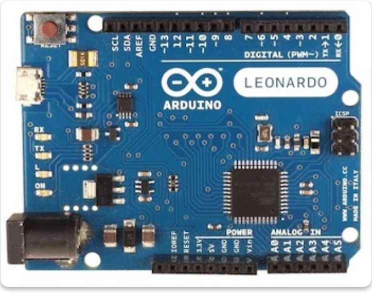
XPanel

XPanel is a plugin for X-Plane >=11 flight simulator. If you have or plan to build a home cockpit then it is good to check this. It can connect your USB HID hardware devices to the X-Plane system.

It has a configuration file where you can define the logical connections between hardware elements (buttons, switches, displays, etc) and the internal datarefs and commands of X-Plane.

Currently, it supports these types of USB-HID devices:

	Saitek Multi Panel	**This is a device that mainly contains the buttons associated with the autopilot functions**
	Saitek Radio Panel	Device to control radio functions of your airplane
	Saitek Switch Panel	Device with switches to control the electrical systems of your plane
	Logitech/Saitek Flight Instrument Panel	Device with a graphical screen to display aircraft instruments (supported only on Windows)
	TRC-1000 PFD/MFD & Audio Panel	These devices are replica of Garmin G1000 cockpit panels

	Saitek Multi Panel	This is a device that mainly contains the buttons associated with the autopilot functions
	Custom USB HID Devices	You can use a custom USB HID device like Arduino Leonardo board

Install

Windows

Get the latest release from github

Copy the xpanel folder into your X-Plane plugin directory (in my case it is c:\XPlane12\resources\plugins).

Please don't forget to remove any other plugins that want to connect to your USB Hid devices in the home cockpit.

The aircraft-specific configuration file (xpanel.ini) shall be put into the aircraft folder.

If you have any errors during the plugin load or run please check the main X-Plane log file. If you want more detailed logs from the plugin, please set the log level to DEBUG or even TRACE. See the details at troubleshooting

Linux

Get the latest release from github
Copy the xpanel folder into your X-Plane plugin directory.

If you have an Arduino based board you need to add the appropriate udev rules to grant device access permissions, for example:

```
  /etc/udev/rules.d/99-leonardo.rules:


SUBSYSTEMS=="usb", ATTRS{idVendor}=="2341", ATTRS{idProduct}=="8036", MODE:="0666"
```

Build

Windows

Check out the latest source file from github

Open the solution file (XPanel.sln) with Visual Studio. Select either Release or Debug build configuration. The solution file contains two projects. One for the xpanel plugin and one for the unit tests.

The build artifact of the plugin is generated in the Release|Debug/plugin/xpanel folder (win.xpl file)

You can also use `cmake` to build the plugin on Windows

Run unit tests

To run the unit tests, open the Visual Studio test menu and select Test Explorer. Push the run-all button and check the test results.

Linux

Check out the latest source file from [github]()

Dependencies

- C++ toolchain
- CMake
- pkg-config
- hidapi
- Lua

```
  $ cmake --install-prefix /tmp/xpanel-install -S . -B build
$ cmake --build build
$ cmake --install build
```

Copy or link the `/tmp/xpanel-install/XPanel` directory into the X-Plane plugin folder.

Configuration

Config options general description

The configuration file format is *similar* to the ini file format. It is divided into sections. A section can have properties. A section is marked by square brackets ([ ]). Every section shall have a unique id.

```
  [button:id="NAV"]                                                language-ini
```

The configuration file shall be named as xpanel.ini and need to put be into the folder of your aircraft.

Comments

All characters after a semi-column (;) are considered comments.

```
  on_push="commandref:/sim/cmd/HDG:begin";this is a comment      language-ini
  ;this is a full line comment
```

Log level

This plugin has a very simple log facility that can be used during debug sessions. The log level can be set from the configuration files:

```ini
log_level="TRACE|DEBUG|INFO|WARNING|ERROR"
```

Set the log level of the plugin. The log lines are written to X-Plane's default log file. In normal use-cases set the log_level to ERROR.

```ini
log_level="ERROR"
```

Aircraft ACF file

The ACF file is the main file for an X-Plane aircraft. The plugin gets the ACF file name parameter from the X-Plane system. The reason to put the ACF file name into the configuration is only for safety. During parse, we can check if accidentally a wrong configuration file (created for another aircraft) has been loaded.

```ini
aircraft_acf="tu154.acf"
```

Script file

You can write action handlers (see later) in LUA script as well. The plugin will load and interpret the script file you specify here. The script file shall be in the current aircraft's folder (the same directory as the xpanel.ini config file)

```ini
script_file="TU154-arduino-home-cockpit.lua"
```

The details of the LUA script files are in the lua config description document.

Devices

Devices can be defined by a new section in the configuration file. Currently, it supports these types of devices: XSaintek's Multi Panel and a homemade custom USB-HID IO board.

```ini
[device:id="saitek_multi"]
[device:id="saitek_radio"]
[device:id="saitek_switch"]
[device:id="saitek_fip_screen"]
[device:id="trc1000_pfd"]
[device:id="trc1000_audio"]
[device:id="aurduino_homecockpit"]
```

The devices have a few config options which can be set by the configuration file.

- USB VID (Vendor ID) in hexadecimal format
- USB PID (Product ID) in hexadecimal format

```ini
[device:id="aurduino_homecockpit"]
vid="2341"
pid="8036"
```

A device can have Buttons, Lights (LEDs), Displays, and Encoders.

Custom USB-HID IO boards

If you have a USB HID capable IO board (like I have an Arduino Lenoardo) you can define the logical (or symbolic) names for each register bits in a configuration file. A USB HID report is based on bytes so the config file follows this order as well.

