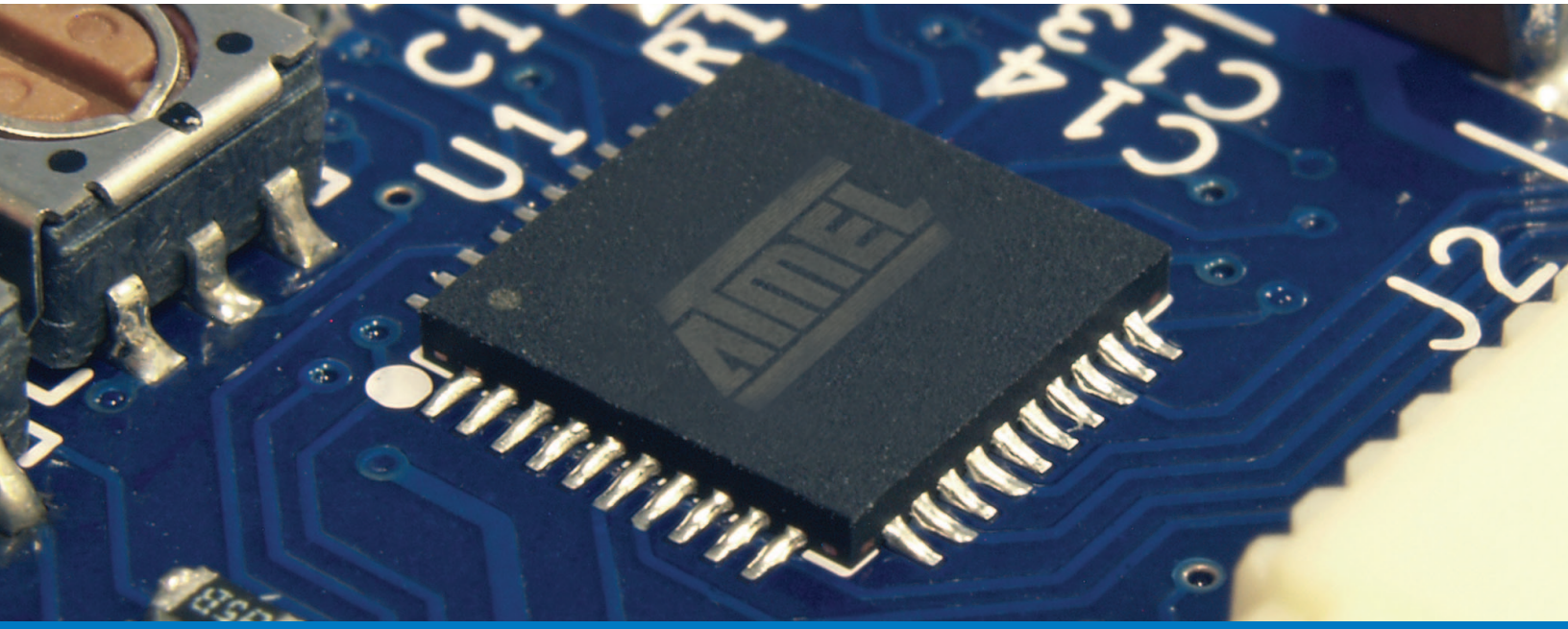


Atmel LED Driver-MSLB9061 LED Driver Module

Compact, 6-channel LED Driver Board with I²C Interface

Datasheet

Atmel LED Driver-MSLB9061
LED Driver Module

Compact, 6-channel LED Driver Board with I²C Interface

General Description

The Atmel® compact, 6-channel LED driver board is a complete LED backlight driver solution using the Atmel LED Driver-MSL1061 LED driver for medium-sized LCD panels. Each channel drives up to 12 series-connected LEDs at up to 30mA per channel. The diver board is configured to operate from 3.3V up to 28V. The full-scale LED current is preset to 15, 20, 25, or 30mA per LED string, selected by an onboard switch. Current can be reduced from full-scale through the I²C serial interface in 16 linear steps. Digital (PWM) dimming is available through an external signal or by using the internal PWM generator via the serial interface.

The optional microcontroller board and graphical user interface (GUI) software allow control of the driver board through a personal computer. This gives access to the internal features of the MSL1061, including fault detection, digital control of LED current, individual LED string on/off control, and internally generated PWM dimming.

The compact six-channel LED driver board is intended for evaluation, prototyping, or production runs. Gerber files and Cadence OrCAD layout files are available to allow the circuit to be integrated into a larger system for large production runs.

