MILLSWOOD engineering

Aerofence

TECHNICAL REFERENCE

1 Contents

2 Configuration overview

The Aerofence is configured via its USB connection. Within the Aerofence itself, the USB connector is routed to an FTDI FT201X IC. With appropriate drivers installed on a host PC, this IC can make the USB connection behave like a traditional serial (COM) port. Serial port emulation makes software development simpler and faster because serial ports are natively supported in most languages.

2.1 Drivers

The drivers that provide serial port emulation are known as Virtual Com Port (VCP) drivers, and are provided free of charge by FTDI. Drivers are available for Windows, Windows CE, Linux and Mac OS, and may be downloaded from:

http://www.ftdichip.com/Drivers/VCP.htm

Most recent operating systems will download and install the correct drivers on demand without user intervention. When using a VCP driver to emulate a serial port, the Baud rate, start and stop bit settings are all irrelevant – any values will work.

It is also possible to access the FT201X directly using D2XX drivers and a DLL. These files may be downloaded from:

http://www.ftdichip.com/Drivers/D2XX.htm

2.2 Communication protocol

The communication protocol consists of a start byte, a command byte, a data byte count, followed by the actual data bytes. The start byte is always 0xfe. A typical command might go as follows:

0xfe 0x38 0x06 0x00 0x00 0x10 0x00 0x31 0x00

This is command 0x38 (Set Geofence 1 Parameters), which takes 6 bytes of data.

16 and 32 bit quantities are always given in little-endian order (low order bytes first).

"Set" commands write values to non-volatile storage within the Aerofence, and "Get" commands read values back from the Aerofence. "Set" commands are processed silently and do not return any acknowledgement. Verification that "Set" commands have been successfully completed is accomplished by reading back and checking the returned values.

There are no timing restrictions on sending "Set" or "Get" commands – the entire non-volatile memory of the Aerofence may be configured in one continuous stream of "Set" commands. More than one "Get" command may also be sent without waiting for the response, but it is usually simpler to wait for the response before sending another command.

3 Configuration commands

Table 1 below lists the configuration commands for the Aerofence:

Command name	Command byte	Number of payload bytes	Payload data	Returned data	Comments
Set Geofence 1 Parameters	0x38	6	Minimum altitude, maximum altitude, included vertex count (byte), excluded vertex count (byte)		Send this command after setting up all the vertices for this geofence.
Get Geofence 1 Parameters	0x39	0		Minimum altitude, maximum altitude, included vertex count (byte), excluded vertex count (byte)	
Set Geofence 2 Parameters	0x3a	6	Minimum altitude, maximum altitude, included vertex count (byte), excluded vertex count (byte)		Send this command after setting up all the vertices for this geofence.
Get Geofence 2 Parameters	0x3b	0		Minimum altitude, maximum altitude, included vertex count (byte), excluded vertex count (byte)	
Set Geofence 1 Vertex	0x3c	9	Vertex number (byte), latitude, longitude		Sending this command causes processing of this geofence to stop. Send the Set Geofence Parameters command to restart processing for this geofence.
Get Geofence 1 Vertex	0x3d	1	Vertex number (byte)	Latitude, longitude	

Set Geofence 2 Vertex	0x3e	9	Vertex number (byte), latitude, longitude		Sending this command causes processing of this geofence to stop. Send the Set Geofence Parameters command to restart processing for this geofence.
Get Geofence 2 Vertex	0x3f	1	Vertex number (byte)	Latitude, longitude	
Set GNSS Baudrate	0x5c	1	Baud index (byte)		Values 0 to 11 correspond to 2400, 4800, 9600, 14400, 19200, 28800, 38400, 57600, 76800, 115200, 230400 and 460800 Baud.
Get GNSS Baudrate	0x5d	0		Baud index (byte)	Baud indices as defined above.
Set LED enables	0x62	1	Bit field (byte)		Bit 7: GF2, Bit 6: GF1, Bit 5: GNSS.
Get LED enables	0x63	0		Bit field (byte)	Bit significances as defined above.
Set GNSS Coordinates	0x70	10	Latitude, longitude, altitude		Not implemented.
Get GNSS Coordinates	0x71	0		Latitude, longitude, altitude	Returns the most recent 3D position fix reported by the GNSS device.
Get Firmware Version	0x75	0		Minor (byte), major (byte)	Returns the minor and major firmware version numbers.
Get Serial Number	0x78	0		Serial number (15 bytes)	Returns a unique 15 byte serial number.
Get Main Loop Frequency	0x79	0		Frequency (unsigned 16-bit integer)	Returns the main loop frequency in increments of 10 Hz.
Get GPIO Registers	0x7a	0		GPIOR0 - GPIOR3 (4 bytes)	Returns the current values from the 4 GPIO registers.
Get Port Registers	0x7b	0		Dir, Out, In, IntFlags x 4 (16 bytes)	Returns the current values from the Dir, Out, In and IntFlags registers for Port A, Port C, Port D and Port R.
Reset	0x7f	0			Performs a software reset (once all EEPROM data is committed to non-volatile memory).

