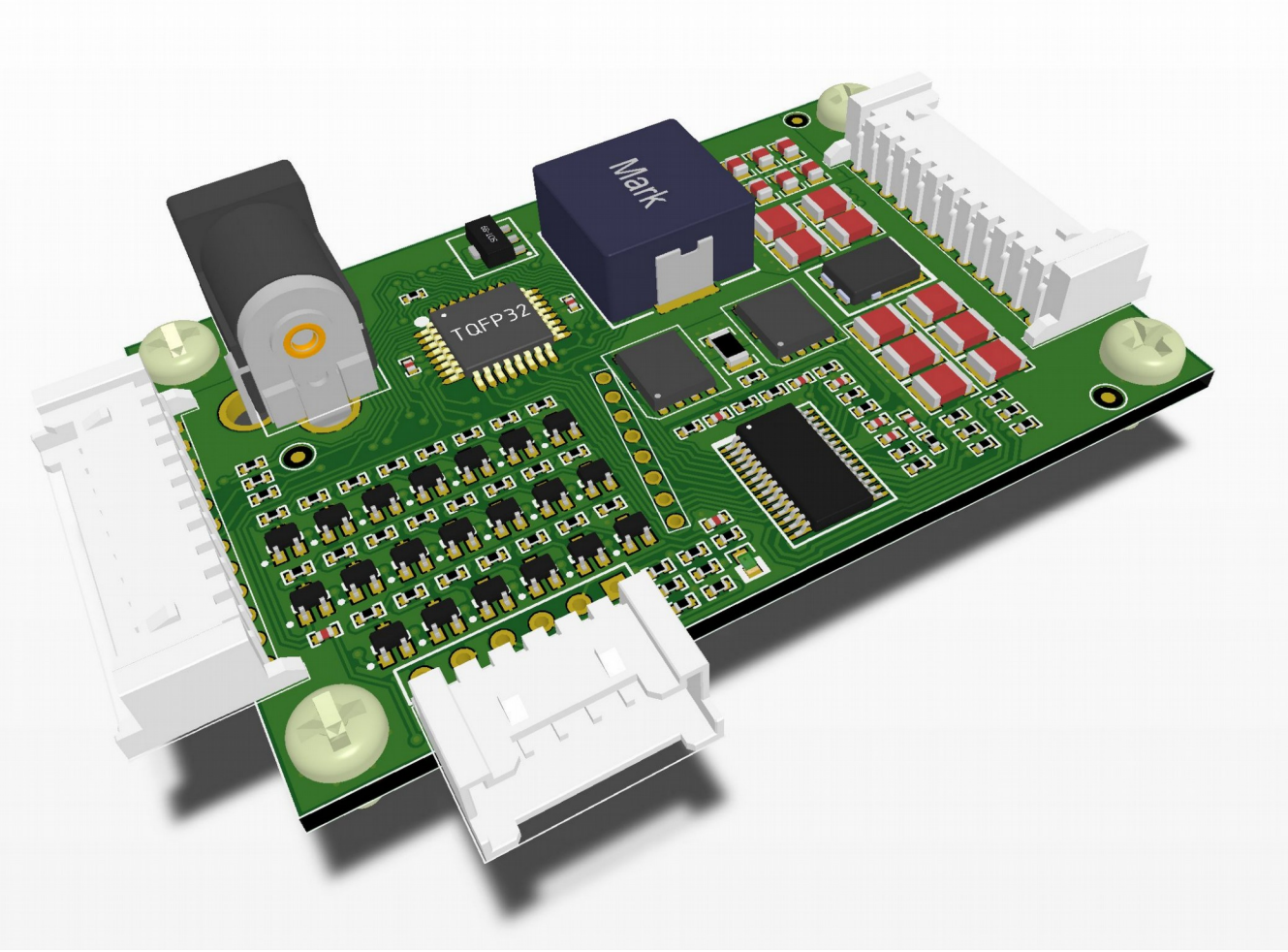
ZisWorks

“Flexible LED Backlight Driver”

HARDWARE USER GUIDE



Document version : 18 August 2017

The latest version of this document and others can be found at:
zisworks.com/downloads

CHANGELOG

Version 1.0 : 14 July 2017 : Original release
Version 1.1 : 19 July 2017 : Added control modes, operational modes, and serial control output sections
Version 1.2 : 18 August 2017 : Minor changes for public posting

