
Datasheet

SmartLED-II

40W LED Backlight Converter

Part number: IN-52-xxx



Design EN55022 and EN61000-6-2 oriented

Version 1.0.11

03.04.2017

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Date	Rev.No.	Description	Page
02.08.2013	1.0.0	Release of preliminary data sheet, derived from Target Specification rev.1.3	All
13.12.2013	1.0.1	New front page picture	1
09.01.2014	1.0.2	Added Features	4
23.01.2014	1.0.3	Corrected absolute maximum ratings	7
27.03.2014	1.0.4	Corrected CON1 type in sec. 8.1	8
20.05.2015	1.0.5	Added description of CON8 and CON9	11
09.10.2015	1.0.7	Added description of Ambient Light Sensor functionality	4
21.10.2015	1.0.8	Added temperature derating spec	5
01.03.2017	1.0.9	Diming Range updated	4
		Storage Temperature Range updated	6
		Input / Output pulse width added	7
		Brightness Input / Output Transfer Characteristic added	8
15.03.2017	1.0.10	Add note Error Flag	7
03.04.2017	1.0.11	Mechanical specifications updated	10

1. Overview

SmartLED-II is a 40W output LED backlight converter able to drive two rails of high-brightness LEDs. The converter is highly configurable by software and thus can be adapted to a multitude of different applications.

2. Warnings

Although the SmartLED-II is using protection circuits for most of its interfaces, it is strongly recommended to adhere to the maximum ratings of SmartLED-II, outlined in this document.

3. General Features

- Input: 11 – 16V
- Output: 7 – 10V, 200mA – 2A per channel (rail)
- Control via analog voltage (0..3.3V or 0..5V) or PWM (100 .. 1000Hz)
- Output PWM synchronized to input, sync signal or free-running with programmable frequency
- I2C for ambient light sensor and temperature sensor(s)
- Additional GPIOs for local control (pushbuttons, sensor pads or potentiometer) of brightness
- Capability to connect multiple boards in a master-slave setup for high-power applications
- Control input for NVIS mode
- Error flag to detect failure of power stage or LED rail
- LED brightness control by PWM dimming for stable colour temperature; optionally, use current control or combined dimming for brightness control
- Wide dimming range up to 1:10000 (depends on PWM frequency)
- Control characteristic curve can be adapted upon customer request

Some features require specific firmware support or are mutually exclusive to other features. Please contact your sales partner to discuss possible options or combinations.

Features will be configured by different firmware and/or configuration files. For high-volume applications, a version without microprocessor control may be possible as a more economical solution – please contact your sales partner to discuss this as a project-based solution.

Configuration via serial port + software (“SmartLED Rover”) is implemented. Serial port control is also possible, but subject to restrictions to avoid interfering with the protocol used for factory programming/configuration.

4. Hardware Features

High-Efficiency Buck Regulator

- 11 - 16V input range
- Max. 2.3A output current (depending on actual rail configuration due to total power limit)
- Efficiency $\geq 92\%$

Flexible Microcontroller Control

- On-Board microcontroller handles all input and control signals
- Features are defined by firmware

5. Application Diagram and User Controls

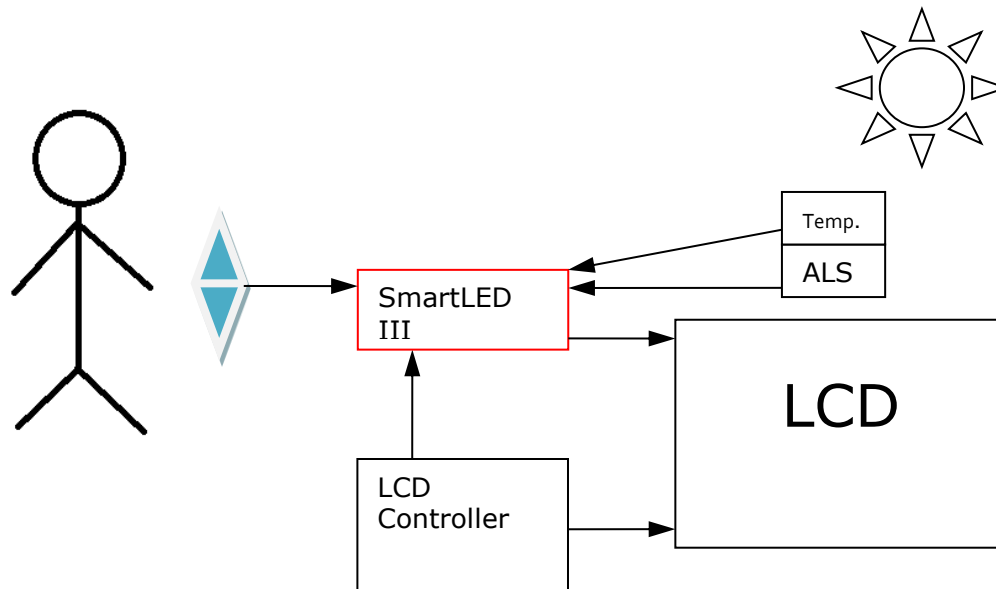


Figure-1: Overview of SmartLED-II usage (ALS = ambient light sensor)

5.1 Ambient Light Sensor

This feature is available from the standard firmware version 1.14.0.49722.