Table 1 – Configuration commands

3.1 Setting up a geofence

Setting up the GNSS Baud rate and LED enables is simply a matter of sending the appropriate values to the Aerofence. Setting up the geofences is more complicated and a detailed explanation is warranted.

Firstly, some definitions:

- **Coordinate**: A latitude or longitude value.
- **Vertex**: A corner of an area, a point of intersection between 2 line segments. The location of a vertex is given by a pair of coordinates.
- **Included area**: A closed shape defined by line-segments connecting a set of vertices, the interior of which is defined to be the "inside".
- **Excluded area**: A closed shape defined by line-segments connecting a set of vertices, the interior of which is defined to be the "outside".
- **Geofence**: A volume of space defined by a 2D region at ground level, and upper and lower altitude limits. The 2D region may consist of one or more included areas, which may each contain zero or more excluded areas.

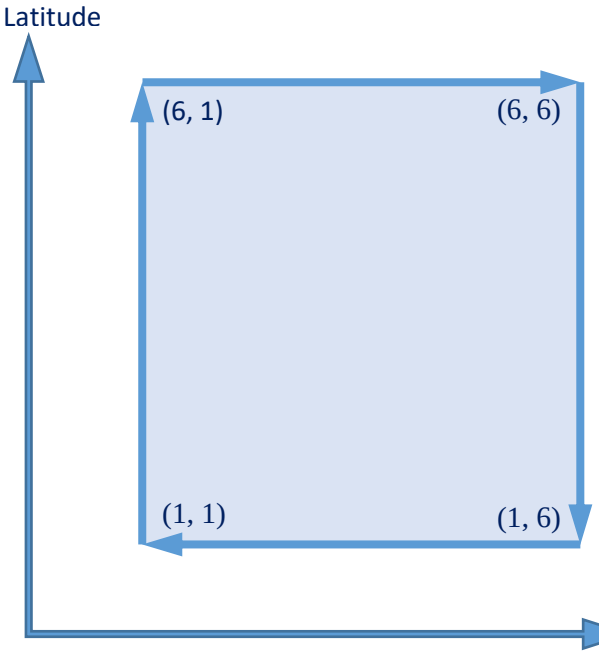
The general procedure for setting up a geofence is as follows:

- Construct a list of vertices.
- Send that list of vertices to the Aerofence (by repeatedly using the "Set Geofence Vertex" command).
- Send the "Set Geofence Parameters" command to tell the Aerofence how to interpret the list of vertices, and to set the altitude limits.

The vertex list defines the 2D component of a geofence; altitude limits are defined later using the "Set Geofence Parameters" command. The vertex list consists of one (or more) included areas followed by any excluded areas.

Included areas must be defined in a clockwise direction; excluded areas must be defined in an anticlockwise direction. Areas must be closed (i.e. the first vertex must be repeated at the end), and must be separated from each other by a delimiter (0, 0).