Applications

- LCD Panel LED Backlight Driver

Ordering Information

PART	DESCRIPTION
MSLB9061	Compact, 6-channel LED driver module

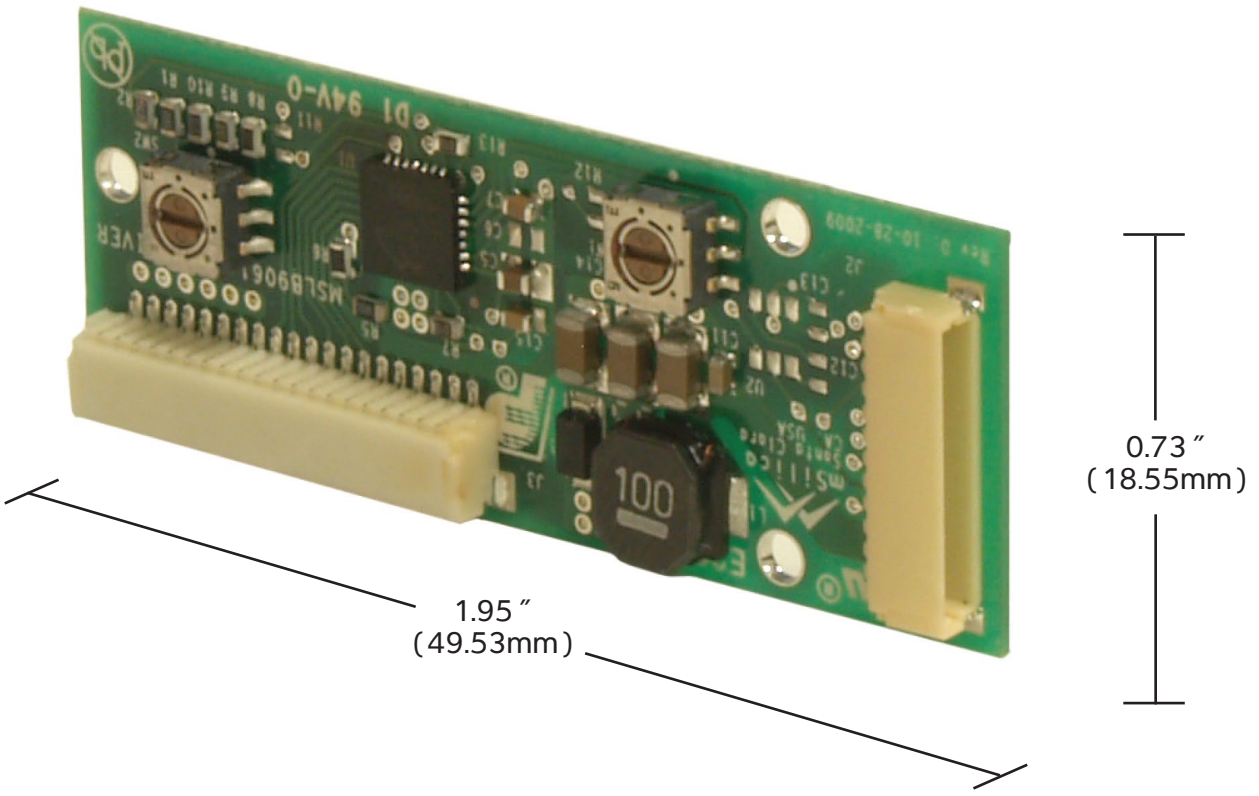
Atmel LED Driver-MSLB9061
LED Driver Module

Compact, 6-channel LED Driver Board with I²C Interface

Key Features

- Drives up to 6 LED Strings
- Up to 12 LEDs per String
- Up to 30mA per LED String
- I²C Serial Interface
- Fault Detection and Protection
- 3.3 to 28V Input Voltage Range
- Up to 7.2W Output Power
- Small Size, 1.95″ X 0.73″
- Four Available I²C Slave Addresses, Switch Selectable
- Four Full-scale Current Settings, Switch Selectable
- Separate Bias and Power Inputs Allows a Variety Of Configurations
- 1Mhz Switching Frequency
- Internal Or External PWM Dimming Control
- Digital Control of LED String Current
- Individual LED String On/Off Digital Control
- Short Circuit or Open Circuit LED String Detection
- Automatic Overvoltage Protection

