

# Demonstration/Evaluation Tool for CAT4016 16-Channel Constant Current LED Driver



Applications Engineering Staff

## 1. INTRODUCTION

This document describes the CAT4016 Demonstration / Evaluation Tool for the Catalyst Semiconductor CAT4016 LED driver. The modular structure of this evaluation tool offers a flexible solution to demonstrate and evaluate the functionality and major parameters of the CAT4016 devices, including the daisy-chain connection.

The CAT4016 is a 16-channel constant current LED driver designed for billboard display and other general LED lighting applications. The driver is controlled through a high speed serial interface, incorporating a 16-bit serial to parallel shift register and data latch. A serial output data pin can be used to cascade multiple CAT4016 devices and programmed via the same serial interface. The LEDs are driven from the LED1 to LED16 outputs which provide 16 tightly matched current sinks. The LED current through each channel is set by the external RSET resistor. An enable input, BLANK, allows to turn off/on all the output drivers.

Detailed descriptions and electrical characteristics of the CAT4016 are in the device data sheet.

## 2. BOARD HARDWARE

The CAT4016 demo/evaluation system contains the following modules:

- CAT4016/4008 Control Board (CAT4016/4008\_MB)
- CAT4016 evaluation board (CAT4016\_DB)
- CAT4016 LED panel board (CAT4016\_LED\_PANEL), Optional

This modular approach allows the user to control the CAT4016 device through the provided control unit board or using the control signals from the application. Also, up to three CAT4016 devices can be used in a daisy-chain connection to drive 48 LEDs. The boards modular system is powered either from an external 9V DC (500mA) adaptor or from the USB port. The user can chose to drive on/off or blink any LEDs combination using the commands through the on-board switches or using a graphical user interface (GUI) through a PC USB connection. The block schematic for the control board module driving up to three CAT4016 devices (3 x CAT4016\_DB) is shown in Figure 1.

