

# ScreenLinq

*HDMI to FPD-Link III Video Converter*

User Manual, Version 0.9.4

Classification: Public

Author: Matěj Bartík (MAB)

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HEAD OFFICE  
Digiteq Automotive s.r.o.  
Novodvorská 994/138  
142 21, Prague 4  
Czech Republic

CONTACTS  
+420 239 046 750  
info@digiteqautomotive.com  
www.digiteqautomotive.com

BILLING INFORMATION  
Company ID. No. 26466023  
VAT ID No.: CZ26466023  
registered by the Municipal  
Court in Prague,  
Section C, Insert 84128

MANAGEMENT BOARD  
Wilhelm Schmitt  
Pavel Štěpánek

BANK ACCOUNT  
Commerzbank Aktiengesellschaft  
Jugoslávská 1, 120 21 Prague 2  
Account No.: 10634787/6200 (EUR)  
IBAN: CZ426200000000010634787  
SWIFT: COBACZPXXXX

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## Changes

Version	Date	Change description	Changed by	Approved by
0.9.3	26.09.23	Initial revision, no spell-check.	MAB	MAB
0.9.4	12.10.23	Default display profiles update, DFU tutorial, basic spell-check	MAB	MAB

## **Preface**

### **About the ScreenLinq**

Dear customer,

Thank you for purchasing ScreenLinq. The ScreenLinq presents a powerful tool whenever it is necessary to display any image from your computer on an infotainment display (ABT), selected types of combined (FPK, ILV), or head-up displays in a vehicle interior.

ScreenLinq is intended to be used mainly in the conceptual phase of HMI / UX and application development, during concept presentations, and user testing. ScreenLinq offers processing of user interactions – touches and gestures – with the projected content for UX testing. ScreenLinq can also be used in serial testing when it allows displaying any testing content on ABT display and interacting with the displayed content (e.g., triggering).

ScreenLinq can be used for testing on test benches as well as directly in a real car.

It fully supports modern software and operating systems and is easy to use. To start using ScreenLinq, you only need to connect the relevant cables and select the desired display profile.

In addition, ScreenLinq supports the processing of messages from the CAN-FD, LIN, or USB interfaces and a wide range of supported and preset screen resolutions, including a selection of the most widely used displays in the Volkswagen Group. It is possible to set up further display profiles based on a request.

This user manual provides instructions for the smooth operation of ScreenLinq. We hope that you will be satisfied with our product.

**Digiteq Automotive s.r.o.**

## 1 About this User Manual

The company reserves the right to make technical changes to the equipment or this document without prior notice. No guarantee is given for the information provided. No part of this manual may be reproduced in any form or by any means without the publisher's written permission. All technical information, drawings, screenshots, etc., are liable to the law of copyright protection.

We are grateful for references to mistakes or suggestions for improvement to offer you even more efficient products in the future.

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## 2 Safety Instruction

The following safety instructions are intended not only for protecting your health but also for protecting the product.

This section overviews all essential safety aspects for protecting individuals and ensuring safe and trouble-free operations.

The warranty/guarantee becomes void if damage is incurred resulting from non-compliance with these operating instructions. We do not assume any liability for consequential damage!

We also do not assume any liability for damage to other property or personal injury caused by improper use or failure to observe the safety instructions. In such cases, the guarantee/warranty will become void!

Therefore, please read the following items carefully before connecting the product and taking it into operation.

### 2.1 General Safety Instructions

- The product may only be set up, started, or serviced after gaining familiarity with the appropriate Operating Instructions.
- The products, equipment, and devices must only be used indoors.
- Use the products, equipment, and devices only for their intended purpose as described in the Product Specification.
- The products, equipment, and devices should not be operated in potentially explosive atmospheres.
- During the operation of the products, equipment, and devices, do not permit any work method that hinders the safety of the products, equipment, and devices.

- Always keep the working area of a unit clean and orderly to avoid danger from dirt or scattered parts.
- Do not exceed the technical performance data specified for each product, equipment, and device.
- Keep all safety precautions and danger hazard labels on the products, equipment, and devices in legible condition and replace the descriptions as needed.
- Operation and work on the products, equipment, and devices must only be carried out by trained personnel.
- In case of malfunction, immediately stop the unit.
- Only qualified personnel could approve a unit as operational after a fault occurs.

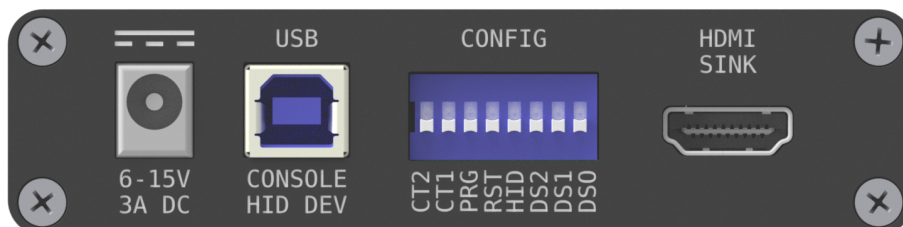
## 3 Product Specification

### 3.1 General Description

The ScreenLinq products family consists of powerful tools for processing video streams (and auxiliary data) from a computer to an in-car display. This particular variant implements an *HDMI to FPD-Link III Video Converter*. Besides this primary function, it can also provide access to the in-car display via several bi-directional communication interfaces to transmit/receive the auxiliary data (touches, gestures, settings, etc.).



(a) Front panel



(b) Rear panel

Figure 1: ScreenLinq's front and rear panels depicting available interfaces.

A ScreenLinq device comes in a **fail-safe** mode (all features are disabled); thus, the device needs to be set-up through a user configuration DIP switch (see Section 3.3.2) located on the rear panel of the device (see Fig. 1b) and a wiring diagram (see Section 4) must be followed as well.

In this section, there are several interfaces mentioned, although they are currently unused. Such interfaces (CAN-FD interface 2 and LIN interface, see Section 3.3.5) are **reserved** for future (on-demand) functions or features.

## 3.2 Mechanical and Electrical Properties

Table 1: Mechanical and electrical properties

Interfaces	HDMI 1.4b Sink (pixel clock up to 210 MHz) FPD-Link III Source (dual-link capable) 2x CAN-FD 1x LIN Master
Operating Voltage	12 – 15 VDC nominal (6 – 15 VDC when an in-car display has an independent power supply).
Operating Current	Maximum of 100 mA, power consumption of an in-car display is not incorporated. Maximum rating: 3 A in total.
Operating temperature	0 °C to 60 °C while preventing condensation
Storage temperature	-40 °C to 85 °C
Dimensions (w × h × d)	105 × 95 × 26 mm (including connectors and control elements)
Weight	200 g
CAN physical layer	In accordance with ISO 11898
Built-in CAN terminators	120 Ω, activated by DIP switches on the rear panel
EMC Compliance	CISPR 32/EN 55032
Water resistance	IP30



### WARNING

In case a ScreenLinq device is used to power an in-car display, the ScreenLinq's input voltage must not exceed the operating voltage of the used in-car display.



### 3.3 Interfaces

#### 3.3.1 Power Input

ScreenLinq uses an industry-standard power barrel jack with dimensions of 2.1 mm inner diameter and 5.5 mm outer diameter (see Fig. 2). The power input accepts a DC (Direct Current) power, where positive voltage is tied to the center pin of the power barrel jack connector.