The Ambient Light Sensor can be connected to CON6.

It assumes control of panel backlight for the selected brightness range as soon as detected.

Required components:

ZU-02-371 IF371-00-R1.0 ambient light detection 46" / 1500 cd
 KA-30-185 Cable ARCB/PIII/PMII / IF371 800mm

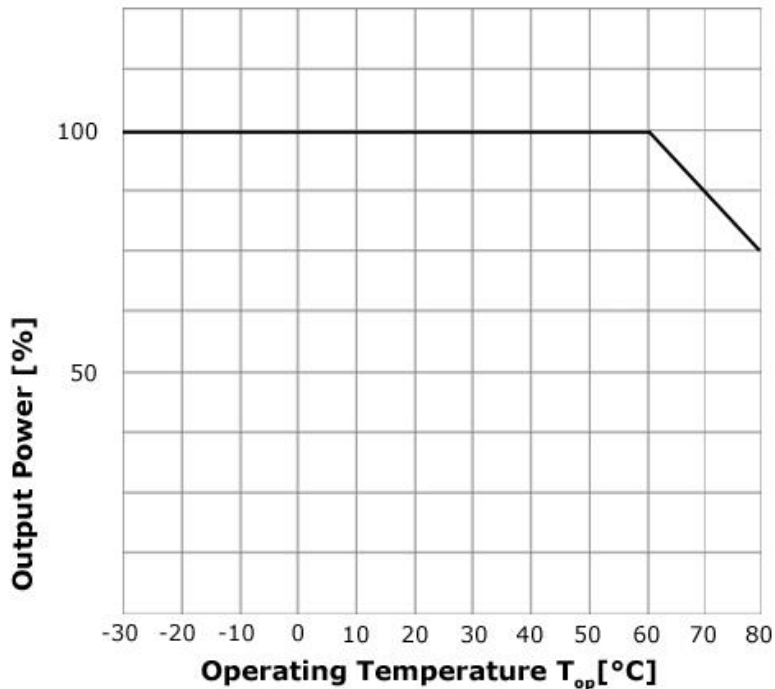
6. Absolute Maximum Ratings

Item	Symbol	Min.	Max.	Unit	Note
Supply Voltage	V_{in}	11.0	16	VDC	1, 2
Control Voltages	$V_{ENABLE},$ $V_{CONTROL},$ V_{SYNC}	-1.0	6.0	V	
Storage Temperature	T_{St}	-40	+105	°C	
Operating Temperature	T_{Op}	-30	+80	°C	3

Note (1) Within operating temperature range.

Note (2) Permanent damage to the device may occur if maximum values are exceeded.

Note (3) In the upper range of T_{Op} total output power as well as the heat dissipation/cooling has to be checked. Forced airflow might be required. The diagram below shows the derating characteristic:



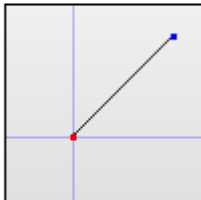
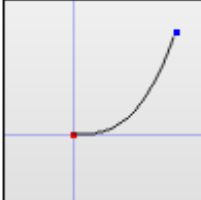
7. Electrical Specification

ITEM	SYMBOL	MIN.	TYP.	MAX.	UNIT	Remarks
Supply Voltage	V_{IN}	11	12	14.5	V	
Efficiency			92		%	
Min. ON Voltage	$V_{ENABLE}, V_{CONTROL}$	1.6		5.0	V	
Max. OFF Voltage	$V_{ENABLE}, V_{CONTROL}$	0		0.6	V	
Brightness control voltage	$V_{CONTROL}$			5	V	$I_{RAIL} = \text{max.}$ Note 1)
				3.3	V	
		0			V	$I_{RAIL} = \text{min.}$
PWM frequency	f_{PWM}	100	162	1000	Hz	
Dimming	Duty(PWM)	0		100	%	Note 1)
Input pulse width	T_{PWI}	90			μs	Note 6)
Output pulse width	T_{PWO}	1.0		T_{PWI}	μs	Note 7)
PWM voltage	$V_{CONTROL}$	0	3.3	5.0	V	Note 1)
IRAIL LED rail current	I_{RAIL}	200		2300	mA	$V_{CONTROL} = \text{max} /$ $\text{Duty(PWM)} = 100\%$ Note 4)
VRAIL LED rail forward voltage	V_{RAIL}	7		10.0	V	
Error Flag	$V_{E,High}$	2.3		3.3	V	10mA max, Note 5, 8)
	$V_{E,Low}$	0			V	Note 5, 8)