To define a symbolic name you need to select the register (1 byte long registers with 0-based index) and then the bit index. In the example below we define two symbolic names (STROBE and DOME) which are in register 1 and assign to the 0 and the 1 bit respectively.

language-ini

```
[register:adr=1]
button:id="STROBE",bit=0
button:id="DOME",bit=1

[register:adr=5]
display:id="ALTIMETER_GAUGE",width=2
```

In the aircraft-specific configuration files, you can use these symbolic names.

Note: The board-specific config file is not aircraft specific therefore you should have only one instance of this config and put it in the same folder where the plugin binary is installed (for example: c:\xplane11\resources\plugins\XPanel\64\board-config.ini)

The release package contains my board-config.ini but for sure you have to modify it according to your HW design.

Buttons

An input device on the HW panel (button, switch, rotation switch) needs to be mapped as button in the configuration file. Practically every bit mapped input device is handled as a button. Even if it is a rotary encoder but it is mapped to USB register bit value (like a Saitek panel's encoder).
Every button shall be defined as a new section and need to have a pre-defined id. The predefined IDs can be seen in the next table.

Device	Button ID	Recommended Function
Saitek Multi Panel	AP	Autopilot
	HDG	Heading mode
	NAV	Navigation mode
	IAS	Indicated Air Speed (IAS) hold mode
	ALT	Altitude hold mode
	VS	Vertical speed hold mode
	APR	Approach mode
	REV	Revers approach mode

Device	Button ID	Recommended Function
	AUTO_THROTTLE	Auto throttle arm
	FLAPS_UP	Flaps up handle
	FLAPS_DOWN	Flaps down handle
	TRIM_WHEEL_DOWN	Trim wheel
	TRIM_WHEEL_UP	Trim wheel
	KNOB_PLUS	Multi function rotation knob, + direction
	KNOB_MINUS	Multi function rotation knob, - direction
	SW_ALT	Selector Switch, ALT position
	SW_VS	Selector Switch, VS position
	SW_IAS	Selector Switch, IAS position
	SW_HDG	Selector Switch, HDG position
	SW_CRS	Selector Switch, CRS position
Saitek Radio Panel	KNOB_UP_BIG_PLUS	Upper Rotation Knob: Outer (big) Ring, Plus Direction
	KNOB_UP_BIG_MINUS	Upper Rotation Knob: Outer (big) Ring, Minus Direction
	KNOB_UP_SMALL_PLUS	Upper Rotation Knob: Iner (small) Button, Plus Direction
	KNOB_UP_SMALL_MINUS	Upper Rotation Knob: Iner (small) Button, Minus Direction
	KNOB_DOWN_BIG_PLUS	Down Rotation Knob: Outer (big) Ring, Plus Direction
	KNOB_DOWN_BIG_MINUS	Down Rotation Knob: Outer (big) Ring, Minus Direction
	KNOB_DOWN_SMALL_PLUS	Down Rotation Knob: Inner (small) Button, Plus Direction
	KNOB_DOWN_SMALL_MINUS	Upper Rotation Knob: Inner (small) Button, Minus Direction
	ACT_STBY_UP	Upper Xchange button (Active <--> Standby)
	ACT_STBY_DOWN	Down Xchange button (Active <--> Standby)
	SW_UP_COM1	Upper Selector Switch, COM1 position
	SW_UP_COM2	Upper Selector Switch, COM2 position
	SW_UP_NAV1	Upper Selector Switch, NAV1 position
	SW_UP_NAV2	Upper Selector Switch, NAV2 position
	SW_UP_ADF	Upper Selector Switch, ADF position

Device	Button ID	Recommended Function
	SW_UP_DME	Upper Selector Switch, DME position
	SW_UP_IDT	Upper Selector Switch, IDT position
	SW_DOWN_COM1	Down Selector Switch, COM1 position
	SW_DOWN_COM2	Down Selector Switch, COM2 position
	SW_DOWN_NAV1	Down Selector Switch, NAV1 position
	SW_DOWN_NAV2	Down Selector Switch, NAV2 position
	SW_DOWN_ADF	Down Selector Switch, ADF position
	SW_DOWN_DME	Down Selector Switch, DME position
	SW_DOWN_IDT	Down Selector Switch, IDT position
Saitek Switch Panel	BATTERY	Battery on/off
	ALTERNATOR	Alternator on/off
	AVIONICS	Avionics power switch
	FUEL_PUMP	Fuel pump
	DE_ICE	De-ice (wing, engine, etc...)
	PITOT_HEAT	Pitot heat
	COWL_FLAPS	Cowl flaps open/close
	PANEL_LIGHTS	Panel lights
	BEACON	Beacon light
	NAV	Nav light
	STROBE	Strobe light
	TAXI	Taxi light
	LANDING	Landing light
	MAG_OFF	Magneto (ignition) off
	MAG_RIGHT	Magneto (ignition) right side
	MAG_LEFT	Magneto (ignition) left side
	MAG_BOTH	Magneto (ignition) both side
	ENG_START	Engine starter
	GEAR_UP	Landing gear up
	GEAR_DOWN	Landing gear down
TRC-1000 PFD/MFD	IAS	Autopilot IAS hold mode
	YD	Yaw dumper
	AP	Autopilot enable
	HDG	Autopilot Heading mode

