PD01000

Data-Vμ™ microLED Display

Development Kit User Guide

www.plesseysemi.com

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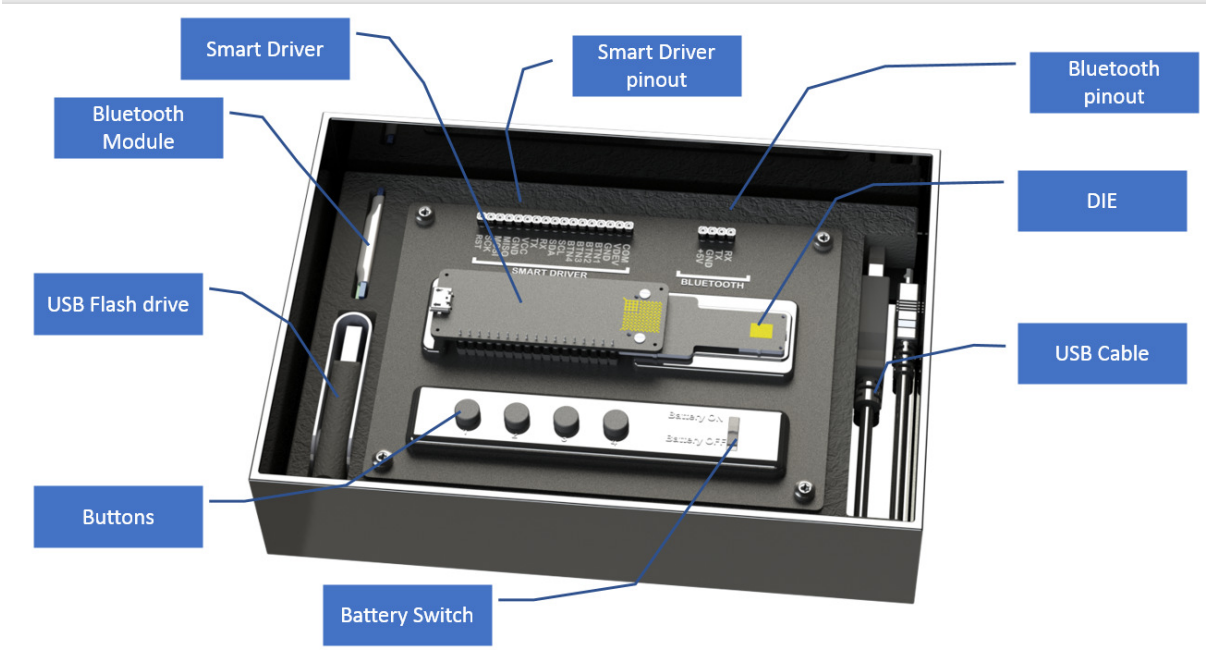
Scope and Introduction

This document provides an outline design, specifications and user manual for the Plessey Data-Vμ™ microLED Evaluation Kit PD01000. The kit contains a microLED display with driver and control board.

Description

The Plessey Data-Vμ™ microLED Evaluation Kit contains components for the user to evaluate the Plessey Data-Vμ™ microLED display. The kit can be used standalone to demonstrate the intensity of the display, or with a computer to evaluate the display technology in more depth. The display can be integrated into existing optical systems to evaluate the benefits of Plessey's Data-Vμ™ microLED displays.



Related Documents and Specifications

296141 - PD01xxx - Data-Vμ™ microLED Chip Advance Product Datasheet

Evaluation Kit Contents

The PD01000 evaluation kit consists the following (contained within a card box):

- PD01001 (driver board assembly)
- PD01002 (green display module)
- Base module board
- Bluetooth Module (HC-06)
- USB battery
- USB Type-A to Micro-B Cable
- USB Memory Stick
- Printed Quick Start Guide

The PD01001 Driver and Connector set consists of the component populated driver board, assembled to the display (PD01002) using a Samtec interposer connector board using screws and alignment pins. The PD01002 display is a PPS4138 green display with normal orientation on an FR4 board. The driver board is supplied with Data-Vμ™ firmware which allows a command line interface over UART/USB.

The PD01001 and PD01002 are supplied assembled, plugged into the PPS4144 base module (which can be powered by the supplied USB).

Safety and Safe Operation

Operating the display on high brightness settings can cause eye damage. When increasing the brightness do not look directly at the light source. Do not stare at the light source. Direct the display away from the eyes, e.g. toward a piece of card.

Driver Board

Description

Refer to Appendix A for the driver board schematic. The driver board is based around an ATMega328 microcontroller and is compatible with the Arduino Integrated Design Environment (IDE). The driver generates a programmable voltage source for the common anode of the Data-Vμ™ microLED display.

The driver board voltage source is generated from the ATMega328 and is buffered through an Op-Amp, NMOS voltage follower and can be programmed anywhere between 0V to VDD (norm 5V).

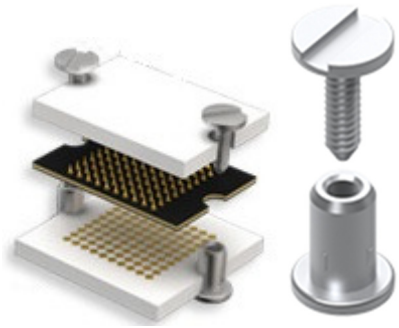
The symbols can then be individually turned on by switching an NMOS to ground. There is an array of 42 dual NMOS transistors to allow up to 84 symbols to be dimmed independently. The gates of the NMOS array is controlled by two LT8500 PWM chips. These chips have 48 individually controllable PWM channels with 12 bit resolution. The PWM is supplied a 2MHz clock generated by the ATMega328, resulting in a PWM frequency of 2MHz/4095 = 488Hz.

The LT8500 ICs also allow a duty cycle correction to be applied to each channel. This is a 6 bit correction which allows a duty cycle variation of 0.5x – 1.5x. Refer to the LT8500 datasheet for more information on calculating the calibration values (https://www.analog.com/media/en/technical-documentation/data-sheets/LT8500.pdf)

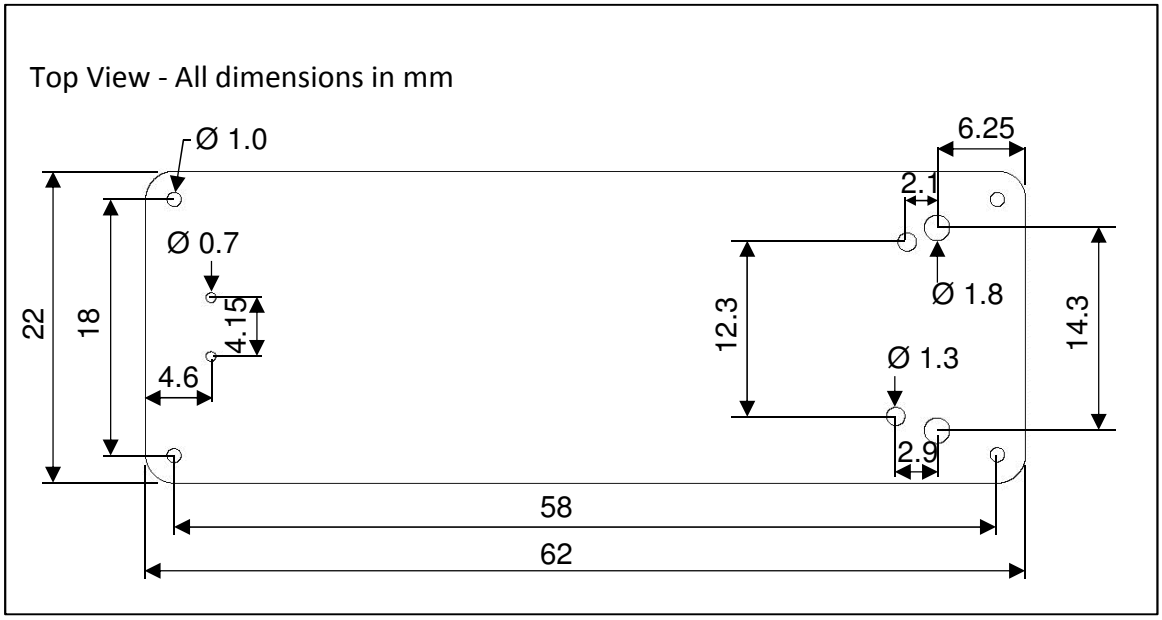
The ATMega328 can be connected by UART over USB using the driver board's FTDI chip. Reprogramming over USB is supported by the bootloader present on the ATMega328. Only one UART port is present on the ATMega328 and is shared by direct UART connection and via the FTDI for USB connection; communicate by UART or USB, the ATMega328 cannot communicate with both simultaneously.

