WAGA Flarm Tool & Simulator User Notes

Introduction

The Flarm Tool and Simulator (the Tool) is intended to be a tool to assist developers of Flarm or SoftRF displays. It was built for testing the SkyView WAGA Display but is likely to useful for other displays.

The Tool is built using MS Access and VBA coding. This platform was chosen due to the database intensive nature of the simulations and the ease of building a user interface. It is a rough tool, not a 'polished' programme. Some understanding of MS Access VBA is needed to set up custom simulations and change parameters.

Simulations are constructed as Flarm data sentences ($PFLAU and $PFLAA) stored as records in Access data tables. The Sim-Tx Form in the Access database creates a time variable trigger that initiates sending data sentences sequential read from the selected simulation data table. The data is sent directly by hard wiring from the PC data port (via a RS232 to TTL converter) to the Skyview Serial input port.

The SkyView requires GPS fix data ($GPGGA and $GPRMC) in order to activate the radar screen. GPS data may be embedded as discrete records in the simulation tables or the Tool can interleave GPS data (both sentence types in one trigger cycle) for a pre-set static location with the Flarm sentences as they are sent.

ID	Data
1	$GPGGA,120000,4518.8701,N,07550.2500,W,1,12,0.92,1000.0,M,-34.3,M,,*75
2	$GPRMC,120000,A,4518.8701,N,07550.2500,W,0.0,0.0,100223,,,A*65
3	$PFLAU,1,1,2,1,0,333,0,-50,2236,C043EC*21
4	$PFLAA,0,2000,-1000,-50,1,C043EC,0.00,0.00,0.00,0.00,1*32
5	$GPGGA,120001,4518.8779,N,07550.2363,W,1,12,0.92,1001.0,M,-34.3,M,,*79
6	$GPRMC,120001,A,4518.8779,N,07550.2363,W,23.1,51.0,100223,,,A*6C
7	$PFLAU,1,1,2,1,0,282,0,-51,2251,C043EC*2A
8	$PFLAA,0,2010,-1011,-51,1,C043EC,334.00,-26.00,2256.00,0.50,1*19
9	$GPGGA,120002,4518.8833,N,07550.2202,W,1,12,0.92,1002.0,M,-34.3,M,,*7E
10	$GPRMC,120002,A,4518.8833,N,07550.2202,W,23.1,63.0,100223,,,A*69
11	$PFLAU,1,1,2,1,0,270,0,-52,2265,C043EC*23
12	$PFLAA,0,2022,-1020,-52,1,C043EC,28.00,54.00,26.00,0.50,1*08
13	$GPGGA,120003,4518.8867,N,07550.2031,W,1,12,0.92,1003.0,M,-34.3,M,,*7D
14	$GPRMC,120003,A,4518.8867,N,07550.2031,W,23.1,75.0,100223,,,A*6C
15	$PFLAU,1,1,2,1,0,258,0,-53,2279,C043EC*25
16	$PFLAA,0,2035,-1025,-53,1,C043EC,42.00,14.00,26.00,0.50,1*02
17	$GPGGA,120004,4518.8872,N,07550.1855,W,1,12,0.92,1004.0,M,-34.3,M,,*70
18	$GPRMC,120004,A,4518.8872,N,07550.1855,W,23.1,87.0,100223,,,A*6B
19	$PFLAU,1,1,2,1,0,246,0,-54,2292,C043EC*28

*Example Simulation table with GPS data embedded and each sentence ends with a CheckSum (the 2 characters after the *)*

Limitations

The simulations created with the Tool must be regarded as approximations only. It can be used for demonstrations, but the resulting radar displays may distort time, distance and apparent traffic path and speed. The major limitations are:

- ThisAircraft is effectively stationary, unless real recorded or meticulously created data is used in the tables. This means the apparent traffic paths are not truly realistic other than when headed directly towards or away from ThisAircraft.
- The Tool sends data sentences are regular intervals whereas, in reality, data is received at the SkyView most likely in an irregular stream eg as $PFLAA data is received from multiple different traffic targets. There may be 3 say $PFLAA sentences for every $PFLAU.