Device	Button ID	Recommended Function
	FD	Flight director
	APR	Autopilot approach mode
	NAV	Autopilot Nav mode
	VNV	Autopilot VNV mode
	ALT	Autopilot altitude hold mode
	UP	Autopilot VS up
	DN	Autopilot VS down
	VS	Autopilot VS mode select
	FLIP_NAV	Flip active and standby NAV frequencies
	FLIP_COM	Flip active and standby COM frequencies
	SOFT_KEY_1	Multipurpose button on the bottom edge of display
	SOFT_KEY_2	Multipurpose button on the bottom edge of display
	SOFT_KEY_3	Multipurpose button on the bottom edge of display
	SOFT_KEY_4	Multipurpose button on the bottom edge of display
	SOFT_KEY_5	Multipurpose button on the bottom edge of display
	SOFT_KEY_6	Multipurpose button on the bottom edge of display
	SOFT_KEY_7	Multipurpose button on the bottom edge of display
	SOFT_KEY_8	Multipurpose button on the bottom edge of display
	SOFT_KEY_9	Multipurpose button on the bottom edge of display
	SOFT_KEY_10	Multipurpose button on the bottom edge of display
	SOFT_KEY_11	Multipurpose button on the bottom edge of display
	SOFT_KEY_12	Multipurpose button on the bottom edge of display
	MENU	Menu
	DIRECT	Direct to a way pooint button

Device	Button ID	Recommended Function
	PROC	Procedures button
	FPL	Flight plane button
	ENT	Enter button
	CLR	Clear button
	SWITCH_NAV_12	Switch between NAV 1/2 frequencies
	SWITCH_COM_12	Switch between NAV 1/2 frequencies
	PRESS_ALT	Press on ALT knob
	SEL_CRS	Push on CRS knob. Sync CRS
	CURSOR	
	ID	
	SYNC_HDG	Push on HDG knob. Sync HDG
	SQ	
	PAN_PUSH	Push on PAN stick
	PAN_UP	PAN stick up
	PAN_UP_LEFT	PAN stick up-left
	PAN_RIGHT	PAN stick right
	PAN_DOWN	PAN stick down
	PAN_DOWN_LEFT	PAN stick left
TRC-1000 AUDIO	COM1MIC	Com1 mic select
	COM2MIC	Com2 mic select
	COM3MIC	Com3 mic select
	COM1/2	Com1/2 switch
	PA	
	MKRMUTE	Mute mic
	DME	Sound source DME
	ADF	Sound source ADF
	AUX	Sound source AUX
	MANSQ	
	PILOT	
	COM1	Sound source COM1
	COM2	Sound source COM2
	COM3	Sound source COM3
	TEL	Sound source TEL

Device	Button ID	Recommended Function
	SPKR	
	HISENSE	
	NAV1	Sound source NAV1
	NAV2	Sound source NAV2
	PLAY	
	COPLT	
	DISPBACKUP	
	VOLSQ	

Define an action for a button

Every button can define multiple push and release actions. An action could be either

- set a `dataref` to a specific value (integer, float or an array)
- increase or decrease a `dataref` by a delta
- execute a `command`
- execute a `lua` code

It is possible to define an action with a condition. This could be used for multipurpose HW elements (like the sliver rotation knob on the Saitek multi panel)

The next example is a simple action. When you push the button (or put the switch to on position) it sets the `sim/custom/lights/nav_lights_set` dataref to 1. When you release the button (switch set to 0) it sets the dataref to 0.

```
[button:id="STROBE"]                                              language-ini
on_push="dataref:sim/custom/lights/nav_lights_set:1"
on_release="dataref:sim/custom/lights/nav_lights_set:0"
```

To set a value in an array you can use the following syntax. This will set the index 0 element of the array to value 1

```
on_push="dataref:/sim/data/data_array[0]:1"                       language-ini
```

You can define actions that change a dataref value by a given delta. This can be used for rotation knob handlers where you change some proportional value (like heading or course). You can also define a min and max value and the plugin won't change above or below the given limits.

```
on_push="dataref:<dataref_name>:<delta>:<min>:<max>"              language-ini
```

This kind of conditional action can be used for multipurpose handlers/displays.
A good example is the Saitek Multi Panel. There is a rotation switch (left side of the display) where you can select the function of the silver rotation knob KNOB_MINUS/KNOB_PLUS (right side of the display) also the display value on the display.

language-ini

```ini
[button:id="KNOB_PLUS"]
on_push="on_select:SW_HDG,dataref:test/dynamic_speed_test:1:0:359"

[button:id="KNOB_MINUS"]
on_push="on_select:SW_HDG,dataref:test/dynamic_speed_test:-1:0:359"
```

The above example will change the dataref value if the selector switch is at SW_HDG position. The minimum is 0 and the maximum is 359.

The following is show how to use X-Plane commands. When you push the button, it issues a command `begin` to X-Plane with the given command ref. When you release the button, we issue a command `end` to X-Plane.
If you don't care about the length of a button press then you can use the commands with `:once` modifier. This will issue a single command to X-Plane which contains a push and a release event as well.

language-ini

```ini
[button:id="HDG"]
on_push="commandref:/sim/cmd/HDG:begin"
on_push="commandref:/sim/cmd/HDG:end"
```

Dynamic speed feature for the dataref change actions {#DynamicSpeed}

On a Saitek device, all the rotation knobs are simple bit-mapped buttons. Turning to one direction sets a bit while turning to the opposite direction turns another bit. From xpanel point of view, this is a simple button (more precisely two buttons). Anyhow it is very boring to rotate the knobs for a long time when you need to change the values on a wide range. To help this you can define speed factors for the action.
It measures the average speed of rotation and based on that it will apply a multiplier for the dataref/commandref change.
You can define two-speed values: mid and high. You can define such behavior for every button/rotation encoder with this syntax:

language-ini

```ini
[button:id="KNOB_PLUS"]
dynamic_speed_mid="2tick/sec:2x"
dynamic_speed_high="6tick/sec:4x"
on_push="on_select:SW_HDG,dataref:B742/AP_panel/heading_set:1:-1:361"
on_push="on_select:SW_CRS,dataref:B742/AP_panel/course_1_set:1:0:361"
on_push="on_select:SW_CRS,dataref:B742/AP_panel/course_2_set:1:0:361"
on_push="on_select:SW_IAS,dataref:B742/AP_panel/AT_spd_set_rotary:1:0:400"
on_push="on_select:SW_ALT,dataref:B742/AP_panel/altitude_set:100:0:40000"
```

This will apply a x2 or x4 speed factor if rotation speed exceeds the 2 tick/sec or 6 tick/sec respectively.

