	LED current set pin for LED 2
8	RSET1	LED current set pin for LED 1
9	LED1	LED channel 1 cathode terminals
10	LED2	LED channel 2 cathode terminals
11	LED3	LED channel 3 cathode terminals
12	COUT	Serial Clock output pin
13	SOUT	Serial Data output pin.
15	LOUT	Latch Serial Data output
16	BOUT	Blank all LED channels output (Active Low)
24	VDD	Positive Supply Voltage

PIN FUNCTION

GND is the ground reference pin for the entire device. This pin must be connected to the ground plane on the PCB.

BIN is the LED enable and disable pin. When low LED's are enabled according to the output latch contents. When high all LED's are off. This pin can be used to turn all the LED's off while preserving the data in the output latches.

LIN is the latch data input. On the rising edge of LIN, data is loaded from the 16-bit serial shift register into the output register latch. On the falling edge of LIN the data is latched in the output register and isolated from the state of the serial shift register.

SIN is the serial data input. Data is loaded into the internal register on each rising edge of CIN.

CIN is the serial clock input. On each rising CIN edge, data is transferred from SIN to the internal 16-bit serial shift register.

RSET1 - 3 are the LED current set inputs. The current pulled out of these pins will be mirrored in the corresponding LED channel with a gain of 400.

LED 1 - 3 are the LED current sink inputs. These pins are connected to the bottom cathodes of the LED strings. The current sinks bias the LED's with a current equal to 400 times RSET pin current. For the LED sink to operate correctly the voltage on the LED pin must be above 0.4v. Each LED channel can withstand and operate with voltages up to 25volts.

COUT is a driven output of CIN and can be connected to the next device in the cascade.

SOUT is the output of the 3-bit serial shift register. Connect to SIN of the next device in the cascade. SOUT is clocked on the falling edge of CIN.

LOUT is a driven output of LIN and can be connected to the next chip in the cascade.

BOUT is a driven output of BIN and can be connected to the next chip in the cascade.

VDD is the positive supply pin voltage for the entire device. A small 1μF ceramic is recommended close to pin.

BLOCK DIAGRAM

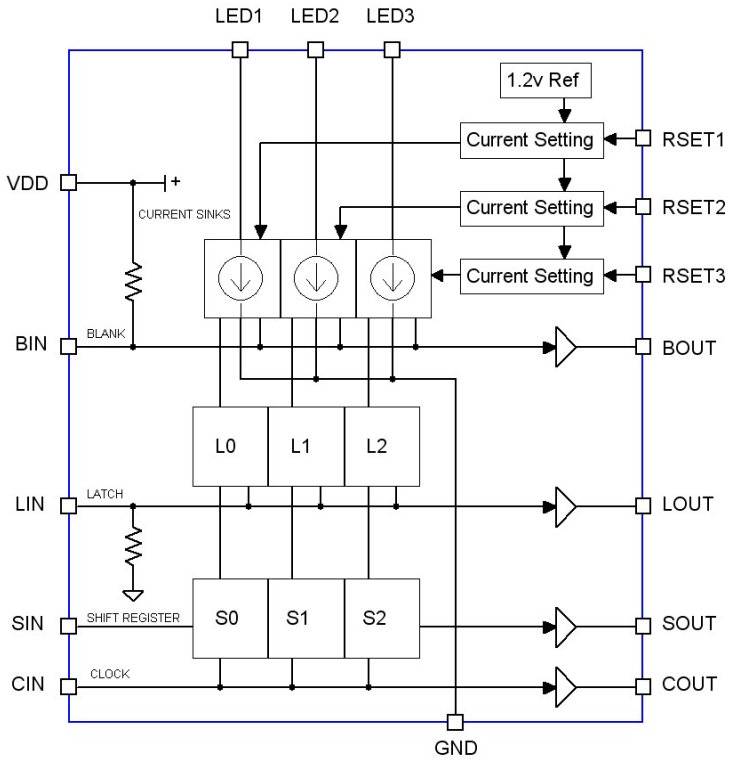


Figure 2. CAT4103 Functional Block Diagram

BASIC OPERATION

The CAT4103 uses 3 tightly matched current sinks to accurately regulate the LED current in each channel to 400 times the current in RSET.

Tight current regulation for all channels is possible over a wide range of input and LED voltages due to independent current sensing circuitry on each channel. The LED channels have a maximum dropout of 0.6v for all current ranges and supply voltages. This helps improve heat dissipation and efficiency over other competing solutions.

Upon power-up an under-voltage lockout circuit clears all latches and shift registers and sets all outputs to off. Once the under-voltage lockout threshold has been reached the device can be programmed.

Pullup and pull down resistors are internally provided to set the state of the BIN and LIN pin to low current off state when not externally driven

A high speed 4 wire interface is provided to program the state of each LED on or off.

The 4 wire interface contains a 3 bit serial to parallel shift register (S0-S2) and a 3 bit latch (L0-L2). Programming the serial to parallel register is accomplished via SIN and CIN input pins. On each rising edge of the CIN signal the data from SIN is moved through the shift register serially. Data is also moved out of SOUT to the next device if programming more then one device on the same interface.