To measure the current of the display measure the voltage drop across R14, the 1 Ohm (+/- 0.25%) current sense resistor. This can be accessed from the VDEV, VCOM pins. The display can be driven with an external power supply if required – connect an external power supply to VCOM and de-solder the current sense resistor R14. The current sense resistor may be bypassed using a zero Ohm resistor in R14 position or by shorting resistor R13.

The driver board is connected to the display using a Samtec Z-Ray. This consists of an interposer and a pair of screws and alignment pins.



Mechanical Specification



Electrical Specification

Parameter	Minimum	Typical	Maximum	Units
Supply Voltage		5.0	5.25	Volts
Supply Current			(TBC)	Amps
Current per channel			(TBC)	Amps
Microcontroller operating frequency		8		MHz
Channel PWM frequency		2		MHz
Channel PWM resolution		12		bits
Number of channels		84		
UART		9600		Baud

Mother/base Board Specifications

The USB battery is supplied partly charged, it is advised to fully charge prior to use. When charged, insert the battery's USB Micro-B plug into the base module. Do not connect to the driver board USB when the battery is in use.

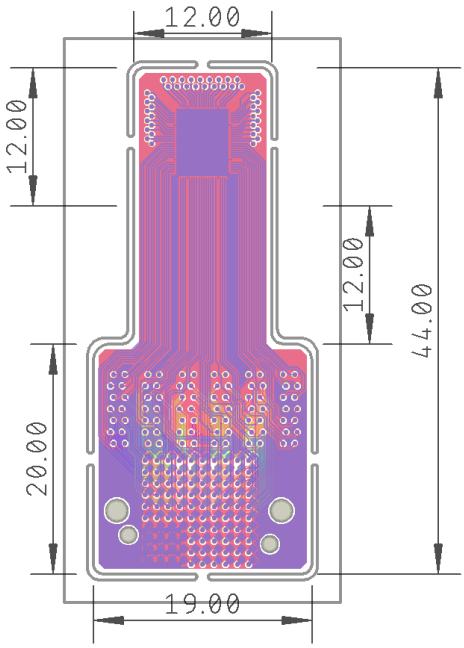
Electrical Specification

Parameter	Minimum	Typical	Maximum	Units
Supply Voltage		5.0	5.25	Volts
Supply Current				Amps
Battery Capacity		3		Ah
Battery Charge Current (USB)		1		Amps
Battery Charge Time		4		Hours

Display Board Specifications

Refer to display PD01xxx Data-Vμ™ microLED Chip Advance Product Datasheet for full information.

Mechanical Specification

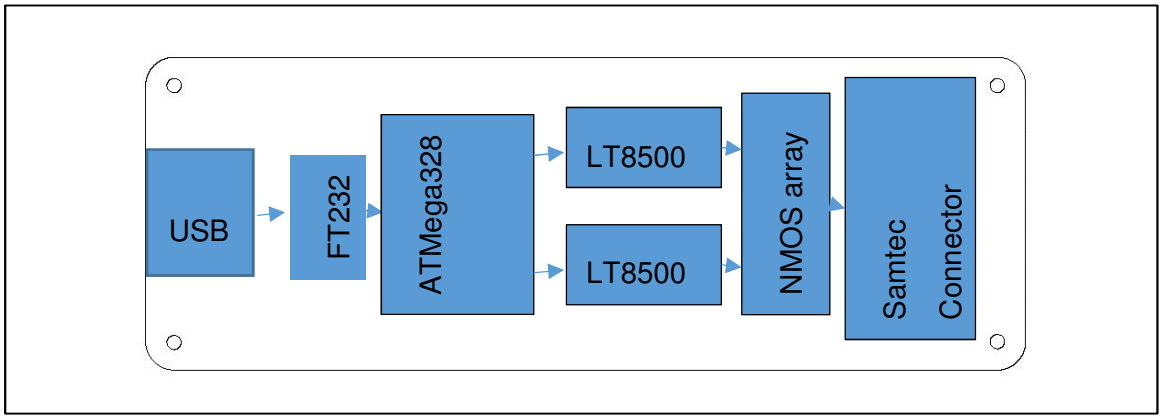


Electrical Specification PD01002

Parameter	Minimum	Typical	Maximum	Units
Forward Voltage			3	Volts
Dominant Wavelength	500		555	nm
Current per channel				Amps
Number of segments		61		

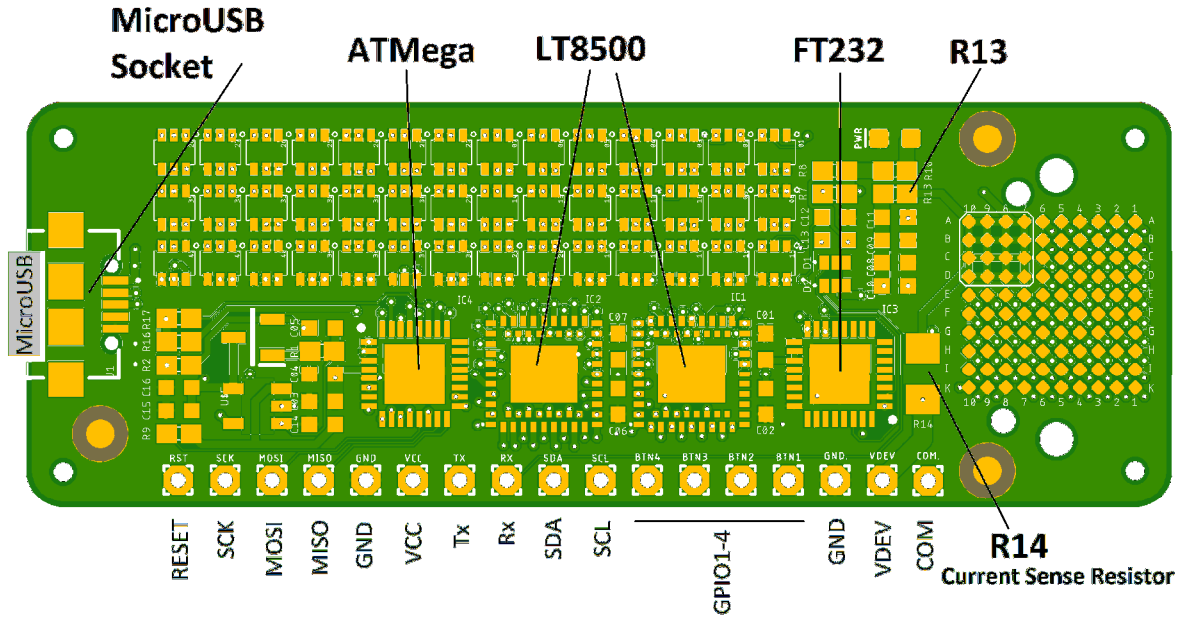
Connection and Control Options

Driver Board Block Diagram



Electrical Connection Detail

The driver board connections consist of a microUSB socket and 17 pins on a 0.1” pitch, connections and major components shown below.