LED Driver Board



Mechanical Drawing

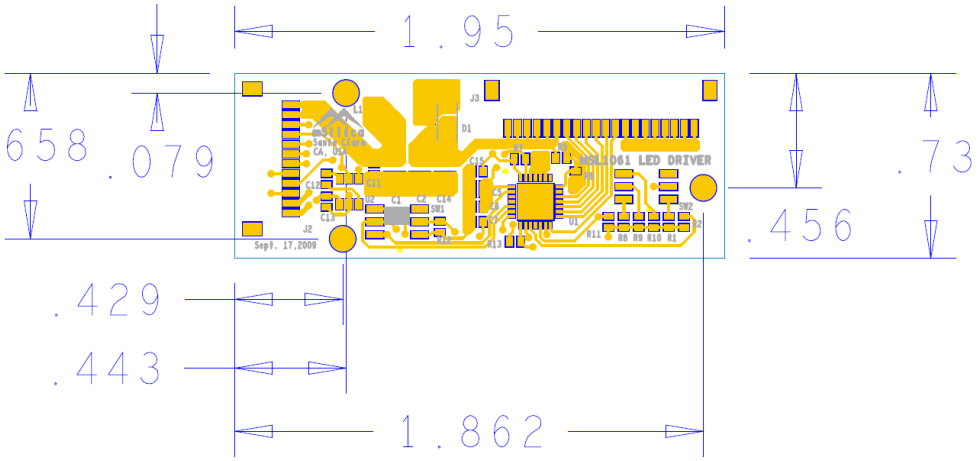


Figure 1. Atmel® LED Driver-MSLB9061 Mechanical Drawing. All Dimensions in Inches.

Connector Pin Descriptions

Table 1. J2 Input Connector Pin Descriptions

PIN NAME	PIN NUMBER	PIN DESCRIPTION
PWR	1,2	Input power to integrated boost regulator circuit
HVBIAS	3	Input to integrated LDO bias voltage regulator
LVBIAS	4	Input to MSL1061 bias voltage
DOUBLE	5	Input to charge pump doubler bias input
SDA	6	I²C serial data
SCL	7	I²C serial clock
FLTB	8	Fault indication output
EN	9	Enable control input
PWM	10	PWM dimming control input
GND	11,12	Ground

Table 2. J3 Output Connector Pin Descriptions

PIN NAME	PIN NUMBER	PIN DESCRIPTION
GND	1-8	Ground
STR6	9	LED string 6 cathode connection
STR5	10	LED string 5 cathode connection
STR4	11	LED string 4 cathode connection
STR3	12	LED string 3 cathode connection
STR2	13	LED string 2 cathode connection
STR1	14	LED string 1 cathode connection
VLED	15-20	LED sting anode output voltage

Absolute Maximum Ratings

Voltage (With Respect to GND)

STR1-STR6 ..... -0.3V to +50V

VLED ..... -0.3V to +40V

PWR, HVBIAS ..... -0.3V to +36V

BIAS, EN, PWM, SDA, SCL, FLTB ..... -0.3V to +5.5V

Ambient operating temperature range $T_A = T_{MIN}$ to T_{MAX} ..... -40°C to +50°C

Table 3 : Electrical Operating Characteristics

(Typical application circuit, VIN = 12V, $T_A = T_{MIN}$ to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C)

PARAMETER	CONDITIONS AND NOTES	MIN	TYP	MAX	UNIT
DC ELECTRICAL CHARACTERISTICS					
Power input voltage	(Note 1)	3.3V		28	V
HVBIAS input voltage	Bias voltage applied to HVBIAS, BIAS unconnected	6.5		28	V
BIAS input voltage	HVBIAS and BIAS inputs connected with bias voltage applied	4.5		6	V
DOUBLE input voltage	HVBIAS and BIAS inputs connected together, bias voltage applied to DOUBLE	3.1		3.6	V
EN logic input high level		2.3			V
EN logic input low level				0.8	V
PWM, SDA, SCL input high voltage		2			V
PWM, SDA, SCL Input low voltage				0.9	V
FLTB output low voltage	I_{FLTB} = 1mA			0.1	V
FLTB leakage current	V_{FLTB} = 3.6V			1	A
STR1-STR6 output current	ISTR*n* = 0x0F, S2 position 1		30		mA
	ISTR*n* = 0x0F, S2 position 2		25		mA
	ISTR*n* = 0x0F, S2 position 3		15		mA
	ISTR*n* = 0x0F, S2 position 4		10		mA