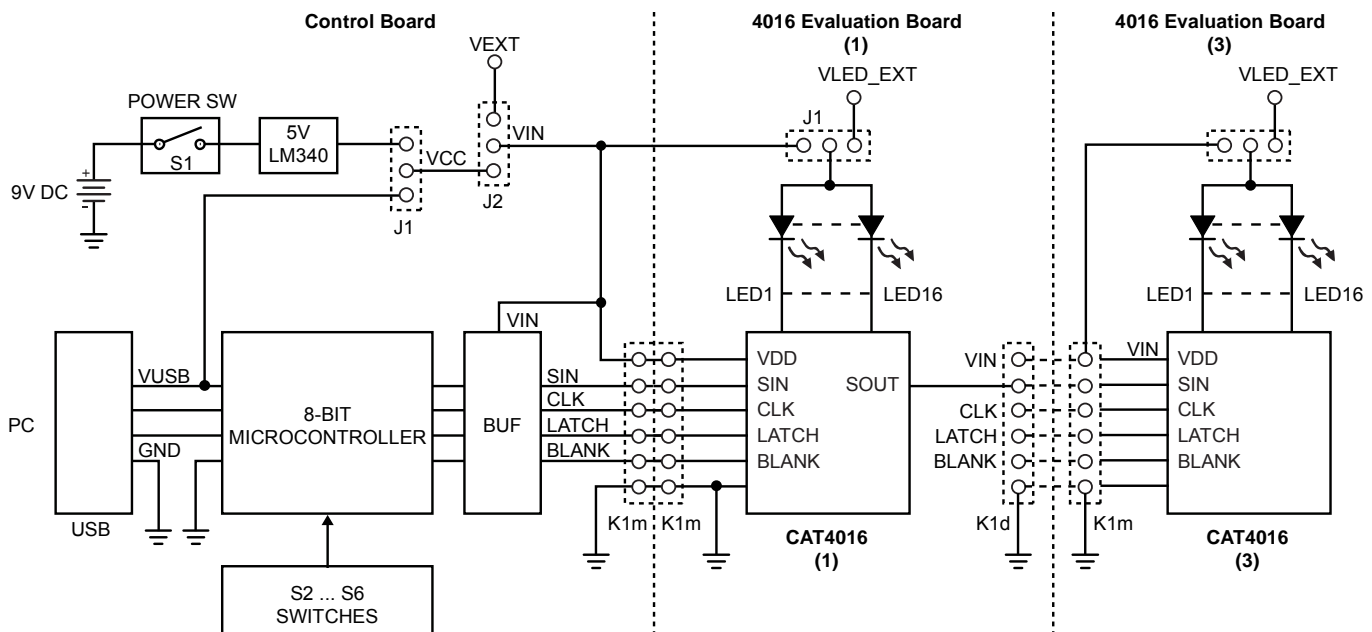


Figure 1. CAT4016 Demo/Evaluation Boards Block Schematic

## 2.1. CAT4016/4008 CONTROL BOARD (CAT4016/4008\_MB)

The control board module contains the microcontroller C8051F327 which translates the commands from 3 pushbuttons and 2 slider switches or the commands received from the PC through the USB port. These commands are transmitted to the CAT4016 device(s) from the CAT4016\_DB board(s) via a 6-pin connector (K1m). This control board has been designed to be used both for the CAT4016 (16-Channel) and CAT4008 (8-Channel) devices.

The K1m connector provides the input signals and power supply for the CAT4016 device:

Pin 1: VIN = VDD – power supply

Pin 2: SIN – serial data input

Pin 3: CLK – serial clock input

Pin 4: LATCH – Latch serial data to output registers

Pin 5: BLANK – Enable / Disable all LED channels

Pin 6: GND

The data is transmitted serially between the microcontroller and the CAT4016. Using the commands received through the S2 to S6 on board switches or from the PC, the microcontroller transfers the data serially on the SIN input of the CAT4016. The input data is shifted with the MSB first into the CAT4016 internal 16-bit shift register. This data is latched into a 16-bit data latch using the LATCH signal. To drive a LED on, the data written to the corresponding latch bit must be “1” and the BLANK input low. When the BLANK input of the CAT4016 is high (the associated S2 switch is set to “BLANK” position), the output drivers are turned into the high-impedance state and all the LEDs are off.

The CAT4016/4008\_MB control board can control up to three cascaded CAT4016 devices. The number of the CAT4016\_DB modules is selected using the K3 jumper connector: 1, 2 or 3 modules connected through the K1m / K1d 6-pin connectors.

The detailed schematic and the list of components for the CAT4016 control board (CAT4016/4008\_MB) are shown in the Appendix attached in the end of this document (Figure 6 and Table1).

### 2.1.1. Power Supply Selection

The J1 jumper connector selects the power supply for the control board: VUSB (Jumper J1 1-2) or the internal provided 5V voltage using the external 9V DC

power supply (Jumper J1 2-3). The external power supply (9V DC / 500mA adaptor) must be connected at VBAT connector and the S1 slider switch set to "ON" position.

The power supply for the CAT4016 device (VIN = VDD) can be selected through the J2 jumper connector (from the Control Board) between the internal provided fixed voltage, VCC = 5V and an external variable voltage, VEXT (3V to 5.5V). The external power supply (VEXT) is applied at T1 and T2 test points from the control board.

### 2.1.2. On-Board Command Switches

The S2 slider switch controls the BLANK input of the CAT4016 device. In “without PC connection” mode, when this slider is set to "BLANK" position, all LED channels are off.

When using commands from the GUI, with "PC connection", the S2 slider must be set to "BLANK" position, as the associated pin of the microcontroller will be in Hi-Z state. In this way the BLANK input will be controlled by the user through the BLANK GUI button.

The S3, “LED SELECT” pushbutton is valid only in "without PC connection" mode. When the user pushes this button, the last selected LED begins to blink with a frequency of 5Hz. At each new push of this button, the selected (blinking) LED moves to the right.