Pin	Function
RESET	Device reset (active HIGH?) – TTL levels
SCK	SPI connection clock – TTL levels

MOSI	SPI data input (Master Output Slave Input) – TTL levels
MISO	SPI data output (Master Input Slave Output) – TTL levels
GND	Ground connection (0V)
VCC	Supply Voltage (+5V) – do not connect if microUSB providing power
Tx	UART transmit (data from driver board) – TTL levels
Rx	UART receive (data to driver board) – TTL levels
SDA	I2C data – TTL levels
SCL	I2C clock – TTL levels
GPIOx	General Purpose I/O to microcontroller, or button inputs – TTL levels
GND	Ground connection (0V)
VDEV	LED drive voltage – high side of current sense resistor
COM	LED common – anode of display (can be used to power display by removing R14)

Control, Command Set and Programming Options

Button Control

Slide the 'battery' switch from Battery OFF to Battery ON. The four buttons on the base module can then be used to demonstrate the display, buttons functions as follows:

Button Number	Button Function
1	Switch all segments on (drive voltage 2.7V) or off
2	Counter demo – press to initiate to 0000, press/hold to increment
3	Decrease display brightness
4	Increase display brightness

Press and release button 1 and the display will illuminate (all segments) at a low level (2.7V drive, PWM value of 1). Press and release button 4 to increase brightness (PWM changed) - 9 presses to maximum brightness. Press and release button 3 to decrease brightness (PWM changed) - 9 presses to minimum brightness. **Ensure display is angled away from eyes when brightness increased.**

Button 2 initiates a displayed counter demonstration. With display on and brightness set (using button 1, 3 and 4), press and release button 2 to set counter to 0000. Press and release to increase counter by 1, press and hold to rapidly increase counter to 9999 and loops to 0000. Pressing button 3 or 4 will increase or decrease brightness (unless at maximum or minimum brightness respectively) and display all segments, press button 2 to return to the counter display.

Serial Connection – UART & USB

The driver board can be accessed using a direct UART connection, or via a USB connection. Do not connect to the UART when USB is active.

To connect via USB, insert the supplied cable's USB Micro-B plug into the driver board module USB socket and connect the USB Type-A plug to a suitable PC's USB socket. The driver board will instantiate as a serial port, communication should be made to this serial port using PuTTY or similar command-line – 9600 baud, 8 data bits, 1 stop bit, no parity.

Once a serial connection is established to the driver board, the driver board will respond with a text line "*******DataVu Driver CLI******" and a prompt ">".

Command	Arguments	Function
h help		Help, returns list of commands.
c	<Cal_1> <Cal_2> <Cal_3> … <Cal_n>	Updates the calibration data. Here *n* is the number of symbols on the display. Each symbol can have a unique PWM weightings which allow for display non-uniformity to be corrected for. Each symbol can be corrected by a weighting of 0.5x to 1.5x with six bit resolution. This calibration data will be saved to the EEPROM on the ATMega and reloaded when the driver is power cycled.
cOn		Turns the calibration feature on. The write frame command will need to be run after to see the effects.
cOff		Turns the calibration feature off. The write frame command will need to be run after to see the effects.
u	<Value1> <Value2> … <Value n>	Updates all values in the software frame buffer. This will reset all the values in the software frame buffer with the specified value, an eight bit (integer, 0-255) PWM value for all the symbols.
ua	<Value>	Updates all values in the software frame buffer. This will reset all the values in the software frame buffer with the specified value, an eight bit (integer, 0-255) PWM value for all the symbols
ud	<C> <Digit> <Value>	Updates a seven segment element in the software frame buffer. **C** - the character to show on the seven segment element (0-9, A-F). **D**igit - the digit number specifies which seven segment element to update. **V**alue - the eight bit (integer, 0-255) PWM value for the seven segment element.
us	<Symbol> <Value>	Updates a single symbol's, an eight bit (integer, 0-255) PWM value in the software frame buffer.
v	<Voltage>	Sets the LED anode voltage. The voltage can be set between 0.0 and 5.0 (volts). The DAC has eight bit resolution which equates to a voltage resolution of 20mV. The specified voltage may not match the output voltage exactly. The output voltage depend on the board voltage which the firmware assumes to be 5V. For an accurate voltage a direct measurement on the driver board is needed.

w		Writes the software frame buffer to the display. This needs to be run to any of the frame buffer updates in the previous commands.

Some programming examples and advisories:

- To display all segments at low intensity, type “v 2.5” (without quotes, this sets the display voltage to 2.5V) and press return, follow this by “ua 10” and “w” (similarly without quotes, and press return each time. This sets all segments to 10/255 PWM and updates the display.
- To turn all segments off, either set voltage to 0 “v 0” or turn all segments off “ua 0” following by “w”.
- To display FE in two 7-segments at low intensity, type “v 2.5” (without quotes, this sets the display voltage to 2.5V) and press return, follow this by “ud E 0 10” “ud F 1 10” and “w” (similarly without quotes, and press return each time).
- *Voltage range is 0-5V, usable range is 2.2 (very dim) to 2.8. Higher than 2.8V will result in varied segment brightness depending on how many segments are illuminated as drive voltage is dropped across the current sense resistor. TBA*
- Command 8-bit PWM value (0-255) is converted to internal 12-bit PWM value (0-4095).

Programming using the Arduino Integrated Design Environment

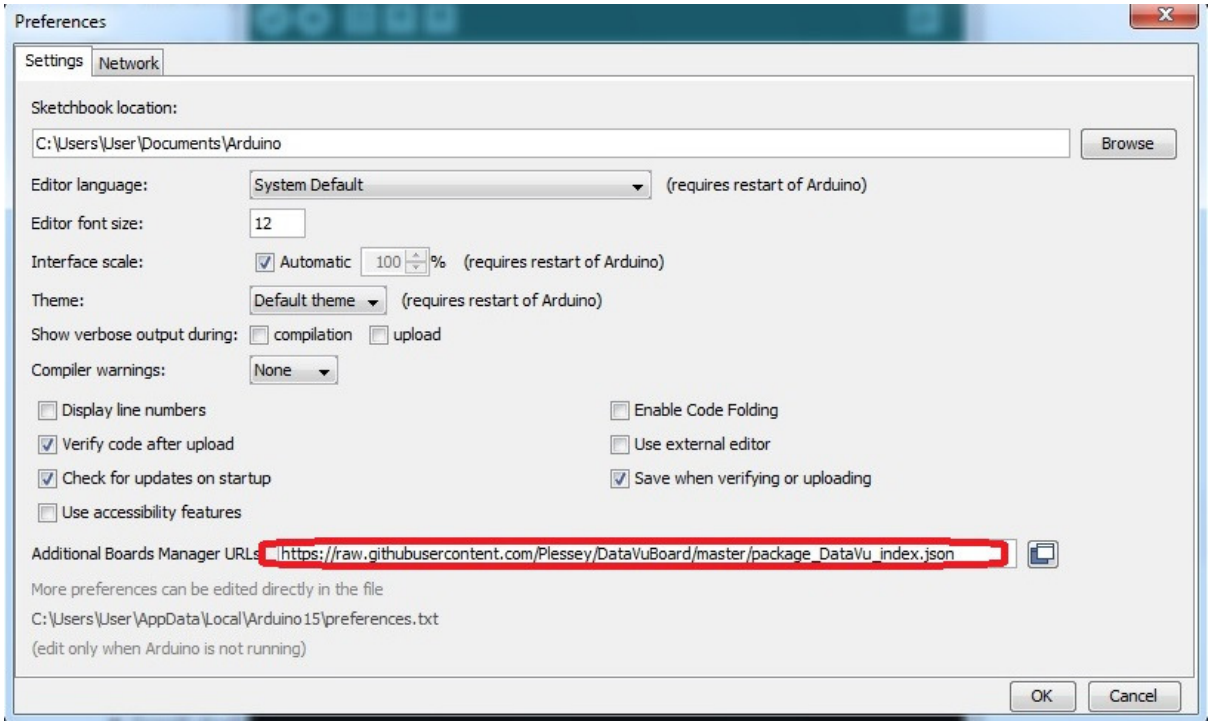
The driver board features an ATMEGA328 microcontroller which contains Data-Vμ™ firmware. The firmware is available for download and modification. Download the Arduino Integrated Development Environment from the Arduino website (1.6.4 or later is required):