Lights

A light means an LED on the panel. This can be as a standalone LED or a background lit of a Saitek Panel's button.

To decide about turning on/off the light you need to define triggers. A trigger means a condition and when the condition is true the lit (turn on) or unlit (turn off) will happen.

If neither the lit nor unlit condition meets it means we don't change the the state of the light.

For sure you can define multiple lit/unlit conditions for a trigger. All the triggers will be evaluated and the last true condition will be dominant.

You can use either dataref value or the return value of a LUA function for triggers:

```ini
[light:id="NAV_L"]
trigger_lit="dataref:sim/custom/lights/button/absu_stab_h:1"
trigger_unlit="dataref:sim/custom/lights/button/absu_stab_h:0"

[light:id="AP_L"]
trigger_lit="lua:get_led_status():1"
trigger_unlit="lua:get_led_status():0"
```

The first section of the above config snippet is for the background light of the NAV button on a Saitek Multi panel. The LED will be turned on if the dataref value is 1 and will be turned off when the dataref value is 0.

The second snippet uses LUA function. The plugin will call the lua function (get_led_status in this example) and check the return value.

Every LED has a predefined symbolic name that can be seen in this table:

Device	Light (LED) ID	Recommended Function
Saitek Multi Panel	AP_L	Autopilot button LED
	NAV_L	Nav button LED
	IAS_L	IAS button LED
	ALT_L	Altitude hold button LED
	VS_L	Vertical speed button LED
	APR_L	Approach button LED
	REV_L	Revers approach button LED
Saitek Switch Panel	GEAR_NOSE_GREEN	Landing gear nose, green light
	GEAR_LEFT_GREEN	Landing gear left, green light
	GEAR_RIGHT_GREEN	Landing gear right, green light
	GEAR_NOSE_RED	Landing gear nose, red light
	GEAR_LEFT_RED	Landing gear left, red light
	GEAR_RIGHT_RED	Landing gear right, red light
TRC-1000 AUDIO	COM1/2	Com1/2 selected
	COM1MIC	Com1 mic selected
	COM2MIC	Com2 mic selected
	COM3MIC	Com3 mic selected
	MKRMUTE	Mic muted

Device	Light (LED) ID	Recommended Function
	COPLT	
	MANSQ	
	PILOT	
	COM1	Com1 audio selected
	COM2	Com2 audio selected
	COM3	Com3 audio selected
	DME	DME audio selected
	ADF	ADF audio selected
	NAV1	Nav1 audio selected
	NAV2	Nav2 audio selected
	TEL	Tel audio selected
	AUX	Aux audio selected
	HISENSE	High sensitivity
	SPKR	
	PLAY	
	PA	

Displays

A display is a character based 7 segment display device or an analog gauge. It can be used to display numeric values. Please note: Saitek's FIP graphical device has specific device type and config options as it can be seen in FIP chapter.
The display value can be either from a dataref or from a LUA function. The display value can be a conditional display which means the value to display depends on the position of a switch. A display that contains conditions called multi-purpose display (multi_display).

The 'on_select:HW input name' part defines a condition. If the HW input is in logical 1 state the display will show you the dataref or lua script value in that line, Thi is somehow similar to a switch-case instruction in C.

```ini
[multi_display:id="MULTI_DISPLAY_UP"]
line="on_select:SW_ALT,dataref:sim/custom/gauges/compas/pkp_helper_course_L"
line="on_select:SW_VS,lua:get_my_display_value()"
```

The first line will display the actual value of the dataref. The second line will call the LUA function and displays the return value of the function.

The SW_ALT or SW_VS will determine which value will be displayed.

If you need a display device without any condition (it means the display will show the same dataeref or lua value all the time) you can define a simple display device in the configuration like this:

language-ini

```ini
[display:id="ALTIMETER"]
line="dataref:sim/test/altimeter"
```

Device	Display ID	Recommended Function
Saitek Multi Panel	MULTI_DISPLAY_UP	Upper Display (7 segments, 5 digits)
	MULTI_DISPLAY_DOWN	Down Display (7 segments, 5 digits)
Saitek Radio Panel	RADIO_DISPLAY_STBY_UP	Upper Standby Display (7 segments, 5 digits)
	RADIO_DISPLAY_ACTIVE_UP	Upper Active Display (7 segments, 5 digits)
	RADIO_DISPLAY_STBY_DOWN	Down Standby Display (7 segments, 5 digits)
	RADIO_DISPLAY_ACTIVE_DOWN	Down Active Display (7 segments, 5 digits)

Encoders {#Encoders}

The TRC-1000 devices have a 1-byte wide encoder. These type of encoders has two events you can use: `on_increment` and `on_decrement`. You can change a `dataref`, execute an XPlane command or call a Lua function. This is the same as for a simple button.
Similarly to the bitmapped rotation knobs, you can define a dynamic speed behavior for the encoders as well:

language-ini

```ini
[encoder:id="HDG"]
dynamic_speed_mid="2tick/sec:2x"
dynamic_speed_high="4tick/sec:4x"
on_increment="dataref:sim/cockpit/autopilot/heading_mag:1:0:360"
on_decrement="dataref:sim/cockpit/autopilot/heading_mag:-1:0:360"
```

Saitek Flight Information Panel (FIP) {#ChapterFIP}

General description

The Saitek FIP is a mini screen with 320x240 pixel resolution and a USB connection. The main purpose of the device is to display flight instruments (speed, altimeter, vario, HSI, CDI, etc.)
The FIP device contains six push buttons with an LED backlight, two rotation knobs, and an up/down button to change the virtual pages.
See details here.