Table of Contents

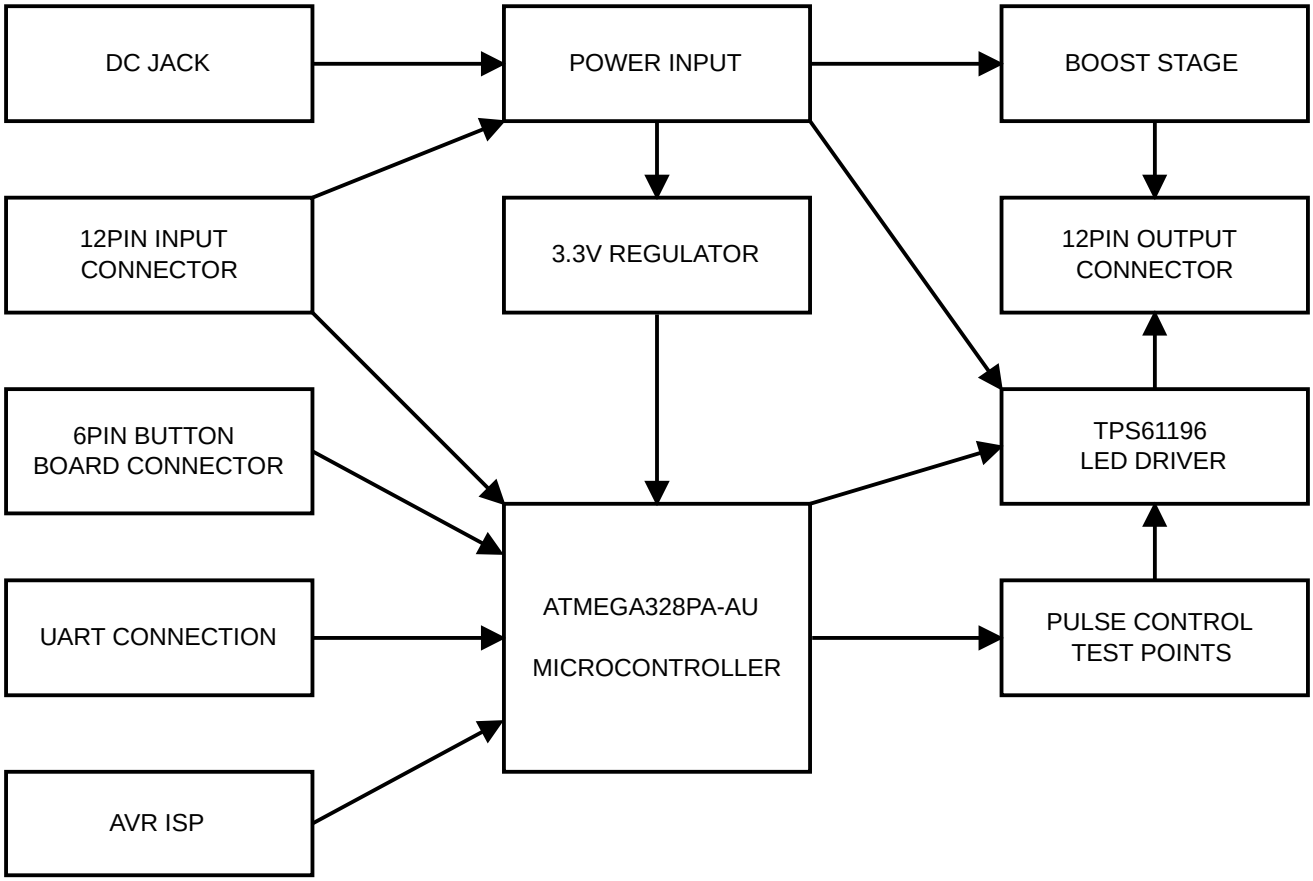
OVERVIEW

The ZWS Smart LED Backlight Driver board is a versatile LED driver with onboard microcontroller for precise control over the backlighting system of an LCD panel. Based on the Atmel ATMEGA328P microcontroller and the Texas Instruments TPS61196 LED driver, it is capable of independently controlling up to six LED strings. The solution is easily user-reprogrammable with a ZWS provided reference firmware which supports pwm, pwm-free, strobing, and scanning backlight modes. Per-string current control is available between 50mA and 370mA in 2.5mA steps.