www.arduino.cc

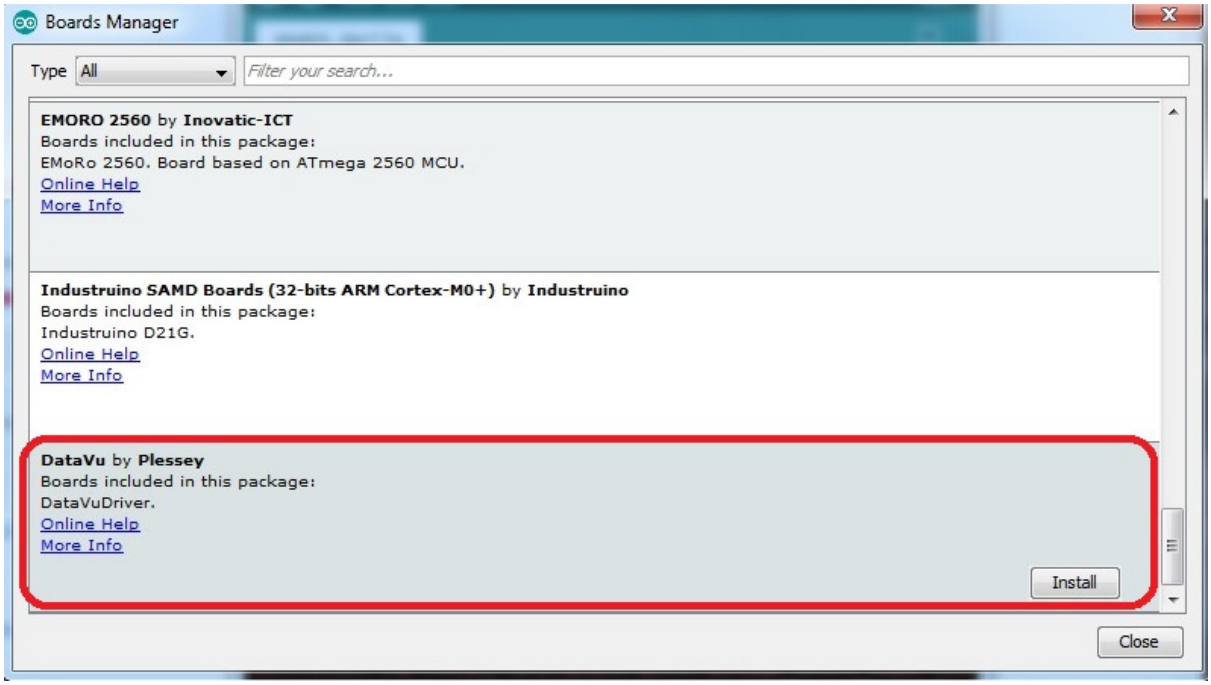
Follow instructions to install the IDE. Once installed, connect the driver board to the PC – on a Windows PC check the Devices and Printers for a “FT232R USB UART” device and note the COM port number.

- Open the Arduino IDE.
- In File->Preferences menu, enter the following into the (initially blank for a new IDE install) *Additional Boards Manager URLs* field:

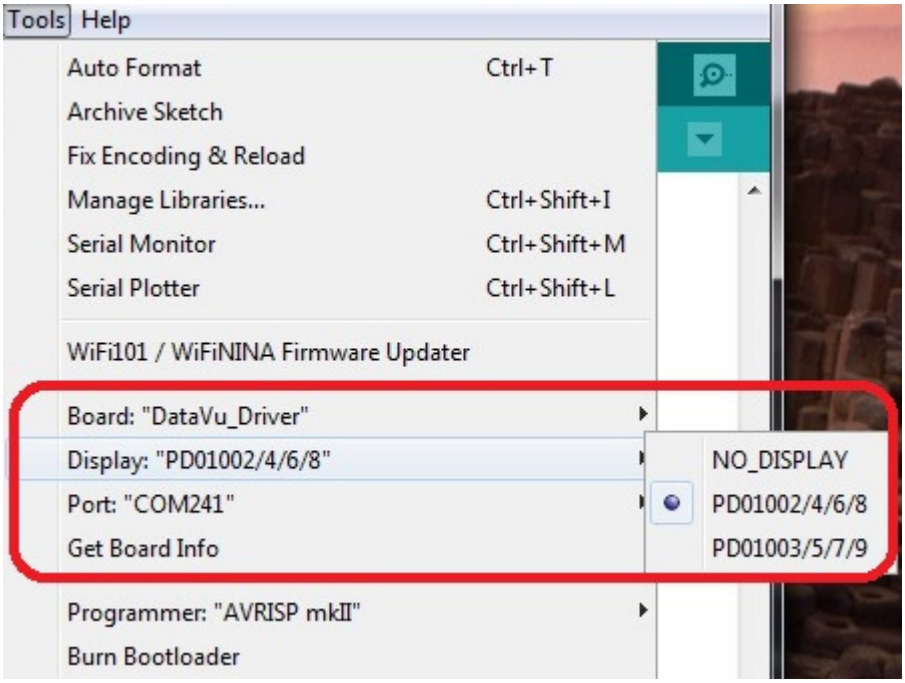
https://raw.githubusercontent.com/Plessey/DataVuBoard/master/package_DataVuBoard_index.json



- In Tools->Board:->Boards Manager... menu, scroll down to the “DataVu by Plessey” board and click the *Install* button, then close the Boards Manager.