PARAMETER	CONDITIONS AND NOTES	MIN	TYP	MAX	UNIT
AC ELECTRICAL CHARACTERISTICS					
PWM input frequency				20	kHz

PARAMETER	CONDITIONS AND NOTES	MIN	TYP	MAX	UNIT
I²C SWITCHING CHARACTERISTICS					
SCL clock frequency	I²C timeout disabled (Note 2)			1000	kHz
Bus timeout			25		ms
Bus free time between a STOP and START condition		0.5			µs
Hold time for a repeated START condition		0.26			µs
Set-up time for a repeated START condition		0.26			µs
Set-up time for STOP condition		0.26			µs
Data hold time		10			ns
Data valid acknowledge time	(Note 3)	0.05		0.45	µs
Data valid time	(Note 4)	0.05		0.45	µs
Data set-up time		100			ns
LOW period of the SCL clock		0.5			µs
HIGH period of the SCL clock		0.26			µs
Fall time of SDA and SCL signals	(Note 5,6)			120	ns
Rise time of both SDA and SCL signals				120	ns
Pulse width of spikes that must be suppressed by the input filter	(Note 7)		50		ns
SDA, SCL, AD0 input capacitance			10		pF

Note 1. Full power available with PWR input voltage greater than 6.5V. For 3.1V to 3.6V operation, doubling charge pump(U2) and C12, C13 are required.

Note 2. Minimum SCL clock frequency is limited by the bus timeout feature, which resets the serial bus interface if either SDA or SCL is held low for 25ms. Disable bus timeout feature for DC operation.

Note 3. Time for acknowledge signal from SCL low to SDA (out) low.

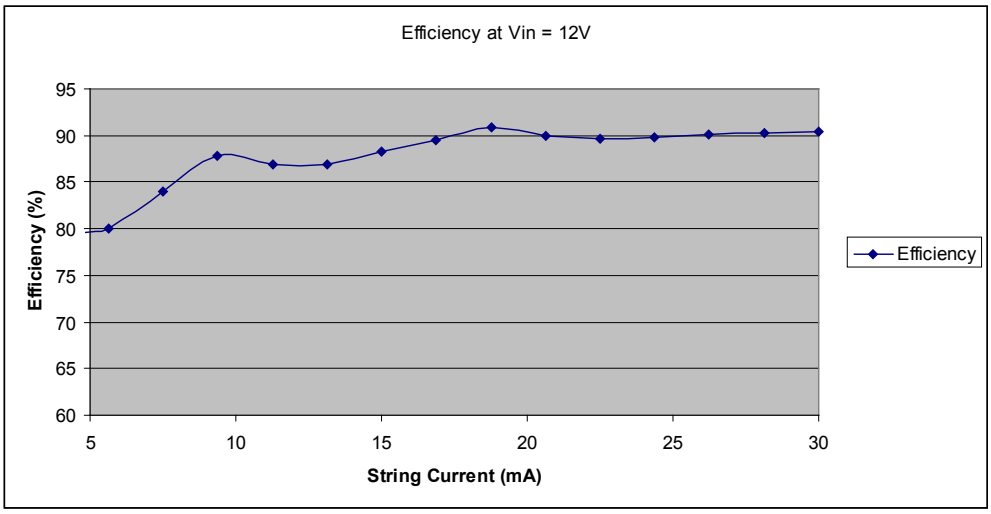
Note 4. Minimum time for SDA data out to be valid following SCL low.

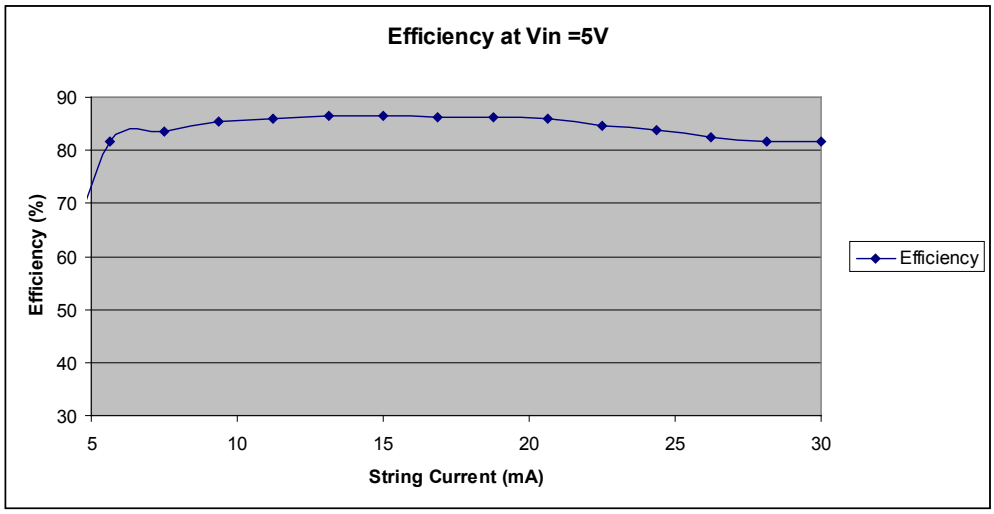
Note 5. A master device must internally provide a hold time of at least 300ns for the SDA signal (refer to the V_{IL} of the SCL signal) in order to bridge the undefined region of SCL falling edge.