FEATURES AND SPECIFICATIONS

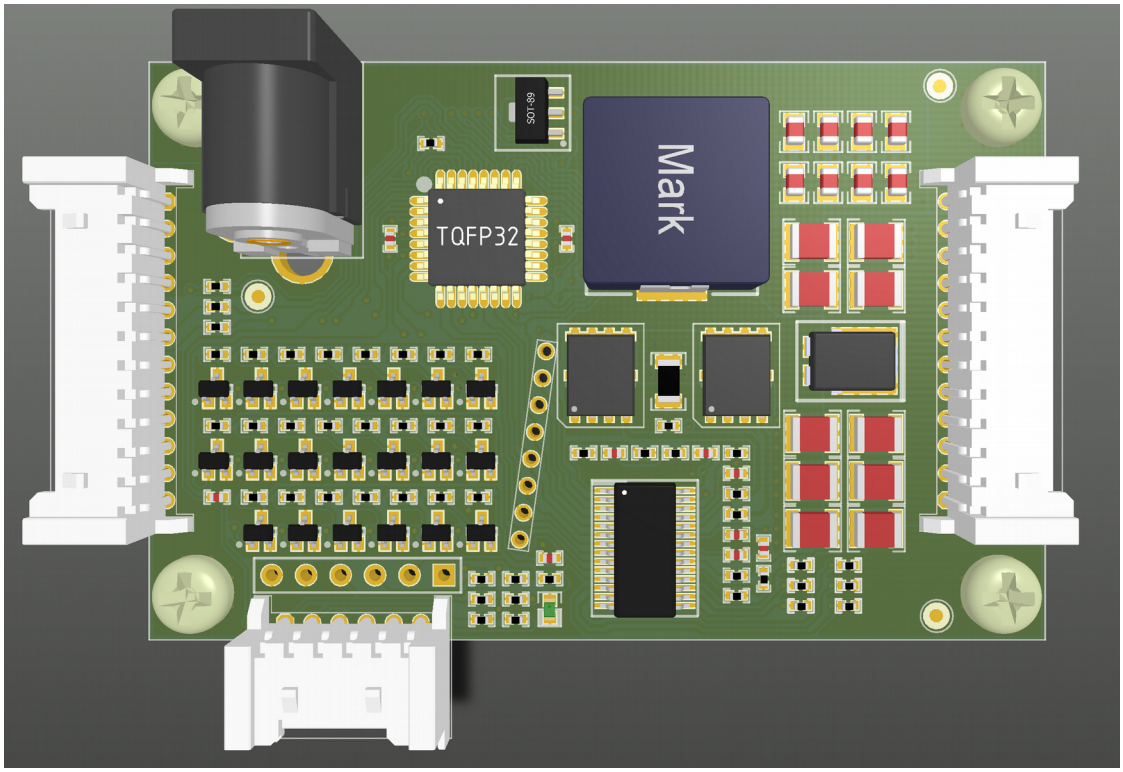
• 12-V to 30-V Input Voltage
• Up to 60-V Output Voltage
• High-quality all-ceramic capacitor design
• Boost topology with adaptive output voltage control
• Current controlled between 50mA ~ 370mA in 2.5mA steps
• Six Current Sinks, 200-mA Continuous Output, 400-mA Pulse Output for each string
• ±1.5% Current Matching Between Strings
• High Precision PWM Dimming Resolution up to 5000:1
• Soft-start control
• LED Open and LED Short Protection
• Thermal Shutdown
• Schottky Diode Open/Short Protection
• ISET Short Protection
• IFB Short Protection
• Output overvoltage protection set to 64V
• Undervoltage lockout set to 10.3~11.1V
• Input overcurrent protection set to 8A
• Atmel 6-pin AVR ISP header footprint
• Pin holes for connection with included USB <=> UART adapter for firmware update and debugging
• Testpoints for verification and debugging of pulse control signals.