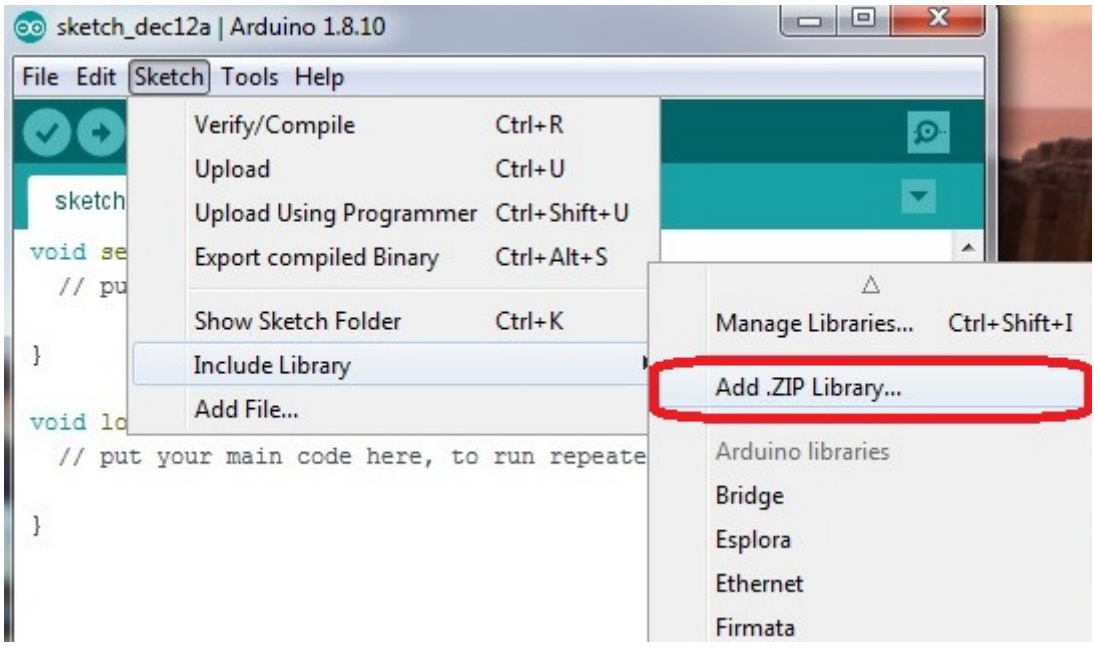
- Now select the DataVu driver board in Tools->Board: When correctly selected, menu should read *Board:”DataVu_Driver”* menu. In Tools->Display: (defaults to NO_DISPLAY) select PD01002/4/6/8 for this PD01000 Evaluation Kit with normal orientation display. Display type PD01003/5/7/9 is for laterally inverted display. In Tools->Port: set the port number (noted above, example shown below is COM241).



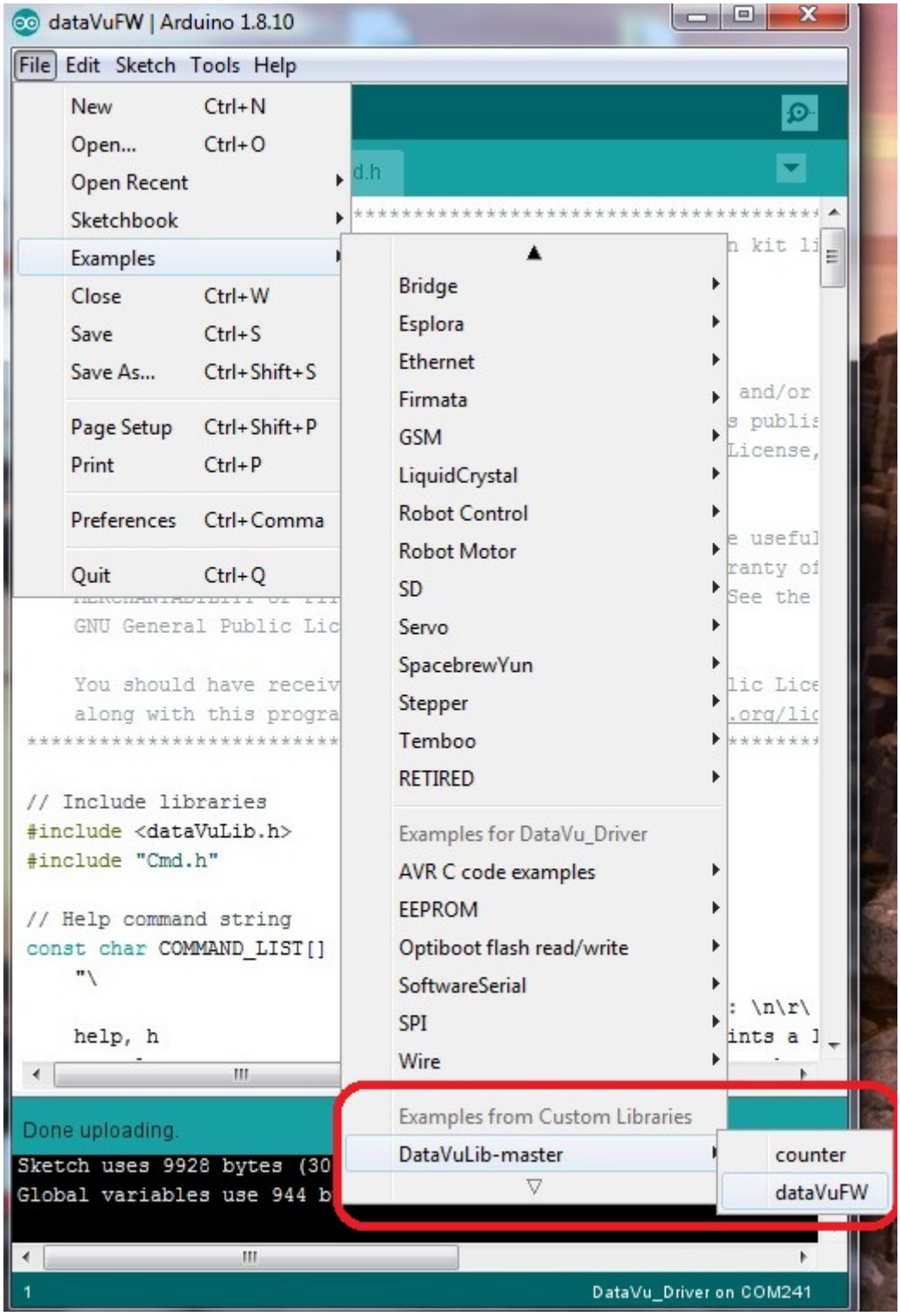
- Once the DataVu driver board has been instantiated, you will need to install the DataVuLib from Github. Create a ZIP file by clicking the *Clone or download* button on the webpage below, then *Download ZIP*.

https://github.com/Plessey/DataVuLib

- In the Arduino IDE Sketch->Include Library menu select *Add ZIP Library…* and select the ZIP file created above.