The operating voltage (see Tab. 1) is 12 – 15 VDC. The ScreenLinq can withstand surges or peaks up to 25 VDC for a short time, allowing the ScreenLinq to connect to a car's on-board power grid easily.

It is recommended to use the provided [CUI Inc. SWM30-12-EV-P5<sup>1</sup>](#) AC/DC power adapter (see Fig. 6) In case the provided AC/DC adapter can not be used; it is necessary to provide sufficient power when ScreenLinq is used to provide power to an in-car display. A typical current drawn by an in-car display usually ranges between 1 and 2 amperes.



Figure 2: A power barrel jack 2.1/5.5 mm.

#### 3.3.2 User DIP Switch, Button, and RGB LEDs

To allow user interaction with ScreenLinq, several ways exist to provide control and visualize status information. The primary user configuration interface is the DIP switch (see Fig. 3) located at the rear panel (see Fig. 1b). The factory state of the DIP switch is all *OFF* state. To transition an individual switch to *ON* state, it is needed to slide the respective switch toward the white **ON** marking. The DIP switch positions **DS2**, **DS1**, and **DS0** are used to select a desired display profile stored in a configuration memory (see factory preset profiles – Tab. 2).

On the front panel (see Fig. 1a), there is the **USER** button (also labeled as *INIT* in the first hardware revision). In the current firmware release, pressing the USER button re-configures the ScreenLinq device from scratch with settings obtained from the DIP switch. However, some cabling might need to be reattached to propagate the new settings to a computer (generating a Hot-Plug event, for example) or to an in-car display.

<sup>1</sup><https://cui.com/product/external-ac-dc-power-supplies/wall-plug/swm30-e-series>

Alternatively, the USER button can be re-configured to serve different purposes, such as restarting an in-car display, generating user events (triggers), and possibly more.

Besides the USER button, two tri-colored (RGB) LEDs are on the front panel to indicate the device's status. As the LED labels indicate, each visualizes the status of the ScreenLinq device's respective part.

The device is considered fully operational when both LEDs are green (there is no difference if they are glowing still or blinking).

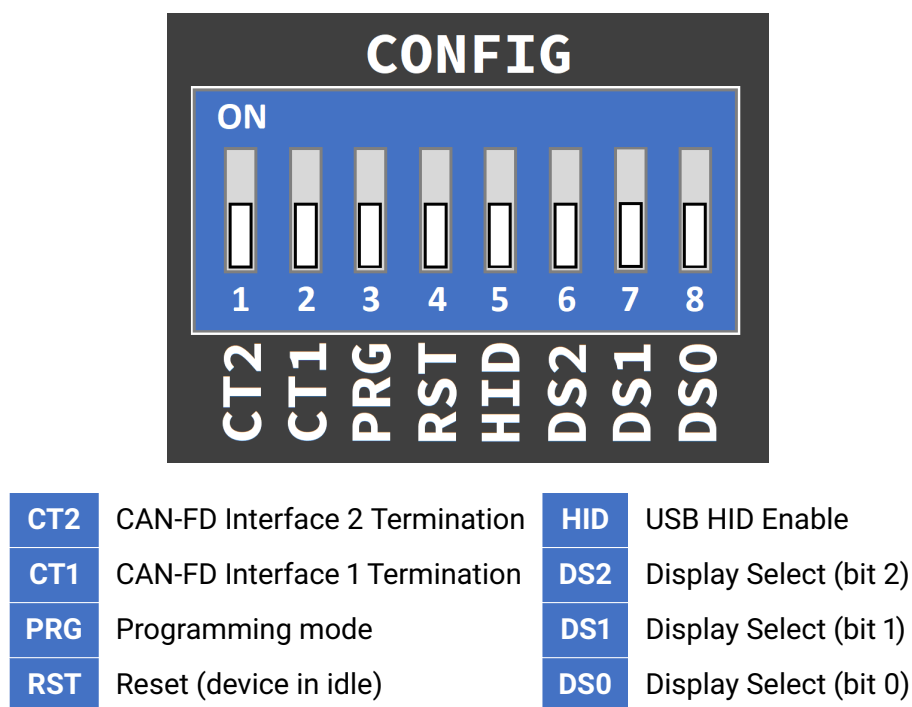


Figure 3: User configuration DIP switch (factory defaults).

### 3.3.3 FPD-Link III

ScreenLinq utilizes *Flat Panel Display Link* technology in its third generation (referred to as **FPD-Link III**<sup>2</sup>) to implement a video source interface. The implementation of the FPD-Link III interface supports a dual link (see pin-out on Fig. 4) feature, which enables image resolution up to 2880x1080 at 60 FPS. The maximum pixel clock of a video stream is 210 MHz. The physical layer uses *Shielded Twisted Pairs* with *LVDS*<sup>3</sup>.

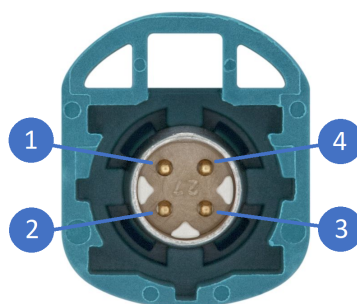
ScreenLinq's FPD-Link III interface uses **Rosenberger HSD**<sup>4</sup> connectors and cables commonly used by in-car displays. The used solution is also compatible with other products of Digiteq Automotive, such as **Modular FrameGrabber (MGB)**<sup>5</sup> or **FrameGrabber4 (FG4)**.

<sup>2</sup><https://www.ti.com/lit/an/slyt581/slyt581.pdf>

<sup>3</sup>Low Voltage Differential Signaling

<sup>4</sup><https://www.rosenberger.com/product/rosenberger-hsd/>

<sup>5</sup><https://www.digiteqautomotive.com/en/product/modular-framegrabber-mgb>



#### FPD-Link III Signals

- |   |           |   |           |
|---|-----------|---|-----------|
| 1 | DOUT0 (-) | 4 | DOUT1 (+) |
| 2 | DOUT1 (-) | 3 | DOUT0 (+) |

Figure 4: Pin-out of HSD connector used for the FPD-Link III source interface.

### 3.3.4 HDMI

A standard 19-pin (Type-A) HDMI connector is present to implement a video sink device to receive a multimedia stream from a computer. ScreenLinq implements the HDMI 1.4b standard. It is also possible to use other video interfaces, such as DisplayPort (with DP++ feature) or DVI (limited by a maximum pixel clock of 165 MHz). Since HDMI 1.4b pixel clock can reach the maximum of 340 MHz, an incoming video stream from the HDMI interface must respect the pixel clock limit of the FPD-Link III interface (see Section 3.3.3). Some HDMI 1.4b features, such as the ethernet channel (HEC) or Audio Return Channel (ARC), are not supported.

### 3.3.5 CAN-FD Connector

The CAN-FD Connector (using industry standardized D-Sub (Canon) 9 connector) provides two [CAN-FD](https://www.can-cia.org/can-knowledge/can/can-fd/)<sup>6</sup> interfaces (CAN-FD is fully backward compatible with CAN Classic), one [LIN](https://lin-cia.org/standards/)<sup>7</sup> (Master) interface, and a power output (VB+) which equals the ScreenLinq's input voltage (see Section 3.3.1) minus a drop-out on a reverse-blocking diode ( $\approx -0.5$  V). Due to this fact and also to the fact that a car on-board power grid utilizes a voltage slightly higher than +12 V, an in-car display can be dual-powered from a provided AC/DC adapter and the car on-board grid simultaneously.