Notes:

- 1) To use voltage or external PWM control of dimming requires alternative firmware. Brightness control characteristics can be adapted on customer request. Please contact your sales partner for possible options.
- 2) Error Flag might be unavailable for very low dimming ratio (< 10%, TBD)
- 3) To use sync input requires alternative firmware. Please contact your sales partner for possible options.
- 4) Maximum output current limited by maximum input current handling capability of 4Amps. Regulator is able to supply up to 2300mA @ 9V output using a sufficiently stable input power supply such that input current is within the given 4A limit.
- 5) Error flag uses a PNP open-collector output with a 100R current limiting resistor. As such, the pin can not sink any current; the current sourced from this pin must not exceed 10 mA for the minimum output voltage to be achieved
- 6) Do not fall below that value to prevent flicker.

- 7) Use the Brightness Input / Output Transfer Characteristic feature of ChandlerRover for dimming the brightness to 0nits with smooth transition and achieving the dimming range up to 1:10000@100Hz.
- 8) SmartLED monitors the LED strings to detect LED short-circuit and string open-circuit faults.
 When verified, all string faults force the ERROR flag and the red LED active.
 As well, only the fault strings are deactivated and remain disabled until toggling ENABLE low and then high.
 Currently, there is not an ERROR flag connection between SmartLED and Prisma, because Prisma doesn't provide a suitable input to monitor this signal.

Standard settings	Settings for smooth transition
<p>Brightness Input / Output Transfer Characteristic</p> <p>out = in ^ (1 + <input type="text" value="0"/> / 8)</p> 	<p>Brightness Input / Output Transfer Characteristic</p> <p>out = in ^ (1 + <input type="text" value="15"/> / 8)</p> 

8. Mechanical Specification

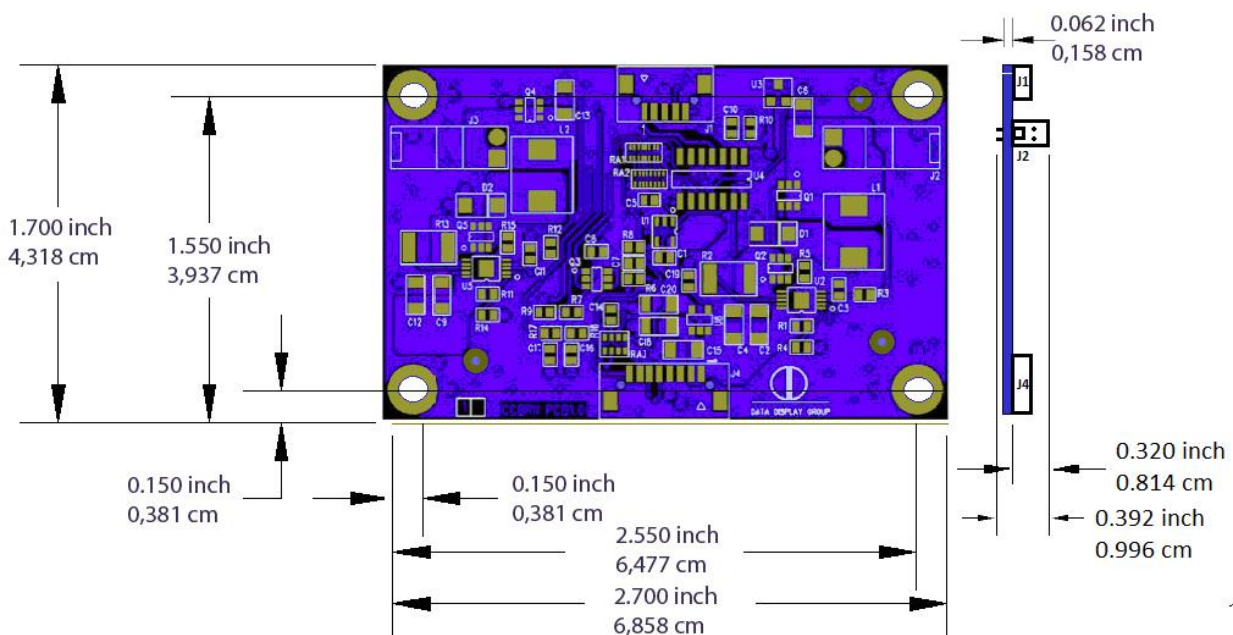
ITEM	DESCRIPTION	REMARKS
Length	68.6 mm	± 0.2 mm
	2.7 inch	± 0.01 inch
Width	43.2 mm	± 0.2 mm
	1.7 inch	± 0.01 inch
Height (top side)	8.13 mm	± 0.2 mm
	0.32 inch	± 0.01 inch
Height (PCB)	1.6 mm	± 0.1 mm
	0.063 inch	± 0.005 inch
Height (bottom side)	2.0 mm	± 0.5 mm
	0.787 inch	± 0.2 inch
Weight	15 g	