Note 6. The maximum fall times for the SDA and SCL bus lines are specified at 300ns. The maximum fall time for the SDA output stage is specified at 250ns. This allows series protection resistors to be connected between SDA and SCL and the SDA/SCL bus lines without exceeding the maximum specified tall time.

Note 7. Input filters on the SDA, SCL, and AD0 inputs suppress noise less than 50ns.

Typical Performance Characteristics





Detailed Description

The MSLB9061 is a standalone, six-channel LED driver board suitable for integration into small production devices. It includes an I²C serial interface for accessing the digital features of the MSL1061 LED driver. Onboard switches set the I²C slave address to one of four available addresses and the full-scale LED current to 30, 25, 15, or 10mA.

Input Power

The MSLB9061 board is powered from input voltages ranging from 3.3 up to 28V, and the integral boost regulator power is separate, allowing operation with separate bias and power input voltages for improved efficiency or operation from a single input power source for simplicity. Full power is available for power (PWR) input voltage greater than 6.5V.

Single Input Voltage Configuration

The MSLB9061 board can be powered from a single input voltage source. The configuration depends on the input voltage range. The three available configurations are:

- Input voltage between 5.5V and 28V. Apply the input voltage to the PWR and HVBIAS inputs, J2 pins 1, 2, and 3, simultaneously. Leave BIAS and DOUBLE, J2 pins 4 and 5, unconnected. Full power is available in this configuration with an input voltage greater than 6.5V.
- Input voltage between 4.5V and 6V. Apply the input voltage to the PWR, HVBIAS, and BIAS inputs, J2 pins 1, 2, 3, and 4, simultaneously. Leave DOUBLE, J2 pin 5, unconnected. Full power is not available in this configuration.
- Input voltage between 3.1V and 3.6V. Apply the input voltage to the PWR and DOUBLE inputs, J2 pins 1, 2, and 5. Connect the BIAS and HVBIAS inputs, J2 pins 3 and 4, together, but do not apply voltage. Full power is not available in this configuration.

Separate Power and Bias Input Configuration

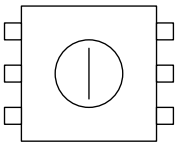
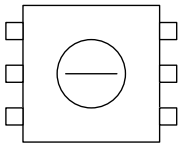
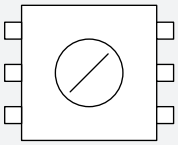
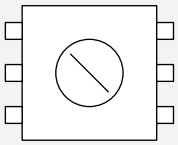
The MSLB9061 board can be powered from separate power and bias input voltage sources. With input bias voltage below the input power voltage, power dissipation is reduced for improved power efficiency. In all cases, apply the power input voltage to the PWR inputs, J2 pins 1 and 2. Full output power is available for an input voltage greater than 6.5V. The three available bias configurations are:

- 5.5V to 28V bias input voltage. Connect the bias voltage to the HVBIAS input, J2 pin 3. Leave BIAS and DOUBLE inputs, J2 pins 4 and 5, unconnected.
- 4.5V to 6V bias input voltage. Connect the bias voltage to the HVBIAS and BIAS inputs, J2 pins 3 and 4, simultaneously. Leave DOUBLE, J2 pin 5, unconnected.
- 3.1V to 3.6V bias input voltage. Connect the bias voltage to DOUBLE, J2 pin 5. Connect the HVBIAS and BIAS inputs, J2 pins 3 and 4, together, but do not apply voltage.

I^2C Serial Interface

The MSLB9061 driver board uses an I^2C/SMBus serial interface for digital LED control and fault detection. Four slave ID addresses are available, and are selected by the I^2C address selection switch. The addresses are shown in Table 4.

Table 4: I²C Slave Address Switch (S1) Settings

ADDRESS SWITCH S1 POSITION	I²C SLAVE ADDRESS	ADDRESS SWITCH S1 POSITION	I²C SLAVE ADDRESS
 Position 1	1100_000 (binary)	 Position 3	1100_010 (binary)
 Position 2	1100_011 (binary)	 Position 4	1100_001 (binary)

There are a number of features available through the I²C serial interface. Table 5 shows the registers for the MSL1061 LED driver.