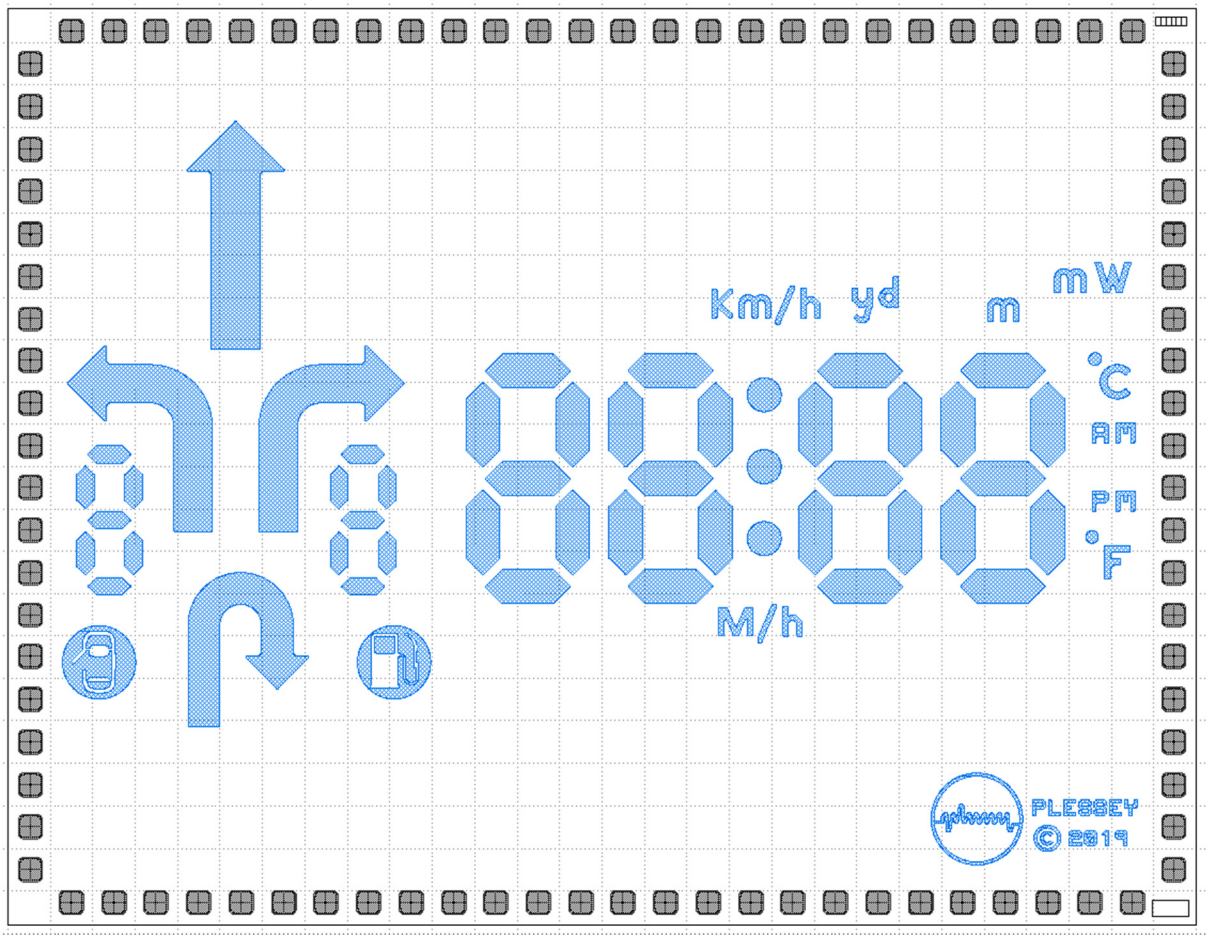


- The DataVuLib provides two examples. In the Arduine IDE File->Examples->DataVuLib-master menu:
  - DataVuFW – the default code allowing serial access via USB
  - Counter – an example counter



- If the IDE Serial Monitor is used, ensure the enter character is *Carriage return* rather than default *Newline*.

Segment driver address mapping

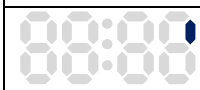
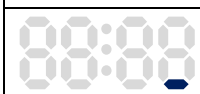


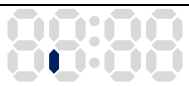
Arrows and Symbols

Symbol	Symbol id	Symbol Description	Address	Emitting Area (sq um)
	A01	Go Straight	0	251800
	A02	Turn left	1	218200
	A03	Turn right	2	218200
	A04	U-turn	3	200400
	S01	Door open	49	72815
	S02	Fuel pump	50	63956

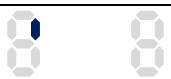
	S03	kilometres per hour	51	29391
	S04	yards	52	15877
	S05	metres	53	9845
	S06	milli-Watts	54	22310
	S07	degrees Celsius	55	13052
	S08	AM	56	10409
	S09	PM	57	9666
	S10	degrees Fahrenheit	58	12240
	S11	miles per hour	59	25584
	S12	Plessey logo	60	66934

Large 7-segment characters and dots

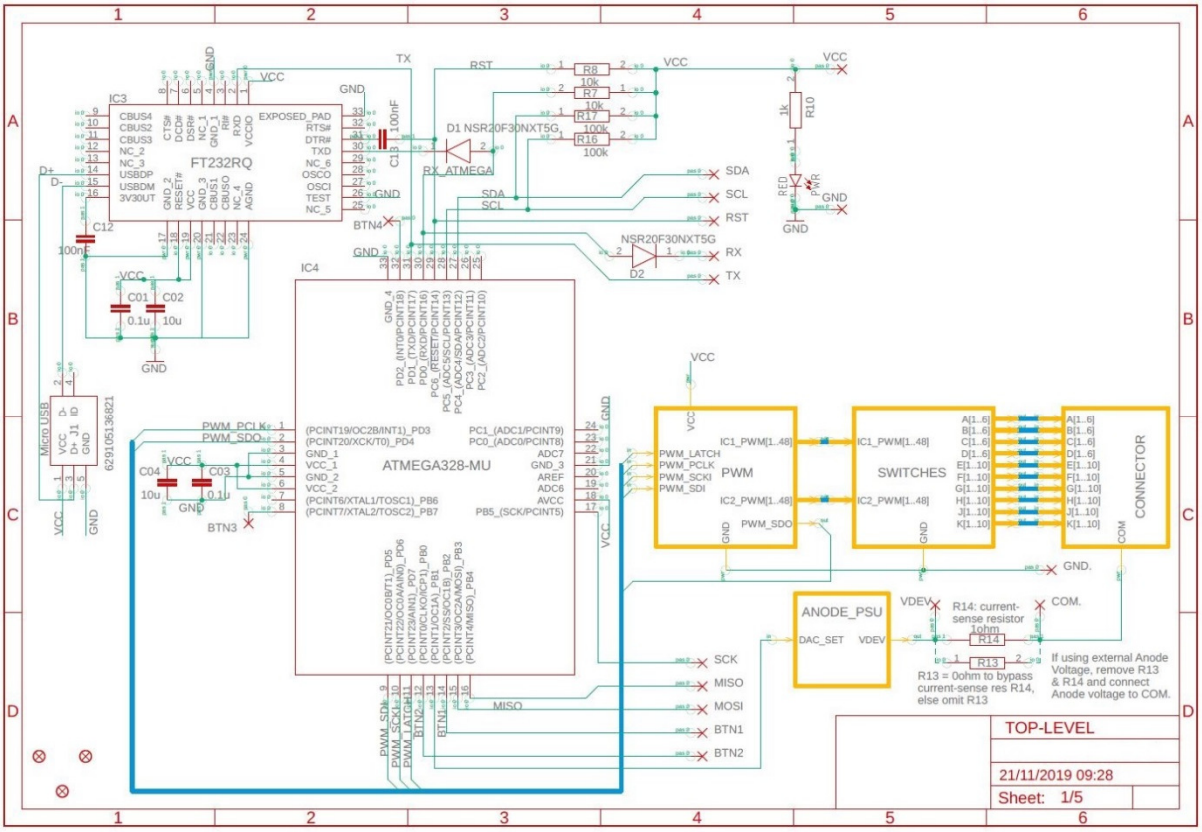
Symbol	Symbol id	Address	Emitting Area (sq um)		Symbol	Symbol id	Address	Emitting Area (sq um)
	N0A	4	51106			N2A	18	51106
	N0B	5	51106			N2B	19	51106
	N0C	6	51106			N2C	20	51106
	N0D	7	51106			N2D	21	51106