8.1 Mounting Hole Specification

ITEM	DESCRIPTION	REMARKS
Quantity	4	
Inner Diameter	3.2 mm	± 0.1 mm
Outer Diameter	6.8 mm	± 0.1 mm
Copper Plating	0.035 mm	± 0.01 mm
Gold Finish	0.05 µm	± 0.02 µm

The mechanical layout will be made according to current SmartLED hardware: outline, input and output connectors will have the same coordinates, new connectors yet TBD.

Current SmartLED mechanics for reference:



9. Connectors and Switches

The following drawing shows the input and output interfaces of the SmartLED-II. The design is implemented as a single printed circuit board.

9.1 Overview

CN	DESCRIPTION	TYPE	MANUFACTURER
CON1	Power supply and control	DF13-14P-1.25H	Hirose
CON2	Rail 1 output	22-05-3021	Molex
CON3	Rail 2 output	22-05-3021	Molex
CON4	Programming/Debug	DF14-5P-1.25H	Hirose
CON5	GPIO / User Interface	DF14-5P-1.25H	Hirose
CON6	I ² C-0	501331-0407	Molex
CON7	I ² C-1	501331-0407	Molex
CON8	Master / Slave	DF13-5P-1.25H	Hirose
CON9	Serial interface	DF13-5P-1.25H	Hirose

9.2 Input Connectors

9.2.1 Input Power/Control Connector

Location: CON1
Connector used: DF13-14P-1.25H (20) (Hirose)
Mating housing: DF13-14S-1.25C (Hirose)
Function:

Pin No.	Symbol	Function	Note
1	ERROR	ERROR Flag (high = Error)	2
2	GND	Power return	
3	GND	Power return	
4	VIN	+12VDC input power	4
5	VIN	+12VDC input power	4
6	SYNC	External Sync input NVIS mode select	3
7	VIN	+12VDC input power	4
8	VIN	+12VDC input power	4
9	GND	Power return	
10	GND	Power return	
11	ENABLE	On/Off control	
12	CONTROL	Brightness control voltage (0-5VDC or PWM)	1
13	+3.3V	Power output	5
14	CONTROL	Brightness control voltage (0-5VDC or PWM)	1

Notes:

- 1) To use voltage or PWM control of dimming requires alternative firmware. Please contact your sales partner for specific information about possible options. Pins 12 and 14 are connected internally but kept for backwards compatibility.
- 2) Error Flag might be unavailable for very low dimming ratio (< 10%, exact value TBD)
- 3) To use sync input or NVIS mode feature requires alternative firmware. Please contact your sales partner for possible options.
- 4) Maximum output current limited by maximum input current handling capability of 4Amps. Regulator is able to supply up to 2300mA @ 9V output using a sufficiently stable input power supply such that input current is within the given 4A limit.
- 5) Output power for supply of analog dimming potentiometer; kept for compatibility, use of GPIO/User Interface for new designs is recommended.

For backward compatibility, the old power cable can be connected to pins 7-14; in case of any doubt, please contact your sales partner!

9.3 Output Connectors

9.3.1 LED Rail connectors

Location: CON2, CON3
 Connector used: 22-05-3021 (Molex) (can handle 4Amps)
 Mating housing: 22-01-3027 (Molex)
 Function:

Pin No.	Symbol	Function
1	LRH1,2	VBLH (High voltage)
2	LRL1,2	VBLL (Low voltage)

Outputs can be paralleled for high-current applications

9.4 Other Connectors

9.4.1 I²C (Temperature/Light Sensor) connector

Location: CON6, CON7
 Connector used: 501331-0407 (Molex)
 Mating housing:
 Function:

Pin No.	Symbol	Function
1	+3.3V	Sensor Supply
2	GND	Ground
3	SCL	clock
4	SDA	data

Two separate I²C channels are used to allow two identical temperature sensors (e.g. mounted on the LED rails) to be used without the need for address selection.