Table 5. Atmel LED Driver-MSL1061 Register Map

REGISTER NAME	ADDRESS	BIT								DESCRIPTION
		D7	D6	D5	D4	D3	D2	D1	D0	
MSTRCNTRL	0x00	-	-	-	-	-	-	-	SLEEP	Sleep enable
CNTRL	0x01	-	-	-	-	INTPWM	EXTCLK	TOEN	FLTEN	Internal/external generated PWM, internal/external clock, I²C timeout and fault pin enable.
STATUS	0x03	-	OTDET	SCDET	OCDET	-	-	-	FLTDET	Open/short detect, over-temperature detect.
OCSTATUS	0x04	-	-	OC6	OC5	OC4	OC3	OC2	OC1	LED open circuit detected on STR6 – STR1
SCSTATUS	0x05	-	-	SC6	SC5	SC4	SC3	SC1	SC0	LED short circuit to VOUT detected on STR6 – STR1
PWMFREQ	0x06	D7	D6	D5	D4	D3	D2	D1	D0	Internal PWM frequency (prescaler) generator
PWMDUTY	0x07	D7	D6	D5	D4	D3	D2	D1	D0	Internal PWM duty cycle generator
STREN	0x09	-	-	STR6EN	STR5EN	STR4EN	STR3EN	STR2EN	STR1EN	String enable, shutdown control
IDAC	0x10	-	-	-	-	DAC3	DAC2	DAC1	DAC0	4-bit current DAC

For detailed descriptions of the Atmel LED Driver-MSL1061 register-controlled operating modes, see the Atmel LED Driver-MSL1061 Datasheet.

On/Off (EN) Control Input

The on/off control Input, pin 9 of input connector J2, turns on/off the LED driver. Drive it high (between 2.3 and 5V) to turn on the LED driver, and drive it low (0 to 0.8V) to turn it off. The on/off control input is internally pulled up by a 100kΩ resistor. For automatic start-up, leave it unconnected.

PWM Control Input

The input connector, J2, pin 10, is the PWM control input. Drive PWM with a digital signal to pulse-width modulate (PWM) the LED brightness. When using the internal PWM generator, the PWM input signal is ignored. The PWM input is pulled high through a 100kΩ resistor. If not used, leave PWM unconnected or drive it high.

Fault Indicator Output

The MSL1061 includes fault detection circuitry that detects an open-circuited LED string or an LED string with one or more short-circuited LEDs. If any fault is detected, the fault indicator output is driven low. Use this output as an alert signal to a system controller. Once the controller gets the alert signal, it determines which LED is faulty by reading the STATUS, OCSTATUS, and SCSTATUS registers through the I²C serial interface.

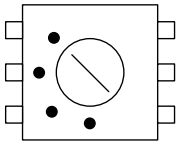
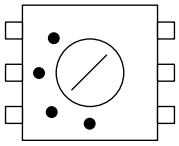
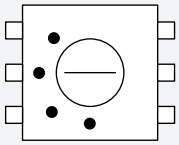
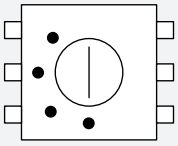
Connecting the LEDs to the Atmel LED Driver-MSLB9061 LED Driver

The MSLB9061 driver board drives LED arrays with up to six parallel strings of up to 12 series LEDs each through the output connector, J3. Six connections for LED cathode connections allow the use of separate LED strings, or common-anode-connected LED strings. Connect unused LED cathode string connections (J3 pins 9-14) to GND to disable that LED string. J3 pins 1-8 are provided for this purpose so that unused string cathode connections are connected to GND through the wiring harness.

Setting the Full-Scale LED Current

The MSL1061 regulates the LED string current. The LED string current is set by a current sense resistor. Four different values are programmed to the MSLB9061 LED driver module, and the switch S2 selects one of those resistors to set the full-scale per-string LED current to 10mA, 15mA, 25mA or 30mA. Table 6 shows the switch settings and the full-scale per-string LED current for each setting.

Table 6: Full-Scale Per-String LED Current (S2) Settings

Full-Scale LED Current Switch S2 Position	Full-Scale Per-String LED Current	Full-Scale LED Current Switch S2 Position	Full-Scale Per-String LED Current
 Position 1	30mA	 Position 3	15mA
 Position 2	25mA	 Position 4	10mA

Driving LEDs with Greater than 30mA LED Current

The maximum current available from each LED driver is 30mA. When using LEDs that require greater than 30mA, connect multiple LED drivers in parallel to drive a single LED string. The LED string current is the sum of the LED driver currents. Table 7 shows a list of the higher currents that can be supported by this board.