BLOCK DIAGRAM

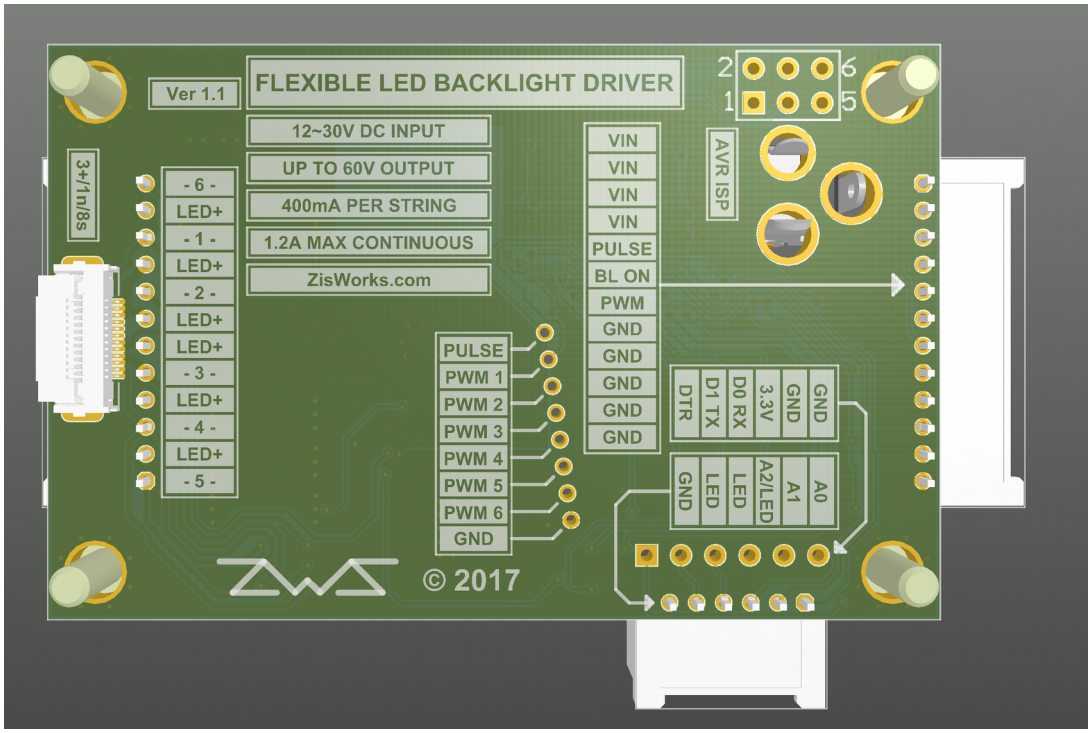


BOARD OVERVIEW

Top view:


TQFP32
Mark

Bottom view:


FLEXIBLE LED BACKLIGHT DRIVER
Ver 1.1
12~30V DC INPUT
UP TO 60V OUTPUT
400mA PER STRING
1.2A MAX CONTINUOUS
ZisWorks.com
3+/1n/8s
- 6 -
LED+
- 1 -
LED+
- 2 -
LED+
LED+
- 3 -
LED+
- 4 -
LED+
- 5 -
VIN
VIN
VIN
VIN
PULSE
BL ON
PWM
GND
GND
GND
GND
GND
AVR ISP
PULSE
PWM 1
PWM 2
PWM 3
PWM 4
PWM 5
PWM 6
GND
DTR
D1 TX
D0 RX
3.3V
GND
GND
GND
LED
LED
A2/LED
A1
A0
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CONNECTOR PINOUTS

DC Jack

Mates with standard 5.5*2.5mm size DC jack
Center-positive, 12-30V input

12pin PH2.0 style connector

Mates with standard PH2.0 12p connectors
Contains the control signal I/O and an alternative power input
Pins are labeled on the rear side of the PCB

VIN is shorted to the positive input of the DC jack
PULSE is connected to an interrupt-capable pin on the microcontroller and is typically used to indicate the video frame state for appropriate alignment of the backlight pulses in strobe and scan modes.
This pin has a 100k pulldown and 1k series resistor.
BL_ON is an additional optional input to the microcontroller, and can change operation as per programming. Typically, BL_ON acts as an enable/disable signal.
This pin has a 100k pulldown and 1k series resistor.
PWM is an additional optional input to the microcontroller, and can change operation as per user programming. Typically, PWM is used as a general brightness control.
This pin has a 100k pulldown and 1k series resistor. The connecting device must tolerate its use as an output in some situations.