The Xpanel plugin allows you to customize the screen content and connect it to the simulator's internal values. Of course, the button functions and the LED backlights are also configurable with the plugin.

Saitek FIP device

The FIP device connects to the PC via a USB bulk endpoint. It has support for virtual pages which means you can define many pages with different contents and the pages can be changed runtime by the up/down arrow buttons on the device.

The device can be identified and opened by the unique serial number of your device. This serial number is displayed on the screen as soon as you give power to the device. For example my test device serial number MZB05779E2. The unique serial number allows you to connect more than one FIP device at the same time.

It can display 24-bit BMP data (without the header and padding parts)

The current implementation uses the Saitek device driver which provides the low-level functions to set images on the screen and handle buttons/LEDs.

How to install FIP device driver?

Windows

First of all, you need to install the Saitek/Logitech FIP device driver.
This can be downloaded from this location
Please note: you need only the "Flight Instrument Panel Drivers" from the above location. The Logitech support page
contains an "X Plane Plug-in". If you installed it previously please remove it because this will conflict with the XPanel plugin.

Linux/Mac

Currently, Saitek/Logitech doesn't provide the device driver for Linux and Mac systems.
Therefore it can't be used on that operating system. I'm looking for the replacement of
the device driver on these systems.

Config options

The Xpanel config options are created to reflect the SW design hierarchy.
At the top level, the FIP *device* is declared with its serial number.

The device contain one *screen*, 6 push *buttons*, 2 *rotation knobs* and 6 *LEDs*.
For the button and LED light handling you can use the same actions and triggers as for the other USB devices (Radio, Multi, etc)

The config item "screen" can contain many virtual *pages*. Each virtual page can be a different flight instrument like a Speed meter, CDI, HSI, etc. You can select the actual page by the up/down arrow buttons.

A virtual page is composed of multiple *layers*. Layers are BMP files with 24-bit color depth.

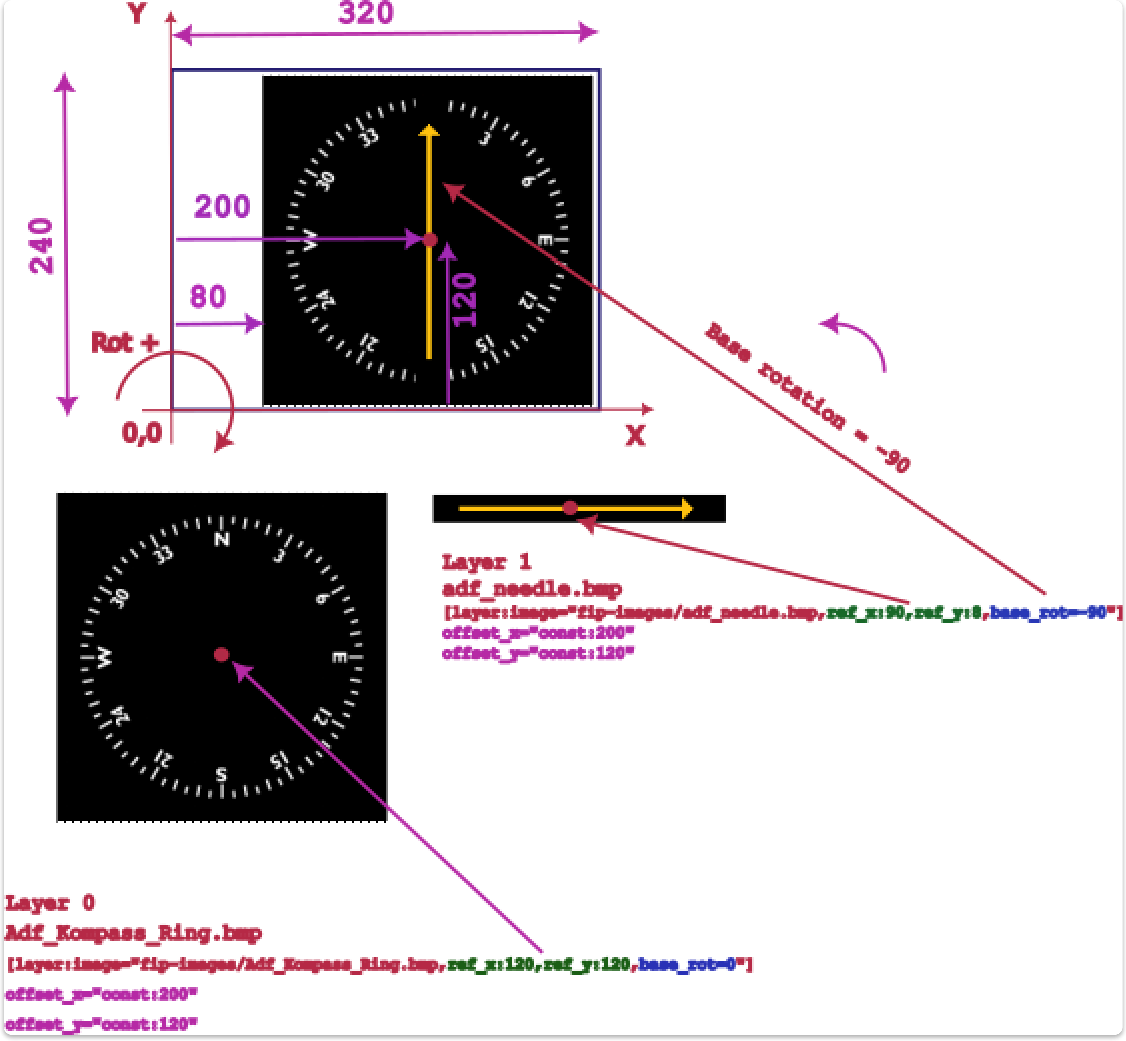
Layers are put in the order of appearance in the config file. The first layer will be the
backmost while the last will be in the front. The black color pixels (RGB: 0,0,0) are used as
transparent pixels, so those pixels won't overwrite layers behind them.

```ini
[device:id="saitek_fip_screen"]
serial="YOUR_DEVICE_SERIAL"

    [screen:id="fip-screen"]
    [page:id="ADF"]
        [layer:image="fip-images/Adf_Kompass_Ring.bmp,ref_x:120,ref_y:120,base_rot=0"]
        offset_x="const:200"
        offset_y="const:120"
        rotation="dataref:sim/cockpit/radios/adf1_cardinal_dir,scale:-1"

        [layer:image="fip-images/adf_needle.bmp,ref_x:90,ref_y:8,base_rot=-90"]
        offset_x="const:200"
        offset_y="const:120"

rotation="dataref:sim/cockpit2/radios/indicators/adf1_relative_bearing_deg,scale:1"
```