3.1.1 Example 1 – Geofence consisting of a single square area



Vertex	Lat, Lng	Comments
0	0, 0	Delimiter
1	1, 1	Lower left corner
2	6, 1	Upper left corner
3	6, 6	Upper right corner
4	1, 6	Lower right corner
5	1, 1	Repeat of first vertex
6	0, 0	Delimiter

Table 2 – Vertex list of a single square area

The commands that would be sent to the Aerofence to define this as geofence 1 are:

0xFE 0x3c 0x09 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
0xFE 0x3c 0x09 0x01 0x01 0x00 0x00 0x00 0x01 0x00 0x00 0x00
0xFE 0x3c 0x09 0x02 0x06 0x00 0x00 0x00 0x01 0x00 0x00 0x00
0xFE 0x3c 0x09 0x03 0x06 0x00 0x00 0x00 0x06 0x00 0x00 0x00
0xFE 0x3c 0x09 0x04 0x01 0x00 0x00 0x00 0x06 0x00 0x00 0x00
0xFE 0x3c 0x09 0x05 0x01 0x00 0x00 0x00 0x01 0x00 0x00 0x00
0xFE 0x3c 0x09 0x06 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00

Vertex numbers are zero-based, and coordinates are signed 32-bit integers in units of minutes/10,000. North and East are defined to be positive. This area is an impossibly small 5/10,000 by 5/10,000 minutes in size, or approximately 0.93m x 0.93m.

Note that this area has been defined in a clockwise direction, because it is an included area. Bear in mind that (Lat, Lng) are in the opposite order to (X, Y). Vertices may be sent to the Aerofence in any order, as long as the vertex numbers are correct.

Once all the vertices have been sent to the Aerofence, the "Set Geofence Parameters" command should be sent. This command defines the upper and lower altitude limits, and also tells the geofence the total numbers of vertices in the included and excluded areas. This geofence consists of 7 vertices in included areas, and zero vertices in excluded areas. The "Set Geofence Parameters" command would therefore be:

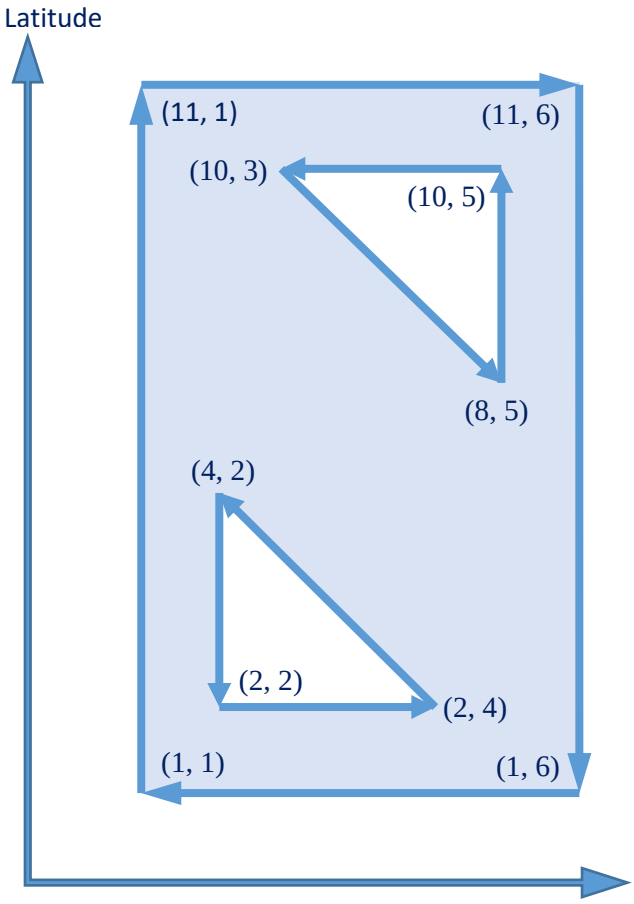
0xFE 0x38 0x06 0x00 0x00 0xe8 0x03 0x07 0x00

Altitudes are given as unsigned 16-bit values in units of metres above mean sea level (AMSL). The command above sets the minimum altitude to be zero and the maximum altitude to be 1000m AMSL.

Geofence 1 is now set up and operational.

3.1.2 Example 2 – Geofence consisting of an included area and 2 excluded areas

Excluded areas – if defined – must also begin, end, and be separated from each other with delimiters. This means that if both included and excluded areas exist, there will be 2 consecutive delimiters separating these two types of areas.