This way, the user can mark the LED which will be affected by the next command (i.e., LED on/off setting, LED blinking and LED intensity setting). When "LED SELECT" button is pressed continuously, the blinking LED (LED selection) switches to the next LED with a frequency of 2Hz, and after 3 steps, the frequency grows to 3Hz. If this pushbutton is released, then the corresponding LED stops blinking after a period of 3 seconds.

The S4, “LED ON/OFF” pushbutton is valid only in "without PC connection" mode. The action of this pushbutton has a toggle function. By pressing the S4 pushbutton, the previously selected LED can reach the following status:

- LED ON or OFF: Every time the pushbutton is pressed (short action) the selected LED status changes between ON and OFF status. When this button is pressed continuously, the LED status is changed from ON to OFF and back with a frequency of 2Hz.

- LED blinking: When the "BLINK" S6 slider is ON (set to BLINK position), and "LED ON/OFF" button is pushed, the LED is in "Blinking" status. In these conditions, if the "LED ON/OFF" button is pushed again, the LED status is changed to OFF status.

The S5, "LED INTENS" pushbutton is valid only in "without PC connection" mode. When this button is held down, the last selected LED intensity varies (it cycles through different intensities using a PWM dimming). If the LED selection is changed, the intensity of previously selected LED is stored. This status can be changed to OFF by pushing the "LED ON/OFF" button.

The S6, "BLINK" slider switch enables the LED blinking. The LED selected with the BLINK switch ON (and set to blink by pressing the "LED ON/OFF" button) is programmed to blink with a 600ms period: 300ms ON, 300ms OFF.

## 2.2. CAT4016 EVALUATION BOARD (CAT4016\_DB)

Each CAT4016 evaluation board (CAT4016\_DB) board contains a single CAT4016 device. The CAT4016 circuit drives 16 LEDs, regardless if these are soldered on this board, or optionally on CAT4016 LED panel board.

The detailed schematic (Figure 7) and the list of components (Table 2) for the CAT4016\_DB board are available in the attached Appendix.

This board has an input 6-pin header connector (K1m) and an output 6-pin "female" connector (K1d). The K1m and K1d connectors allow a daisy-chain connection to cascade up to three CAT4016\_DB modules. Both connectors have 6 pins with common signals, and therefore, these signals form a bus.

The K1m input connector provides the input signals and power supply for the on-board CAT4016 device:

- Pin 1: VIN = VDD – power supply
- Pin 2: SIN – serial data input
- Pin 3: CLK – serial clock input
- Pin 4: LATCH – Latch serial data to output registers.
- Pin 5: BLANK – Enable / Disable all LED channels.
- Pin 6: GND.

The K1d output connector provides the input signals and power supply for the next CAT4016 device from the daisy-chain connection:

- Pin 1: VIN = VDD – power supply
- Pin 2: SOUT – serial data out (connect to SIN of the next device)
- Pin 3: CLK – serial clock input
- Pin 4: LATCH – Latch serial data to output registers.
- Pin 5: BLANK – Enable / Disable all LED channels.
- Pin 6: GND.

The CAT4016\_DB board can be also used as a stand-alone evaluation board. In this case the user should provide the input signals and power supply on the K1m input connector.

### 2.2.1. LED Current Setting

The LED current through each channel is controlled through the external R<sub>SET</sub> (R<sub>1</sub> + R<sub>2</sub>) resistor:

$$I_{LED} = 50 \times \frac{1.2}{R_{SET}} = 50 \times \frac{1.2}{R_1 + R_2}$$

Using the on board R<sub>2</sub> variable resistor, the LED current can be set between 2mA and 30mA.