The respective pin-out (see Fig. 5) is (partially compatible) with products from [Vector](https://www.vector.com/int/en/products/products-a-z/hardware/network-interfaces/cables/can-cables/)<sup>8</sup> or [PEAK-System](https://www.peak-system.com/Contact.54.0.html?&L=1)<sup>9</sup> to enable a seem-less integration into existing projects. Each of the CAN-FD interfaces has been internally terminated with a 120  $\Omega$  resistor, which can be (de)activated by CT1 (or CT2 respectively) DIP switch position (see Section 3.3.2).

<sup>6</sup><https://www.can-cia.org/can-knowledge/can/can-fd/>

<sup>7</sup><https://lin-cia.org/standards/>

<sup>8</sup><https://www.vector.com/int/en/products/products-a-z/hardware/network-interfaces/cables/can-cables/>

<sup>9</sup><https://www.peak-system.com/Contact.54.0.html?&L=1>



### WARNING

Do not attach or detach the D-Sub (Canon) 9 connector when a ScreenLinq device is powered on. Shielding of the D-Sub (Canon) 9 connector may cause a short circuit between VB+ and ground pins.

In case the power needs to be re-applied to an in-car display, re-attach the connector on the in-car display's side.

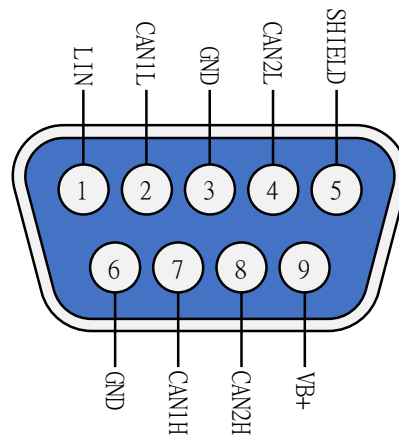


Figure 5: Pin-out of the ScreenLinq's CAN-FD Connector.

CAN-FD 1 interface implements necessary commands to keep an in-car display in a power-on state. In addition to this, it also receives commands from the in-car display and translates user-triggered events (such as touches and gestures) to **USB HID<sup>10</sup>** commands (see Section 3.3.6).

### 3.3.6 USB

ScreenLinq implements a USB 2.0 (Full-speed) device with one or multiple endpoints when USB HID functions are activated. It provides the following functions (which can be invoked via the User DIP switch, see Section 3.3.2):

- Implementation of a USB HID class to provide touches or gestures to an operating system,
- Implementation of a raw communication interface via a control application (including communication over CAN-FD and LIN interfaces),
- Updating to a new firmware,
- Uploading or downloading in-car display profiles.

<sup>10</sup>[https://www.usb.org/sites/default/files/hid1\\_11.pdf](https://www.usb.org/sites/default/files/hid1_11.pdf)

## 4 Operations

This section provides various helpful information to operate your ScreenLinq device successfully, including fundamental procedures such as:

- 1 Describing the provided cables and accessories,
- 2 Wiring the ScreenLinq to a computer or an in-car display,
- 3 Configuring the ScreenLinq device,
- 4 Using custom display profiles,
- 5 Uploading a new firmware,
- 6 Troubleshooting a problem.

### 4.1 Package Content

Besides this user manual, ScreenLinq's package (see Fig. 6) contains the device itself, an AC/DC power adapter, three data cables (HDMI, HSD, USB), and a Power & CAN-FD harness.



Figure 6: ScreenLinq package content.

### 4.1.1 Power & CAN-FD harness

The provided Power & CAN-FD harness has two D-Sub (Canon 9) female connectors, which are equal in function and pin-out (see Fig. 5); therefore, either of them can be attached to the ScreenLinq's CAN-FD connector (see Section 3.3.5). The remaining D-Sub (Canon 9) female connector can be used to provide access to a compatible system (CAN analyzer, for example).

The last connector of the Power & CAN-FD harness is a block connector (see Fig. 7) intended to provide power and CAN-FD 1 interface to an in-car display. Such block connector has been used in several car platforms in the Volkswagen group. In case an in-car display uses a different connector, a new harness should be designed to fit your needs. In that case, please don't hesitate to contact us for additional support.

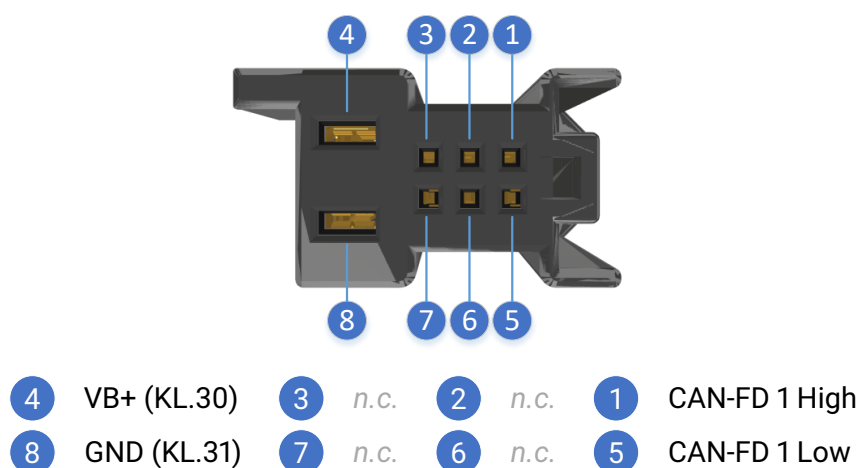


Figure 7: Pin-out of the in-car display block connector.

## 4.2 User Configuration & Wiring Diagram

Prior to the first run (or when a different configuration is required), the ScreenLinq device needs to be configured via the *user configuration DIP switch* (see Section 3.3.2). The configuration setup can be divided into three separate steps:

- 1 Select an operation mode:
  - Normal operation mode (video interfaces are active) (RST=0, PRG=0)
    - USB HID function activated (HID=1)
    - USB HID function disabled (HID=0)
  - Firmware update mode (RST=0, PRG=1, HID=X<sup>11</sup>)
  - Idle mode (RST=1, PRG=X, HID=X)

<sup>11</sup>X – represents *Don't Care* value.

- 2 Activate or deactivate termination for CAN-FD interfaces – it is recommended to activate termination for CAN-FD 1 interface by the *CT1* switch because a majority of in-car displays expect the termination to be implemented by a head unit (such as ICAS3). In case no such unit is attached to the ScreenLinq device nor the in-car display, the CAN-FD 1 interface **must** be terminated.
- 3 Select the desired in-car display profile via DS2, DS1, and DS0 switches. It is possible to invoke a custom user profile or a pre-loaded one (see Tab. 2).

With the ScreenLinq properly configured, it is possible to proceed to a wiring diagram (see Fig. 8) as the first step has already been completed. The numbers in the wiring diagram represent both the step number and part number (they match each other) as they were described (see Fig. 6) in the previous section.

For certain operation modes, there might be some deviations from the general wiring diagram:

- For *normal mode*, attaching the USB cable is optional (USB HID commands or auxiliary data can not be processed).
- For *firmware update mode*, attaching an in-car display is optional.
- For *idle mode*, all cabling beside the power input is optional.