Each layer has a reference point (ref_x, ref_y). This is the point of the layer we use during the transformations of the layer.
You can select the most convenient reference point which allows you to use to either translate or rotate a layer.

For your convenience, the layer can have a base rotation value. This means that even if the BMP file is created with a different
orientation you can rotate it according to your purposes. Further rotation is allowed on the layer but the
rotation angle=0 will be the position defined by the base_rot property.

A layer can be moved in two different ways: translation and rotation.



Layer 1
adf_needle.bmp

```
[layer:image="fip-images/adf_needle.bmp,ref_x:90,ref_y:8,base_rot=-90"]
offset_x="const:200"
offset_y="const:120"
```

Layer 0
Adf_Kompass_Ring.bmp

```
[layer:image="fip-images/Adf_Kompass_Ring.bmp,ref_x:120,ref_y:120,base_rot=0"]
offset_x="const:200"
offset_y="const:120"
```

Translate a layer

You can move the layer in horizontal or vertical directions or both. A horizontal translation is declared in the config file by the offset_x and the vertical one by offset_y.

The value for the translation is in pixel units. You can use three different sources for translation value:

- constant value
- dataref value
- return value of a lua function

The ref_x, ref_y point of your BMP file will be moved to the value of position defined by offest_x and offest_y respectively.

If you define more than one offest_x only the last one will be used. The same is true for the offset_y as well.

Rotate a layer

The center of rotation is the ref_x and ref_y properties defined in the layer declaration.
The angle of rotation is defined in degree units (not radians). The positive rotation angle means clockwise rotation.
Similar to translations you can use three different sources for the rotation angle:

- constant value
- dataref value

- return value of a lua function

Mask a layer

You can define a mask for a layer. This means that only a part of the layer image will be drawn. It is useful to draw a sliding scale (like a linear altimeter scale on a PFD). The mask is positioned to the screen coordinates
so in the configuration file, you should define this:

```ini
        [page:id="TEST_MASK"]
            [layer:image="fip-images/bmp_test_big_image.bmp,ref_x:0,ref_y:157,base_rot=0"]
            mask="screen_x:0,screen_y:120,height:100,width:60"
```

With the above config only those parts of the layer image will be displayed that are inside the defined mask window.

Text layers

XPanel plugin can render ASCII text characters to the FIP screen. You can put text in any position on the screen. These texts are handled as text layers. All the functions that are available for the image layers, can be used to text layers as well (mask, translate, rotate).

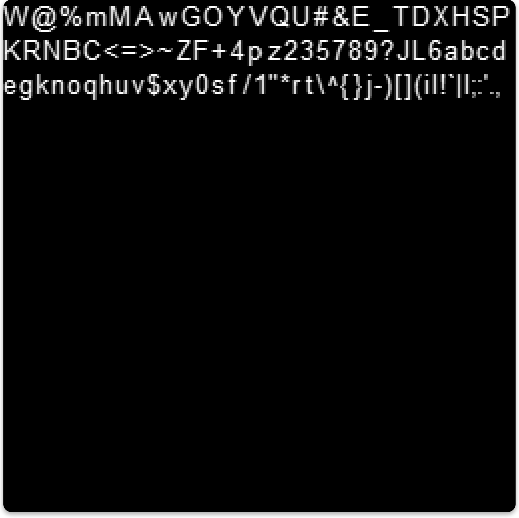
config options for a text layer

You can create text layers in the config file using the type="text" definition. The displayed text is set by the text=... field. The text can be either a constant value a dataref (numeric or text type) or a return value of a lua function.

```ini
[layer:type="text"]
offset_x="const:50"
offset_y="const:40"
rotation="const:45"
mask="screen_x:0,screen_y:120,height:100,width:60"
text="const:Hello XPlane"

[layer:type="text"]
text="dataref:/sim/cockpit2/gauges/indicators/airspeed_kts_pilot"

[layer:type="text"]
text="lua:fip_text_test()"
```

Generate new fonts for text layers##

The plugin has been released with a simple font set (fip-fonts.bmp). If you'd like to generate a new font collection you can use bmfont tool.