### 2.2.2. Power supply for the LEDs on the CAT4016\_DB Board

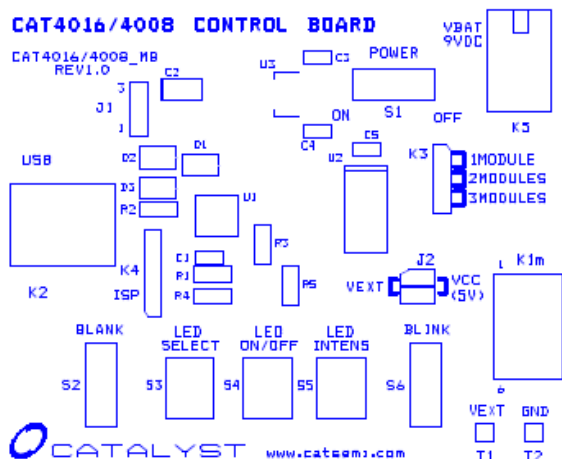
The LEDs anode can be connected to the same VIN (VDD) power supply as CAT4016 device when the J1 jumper (from CAT4016\_DB board) is set to position (1-2). In this case it is recommended a 10 mA max current per channel, especially when three CAT4016 devices are connected in a "daisy-chain" (48 LEDs).

The board provides the option for an external voltage to supply the LEDs independently: J1 jumper set to position (2-3) and apply an external voltage VLED\_EXT at T1 and T2 (GND) test points. In this case, the user can set the LEDs current to the maximum range (30mA for RSETmin = R<sub>1</sub> = 2kΩ).

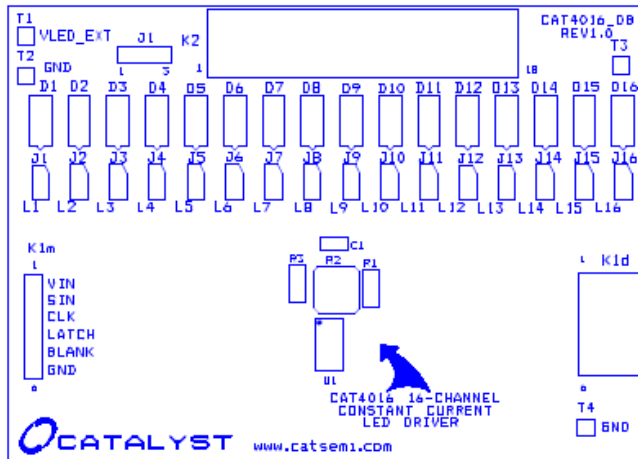
**2.3. CAT4016 LED PANEL (OPTIONAL)**

The CAT4016 LED Panel board provides the user the option to use their own LEDs. This module has an 18-pin header connector for the connection to the CAT4016 device from the CAT4016\_DB board.

The component placement for the CAT4016/4008\_MB control board and CAT4016\_DB evaluation board are shown in Figure 2. The boards picture (CAT4016 control board driving one CAT4016\_DB module) is shown in Figure 3.