### 4.3 Using (Custom) Display Profiles



#### WARNING – PRELIMINARY INFORMATION

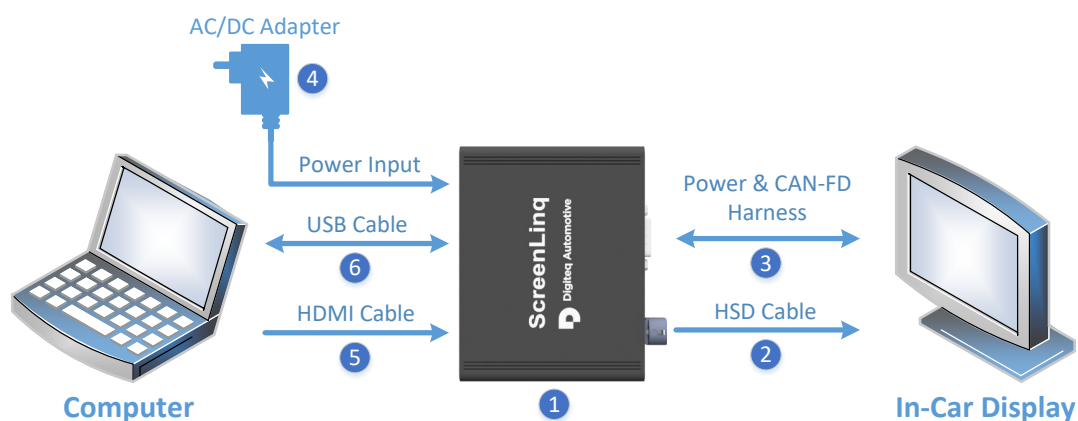
This feature has not been fully implemented nor documented yet.

ScreenLinq has a total of eight display profile slots, each of which can be used to upload (or download) custom profiles to support many in-car displays. Thanks to the effort of ScreenLinq's team, a desired profile might exist already; therefore, it is recommended to check [ScreenLinq's Display Database](https://digiteqautomotive.com)<sup>12</sup> first.

If the desired profile is unavailable, you can ask ScreenLinq's team to create such profiles (see Appendix A) or create your own display profiles, as explained below.

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<sup>12</sup><https://digiteqautomotive.com>



- 1 Configure a ScreenLinq device via the *User Configuration DIP Switch* (see Section 4.2) including individual steps such as:
  - 1 Select an operating mode,
  - 2 Select an in-car display profile,
  - 3 Activate CAN-FD 1 interface termination by sliding **CT1** switch to **ON** position,
- 2 Attach *HSD cable* to both the ScreenLinq and an in-car display,
- 3 Attach *Power & CAN-FD harness* (see Section 4.1.1) to both the ScreenLinq and an in-car display (both D-Sub (Canon 9) female connectors of the harness are equal),
- 4 Apply power to ScreenLinq device and wait for green LEDs indicating a *Ready* status,
- 5 Attach *HDMI cable* to both the ScreenLinq and a computer,
- 6 Attach *USB cable* to both the ScreenLinq and a computer when these features are required:
  - 1 Processing of USB HID commands or auxiliary data over USB interface,
  - 2 Uploading or downloading a display profile,
  - 3 Updating a firmware.



### WARNING

In case the HDMI cable is attached to a computer before powering the ScreenLinq device up, an incorrect (generic) display profile (see Fig. 10 or respective E-EDID as Listing 2) might be loaded instead the desired display profile.

Figure 8: ScreenLinq's wiring diagram including instructions for basic operation.



Table 2: Pre-loaded in-car displays parameters (version 0.9.4)

DS2	DS1	DS0	ResX (Pixels)	ResY (Lines)	Pixel Clock (MHz)	In-car Displays	Notes
0	0	0	1560	700	77.85	VW 10.0", VW 12.0", SA 13.1" (H01, H03, H05, H07, H08) with scaler	
0	0	1	1442 <sup>2</sup>	700	77.85	SA 13.1" (H01, H03, H05, H07, H08) with scaler	Experimental <sup>1</sup>
0	1	0	1920	1080	136.90	SA 13.1" UNECE (H07, H22)	
0	1	1	1920	932 <sup>3</sup>	136.90	SA 13.1" UNECE (H07, H22)	Experimental <sup>1</sup>
1	0	0	1920	1080	136.83	SA 12.9", SA E3 13.0" (H32)	
1	0	1	1560	878	92.26	SA 10.4", SA E3 10.0" (H30, H40)	
1	1	0	1280	640	61.43	SA 9.2" (H05)	
1	1	1	2240	1260	133.82	VW E3 15.0" (H43)	45 FPS <sup>4</sup>

1. Such display profile is not guaranteed to work as the video signal parameters deviate from the original display's parameters.
2. Reduced horizontal resolution from 1560 px to match visible area.
3. Reduced vertical resolution from 1080 px to match visible area.
4. Reduced from 60 FPS because a significant number of laptops (or docking stations) have a built-in resolution or pixel clock limit<sup>a</sup>.

<sup>a</sup><https://www.dell.com/support/keyboard/en-us/000126548/resolution-on-external-monitor-limited-to-1920-x-1080-using-hdmi>

### 4.3.1 Setting Up a New (Custom User) Display Profile

Before uploading a custom user display profile into a ScreenLinq device, it is necessary to create the profile first. This step requires knowledge of video timing parameters (see Appendix A). ScreenLinq's display profiles have been using *VESA Enhanced - Extended Display Identification Data (E-EDID) format*<sup>13</sup>. ScreenLinq supports E-EDIDs in version 1.3 and 1.4 with a maximal size of 256 bytes. Version 1.4 is required when a profile requires a pixel clock greater than 165 MHz.

It is recommended to use an E-EDID editor, such as *DELTACAST.TV E-EDID Editor*<sup>14</sup> alongside a provided E-EDID template (see Listing 3) to prevent creating an invalid E-EDID structure. However, it is also possible to create an E-EDID structure from scratch. The recommended E-EDID editor allows to set various details, including video timing parameters (see Fig 9).



#### WARNING

Uploading an invalid E-EDID structure to a ScreenLinq device will cause a GPU driver display identification process to fail.

E-EDID structure also supports *CTA Extensions*, which can be used to specify additional features. One of the features is bridging up to eight audio streams over the FPD-Link III interface (see Section 3.3.3) from the HDMI interface (see Section 3.3.4).

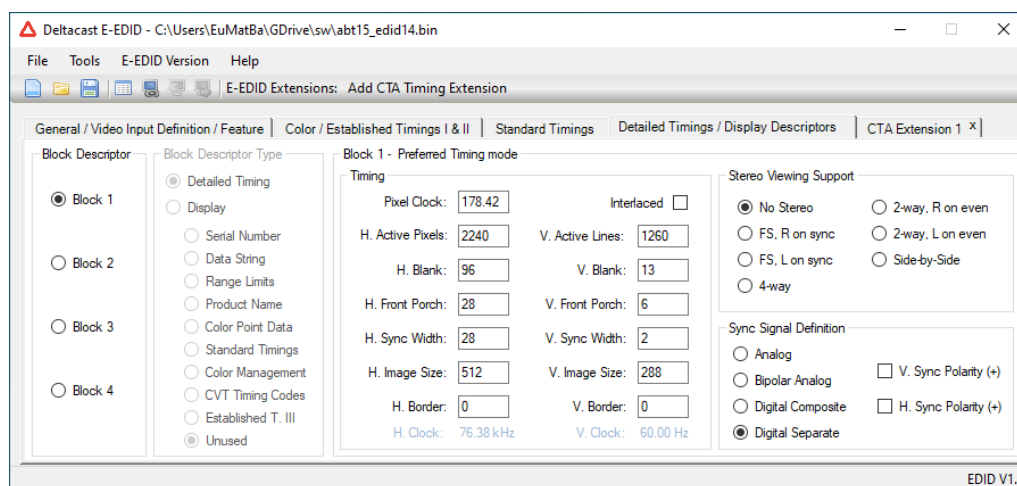


Figure 9: GUI of the DELTACAST.TV E-EDID Editor.