Vertex	Lat, Lng	Comments
0	0, 0	Delimiter
1	1, 1	Lower left corner
2	11, 1	Upper left corner
3	11, 6	Upper right corner
4	1, 6	Lower right corner
5	1, 1	Repeat of first vertex
6	0, 0	Delimiter
7	0, 0	Delimiter
8	2, 2	Lower left corner
9	2, 4	Lower right corner
10	4, 2	Upper left corner
11	2, 2	Repeat of first vertex
12	0, 0	Delimiter
13	10, 5	Upper right corner
14	10, 3	Upper left corner
15	8, 5	Lower right corner
16	10, 5	Repeat of first vertex
17	0, 0	Delimiter

Table 3 – Vertex list of an included area and 2 excluded areas

The commands that would be sent to the Aerofence to define this as geofence 2 are:

0xFE 0x3e 0x09 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
0xFE 0x3e 0x09 0x01 0x01 0x00 0x00 0x00 0x01 0x00 0x00 0x00
0xFE 0x3e 0x09 0x02 0x0b 0x00 0x00 0x00 0x01 0x00 0x00 0x00
0xFE 0x3e 0x09 0x03 0x0b 0x00 0x00 0x00 0x06 0x00 0x00 0x00
0xFE 0x3e 0x09 0x04 0x01 0x00 0x00 0x00 0x06 0x00 0x00 0x00
0xFE 0x3e 0x09 0x05 0x01 0x00 0x00 0x00 0x01 0x00 0x00 0x00
0xFE 0x3e 0x09 0x06 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
0xFE 0x3e 0x09 0x07 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
0xFE 0x3e 0x09 0x08 0x02 0x00 0x00 0x00 0x02 0x00 0x00 0x00
0xFE 0x3e 0x09 0x09 0x02 0x00 0x00 0x00 0x04 0x00 0x00 0x00
0xFE 0x3e 0x09 0x0a 0x04 0x00 0x00 0x00 0x02 0x00 0x00 0x00
0xFE 0x3e 0x09 0x0b 0x02 0x00 0x00 0x00 0x02 0x00 0x00 0x00
0xFE 0x3e 0x09 0x0c 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
0xFE 0x3e 0x09 0x0d 0x0a 0x00 0x00 0x00 0x05 0x00 0x00 0x00
0xFE 0x3e 0x09 0x0e 0x0a 0x00 0x00 0x00 0x03 0x00 0x00 0x00
0xFE 0x3e 0x09 0x0f 0x08 0x00 0x00 0x00 0x05 0x00 0x00 0x00
0xFE 0x3e 0x09 0x10 0x0a 0x00 0x00 0x00 0x05 0x00 0x00 0x00
0xFE 0x3e 0x09 0x11 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00

There is no upper limit on the number of included or excluded areas within a geofence as long as the total vertex count for each geofence does not exceed 53 (repeated vertices and delimiters do contribute to this count).

Once all the vertices have been sent to the Aerofence, the "Set Geofence Parameters" command should be sent. This geofence consists of 7 vertices in included areas, and 11 vertices in excluded areas. The "Set Geofence Parameters" command would therefore be:

0xFE 0x3a 0x06 0x00 0x00 0xe8 0x03 0x07 0x0b

Geofence 2 is now set up and operational.

3.2 Interpreting the GPIO registers

Of the 4 GPIO registers, only GPIOR0 contains any useful information:

- GPIOR0 bit 6 contains the geofence 1 valid flag, which is set when geofence 1 has sufficient vertices to be deemed valid.
- GPIOR0 bit 7 contains the geofence 2 valid flag, which is set when geofence 2 has sufficient vertices to be deemed valid.