On the rising edge of LIN the data contents of the serial to parallel shift register is reflected in the latches. On the falling edge of LIN the state of the serial to parallel register at that particular time is saved in the latches and does not change irrespective of the contents of the serial to parallel register.

BIN is used to disable all LED's off at one time while still maintaining the data contents of the latch register. BIN is Active low input pin. When low the outputs reflect the data in the latches. When high the outputs are all high impedance.

All 4 wire inputs have a corresponding output driver for cascaded systems (SOUT, COUT, LOUT, BOUT).

Timing Characteristics

For 3.0V ≤ VIN ≤ 5.5V, over full ambient temperature range -40 to +85ºC unless specified otherwise.

Symbol	Name	Conditions	Min	Typ	Max	Units
CIN						
f_{cin}	CIN Clock Frequency				25	MHz
t_{cwh}	CIN Pulse Width High		15			ns
t_{cwl}	CIN Pulse Width Low		15			ns
SIN						
t_{ssu}	Setup time SIN to CIN		4			ns
t_{sh}	Hold time SIN to CIN		4			ns
LIN						
t_{xwh}	LIN Pulse width		20			ns
t_{lchd}	Hold time LIN to CIN		4			ns
t_{lcsu}	Setup time LIN to CIN		8			ns
LEDn						
t_{ledpl}	LED Propagation delay LIN	LIN to LED(n) off/on		100	200	ns
t_{ledpb}	LED Propagation delay BIN	BIN to LED(n) off/on		100	200	ns
t_{ledr}	LED rise time (10% to 90%)	Pullup resistor = 50Ω to 3.0v		80	160	ns
t_{ledf}	LED fall time (90% to 10%)	Pullup resistor = 50Ω to 3.0v		80	160	ns
SOUT						
t_{sr}	SOUT rise time (10% to 90%)	C_L = 15pF		5		ns
t_{sf}	SOUT fall time (90% to 10%)	C_L = 15pF		5		ns
t_{sdf}	Propagation delay time SOUT	CIN falling to SOUT falling		4	10	ns
t_{sdr}	Propagation delay time SOUT	CIN falling to SOUT rising		4	10	ns
COUT						
t_{cr}	COUT rise time (10% to 90%)	C_L = 15pF		5		ns
t_{cf}	COUT fall time (90% to 10%)	C_L = 15pF		5		ns
t_{cdf}	Propagation delay time COUT	CIN falling to COUT falling		4	10	ns
t_{cdr}	Propagation delay time COUT	CIN rising to COUT rising		4	10	ns
LOUT						
t_{lr}	LOUT rise time (10% to 90%)	C_L = 15pF		5		ns
t_{lf}	LOUT fall time (90% to 10%)	C_L = 15pF		5		ns
t_{ldf}	Propagation delay time LOUT	LIN falling to LOUT falling		4	10	ns
t_{ldr}	Propagation delay time LOUT	LIN rising to LOUT rising		4	10	ns
BOUT						
t_{br}	BOUT rise time (10% to 90%)	C_L = 15pF		5		ns
t_{bf}	BOUT fall time (90% to 10%)	C_L = 15pF		5		ns
t_{bdf}	Propagation delay time BOUT	BIN falling to BOUT falling		4	10	ns
t_{bdr}	Propagation delay time BOUT	BIN rising to BOUT rising		4	10	ns