a) CAT4016/4008\_MB Control Board



b) CAT4016\_DB Evaluation Board

Figure 2. Board Component Placement

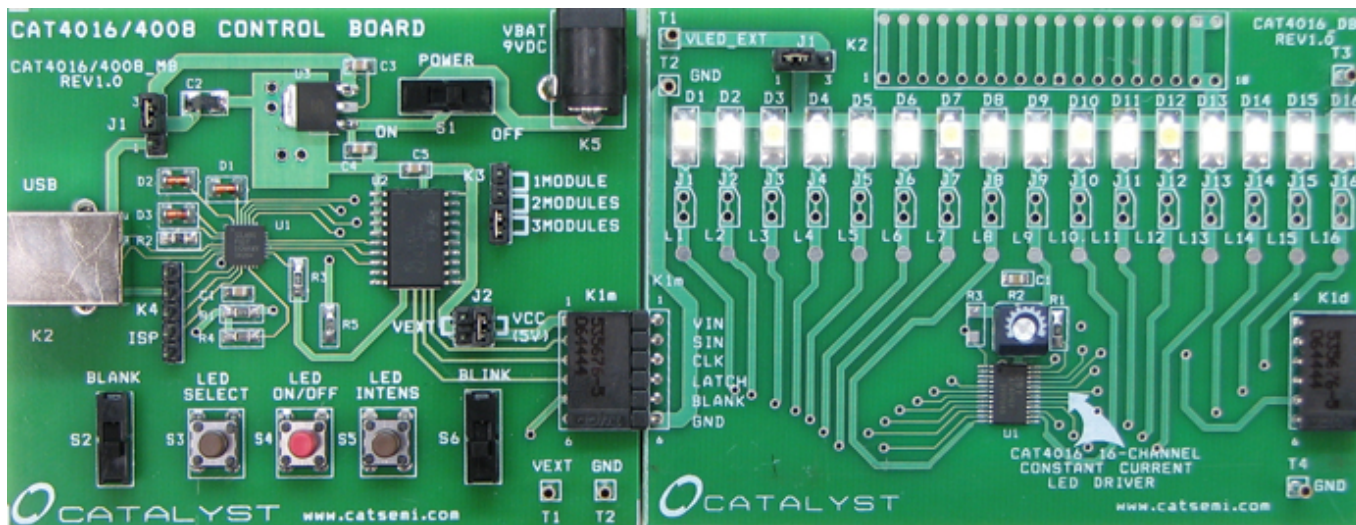


Figure 3. CAT4016 Demo/Evaluation Modular Boards



### 3. CAT4016 DEMO/EVALUATION BOARDS CONTROLLED THROUGH THE PC USB INTERFACE

The board can be controlled through a PC USB port. The user can send the commands to drive on/off, set the LED intensity or blink any LEDs configuration using a friendly graphical user interface (GUI).

The CAT4016DB software requires the following minimum system configuration:

- Microsoft Windows 2000XP or above
- 3MB of available hard disc space
- USB Interface Port

The software is available as a password protected archive file installation kit on the CAT4016DB software distribution CD-ROM or it can be downloaded at: [www.catsemi.com/evaluationtools](http://www.catsemi.com/evaluationtools)

To extract the files from the "CAT4016DB\_SW.zip" archive, use the password: 4016.

After extracting the files, running the "setup.exe" file automatically will guide you through the installation of the CAT4016DB.exe program (the CAT4016DB icon is automatically installed).

After the connection of the CAT4016 Control Board through the PC USB interface the GUI automatically reflects the configuration of the system. The number

of LEDs which appears on the GUI window depends on how many CAT4016\_DB modules are connected. For a fast LED selection, the GUI has 2 buttons and a slider. The 2 buttons makes right/left LED selection step by step. With the potentiometer cursor, the user can quickly select any LED.

The "LED INTENS" button is replaced with a potentiometer.

In addition, the GUI has the following options:

- Two buttons for setting all LEDs to "ON" or "OFF" status.
- A button for setting odd LEDs to "ON" status.
- A button for setting even LEDs to "ON" status.
- A button for setting odd LEDs to "BLINK" status.
- A button for setting even LEDs to "BLINK" status.
- A button for shifting LEDs status to right, step by step and another button for continuous shift.
- A button for shifting LEDs status to left, step by step and another button for continuous shift.
- the user can also apply the "shift" mode with "roll-over".

Figure 4 shows the user interface window for driving one CAT4016 device with 16 LEDs.