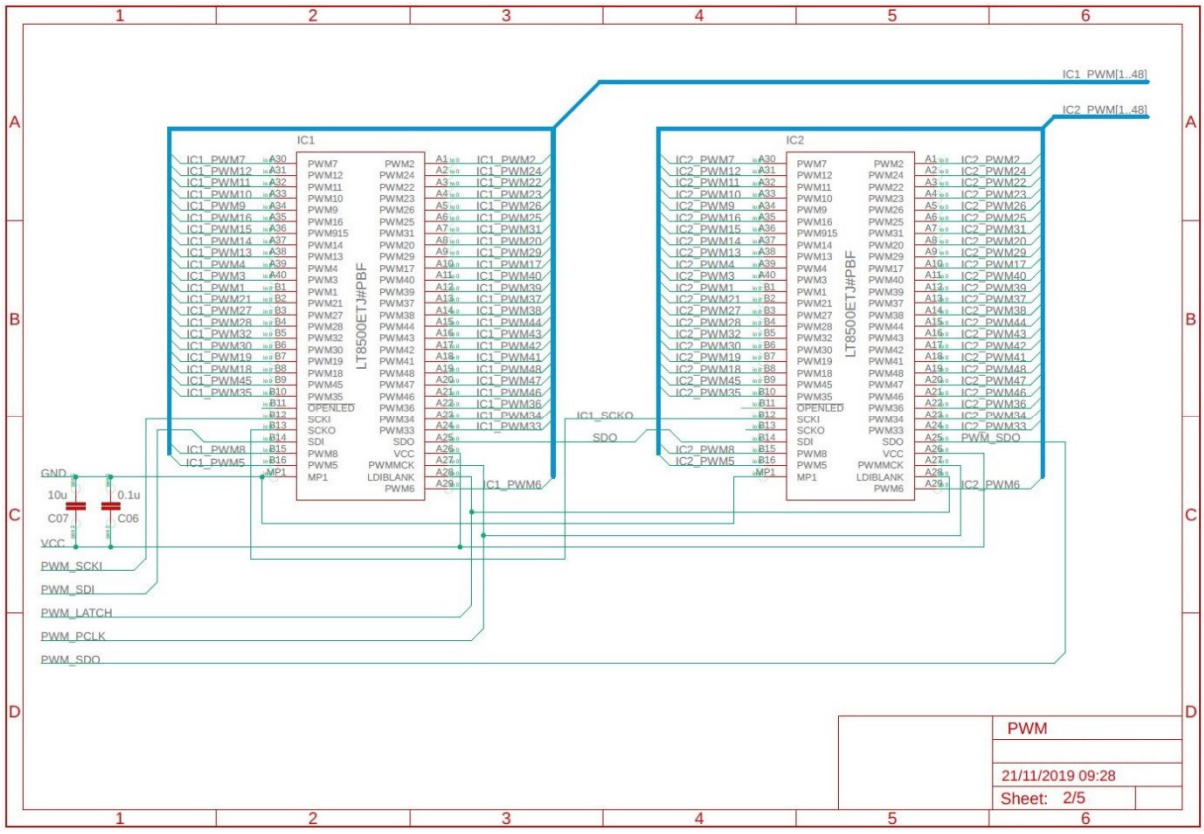
	N0E	8	51106			N2E	22	51106
	N0F	9	51106			N2F	23	51106
	N0G	10	51106			N2G	24	51106
	N1A	11	51106			N3A	25	51106
	N1B	12	51106			N3B	26	51106
	N1C	13	51106			N3C	27	51106
	N1D	14	51106			N3D	28	51106
	N1E	15	51106			N3E	29	51106
	N1F	16	51106			N3F	30	51106
	N1G	17	51106			N3G	31	51106
						D01	46	20105
						D02	47	20105
						D03	48	20105