CheckSum

The SkyView requires that each data sentence has a valid CheckSum else it will ignore the data. An example CheckSum looks like *68 where the number 68 is the actual CheckSum value. The Tool has a CheckSum calculator which can append the required value if it is missing from the data sentence.

There are numerous online CheckSum calculators eg https://nmeaCheckSum.eqth.net/

Flarm data sentences

There are two main sentence types used to pass traffic data and alarms which start with the keys $PFLAU and $PFLAA.

$PFLAU. This is a once a second heartbeat from the transceiver and the primary conveyor of threat/alarm information. Traffic is located by relative bearing and distance from ThisAircraft. Plus relative vertical height above/below.

$PFLAA. This passes data on other proximate aircraft, including alarm information. Traffic position is given by relative distance 'north' and 'east' but relative to ThisAircraft track, so really it is in front/behind and left/right. Plus relative vertical height above/below. The 'Source' field can determine if the traffic is Flarm, ADSB or Mode-S.

Definitions of the sentence structures and parameters can be found in Flarm documents FTD-012 and FTD-014. All these parameters can be set or modified in the custom simulations. Take care to understand the fields formats and units.

PowerFlarm Built in simulations

PowerFlarms have 6x built-in traffic simulations, each intended to last approx 30 seconds. If a PowerFlarm is connected to the SkyView Display, then the Tool can issue the required $PFLAF commands to the PowerFlarm that will cause it to commence outputting the selected simulation.

The 6x PowerFlarm simulations have been recorded and are included as Tables in the simulation database. It is thus not necessary to connect the SkyView to a Flarm in order to use the PowerFlarm sims.

Since the records in these tables include a CheckSum, then following any modification to the fields in these records, the CheckSum must be calculated and updated. It would be easier, to strip the CheckSum from the data and then use the tool's CheckSum function to automatically calculate and append the CheckSum as the data is sent.

Custom simulations

In the tool there is provision for 11 (labelled A- K) simulations.

Simulations can be constructed as a single Flarm sentence type or combining the 2 types.

Single Flarm sentence type simulations can be constructed directly in the MS Access tables where individual fields for the parameters have been created and a calculated field concatenates all the rows fields into a CSV sentence in the 'Data' field/column (without CheckSum).

Mixed Flarm Sentence types are best created by the following steps:

1. Create an MS Access table for each sentence type
2. Copy/paste the calculated/concatenated field of each table to separate excel sheets. Do not separate out the fields.
3. Add a column alongside the data and insert a numbering scheme that will be used to sort the data when the two files are merged. Eg if alternating $PFLAU with $PFLAA records, then give odd numbers to the PFLAU records and even numbers to the $PFLAA records.
4. Append the $PFLAA records (with the numbering) to the end of the $PFLAU data.
5. Sort by the number column.
6. Create a new data table in the MS Access tool and copy the merged data into this table.

Simulations can be constructed as either:

Sequential lines. Sentences are entered in every record of the sim table and sent at the rate of 1/SImDelay. Ideally the $PFLAU sentence should be sent once per second. If the Tool is set (FixNeeded=True) to add GPS data, this will interleave the Flarm sentences every other trigger so make allowance for this. Eg set SimDelay=250 (4 triggers in 1 second);

ID	Time	Sentence
1	0	$PFLAU, ...
2	250	$GPGGA, ... and $GPRMC, ...
3	500	$PFLAA, ...
4	750	$GPGGA, ... and $GPRMC, ...
5	1000	$PFLAU, ...
6	1200	$GPGGA, ... and $GPRMC, ...
cont..		

Time frames. This method establishes a number of time slots per second. Eg set SimDelay=100ms so that there are slots for 10 sentences per second. In a sim table enter $PFLAU sentences every 10th record (eg 1 per second). Enter GPS data strings in slots 2 and 3. Enter $PFLAA strings in any of the free slots and leave the remainder empty.