<sup>13</sup><https://glenwing.github.io/docs/>

<sup>14</sup><https://www.deltacast.tv/products/free-software/e-edid-editor>

### 4.3.2 Uploading and Downloading a Display Profile to ScreenLinq



#### **WARNING – PRELIMINARY INFORMATION**

This feature has not been fully implemented nor documented yet.

A display profile can be uploaded to one of eight display profile slots, where the content of the selected slot will be overwritten (including the pre-loaded display profiles – see Table 2). To upload a display profile, connect a powered-up ScreenLinq device to a computer via the USB interface and use a profile upload tool. The tool can be invoked by executing a command:

```
screenlinq profile [upload|download] [0-7] filename.bin
```

To reload the pre-loaded display profiles back to their original slots, simply call:

```
screenlinq profile reload
```

### 4.4 Uploading a New Firmware

This topic is covered in the Appendix B.

### 4.5 Configuring and Using USB HID Function on a Computer



#### **WARNING**

This feature has not been implemented nor documented yet.

## 5 Troubleshooting & Support

This section presents a list of known issues and their possible causes or solutions. The list has been divided into sections dealing with general issues and issues related to a specific in-car display.



#### **Still looking for a solution?**

In case you are unable to find an answer to your question, do not hesitate to contact us via email: [support.products@digiteqautomotive.com](mailto:support.products@digiteqautomotive.com)

## 5.1 General Issues

### Issue 1: ScreenLinq's user LEDs are not green (glowing still or blinking)

Possible causes:

- ScreenLinq device is not (properly) powered.
- ScreenLinq device is in *Idle* or *Firmware update mode*.
- ScreenLinq's internal configuration process has failed.
- ScreenLinq device is faulty.

### Issue 2: ScreenLinq is not identified by an OS or a GPU driver at all

Possible causes:

- ScreenLinq device is not (properly) powered.
- HDMI cable is not attached properly.
- ScreenLinq's internal configuration process has failed.
- ScreenLinq device is faulty.

### Issue 3: ScreenLinq is identified by an OS or a GPU driver, but the resolution can not be set to any value

Possible causes:

- Display profile with an invalid E-EDID structure has been selected (re-upload a valid E-EDID structure).
- E-EDID 1.3 structure is used for pixel clock greater than 165 MHz (switch to E-EDID 1.4 structure instead).
- Resolution or pixel clock exceeds the HDMI interface's capabilities (see Note 4 in Table 2 and contact the manufacturer of such HDMI source for additional support).
- ScreenLinq device is faulty.

#### Issue 4: ScreenLinq is being identified by an OS or a GPU driver with a different resolution than requested

- Does the resolution match other display profiles? If so, detach the HDMI cable and press INIT (or power cycle the ScreenLinq device) to load the new configuration and attach the HDMI cable back.
- Is ScreenLinq recognized as **TI-DS90Ux949** device? Is the primary resolution 1280x720 (see Fig. 10 for additional timing information)? If so, detach the HDMI cable, power cycle the ScreenLinq device, and attach the HDMI cable back.

Timing

Pixel Clock:	<input type="text" value="74.25"/>	Interlaced	<input type="checkbox"/>
H. Active Pixels:	<input type="text" value="1280"/>	V. Active Lines:	<input type="text" value="720"/>
H. Blank:	<input type="text" value="370"/>	V. Blank:	<input type="text" value="30"/>
H. Front Porch:	<input type="text" value="110"/>	V. Front Porch:	<input type="text" value="5"/>
H. Sync Width:	<input type="text" value="80"/>	V. Sync Width:	<input type="text" value="5"/>
H. Image Size:	<input type="text" value="512"/>	V. Image Size:	<input type="text" value="288"/>
H. Border:	<input type="text" value="0"/>	V. Border:	<input type="text" value="0"/>
H. Clock:	45.00 kHz	V. Clock:	60.00 Hz

Figure 10: Timing of the generic display profile.

#### Issue 5: ScreenLinq is being correctly identified by an OS or a GPU driver, but no image can be seen

Possible causes:

- An in-car display might not be powered up – check Power & CAN-FD harness (see Fig. 6, number 3) connectors are attached properly.
- CAN-FD 1 interface might not be terminated; therefore, an in-car display has not been awakened from sleep mode – Slide **CT1** switch on the rear panel (see Fig. 1b) to **ON** position to activate termination for the CAN-FD 1 interface.
- HSD cable is not attached properly.
- Some in-car displays can (incorrectly) lock onto an FPD-Link III signal with no active video stream; thus, they cannot re-lock when a valid video signal appears. Power cycle such in-car display via re-attaching display block connector (see Fig. 7).

#### Issue 6: I can see an image on an in-car display, but it looks like a "gray grain"

A GPU Driver (which seems nVidia to be the most problematic) starts a video stream and temporarily stops the stream, causing the FPD-Link III interface to glitch. Consequently, an FPD-Link III deserializer on an in-car display side cannot lock (and generate the "gray grain" image).

To rectify such behavior, there are several options:

- Power cycle the in-car display via re-attaching the display block connector (see Fig. 7).
- Re-attach the HDMI cable.
- Try a different computer.

#### Issue 7: I can see image on an in-car display, but there is a black padding surrounding the image

An OS or a GPU driver has set up a *Cloning* (Duplication) for secondary available display (ScreenLinq), but resolution does not match the primary display. Therefore, the image is being scaled to the ScreenLinq's resolution while keeping the aspect ratio. When aspect ratio differs, a black padding is being added to the image.

To rectify such behavior, use displays in *Extended* (Individual) mode or adjust the resolution on the primary display to match the ScreenLinq's resolution.

#### Issue 8: I can see image on an in-car display, but it is "unstable"

Possible causes:

- If an experimental display profile is used, switch to a profile that matches the video timing parameters of the display's original head unit.
- An incorrect display profile has been selected.
- A display profile is intended for a different hardware or software revision listed as supported.

## 5.2 Issues Related to a Specific In-Car Display

#### Issue 9: Skoda Auto ABT 13.1"

The Skoda Auto ABT 13.1" has been produced in many variants (both hardware and software), where only the five most common combinations are known to ScreenLinq's team.

Furthermore, this display is prone to generate a visual error when the exact display timing is not met (which could differ between each revision). Also, relying solely on hardware revision to determine a display profile is impossible, as used image resolution can vary within one hardware revision.

#### Issue 10: Volkswagen ABT 15.0"

The Volkswagen ABT 15.0" display stays black, and ScreenLinq is not recognized correctly by an OS or a GPU driver. The problem is caused by many laptop vendors, which limit the capabilities of an HDMI source interface to a certain resolution (FullHD/1080p usually).