W@%mMAwGOYVQU#&E_TDXHSP
KRNBC<=>~ZF+4pz235789?JL6abcd
egknoqhuv$xy0sf/1"*rt\^{}j-)[](il!`|l;:',

1. bmfont program creates a PNG image that needs to convert to a 24bit BMP format. You can do it with your favorite image editor.
2. bmfont program also generates a .fnt file that holds the position and size of each character in the image. I created a Python script (convert.py) that converts this info into a C header file (fip-fonts.h) that will be used by the Xpanel plugin.

```
python3 convert.py
```

3. Once you created the new FipFonts.h copy it to the src folder and recompile the plugin. Put the fip-fonts.bmp file in the install folder of the plugin.

[Example] Create your own custom instrument displays

In this example, we create a virtual ADF display. The ADF has a needle pointer and a background scale which can be rotated by the OBS knob. You can see this kind of instrument on many GA aircraft like C172-SP.

Create the necessary BMP files

This ADF instrument will have two layers. One for the ring scale and one for the needle.
These layers shall be drawn as 24-bit color-depth BMP files. The background color of the images shall be RGB 0,0,0 (black).

Install the BMP files

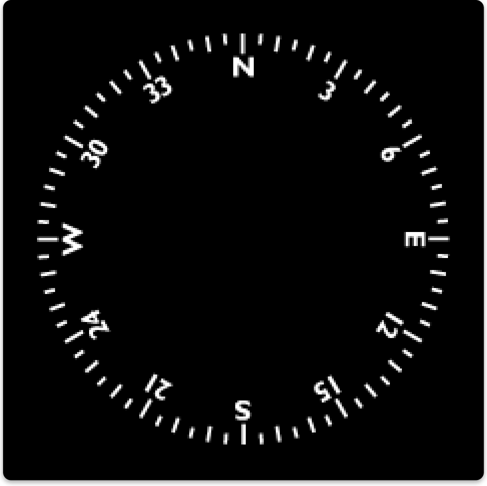
Put the BMP files into the aircraft folder practically into a separated sub-folder.
I use the folder name fip-images but for sure you can use any other name. The config file refers to the above folder relative to the current aircraft folder.
In my config a BMP file is referred like this:

```ini
[layer:image="fip-images/Adf_Kompass_Ring.bmp..."]
```

language-ini

Ring scale

The ring scale image can be found in test/fip-images/Adf_Kompass_Ring.bmp:



The size of the BMP file is 240x240 pixels.

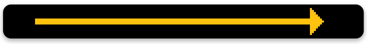
As this ring scale can be rotated by the OBS knob,
we select as a reference point the middle of the image (120,120). This will be the rotation center.
We want to put the image in the top-right
corner of the 320x240 size screen. This means we have to translate the image along the x-axis by 200 pixels (320-120=200).

The angle of rotation is connected to a dataref value of the simulator. If you turn the rotation OBS in the simulator, the dataref value will be updated. The plugin will read this value and rotate the image according to the actual value. The scale parameter means a proportional
scale factor for the amount of rotation. The -1.0 in this example simply means an inverted direction.
If you put for example -1.5 it will rotate x1.5 speed.

```ini
[page:id="ADF"]
    [layer:image="fip-images/Adf_Kompass_Ring.bmp,ref_x:120,ref_y:120,base_rot=0"]
    offset_x="const:200"
    offset_y="const:120"
    rotation="dataref:sim/cockpit/radios/adf1_cardinal_dir,scale:-1"
```

Needle

Similar to the previous image we have to create the BMP file for the needle: test/fip-images/Adf_Kompass_Ring.bmp:



The reference point for this image is set to the center (90,8). This is the middle of the image.
It is practical to select this point because we have to rotate the needle according to dataref value in the simulator.

We apply a x=200, y=120 translation to put the center of the image in the same position as we put the ring scale image previously.
The rotation of the needle (on this default C172 aircraft) shall be connected to the adf1_relative_bearing_deg dataref

```ini
    [layer:image="fip-images/adf_needle.bmp,ref_x:90,ref_y:8,base_rot=-90"]
    offset_x="const:200"
    offset_y="const:120"
    rotation="dataref:sim/cockpit2/radios/indicators/adf1_relative_bearing_deg,scale:1"
```