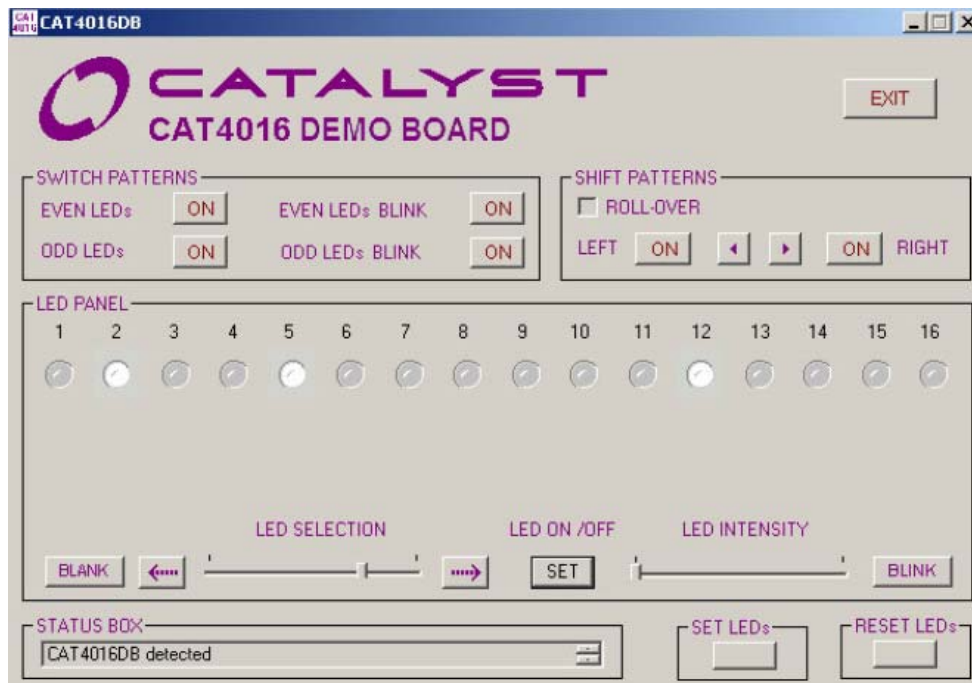
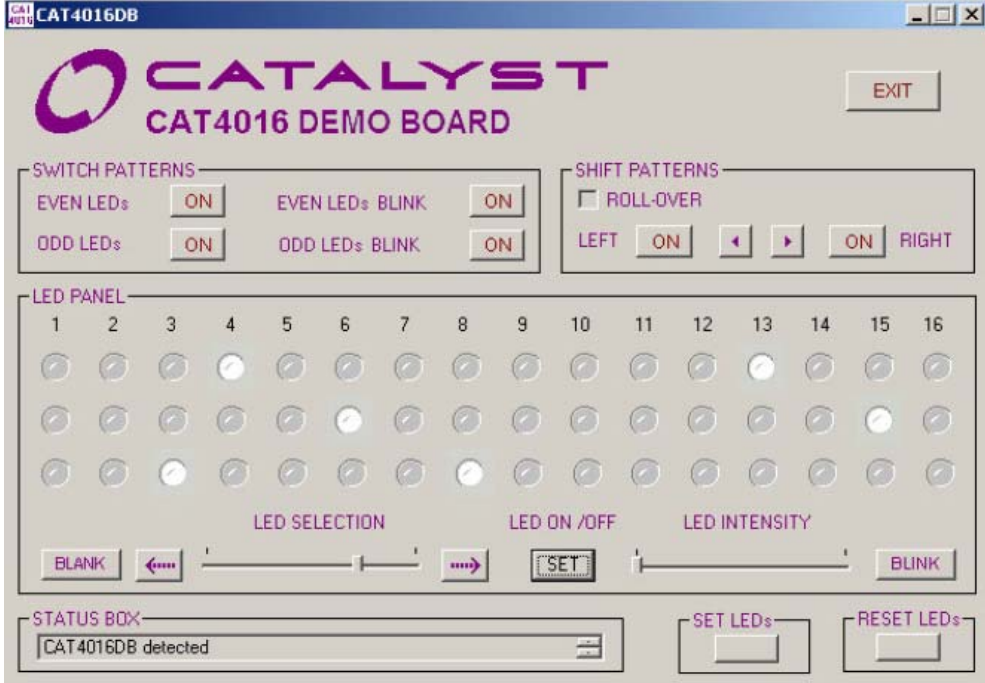


Figure 4. CAT4016DB Software User Interface Window driving 16 LEDs (1 x CAT4016\_DB)

**Demonstration/Evaluation Tool for CAT4016**

The user interface window for three cascaded CAT4016 devices driving 48 LEDs is shown in Figure 5.