It is possible to use the VW 10.0" or SA 12.9" profile to test the setup/wiring, but the displayed image will be corrupted.

If you were able to display any image, the only solution is to find a computer with no such limitations. It seems discrete GPUs in a PC have no such limits.

## Appendix A: Request for a New In-Car Display Profile

In case an in-car display is not supported (respectively, the display profile does not exist), it is possible to tailor a custom user profile to fit your needs. To create such a profile, the following information are required:

- 1 Part number of an in-car display,
- 2 Video timing parameters of the used display/screen/LCD panel:
  - These parameters are known to you, and it is possible to provide them to us (via filling up a form – see Table 3).
  - You have a matching head unit (ICAS3, for example) and the in-car display in a working setup, and you are willing to share the setup with us for the measurement to obtain the video timing parameters.

Please remember that the resolution of an active video (visible area) is not enough to create a display profile.

- 3 Any other known details such as manuals, datasheets, car platform, hardware revision, or software version.

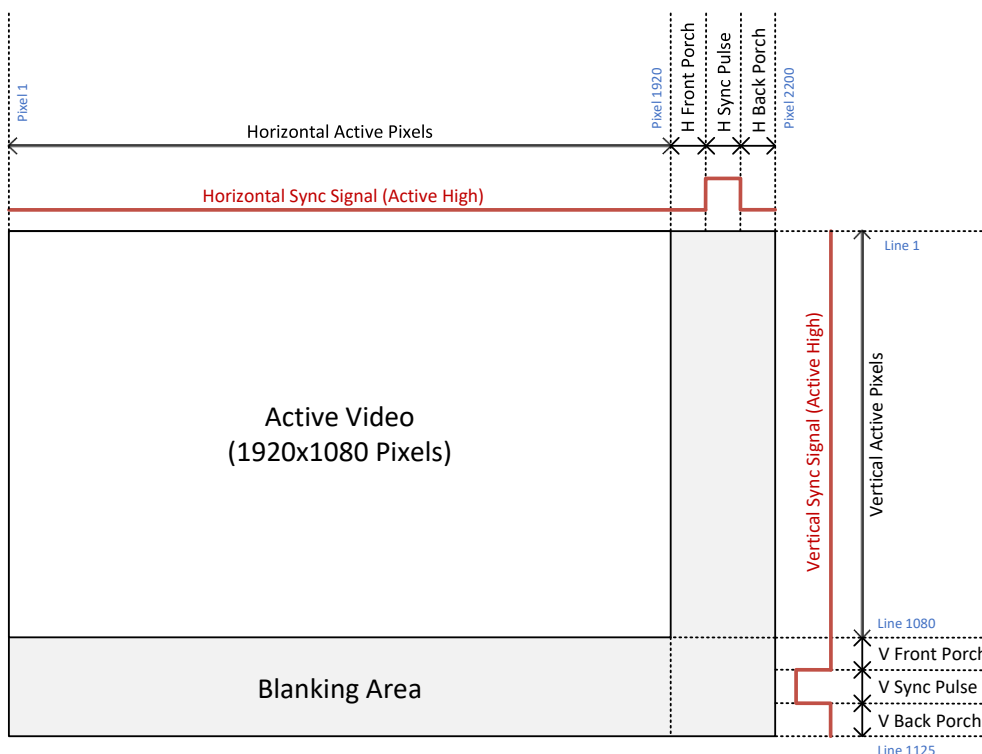


Figure 11: Visualization of video timing parameters - Full HD (1080p) resolution as defined by CEA-861 standard.



Table 3: Video timing parameters required for creating a custom display profile

Video Timing Parameter	Parameter Value	Unit
Pixel Clock		Hz
Framerate		Hz (FPS)
H Active		Pixels
H Total		Pixels
H Blanking		Pixels
H Front Porch		Pixels
H Back Porch		Pixels
H Sync Pulse		Pixels
H Sync Polarity <sup>1</sup>		Log. Level
V Active		Lines
V Total		Lines
V Blanking		Lines
V Front Porch		Lines
V Back Porch		Lines
V Sync Pulse		Lines
V Sync Polarity <sup>1</sup>		Log. Level

1. Only two values are possible: Active-Low or Active-High logic levels.

Some of the parameters can be calculated from other parameters by following these equations (to calculate vertical parameters, substitute **H** for **V** in the equations):

$$H_{Blanking} = H_{Front\ Porch} + H_{Back\ Porch} + H_{Sync\ Pulse}$$

$$H_{Total} = H_{Active} + H_{Blanking}$$

$$Pixel\ Clock = H_{Total} \times V_{Total} \times Framerate$$

## Appendix B: How to upload a firmware via USB

To upload a firmware to your ScreenLinq device, you need to make these four steps:

- 1 Download and unpack a provided ZIP archive (see an example of a ZIP archive's file system on Listing 1), which usually includes:
  - A driver for ScreenLinq (an STM32 Bootloader driver),
  - A firmware upload utility ([dfu-util](https://dfu-util.sourceforge.net))<sup>15</sup>,
  - A DFU file containing the ScreenLinq's firmware,
  - A batch file for easy execution of firmware upload process.
- 2 Configure and power-on the ScreenLinq device into "Firmware update mode".
- 3 Install the driver by following a standard procedure.
- 4 Upload a firmware via the DFU interface.

```
[DIR] ScreenLinq_Firmware
[DIR] STM32_Bootloader_Driver
[FILE] flash_screenlinq_fw_v0.9.4_beta.bat
```

Listing 1: Example of a the ZIP archive's file-system.

### B.1 Invoking ScreenLinq's "Firmware update mode"

To activate ScreenLinq's "Firmware update mode", find a switch "PRG" on the *User DIP switch* (see Section 3.3.2) on the rear side of your ScreenLinq device (see Fig.1b) and slide it into **ON** position. Then, power-on the ScreenLinq device and connect it to your computer with the provided USB cable.

### B.2 Installing an STM32 Bootloader Driver for a ScreenLinq Device

To gain access to *Device Firmware Upgrade (DFU)* interface over a USB interface, it is necessary to install an appropriate driver (STM32 Bootloader) as they might not be included nor supported by your operating system.



#### WARNING

You might need administration rights to install or update a driver. In case you don't have such rights, contact an IT department of your organization to let them install the driver on your computer.

<sup>15</sup><https://dfu-util.sourceforge.net>

In the case of Microsoft Windows 10, a ScreenLinq device will appear in *Device Manager* as a device with a *Warning* symbol (see Fig. 12), indicating that such a device might not operate as desired.

**The STM32 Bootloader driver can be installed by following steps:**

- 1 Invoking ScreenLinq's "Firmware update mode" (see Section B.1).
- 2 Find a ScreenLinq device in *Device Manager* (see Fig. 12),
- 3 Use the option *Browse my computer for drivers* to pick the driver manually (see Fig. 13).
- 4 Browse for the "STM32\_Bootloader\_Driver" directory (have the option "Include sub-folders" checked (see Fig. 14) and press Next).
- 5 The driver should now be installed successfully (see Fig. 15).
- 6 Close all dialogues and *Device Manager* itself.