Simulation settings

Each simulation must have settings entered in the VBA code module 'Form_Simulations'. Eg:

```
Private Sub Btn_SimC_Click()
    SimToUse = "PFLAU"    ' table name
    FixNeeded = True
    CSumNeeded = True
    SimDelay = 1000
    DoCmd.OpenForm FormName:="Sim_Tx"
End Sub
```

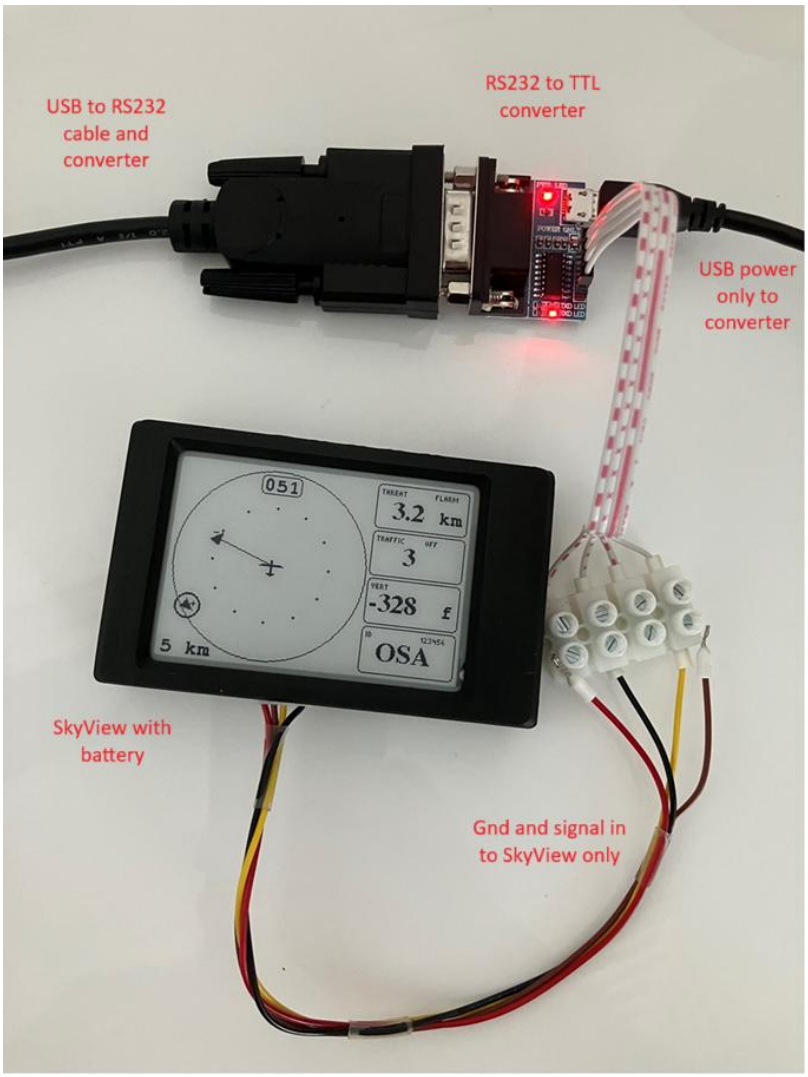
Built-in GPS data

GPS data sentences ($GPGGA and $GPRMC) for a static position are hard-coded in VBA 'module 1'. This data can be edited provided the correct format is maintained. The code automatically adds the correct CheckSum.

```
Public Sub SendFix()
Dim i As Integer
' ThisAircraft fix data is required if not in sim Table file.
' Any changes to the GPS lines requires recalculation of the CheckSum (the *xx at end of the string),
' which is done automatically.  Can be checked using calculator at:  https://nmeachecksum.eqth.net/
' ThisAircraft_Track variable in $GPRMC sentence sets the course over the ground. Entered in the GUI.

    i = 0
    FixData = "$GPGGA,120001,3200.0000,S,11725.0000,E,1,12,0.92,1001.0,M,-34.3,M,,*"
    FixData = FixData & NMEAChecksum(FixData) & Chr(13) & Chr(10)

    For i = 1 To Len(FixData)
    Call PUT_COM_PORT(SkyViewPort, Mid(FixData, i, 1))
    Next i

 '  Example  "$GPRMC,120001,A,3200.0000,S,11725.0000,E,23.1,51.0,100223,,,A*68" & Chr(13) & Chr(10)
    i = 0
    ThisAircraft_Track = Forms!Simulations!Txt_Track

    FixData = "$GPRMC,120001,A,3200.0000,S,11725.0000,E,23.1," & ThisAircraft_Track & ",100223,,,A*"
    FixData = FixData & NMEAChecksum(FixData) & Chr(13) & Chr(10)
    Debug.Print FixData

    For i = 1 To Len(FixData)
    Call PUT_COM_PORT(SkyViewPort, Mid(FixData, i, 1))
    Next i

End Sub
```