Example configuration file

language-ini

```
log_level="TRACE"
script_file="tu154-saitek-multipanel.lua"
aircraft_acf="generic.acf"

;----------- Saitek Multi Panel --------------
[device:id="saitek_multi"]
vid="12AB"
pid="34CD"

;AP button
[button:id="AP"]
on_release="dataref:/sim/hello/AP:0"; test for button press
on_release="dataref:/hello/bello:0"
on_push="dataref:/sim/hello/AP:1"
on_push="dataref:/sim/hello/AP2:1"

;AP button light
[light:id="AP_L"]
trigger_lit="lua:get_led_status():1"
trigger_unlit="lua:get_led_status():0"

;NAV button
[button:id="NAV"]
on_push="commandref:/sim/cmd/NAV:begin"
on_release="commandref:/sim/cmd/NAV:end"

[light:id="NAV_L"]
trigger_lit="dataref:sim/custom/lights/button/absu_stab_h:1"
trigger_unlit="dataref:sim/custom/lights/button/absu_stab_h:0"

[multi_display:id="MULTI_DISPLAY_UP"]
line="on_select:SW_ALT,dataref:sim/custom/gauges/compas/pkp_helper_course_L"
line="on_select:SW_VS,dataref:sim/custom/gauges/compas/pkp_helper_course_L"
line="on_select:SW_HDG,dataref:sim/custom/gauges/compas/pkp_helper_course_L"

[multi_display:id="MULTI_DISPLAY_DOWN"]
line="on_select:SW_ALT,dataref:sim/custom/gauges/compas/pkp_helper_course_L"
line="on_select:SW_VS,dataref:sim/custom/gauges/compas/pkp_helper_course_L"

;---------------- Arduino based IO board ------
[device:id="aurduino_homecockpit"]
vid="2341"
pid="8036"

;STROBE light
[button:id="STROBE"]
on_push="dataref:sim/cockpit/electrical/strobe_lights_on:-1"
on_release="dataref:sim/cockpit/electrical/strobe_lights_on:0"
```

```
;BEACON light
[button:id="BEACON"]
on_push="dataref:sim/cockpit/electrical/beacon_lights_on:1"
on_release="dataref:sim/cockpit/electrical/beacon_lights_on:0"
```

LUA script intergration

XPanel plugin is shipped with a Lua 5.4 interpreter. You can call Lua expressions from the config file. The more convenient way is to put all you Lua codes int a .lua file and refer this in your config file.

This plugin is independent of the FlyWithLua plugin! You can't use the functions defined by that plugin.

The following Lua command are defined by the plugin:

Do an X-Plane command

language-lua

```lua
command_once('/xplane/command')
command_begin('/xplane/command')
command_end('/xplane/command')
```

The parameters are the X-Plane command names as a string.

You can trigger an X-Plane command in three different ways: The "begin" means like you keep pushing a button.
The "end" means you release the button. If you don't care about the length of the button press you can issue a single command as "once".
This contains a beginning and immediately an end.

Set or get X-Plane datarefs

language-lua

```lua
value = get_dataref('/xplane/dataref')
set_dataref('/xplane/dataref',value)
```

The X-Plane dataref values can set or get by these functions. The first parameter is the dataref name as a string. The get_dataref will return the current value of the dataref.

The set_dataref second parameter is the value that you want to set. Please be careful to pass the right type of value here. X-Plane checks the value type and rejects it if it doesn't match with the required type of the dataref.

The plugin tries to convert it to the required type but it could make tricky issues if you don't care about the type of values. The dataref types are listed here

You may know that it's a high cost call into the X-Plane system to find an internal dataref by the name (more details here) Therefore the plugin will
store the dataref pointer so the costly XPLMFindDataRef will be called only once.

Get the value of an Input or Output HW line

You can query the value of input/output HW lines. For example, you can read the position of a switch or a light state.

To read the state of a button/switch:

```lua
hid_get_button_state(vid,pid,button_name)                                    language-lua
```

, where vid and pid are the integer value of the USB HID device's VID and PID. Please note you can query only those devices which are in your active configuration. The button_name is a string parameter and it shall be matched with the button names used in the configuration.

The return value is a string type:

"ON", "OFF", "UNKNOWN"

UNKNOWN could mean either the button_name is not valid or the button didn't change its state.

To read the state of a light:

```lua
hid_get_light_state(vid,pid,light_name)                                      language-lua
```

, where vid and pid are the integer value of the USB HID device's VID and PID. Please note you can query only those devices which are in your active configuration. The light_name is a string parameter and it shall be matched with the light names used in the configuration.

The return value is a string type:

"LIT", "UNLIT", "BLINK", ""UNKNOWN"

UNKNOWN could mean either the light_name is not valid or the light didn't change its state.

Logger command

To put a log line into X-Plane's log file you can use this lua command.
The first parameter determines the log level. If the actual log level is higher than your message here (for example you call log_msg with the first parameter as 'TRACE' and the log level is set to INFO by the config file)
your log message will be ignored.

```
log_msg('ERROR|WARNING|INFO|DEBUG|TRACE','log message')
```

How to use the Lua commands in the config file?

An example lua script file can be found here. This script defines a function `button_AP` with one parameter named `action` which can be

- 'push'
- 'release'
- 'once'

language-lua

```lua
function button_AP(action)
    log_msg("TRACE","button AP handler "..action)
    if (action == "push") then
        command_begin("/sim/test/lua/button_AP")
    elseif (action == "release") then
        command_end("/sim/test/lua/button_AP")
    elseif (action == "once") then
        command_once("/sim/test/lua/button_AP")
    else
        log_msg("ERROR","invalid action parameter "..action)
    end
end
```

You can call the button_AP function from the config file like this:

language-ini

```ini
script_file="test-script.lua"

[button:id="AP"]
on_push="lua:button_AP('push')"
on_release="lua:button_AP('release')"
```

Please note that in the config file, we use single quote (') instead of double (") in the lua function parameter.

Flight loop function

If you define a LUA function named flight_loop(param) in your script, that function will be periodically called by the plugin in every flight loop.
The param is the elapsed time (in seconds) since the previous call of the function.
You can use the dataref set/get and command handler functions as well from this flight loop function.

language-lua

```lua
function flight_loop(param)
    log_msg("TRACE","flight loop called. Time elapsed "..param)
    set_dataref("/sim/test/lua_flight_loop",12345)
end
```

Trouble shooting {#trouble-shooting}

Xpanel plugin has log mechnism to put log messages into XPlane's main log. Every error detected by the plugin will be put into the main log file (c:\X-Plane12\log.txt in my setup).