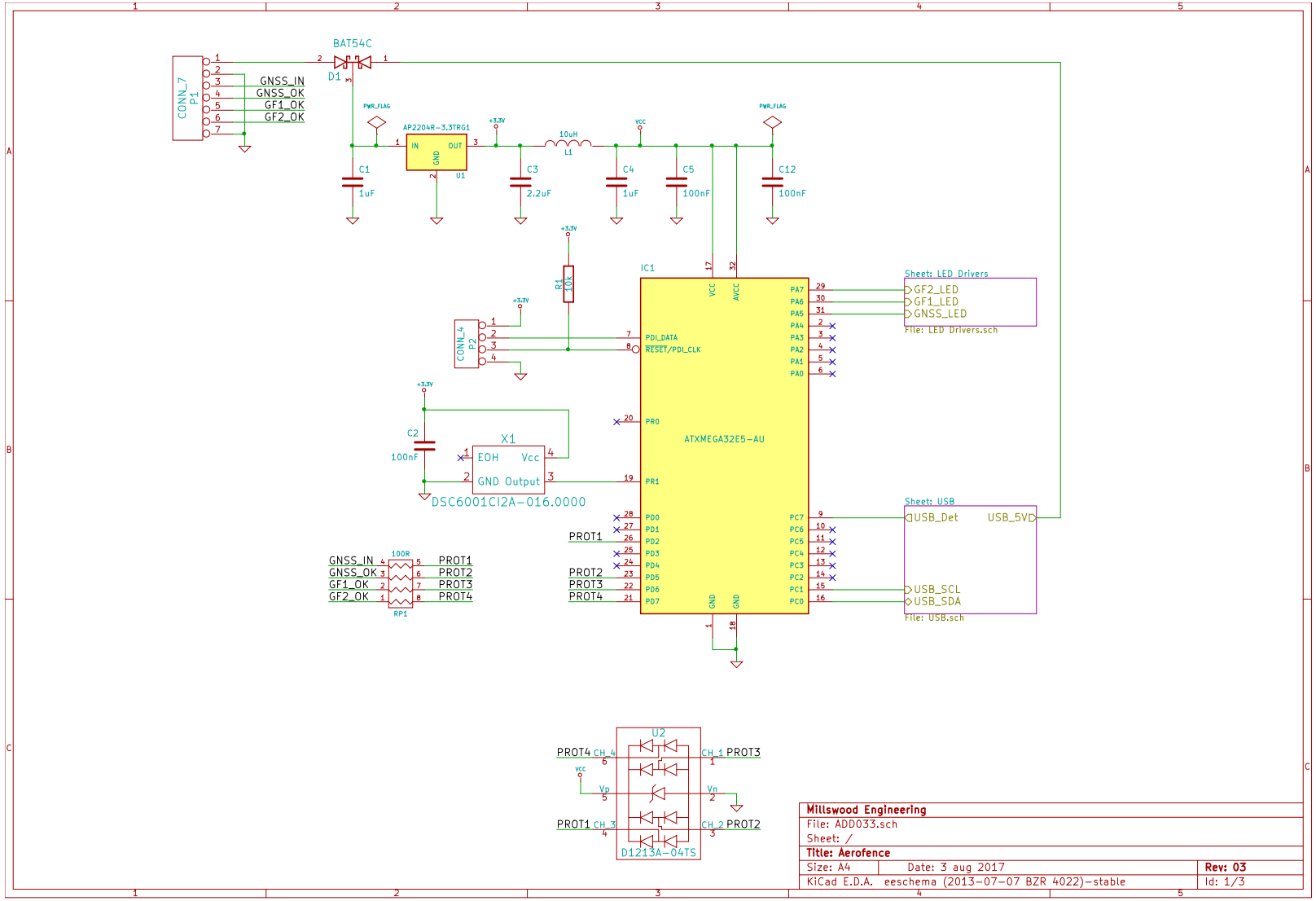
3.3 Interpreting the Port registers

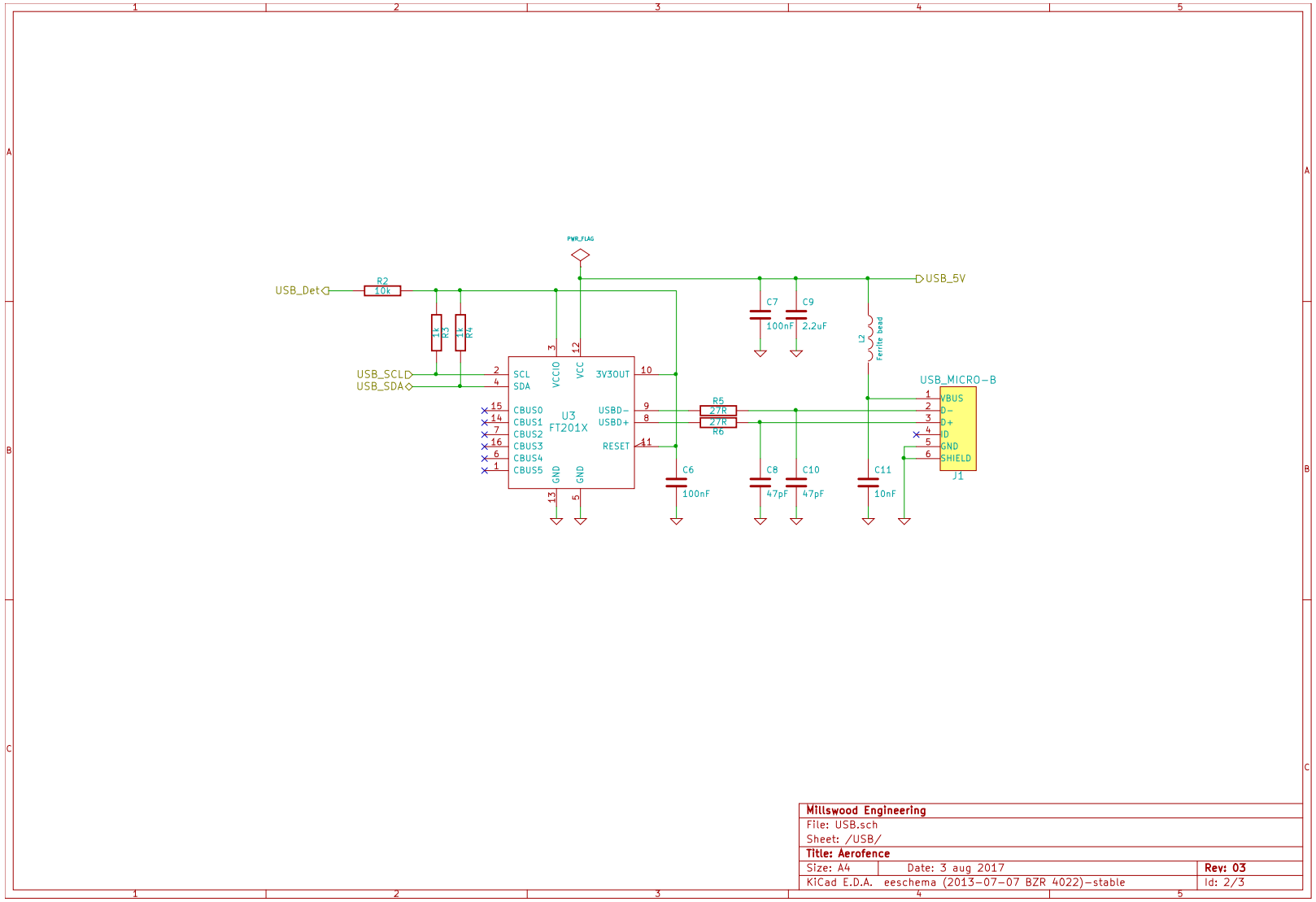
Of the 4 ports, only Port D contains any useful information:

- Port D (Out register) bit 5 contains the GNSS OK flag.
- Port D (Out register) bit 6 contains the GF1 OK flag.
- Port D (Out register) bit 7 contains the GF2 OK flag.