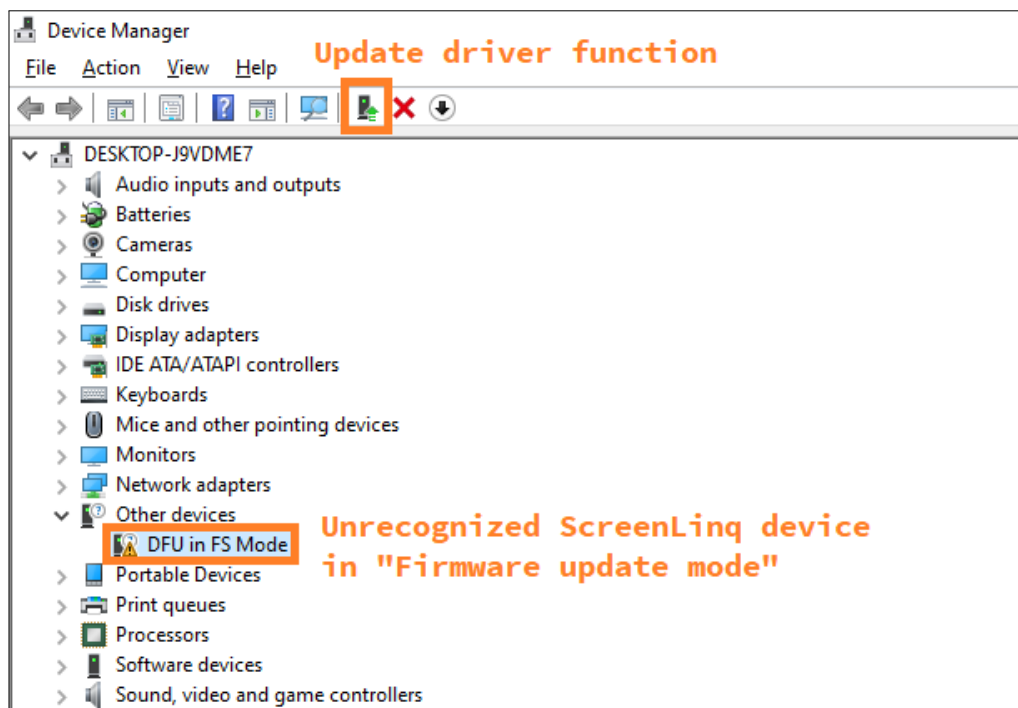


Figure 12: An unrecognized ScreenLinq device in Windows 10 Device Manager.

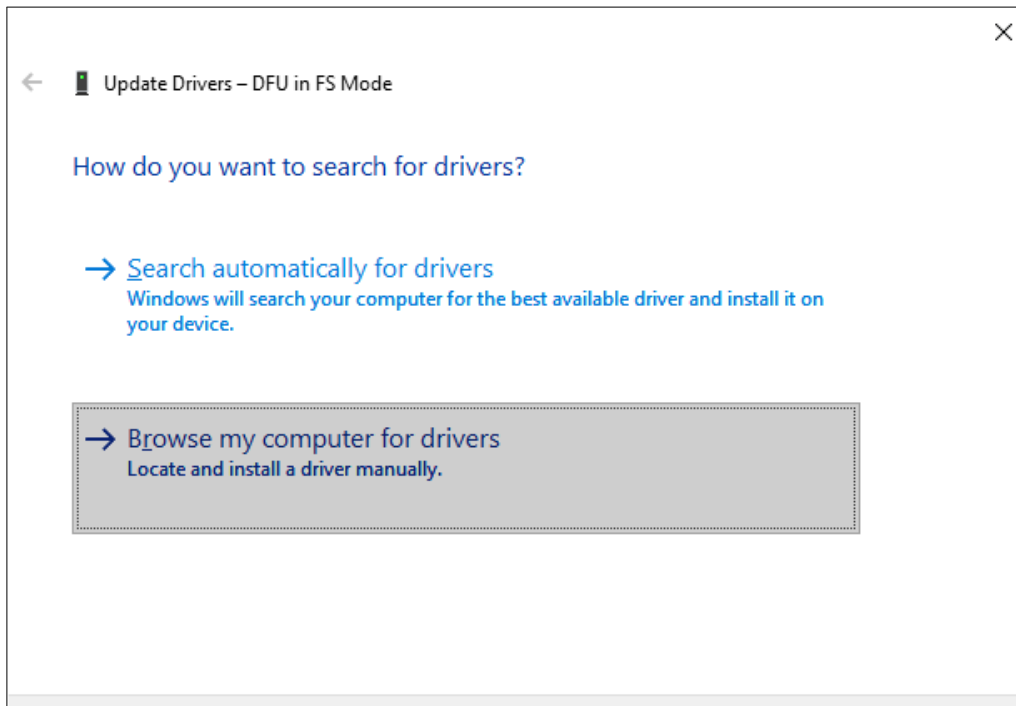


Figure 13: Use the option "Browse my computer for drivers" to pick the driver manually.

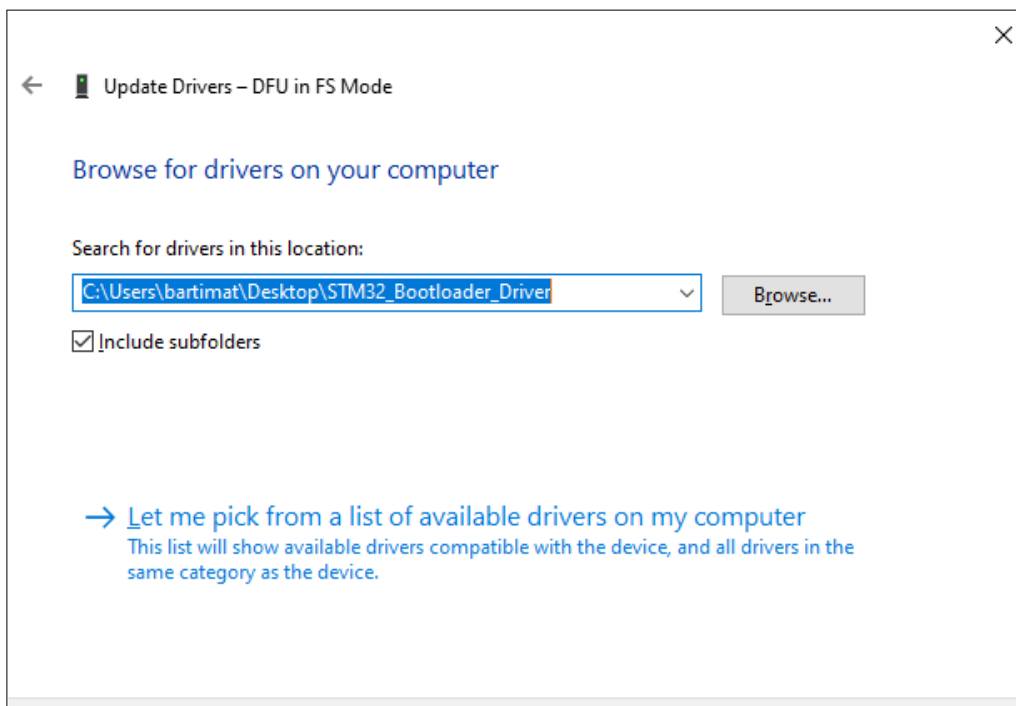


Figure 14: Locate the provided "STM32\_Bootloader\_Driver" directory.