12pin PH2.0 style connector

Mates with standard PH2.0 12p connectors
Connections to the LED strings
Pins are labeled on the rear side of the PCB

LED+ pins are all connected to the high-voltage supply output
Numbered pins are connected to the current sinks of the TPS61196

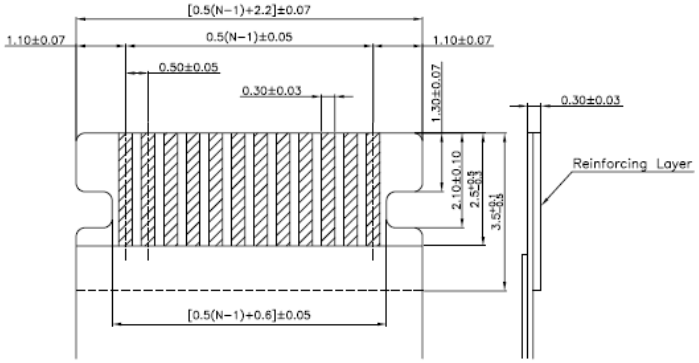
6pin PH2.0 style connector

Mates with standard PH2.0 62p connectors
Connections to the button board
Pins are labeled on the rear side of the PCB

A0/A1/A2 are connected to the analog inputs of the microcontroller and are used for detecting button input states. These pins have a hardwired 1K pullup to 3.3v.
LED pins are connected to LEDs on the button board
See the firmware for details

12pin 0.5mm FPC/FFC style connector

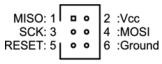
Mates with FPC/FFC cables with the shown latching profile
Enables direct connection to V390DK1-LS1 panel and potentially others.



Testpoints/Pin holes

There are three groups of testpoints/pin holes present on the board.

The AVR ISP is intended for use with the 6-pin AVR ISP programmers such as the AVRISP MKII.



The 6 pin 0.1” hole array is labeled on the underside of the board. It is intended for use with a USB <=> UART adapter for debugging and user-repgrogramming.

An 8-pin 2.0mm hole array is labeled on the underside of the board. These testpoints are useful for analyzing the timing of the input pulse stream and the six generated LED string enable signals.

MICROCONTROLLER PINOUT

PCB VERSION 1.1

ATMEGA328P-AU	ARDUINO #	CONNECTION
23	A0	BUTTON_A
24	A1	BUTTON_B
25	A2	BUTTON_C/LED
26	A3	ENABLE
27	A4	INPUT_PWM/SDA/ZWS
28	A5	INPUT_ENALBE/SCL
30	0	RX/LED
31	1	TX/LED
32	2	INPUT_PULSE
1	3	PWM_1
2	4	ADIM_BIT_0
9	5	PWM_6
10	6	PWM_5
11	7	ADIM_BIT_1
12	8	ADIM_BIT_3
13	9	PWM_4
14	10	PWM_3
15	11	PWM_2
16	12	ADIM_BIT_5
17	13	ADIM_BIT_6
7	14	ADIM_BIT_2
8	15	ADIM_BIT_4

FIRMWARE INFORMATION

In order program with the arduino IDE, some changes must be made to support the board. These notes are intended for use with version 1.82 of the IDE and may need modification for other verrsions.

Addition to boards.txt, typically located at:
“C:\Program Files (x86)\Arduino\hardware\arduino\avr\boards.txt”

```
##############################################################
optiboot_328_8M.name=[Optiboot] ATmega328p (3.3V, intOSC 8 MHz)
optiboot_328_8M.upload.tool=avrdude
optiboot_328_8M.upload.protocol=arduino
optiboot_328_8M.upload.maximum_size=31744
# This used to be 32256, but i had corruption problems, so lowered to 1024+30720 based on the stk500 bootloader having fuses set for 1k and this one having fuses set for 0.5k
optiboot_328_8M.upload.maximum_data_size=2048
optiboot_328_8M.upload.speed=38400
optiboot_328_8M.bootloader.extended_fuses=0xFD
optiboot_328_8M.bootloader.high_fuses=0xDC
optiboot_328_8M.bootloader.low_fuses=0xE2
optiboot_328_8M.bootloader.file=optiboot/optiboot_atmega328p_8MHz_38400.hex
optiboot_328_8M.bootloader.unlock_bits=0x3F
optiboot_328_8M.bootloader.lock_bits=0x0F
optiboot_328_8M.build.mcu=atmega328p
optiboot_328_8M.build.f_cpu=8000000L
optiboot_328_8M.build.core=arduino
optiboot_328_8M.build.variant=diy
optiboot_328_8M.build.board=AVR_OPTIBOOT_328_8M
##############################################################
```

Additionally, a ‘diy’ variant must be added to the variants directory to enable the use of pins commonly used by arduinos for the crystal oscillator.