In the Custom simulations panel, you can set This>Aircraft track angle (0-360 degrees). If testing with the radar display in track-up mode, the traffic position(s) on the radar will not change as Flarm sentences provided position data relative to ThisAircraft heading.

Typical hardware arrangement



The hardware I use

Annex A. Extract from Flarm Document FTD-012

8.1 PFLAU – Heartbeat, status, and basic alarms

Syntax:

```
PFLAU,<RX>,<TX>,<GPS>,<Power>,<AlarmLevel>,<RelativeBearing>,
<AlarmType>,<RelativeVertical>,<RelativeDistance>[,<ID>]
```

Description:

Heartbeat message; output once per second. Consumers should use this message to detect the presence (and absence) of a compatible data stream.

The sentence summarizes the most relevant status information from the last one-second interval: RF status (RX, TX), power state, and the most important current threat, either traffic, an obstacle, or an alert zone. Consumers with limited resources (e.g. with respect to display capabilities or computational resources) can thus use `PFLAU` to display basic safety information. Other consumers shall also use `PFLAA` for extended information.

On devices with SSR/ADS-B Module, non-directional targets are output if enabled (`PCASPFLAU` configuration setting).

For data port version >=7, Alert Zone alarms are available; see the `<AlarmLevel>` and `<AlarmType>` fields.

For data port version >= 4, traffic advisory notifications (INFO alarms) are available, see the `<AlarmType>` field.

8.2 PFLAA – Data on other proximate aircraft

Syntax:

```
PFLAA,<AlarmLevel>,<RelativeNorth>,<RelativeEast>,
<RelativeVertical>,<IDType>,<ID>,<Track>,<TurnRate>,<GroundSpeed>,
<ClimbRate>,<AcftType>[,<NoTrack>[,<Source>,<RSSI>]]
```

Description:

Data on other proximate aircraft, intended for connected devices with sufficient CPU performance. This sentence should be treated with utmost flexibility and tolerance on a best effort base. Individual parameters may be empty. The sentence is only sent when port baud rate is 19.2k or higher. In case of serial port congestion or high CPU load, this sentence may be omitted for several objects independent of the alarm level. On devices with SSR/ADS-B Module, ADS-B and non-directional targets are output as well (transponder Mode-C/S only from protocol version 6 and higher).

Obstacle information is not delivered with this sentence.

Note that in case of many targets within range, individual targets, including the most dangerous one, might not be delivered every second, not regularly, or not at all, due to less strict priority handling for the `PFLAA` sentence. **Always use** `PFLAU` **as primary alarm source.** Usually, but not always, the last `PFLAA` sentence is the one causing the `PFLAU` content. The other `PFLAA` sentences are not ordered. Do not expect to receive `PFLAU <Rx>` times `PFLAA` sentences, because the number of aircraft being processed might be higher or lower. `PFLAA` sentences can be based on extrapolated historical data. `PFLAA` sentences are limited to other aircraft with a horizontal and vertical distance less than the configured range. On Classic FLARM-based devices, the vertical distance is always 500 m. Non-moving aircraft are suppressed.