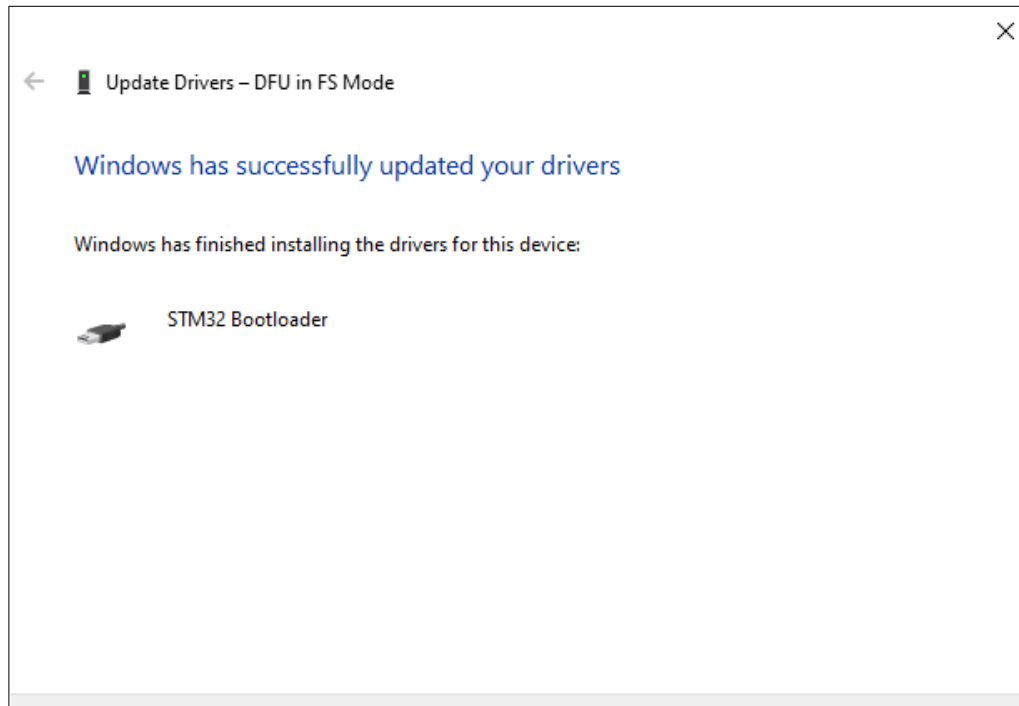


Figure 15: The STM32 Bootloader driver has been installed successfully.

### B.3 Uploading a Firmware via DFU Interface

To upload a firmware (provided as DFU file) to your ScreenLinq device, it is necessary to invoke the "Firmware update mode" (see Section B.1) first. Therefore, the second step is to execute **flash\_screenlinq\_fw\_v0.9.4\_beta.bat** simply by double-clicking on the batch file with a computer's mouse. The bat file will execute the *dfu-util* with the required parameters to flash the ScreenLinq device successfully (see Fig. 16 for an example run).



#### WARNING

Do not forget to deactivate ScreenLinq's "Firmware update mode" in the end by sliding "PRG" switch to **OFF** position and to power-off ScreenLinq device before using other ScreenLinq's operating modes (see Section 4.2).

```
C:\Windows\system32\cmd.exe
dfu-util 0.11

Copyright 2005-2009 Weston Schmidt, Harald Welte and OpenMoko Inc.
Copyright 2010-2021 Tormod Volden and Stefan Schmidt
This program is Free Software and has ABSOLUTELY NO WARRANTY
Please report bugs to http://sourceforge.net/p/dfu-util/tickets/

Match vendor ID from file: 0483
Match product ID from file: df11
Multiple alternate interfaces for DfuSe file
Opening DFU capable USB device...
Device ID 0483:df11
Device DFU version 011a
Claiming USB DFU Interface...
Setting Alternate Interface #2 ...
Determining device status...
DFU state(2) = dfuIDLE, status(0) = No error condition is present
DFU mode device DFU version 011a
Device returned transfer size 1024
DfuSe interface name: "Internal Flash"
DfuSe interface name: "Internal Flash"
DfuSe interface name: "Internal Flash"
File contains 1 DFU images
Parsing DFU image 1
Target name: STM32g0b1
Image for alternate setting 0, (1 elements, total size = 79688)
Setting Alternate Interface #0 ...
Parsing element 1, address = 0x08000000, size = 79680
Erase [=====] 100% 79680 bytes
Erase done.
Download [=====] 100% 79680 bytes
Download done.
Done parsing DfuSe file
Press any key to continue . . . _
```

Figure 16: An example of running the batch file successfully including the **dfu-util** command.

## Appendix C: E-EDID 1.3 structure of the generic (incorrect) display profile

```
0x00 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0x00 0x53 0x0E 0x49 0x09 0x01 0x00 0x00 0x00
0x1C 0x18 0x01 0x03 0x80 0x34 0x20 0x78 0x0A 0xEC 0x18 0xA3 0x54 0x46 0x98 0x25
0x0F 0x48 0x4C 0x00 0x00 0x00 0x01 0x01 0x01 0x01 0x01 0x01 0x01 0x01 0x01 0x01
0x01 0x01 0x01 0x01 0x01 0x01 0x01 0x1D 0x00 0x72 0x51 0xD0 0x1E 0x20 0x6E 0x50
0x55 0x00 0x00 0x20 0x21 0x00 0x00 0x18 0x00 0x00 0x00 0xFD 0x00 0x3B 0x3D 0x62
0x64 0x08 0x00 0x0A 0x20 0x20 0x20 0x20 0x20 0x20 0x00 0x00 0x00 0xFC 0x00 0x54
0x49 0x2D 0x44 0x53 0x39 0x30 0x55 0x78 0x39 0x34 0x39 0x0A 0x00 0x00 0x00 0x10
0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x01 0x57
0x02 0x03 0x15 0x40 0x41 0x84 0x23 0x09 0x7F 0x05 0x83 0x01 0x00 0x00 0x66 0x03
0x0C 0x00 0x10 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x28
```

Listing 2: E-EDID 1.3 structure of the generic (incorrect) display profile.

## Appendix D: Display Profile Template – E-EDID 1.4

```
0x00 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0x00 0x53 0x0E 0x49 0x09 0x01 0x00 0x00 0x00
0xFF 0x21 0x01 0x04 0xA2 0x34 0x20 0x78 0x0A 0xEC 0x18 0xA3 0x54 0x46 0x98 0x25
0x0F 0x48 0x4C 0x00 0x00 0x00 0x01 0x01 0x01 0x01 0x01 0x01 0x01 0x01 0x01 0x01
0x01 0x01 0x01 0x01 0x01 0x01 0x01 0x1D 0x00 0x72 0x51 0xD0 0x1E 0x20 0x6E 0x50
0x55 0x00 0x00 0x20 0x21 0x00 0x00 0x18 0x00 0x00 0x00 0xFC 0x00 0x53 0x41 0x5F
0x31 0x33 0x69 0x31 0x5F 0x48 0x78 0x78 0x0A 0x20 0x00 0x00 0x00 0xFE 0x00 0x52
0x45 0x56 0x30 0x30 0x31 0x0A 0x20 0x20 0x20 0x20 0x20 0x20 0x00 0x00 0x00 0x10
0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x01 0xA4
0x02 0x03 0x0C 0x40 0x23 0x09 0x57 0x05 0x83 0x01 0x00 0x00 0x00 0x00 0x00 0x00
0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0xA3
```

Listing 3: E-EDID 1.4 structure template in hexadecimal format.