Table 7. Settings for Higher Currents

Current	# of Strings	EVU-MSL1061
40mA	2	2 x 20mA x 2 strings
	3	2 x 20mA x 3 strings
50mA	2	2 x 25mA x 2 strings
	3	2 x 25mA x 3 strings
60mA	2	2 x 30mA x 2 strings
	3	2 x 30mA x 3 strings

Atmel LED Driver-MSLB9061 Schematic

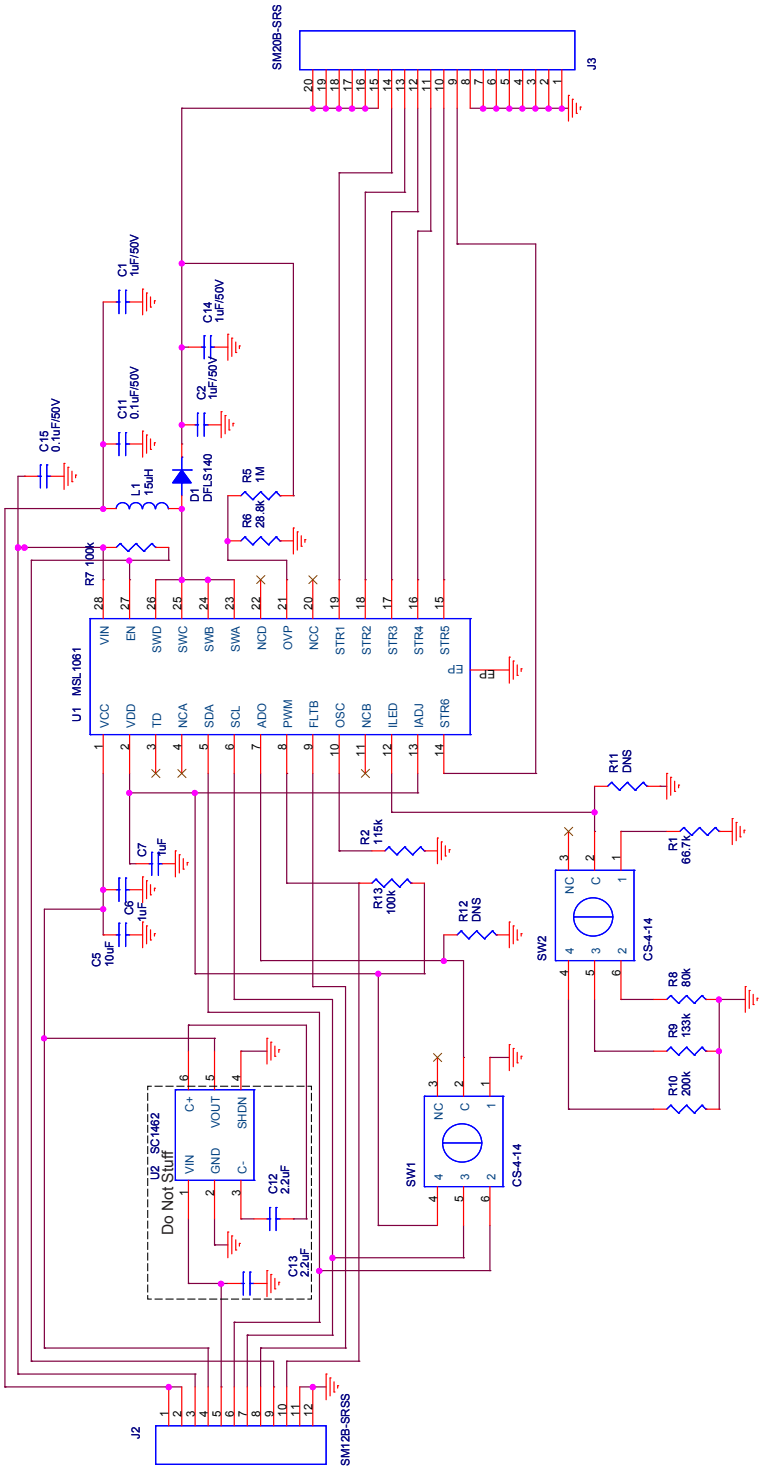
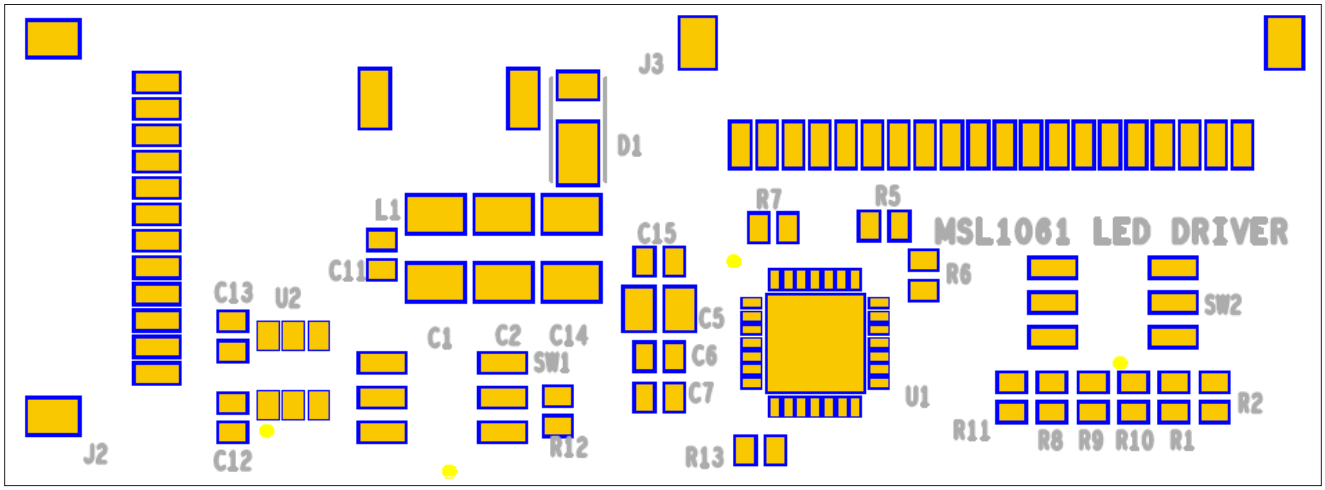