The files can be found with the source code and should typically be placed in (on a windows platform):
“C:\Program Files (x86)\Arduino\hardware\arduino\avr\variants\diy\”

There may be additional modifications necessary for the firmware itself. Please see the firmware documentation for additional information.

zisworks.com/support/FlexibleLEDBacklightDriver/FlexibleLEDBacklightDriverFWUserGuide.pdf

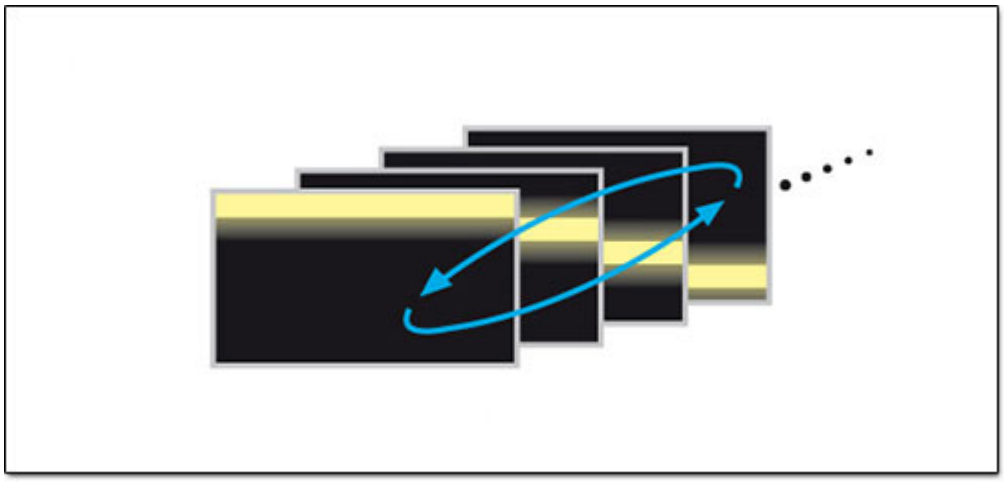
OPERATIONAL MODES

OFF : The system is off. Boost controller is disabled, backlight is off.

STABLE : The system is operating in either constant-current or high-frequency PWM mode.

STROBE : All LEDs are simultaneously pulsed at high current levels and brief active times. Pulses are timed to end with the falling edge of the pulse input. Brightness control adjusts the pulse duration and current level. Strobe mode is only available if the pulse input signal (vertical blanking indicator) is active for a sufficient amount of time.

SCAN : LED strings are pulsed individually with high current levels and brief active times. Pulses are sequential and aligned to be active immediately before the corresponding part of the display is updated. Using scanning mode maximizes the time available for pixel response without requiring a long vertical blanking period, a particularly important property at high refresh rates.



CONTROL MODES

OFF MODE : The system is not receiving any control inputs and remains off. During this state, the output serial commands over the DIM input are active.

ZWS MODE : In the ZWS control mode, the system is configured through the button board and/or the serial debugging interface. All operational modes are enabled and the pulse input signal is used as both a keepalive and pulse alignment control input.

Other control modes may be available with new firmwares.

SERIAL CONTROL OUTPUT

The PWM input line can, in some control modes, be used as an output. This output is a unidirectional serial interface operating at 115200 baud, 8n1 configuration, and is used to repeatedly send a single control byte with the shown format. ZWSX28 and ZWSX39 series displays use this control scheme for communicating OSD enable/disable, EDID selection, and power saving state to the input boards.

BIT POSITON	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
FIELD NAME	ALWAYS 1	ON SCREEN DISPLAY ENABLE	PACKED BIT 3	PACKED BIT 2	PACKED BIT 1	PACKED BIT 0	CHECKSUM	CHECKSUM

A two-bit checksum and static leading ‘1’ allows for strong error detection and rejection.

Packed bits encode the EDID and power state as shown.

VALUE	EDID	POWERSAVE
0	0	SHUTDOWN
1	0	LOW POWER
2	0	FULLY ON
3	1	SHUTDOWN
4	1	LOW POWER
5	1	FULLY ON
6	2	SHUTDOWN
7	2	LOW POWER
8	2	FULLY ON
9	3	SHUTDOWN
10	3	LOW POWER
11	3	FULLY ON
12	4	SHUTDOWN
13	4	LOW POWER
14	4	FULLY ON
15	RESERVED	RESERVED

MECHANICAL DRAWING

<todo: add me>