Figure 1. Timing Diagram A

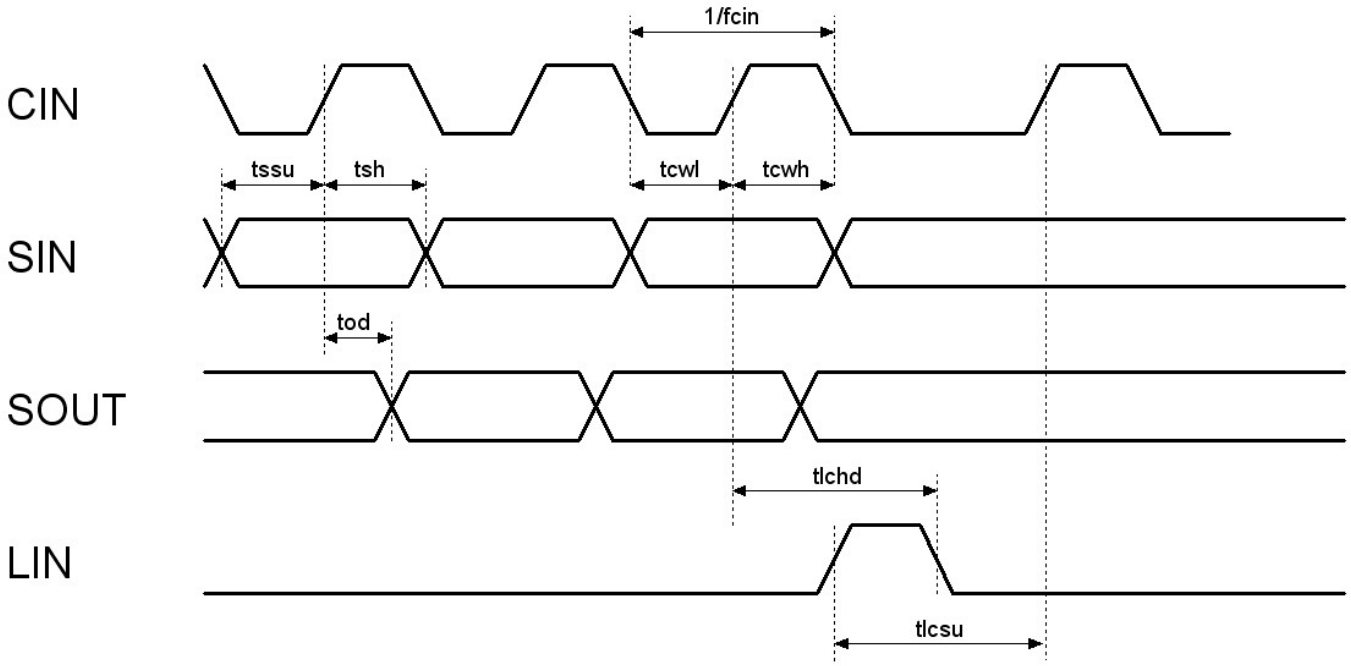
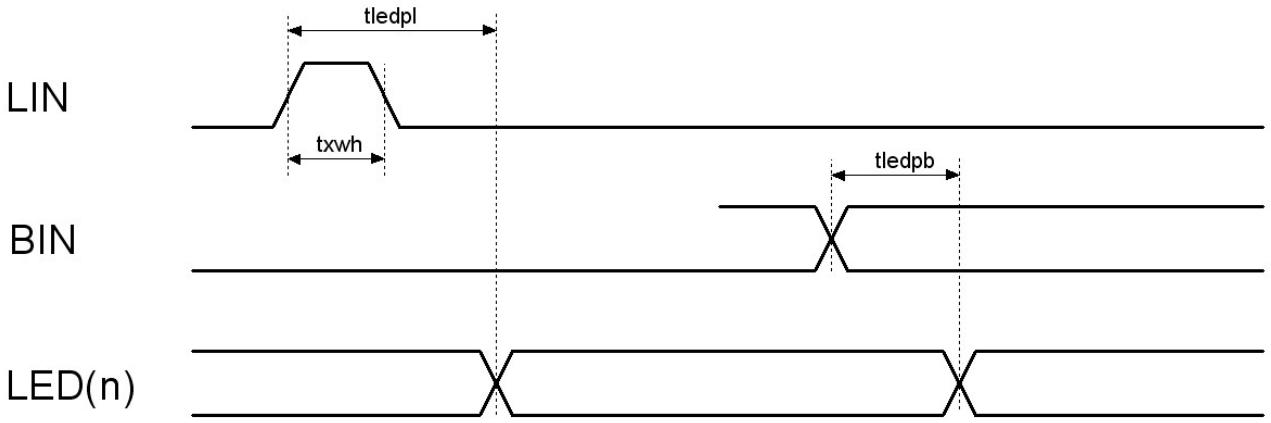
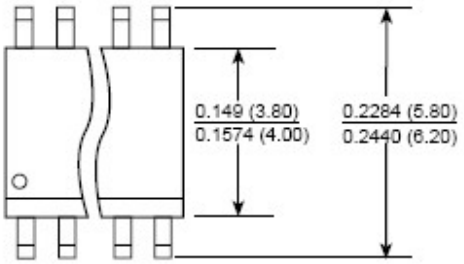


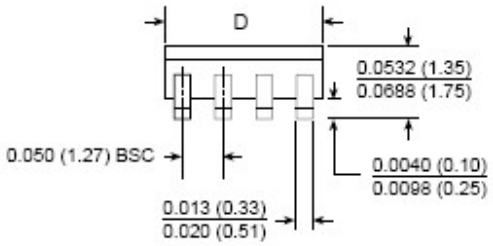
Figure 2. Timing Diagram B

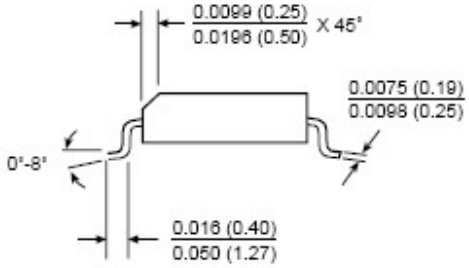


Package Drawing and Dimensions

16 Lead SOIC
All dimensions in millimeters







Dimension D		
Pkg	**Min**	**Max**
8L	0.1890(4.80)	0.1968(5.00)
16L	0.386(9.80)	0.394(10.01)

REVISION HISTORY

Date	Rev.	Reason
		Initial Issue

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