**Figure 5. CAT4016DB Software User Interface Window driving 48 LEDs (3 x CAT4016\_DB)**



**Table 1. CAT4016/4008 Control Board List of Components**

Name	Manufacturer	Description	Part Number	Units
U1	Silicon Laboratories	8 bit Microcontroller with USB interface, 28-pin QFN	C8051F327	1
U2	Fairchild	octal D-type latches, SOIC 20-pin	74HCT573WM	1
U3	National	5V Series 3 Terminal Positive Regulator, SOT223	LM340MP - 5.0	1
D1,D2,D3	Vishay	Switching diode, SOD80	LL4148-GS18	3
C1,C3,C4,C5	AVX	Ceramic Capacitor 0.1µF / 10V, 10%, X7R, Size 0805	0805ZC104KAT2A	4
C2	Kemet	SMD tantal 10uF / 10V	TANTB SMD10 10uF10V	1
R1,R4,R5	Dale	SMT Resistor 1/8W, 22Kohm, 1%, Size 0805	CRCW08055K10FKTA	3
R2	Dale	SMT Resistor 1/8W, 7.5Kohm, 1%, Size 0805	CRCW08057K50FKTA	1
R3	Dale	SMT Resistor 1/8W, 5.1Kohm, 1%, Size 0805	CRCW08055K10FKTA	1
S1,S2,S6	E-Switch	Slide Switch, SPDT	Digi-Key EG1903-ND	3
S3,S4,S5	HDK	Momentary Contact Switch SPST (on)-off	Schukat Electronic DTS62K	3
J2	MMM	2-pin Header Connector, 0.1", Single Strip	2302-6211TG	2
J1	MMM	3-pin Header Connector, 0.1", Single Strip	2303-6211TG	1
K3	MMM	4-pin Header Connector, 0.1", Single Strip	2304-6211TG	1
K4	MMM	5-pin Header Connector, 0.1", Single Strip	2305-6211TG	1
		Speciality Electronics Shunts	2JM-G	3
T1,T2	Mil-Max	Pin Receptacle (Test Points)	#0149-0-15-01-30-14-04-0 (or equiv)	2
K5		DC Adaptor/Power Supply Connector	Schukat Electronic T252j	1
K1m	Tyco	6-pin Female Connector for PCB	535676-5 064444	1
K2		USB Mounting Jack for PCB	Schukat Electronic USB_BP	1