Annex B. $PFLAA and $PFLAU example simulation tables

Note that the data column is the concatenation of the other columns with commas inserted between fields and no CheckSum. Only the 'Data' column is sent as a sentence. The CheckSum is added by the Tool provided CheckSum=True is set.

main | PFLAA

ID	PFLAA	AlarmLevel	Rel_N	Rel_E	Rel_V	IDT	TargetID	Track		GS	ClimbRate	AcftTyp	NoTrack	Source	Data
1	$PFLAA	0	0	3500	373	1	DD506F	270		150	0	2	0	0	$PFLAA,0,0,3500,373,1,DD506F,270,,150,0,2,0,0,
2	$PFLAA	0	0	3250	373	1	DD506F	270		150	0	2	0	0	$PFLAA,0,0,3250,373,1,DD506F,270,,150,0,2,0,0,
3	$PFLAA	0	0	3000	373	1	DD506F	270		150	0	2	0	0	$PFLAA,0,0,3000,373,1,DD506F,270,,150,0,2,0,0,
4	$PFLAA	0	0	2750	373	1	DD506F	270		150	0	2	0	0	$PFLAA,0,0,2750,373,1,DD506F,270,,150,0,2,0,0,
5	$PFLAA	1	0	2500	373	1	DD506F	270		150	0	2	0	0	$PFLAA,1,0,2500,373,1,DD506F,270,,150,0,2,0,0,
6	$PFLAA	1	0	2250	373	1	DD506F	270		150	0	2	0	0	$PFLAA,1,0,2250,373,1,DD506F,270,,150,0,2,0,0,
7	$PFLAA	1	0	2000	373	1	DD506F	270		150	0	2	0	0	$PFLAA,1,0,2000,373,1,DD506F,270,,150,0,2,0,0,
8	$PFLAA	2	0	1750	373	1	DD506F	270		150	0	2	0	0	$PFLAA,2,0,1750,373,1,DD506F,270,,150,0,2,0,0,
9	$PFLAA	2	0	1500	373	1	DD506F	270		150	0	2	0	0	$PFLAA,2,0,1500,373,1,DD506F,270,,150,0,2,0,0,
10	$PFLAA	2	0	1250	373	1	DD506F	270		150	0	2	0	0	$PFLAA,2,0,1250,373,1,DD506F,270,,150,0,2,0,0,
11	$PFLAA	3	0	1000	0	1	DD506F	270		150	0	2	0	0	$PFLAA,3,0,1000,0,1,DD506F,270,,150,0,2,0,0,
12	$PFLAA	3	0	750	-373	1	DD506F	270		150	0	2	0	0	$PFLAA,3,0,750,-373,1,DD506F,270,,150,0,2,0,0,
13	$PFLAA	3	0	500	-373	1	DD506F	270		150	0	2	0	0	$PFLAA,3,0,500,-373,1,DD506F,270,,150,0,2,0,0,
14	$PFLAA	3	0	250	-373	1	DD506F	270		150	0	2	0	0	$PFLAA,3,0,250,-373,1,DD506F,270,,150,0,2,0,0,
15	$PFLAA	1	0	0	-373	1	DD506F	270		150	0	2	0	0	$PFLAA,1,0,0,-373,1,DD506F,270,,150,0,2,0,0,
16	$PFLAA	1	0	-250	-373	1	DD506F	235		150	0	2	0	0	$PFLAA,1,0,-250,-373,1,DD506F,235,,150,0,2,0,0,
17	$PFLAA	1	-250	-500	-373	1	DD506F	235		150	0	2	0	0	$PFLAA,1,-250,-500,-373,1,DD506F,235,,150,0,2,0,0,
18	$PFLAA	3	-500	-750	-373	1	DD506F	235		150	0	2	0	0	$PFLAA,3,-500,-750,-373,1,DD506F,235,,150,0,2,0,0,
19	$PFLAA	3	-750	-1000	-373	1	DD506F	235		150	0	2	0	0	$PFLAA,3,-750,-1000,-373,1,DD506F,235,,150,0,2,0,0,
20	$PFLAA	3	-1000	-1250	-373	1	DD506F	235		150	0	2	0	0	$PFLAA,3,-1000,-1250,-373,1,DD506F,235,,150,0,2,0,0,
21	$PFLAA	0	-1250	-1500	-373	1	DD506F	235		150	0	2	0	0	$PFLAA,0,-1250,-1500,-373,1,DD506F,235,,150,0,2,0,0,