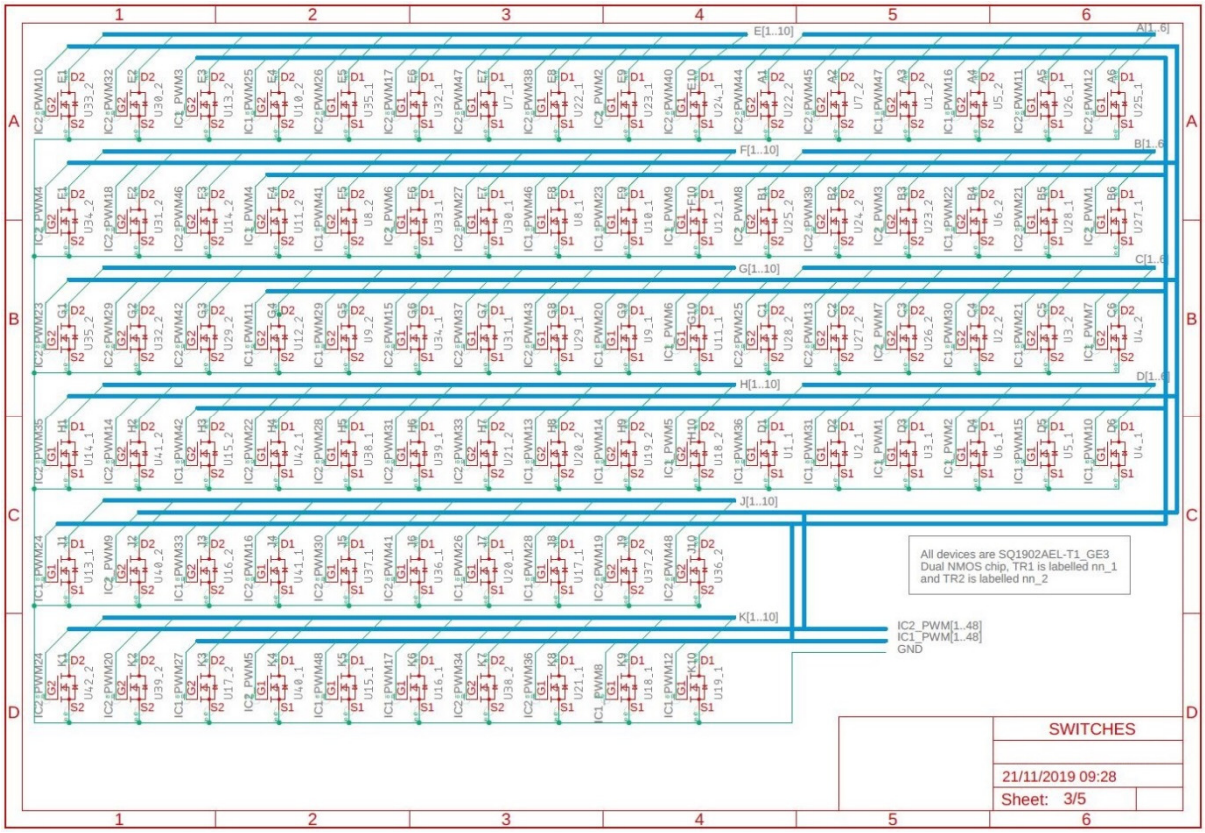
Small 7-segment characters and dots

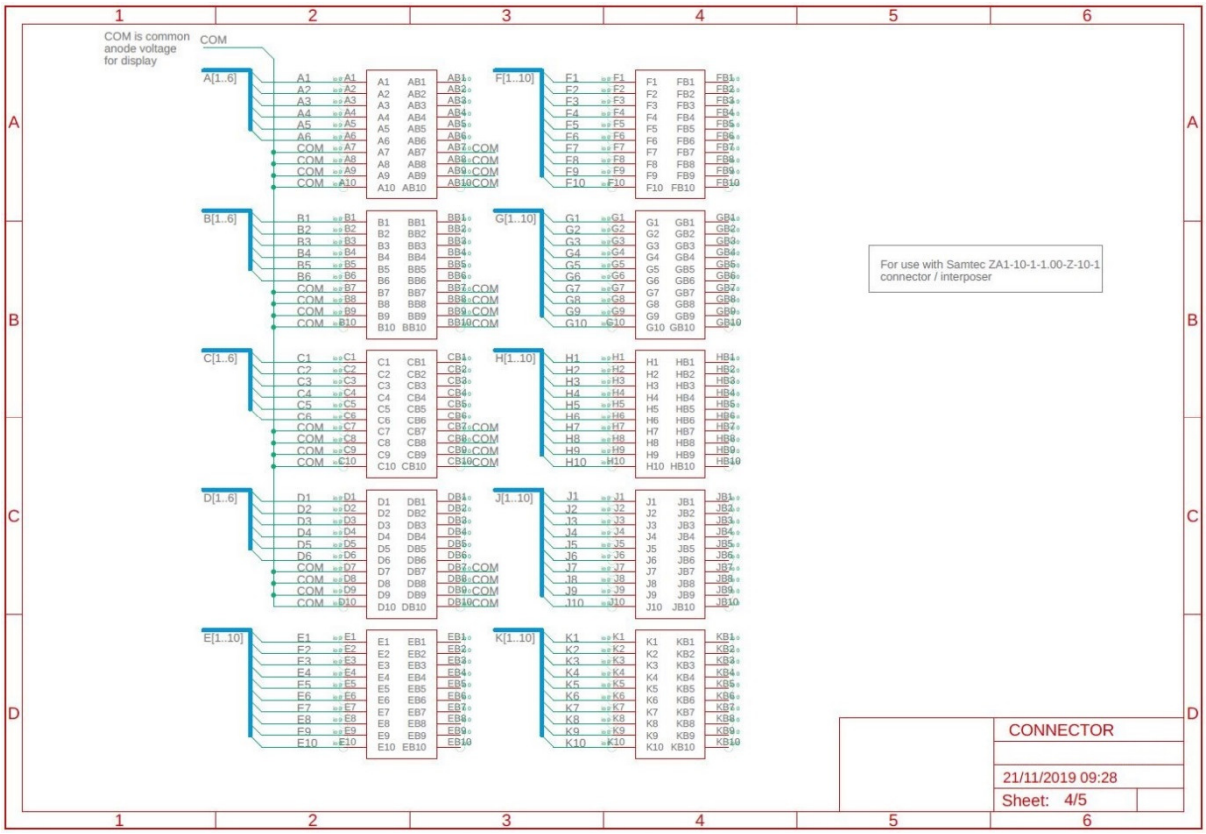
Symbol	Symbol id	Address	Emitting Area (sq um)
	N4A	32	13357
	N4B	33	13357
	N4C	34	13357
	N4D	35	13357
	N4E	36	13357
	N4F	37	13357
	N4G	38	13357
	N5A	39	13357
	N5B	40	13357
	N5C	41	13357
	N5D	42	13357
	N5E	43	13357
	N5F	44	13357
	N5G	45	13357

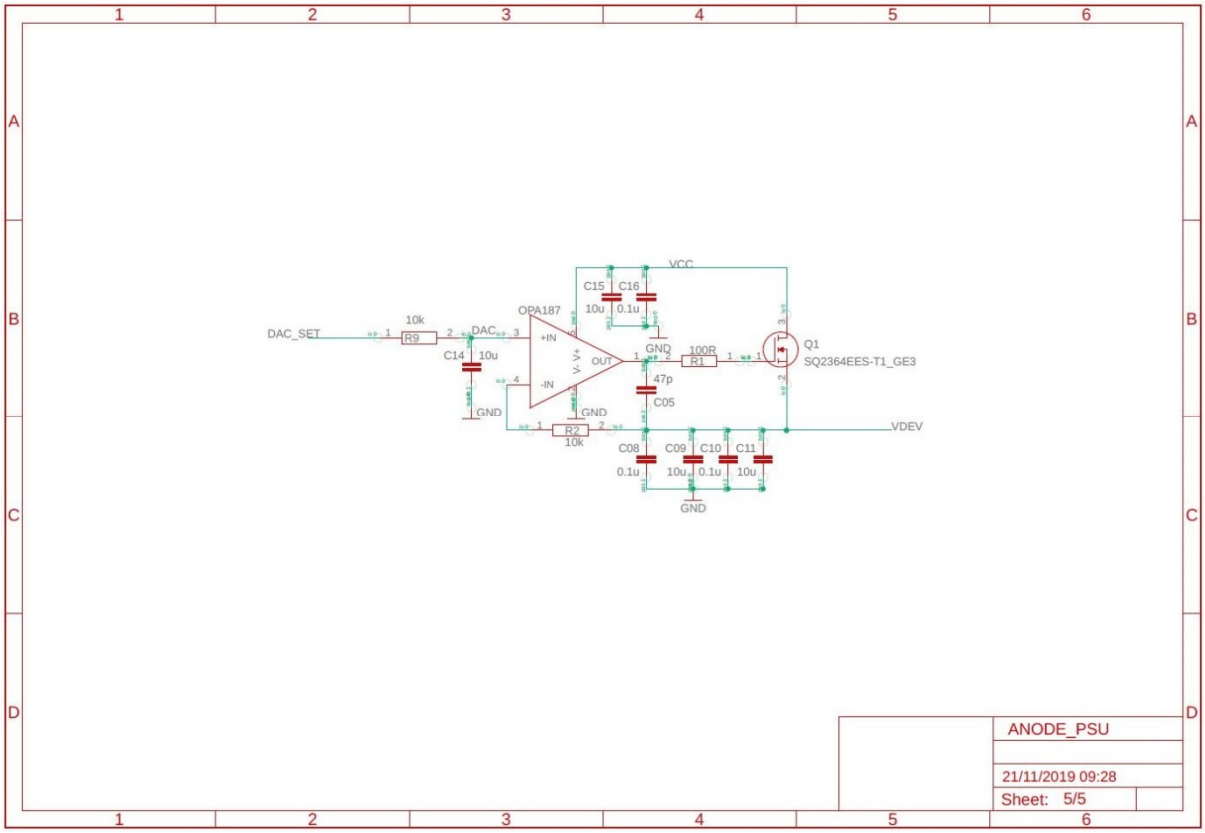
Appendix A - Driver PCB Schematics




IC1_PWM[1..48]
IC2_PWM[1..48]
IC1
IC2
LT8500ETJ#PBF
IC1_SCKO
SDO
IC2_PWM6
IC1_PWM6
GND
10u
0.1u
C07
C06
VCC
PWM_SCKI
PWM_SDI
PWM_LATCH
PWM_PCLK
PWM_SDO
PWM
21/11/2019 09:28
Sheet: 2/5


E[1..10]
F[1..10]
G[1..10]
H[1..10]
J[1..10]
K[1..10]
All devices are SQ1902AEL-T1_GE3
Dual NMOS chip, TR1 is labelled nn_1
and TR2 is labelled nn_2
IC2_PWM[1..48]
IC1_PWM[1..48]
GND
SWITCHES
21/11/2019 09:28
Sheet: 3/5

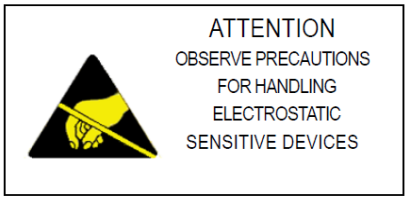

COM is common anode voltage for display
COM
A[1..6]
B[1..6]
C[1..6]
D[1..6]
E[1..10]
F[1..10]
G[1..10]
H[1..10]
J[1..10]
K[1..10]
For use with Samtec ZA1-10-1-1.00-Z-10-1 connector / interposer
CONNECTOR
21/11/2019 09:28
Sheet: 4/5


VCC
C15
C16
10u
0.1u
OPA187
DAC_SET
10k
R9
DAC
C14
10u
+IN
-IN
V+
V-
OUT
GND
100R
R1
Q1
SQ2364EES-T1_GE3
47p
C05
R2
10k
VDEV
C08
C09
C10
C11
ANODE_PSU
21/11/2019 09:28
Sheet: 5/5

Appendix B - Handling and Safety Instructions

The devices must not be operated in reverse bias.

There is no ESD protection on individual symbol channels so all precautions for handling electrostatic sensitive devices must be observed.



Operating the display on high brightness settings can cause eye damage. When increasing the brightness do not look directly at the light source. Do not stare at the light source. Direct the display away from the eyes, e.g. toward a piece of card.

Contact

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