9.4.2 User Interface/GPIO Connector

GPIO pulled out externally via connector to allow for brightness adjustment using external controls.

GPIO pins can be used for keypad (push button or sensor key) as well as analog input for potentiometer. 3.3V supply for potentiometer or external logic is available on user interface connector.

Location: CON5
 Connector used: DF13-10P-1.25H (20) (Hirose)
 Mating housing: DF13-10S-1.25C (Hirose)
 Function:

Pin No.	Symbol	Function	Note
1	V3.3V	+3.3VDC output power	1)
2	GND	Power return/shield	
3	GPIO1	GPIO/ADC/TSI	2)
4	GND	Power return/shield	
5	GPIO2	GPIO/ADC/TSI	2)
6	GND	Power return/shield	
7	GPIO3	GPIO/ADC/TSI	2)
8	GND	Power return/shield	
9	GPIO4	GPIO/ADC/TSI	2)
10	GND	Power return/shield	

Notes:

- 1) Maximum current drawn 300mA
- 2) Pin function is software defined; contact your sales partner for possible options

9.4.3 Master/Slave Connector

The master/slave connector is intended to connect and synchronise multiple SmartLED-II converters for high power applications. Additionally, the GPIO pin present on this connector may be used as an alternative enable input by configuration option.

Note that the usage of this connector needs a customized FW. Please contact your sales partner to discuss this option.

Location: CON8
 Connector used: DF13-5P-1.25H (20) (Hirose)
 Mating housing: DF13-5S-1.25C (Hirose)
 Function:

Pin No.	Symbol	Function	Note
1	PWM	PWM signal from master to slave	
2	GPIO	General Purpose Input/Output	1)
3	NC	No Connection	
4	NC	No Connection	
5	GND	Ground/Shield	

Notes:

1) This pin can be used as an alternative enable input via configuration option

9.4.4 Serial Interface Connector

The serial interface connector is used for factory programming and can also be used for field firmware or configuration upgrade. The signals are 3,3V TTL/CMOS level. For special applications, a serial control channel can also be implemented in firmware upon request. Please contact your sales partner to discuss further options.

Location: CON9
 Connector used: DF13-5P-1.25H (20) (Hirose)
 Mating housing: DF13-5S-1.25C (Hirose)
 Function:

Pin No.	Symbol	Function	Note
1	TXD	Transmit data from SmartLED-II	1)
2	RXD	Receive Data to SmartLED-II	1)
3	+3,3V	3,3V power supply for e.g. level converter	
4	NC	No Connection	
5	GND	Ground/Shield	

Notes:

1) 3,3V TTL/CMOS signal level.

10. Supported Panels / LED Rails

The SmartLED-II can support single or dual rails at a voltage/current rating of 7 – 10 V at 200 – 2300 mA. The total output power must not exceed 44 Watts, however! Output channels can be combined by connecting in parallel. In master-slave mode, also outputs of multiple boards can be connected in parallel to combine output power.

Manufacturer	Model	Size	Current	Voltage (volts)	Power (watts)	Brightness (cd/m ²)
Apollo	LED	6.5"	2 x 240mA	9	4.32	
Apollo	LED	8.4"	2 x 400mA	9	7.2	
Apollo	LED	10.4"	2 x 600mA	9	10.8	
Apollo	LED	12.1"	2 x 800mA	9	14.4	
Apollo	LED	15"	2 x 900mA	9	16.2	
Apollo	LED	17"	2 x 1.0A	9	18	
Apollo	LED	19"	2 x 1.1A	9	19.8	
Apollo	LED		2 x 1.2A	9	21.6	
Apollo	LED		2 x 1.3A	9	23.4	
Apollo	LED		2 x 1.4A	9	25.2	
Apollo	LED		2 x 1.5A	9	27	
Apollo	LED		2 x 1.6A	9	28.8	
Apollo	LED		2 x 1.7A	9	30.6	
Apollo	LED		2 x 1.8A	9	32.4	
Apollo	LED		2 x 1.9A	9	34.2	
Apollo	LED		2 x 2.0A	9	36	

Table-2: Supported Panels

A combination of two different rails is possible for NVIS applications; the active rail and corresponding current is selected via means of a digital trigger input, e.g.:

Trigger	Channel	Setting	Remarks
Low (0V)	1	On, 1A	Normal mode
	2	Off	
High (3.3V)	1	Off	NVIS mode
	2	On, 200mA	

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