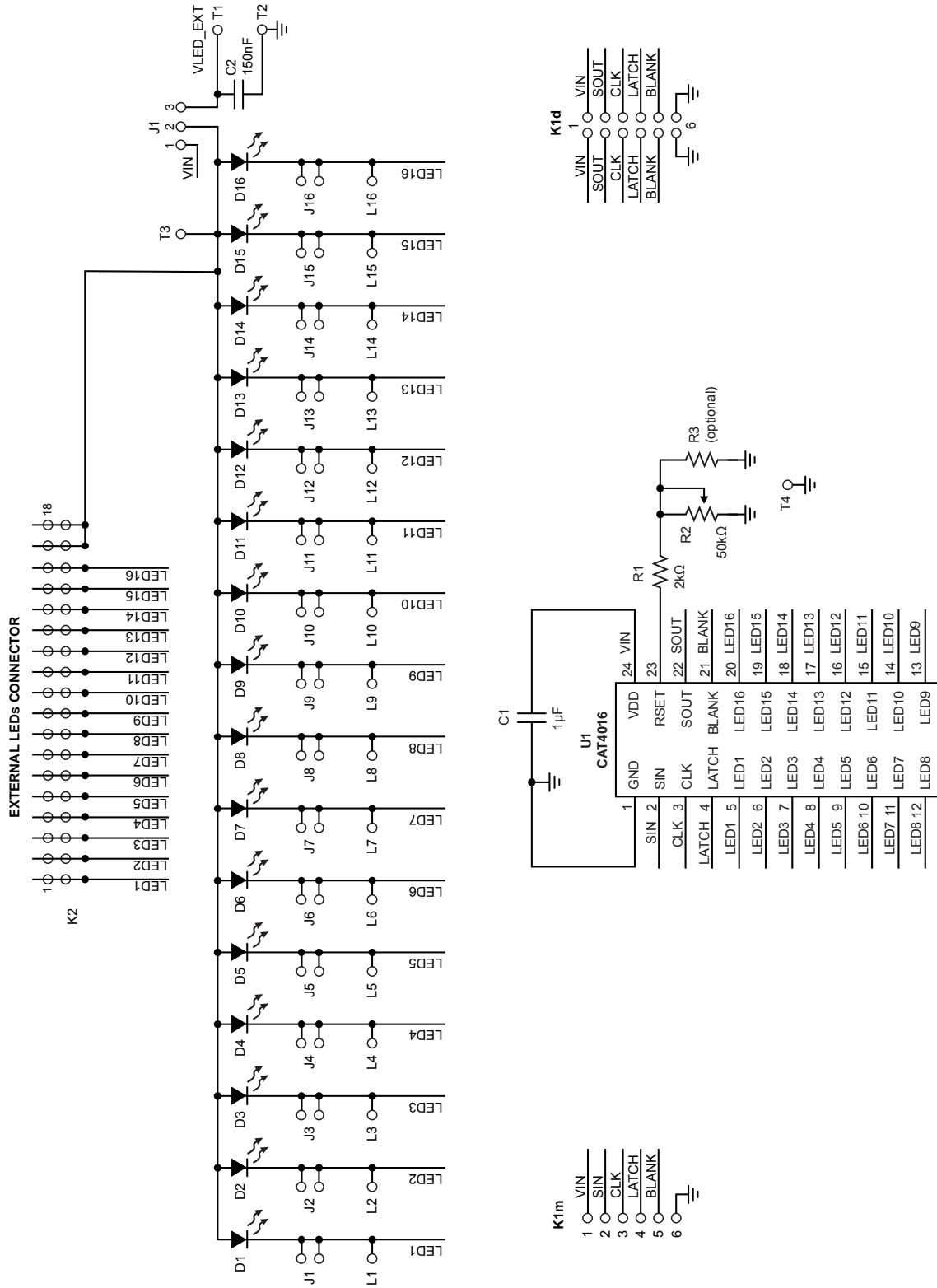


Figure 7. CAT4016\_DB Eval Board Schematic

**Table 2. CAT4016\_DB Eval Board List of Components**

Name	Manufacturer	Description	Part Number	Units
U1	Catalyst	16-channel constant current LED Driver, TSSOP 24-pin	CAT4016Y	1
D1 to D16	Nichia/Everlight	White LED SMD (optional)	NSCW100 / EL67-21UWC	16
C1	AVX	Ceramic Capacitor 1 $\mu$ F / 10V, 10%, X5R, Size 0603	0603ZD105KAT2A	1
R1	Dale	SMT Resistor 1/8W, 2.0K $\Omega$ , 1%, Size 0805	CRCW08052K20FKTA	1
R2	HDK	Miniature potentiometer 50K $\Omega$	PK50HK050	1
J1	MMM	3-pin Header Connector, 0.1", Single Strip	2303-6211TG	1
	Speciality Electronics	Shunts	2JM-G	1
T1, T2, T3, T4	Mil-Max	Pin Receptacle (Test Points)		4
K1m		6-pin Header Connector, 0.1", Angled	Schukat Electronic ASL050_W	1
K1d	Tyco	6-pin female connector for PCB	535676-5 064444	1

## REVISION HISTORY

Date	Rev.	Comments
09/25/2007	A	Initial Issue

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Catalyst Semiconductor, Inc.  
Corporate Headquarters  
2975 Stender Way  
Santa Clara, CA 95054  
Phone: 408.542.1000  
Fax: 408.542.1200  
www.catsemi.com

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