Figure 2: Atmel LED Driver-MSLB9061 Board Schematic.

Atmel LED Driver-MSLB9061 Component Placement



Atmel LED Driver-MSLB9061 Bill of Materials

REF	QTY	DESCRIPTION	MANUFACTURER	MANUFACTURER P/N
C1, C2, C14	3	Capacitor, ceramic, 1µF, 50V, X7R, 1206	Murata GRM31CR71H105KA61L or equivalent	
C5, C13*	2	Capacitor, ceramic, 10µF, 6.3V, X7R, 0805	Murata GRM21BR70J206KE76L or equivalent	
C6, C7	2	Capacitor, ceramic, 1µF, 10V, X7R, 0603	Murata GRM188R7A105KA61D or equivalent	
C11, C15	2	Capacitor, ceramic, 0.1µF, 50V, X7R, 0603	Murata GRM188R71H104KA93D or equivalent	
C12*	1	Capacitor, ceramic, 2.2µF, 10V, X7R, 0603	Murata GRM188R71A225KE15D or equivalent	
D1	1	Rectifier, Schottky, 1A, 40V, Power-Di 123	Diodes Inc. DFLS140L-7 or equivalent	
J3	1	Connector, 12-position, 1.0mm spacing, low profile	JST SM12B-SRSS-TB	
J3	1	Connector, 20-position, 1.0mm spacing, low profile	JST SM20B-SRSS-TB	
L1	1	Inductor, 15µH, 1.4A, CDRH5D28R/HP	Sumida CDRH5D28R/HP-150 or equivalent	
R1	1	Resistor, 66.5KΩ, 1%, 0603	Rohm MCR03EZPFX6652 or equivalent	
R2	1	Resistor, 115KΩ, 1%, 0603	Rohm MCR03EZPFX1153 or equivalent	
R5	1	Resistor, 1.00MΩ, 1%, 0603	Rohm MCR03EZPFX1004 or equivalent	
R6	1	Resistor, 28.7KΩ, 1%, 0603	Rohm MCR03EZPFX2872 or equivalent	
R7, R13	2	Resistor, 100KΩ, 1%, 0603	Rohm MCR03EZPFX1003 or equivalent	
R8	1	Resistor, 80.6KΩ, 1%, 0603	Rohm MCR03EZPFX8062 or equivalent	
R9	1	Resistor, 133KΩ, 1%, 0603	Rohm MCR03EZPFX1333 or equivalent	
R10	1	Resistor, 200KΩ, 1%, 0603	Rohm MCR03EZPFX2003 or equivalent	
SW1, SW2	2	Switch, 4-position, rotary, surface mount, 4.5x5mm	Copal Electronics CS-4-14NTA or equivalent	
U1	**1**	**LED driver with boost, six-channel, QFN55-28**	**MSL1061**	
U2*	1	Doubling charge pump, SOT-23-6	Semtech SC1462ISKTR or equivalent	

*** Foot print are available for optional use. Do not stuff.**

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