4 Documentation change log

5 Appendix 1 – Schematic diagrams




PWR_FLAG
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R2
10k
R3
1k
R4
1k
USB_SCL
USB_SDA
SCL
SDA
VCCIO
VCC
3V3OUT
CBUS0
CBUS1
CBUS2
CBUS3
CBUS4
CBUS5
U3
FT201X
USBD-
USBD+
RESET
GND
GND
R5
27R
R6
27R
C6
100nF
C7
100nF
C9
2.2uF
C8
47pF
C10
47pF
C11
10nF
L2
Ferrite bead
USB_5V
USB_MICRO-B
VBUS
D-
D+
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GND
SHIELD
J1
Millswood Engineering
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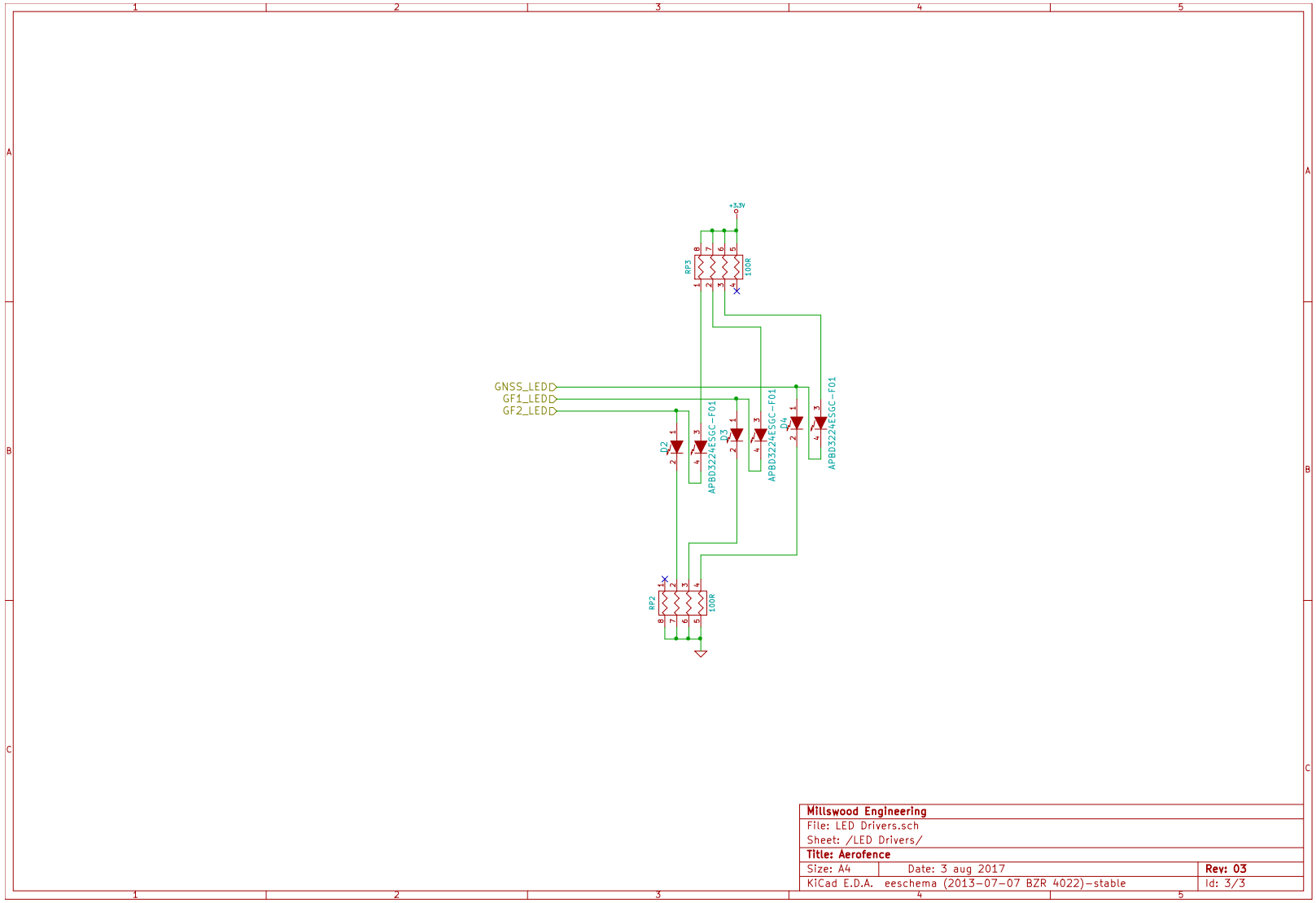
Date: 3 aug 2017
Rev: 03
KiCad E.D.A. eeschema (2013-07-07 BZR 4022)-stable
Id: 2/3


+3.3V
RP3
100R
GNSS_LED
GF1_LED
GF2_LED
D2
APBD3224ESGC-F01
D3
APBD3224ESGC-F01
D4
APBD3224ESGC-F01
RP2
100R
Millswood Engineering
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Date: 3 aug 2017
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