main | PFLAU

ID	PFLAU	RX	TX	gPS	Pow	AlarmLevel	Rel_B	AlarmType	Rel_V	Rel_D	TargetID	Data
1	$PFLAU	2	1	0	0	0	90		0	4500	DF0957	$PFLAU,2,1,0,0,0,90,,0,4500,DF0957
2	$PFLAU	2	1	0	0	0	90		0	4000	DF0957	$PFLAU,2,1,0,0,0,90,,0,4000,DF0957
3	$PFLAU	2	1	0	0	0	90		0	3500	DF0957	$PFLAU,2,1,0,0,0,90,,0,3500,DF0957
4	$PFLAU	2	1	0	0	0	90		0	3000	DF0957	$PFLAU,2,1,0,0,0,90,,0,3000,DF0957
5	$PFLAU	2	1	0	0	0	90		0	2500	DF0957	$PFLAU,2,1,0,0,0,90,,0,2500,DF0957
6	$PFLAU	2	1	0	0	0	90		0	2000	DF0957	$PFLAU,2,1,0,0,0,90,,0,2000,DF0957
7	$PFLAU	2	1	0	0	0	90		0	1750	DF0957	$PFLAU,2,1,0,0,0,90,,0,1750,DF0957
8	$PFLAU	2	1	0	0	1	90		0	1500	DF0957	$PFLAU,2,1,0,0,1,90,,0,1500,DF0957
9	$PFLAU	2	1	0	0	1	90		0	1250	DF0957	$PFLAU,2,1,0,0,1,90,,0,1250,DF0957
10	$PFLAU	2	1	0	0	2	90		0	1000	DF0957	$PFLAU,2,1,0,0,2,90,,0,1000,DF0957
11	$PFLAU	2	1	0	0	2	90		0	750	DF0957	$PFLAU,2,1,0,0,2,90,,0,750,DF0957
12	$PFLAU	2	1	0	0	3	90		0	500	DF0957	$PFLAU,2,1,0,0,3,90,,0,500,DF0957
13	$PFLAU	2	1	0	0	3	90		0	250	DF0957	$PFLAU,2,1,0,0,3,90,,0,250,DF0957
14	$PFLAU	2	1	0	0	3	90		0	0	DF0957	$PFLAU,2,1,0,0,3,90,,0,0,DF0957
15	$PFLAU	2	1	0	0	0	270		0	250	DF0957	$PFLAU,2,1,0,0,0,270,,0,250,DF0957
16	$PFLAU	2	1	0	0	0	270		-100	500	DF0957	$PFLAU,2,1,0,0,0,270,,-100,500,DF0957
17	$PFLAU	2	1	0	0	0	270		-100	1000	DF0957	$PFLAU,2,1,0,0,0,270,,-100,1000,DF0957
18	$PFLAU	2	1	0	0	0	270		-85	1500	DF0957	$PFLAU,2,1,0,0,0,270,,-85,1500,DF0957
19	$PFLAU	2	1	0	0	0	270		-65	2000	DF0957	$PFLAU,2,1,0,0,0,270,,-65,2000,DF0957
20	$PFLAU	2	1	0	0	0	270		-45	4500	DF0957	$PFLAU,2,1,0,0,0,270,,-45,4500,DF0957
21	$PFLAU	2	1	0	0	0	270		-30	5000	DF0957	$PFLAU,2,1,0,0,0,270,,-30,5000,DF0957
22	$PFLAU	2	1	0	0	0	270		0	5500	DF0957	$PFLAU,2,1,0,0,0,270,,0,5500,DF0957
23	$PFLAU	2	1	0	0	0	270		45	6000	DF0957	$PFLAU,2,1,0,0,0,270,,45,6000,DF0957
24	$PFLAU	2	1	0	0	0	270		80	6500	DF0957	$PFLAU,2,1,0,0,0,270,,80,6500,DF0957
25	$PFLAU	2	1	0	0	0	270		120	7000	DF0957	$PFLAU,2,1,0,0,0,270,,120,7000,DF0957
26	$PFLAU	2	1	0	0	0	270		160	7500	DF0957	$PFLAU,2,1,0,0,0,270,,160,7500,DF0957
(New)												