

## **Introduction**

The mobile high-definition link, or MHL, is a widely used standard in mobile applications to get high-definition videos, TV and audio, power sinking and interactivity. It allows the excellent mobile connectivity through USB compatibility and is adopted by more than 200 manufacturers in different audio and video applications (home entertainment, gaming, productivity and automotive).

The high data rate used to transmit information implies the attention on the signal integrity and the exterior connectivity with potential ESD issues.

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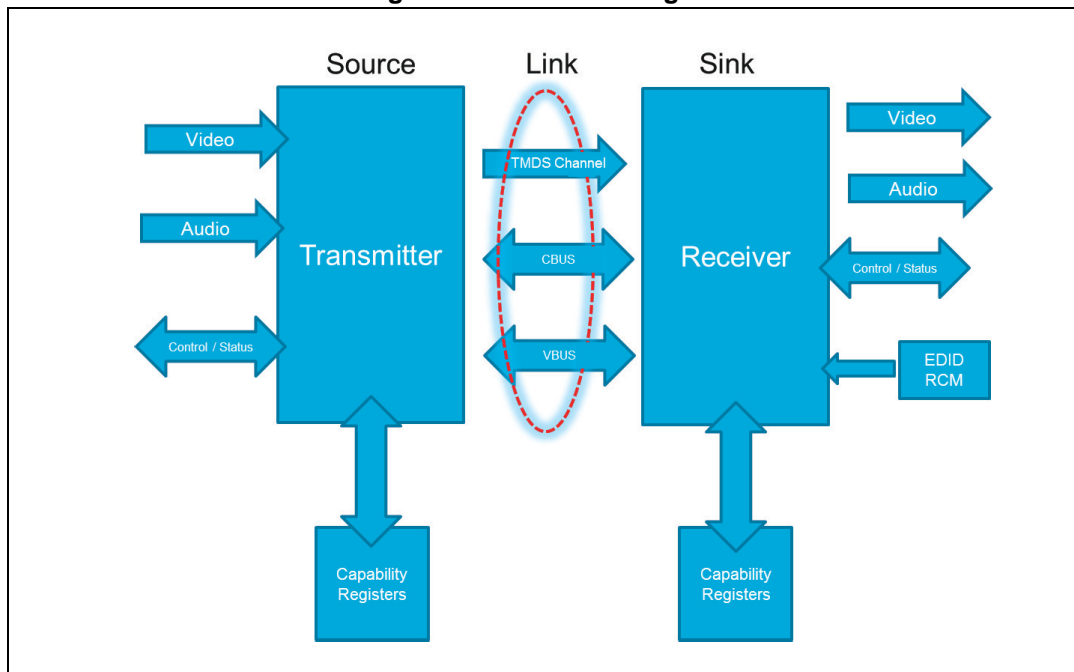
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# 1 MHL link

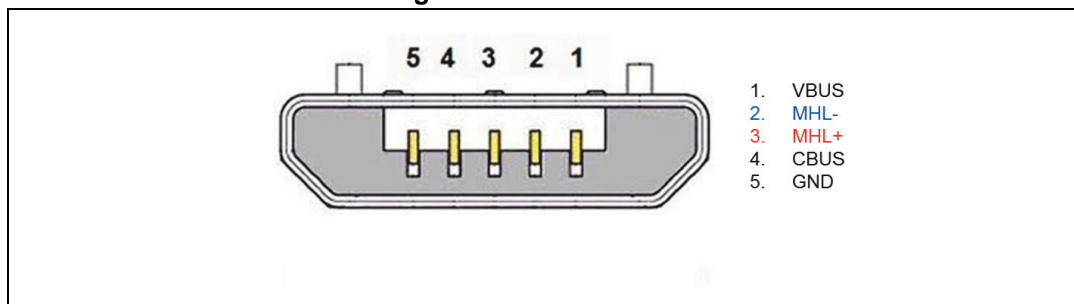
This link is based on a single high-speed differential pair (TMDS). It carries out a CBUS, a single wire control bus replacing DDC bus, and VBUS power supply ([Figure 1](#)).

**Figure 1. MHL block diagram**



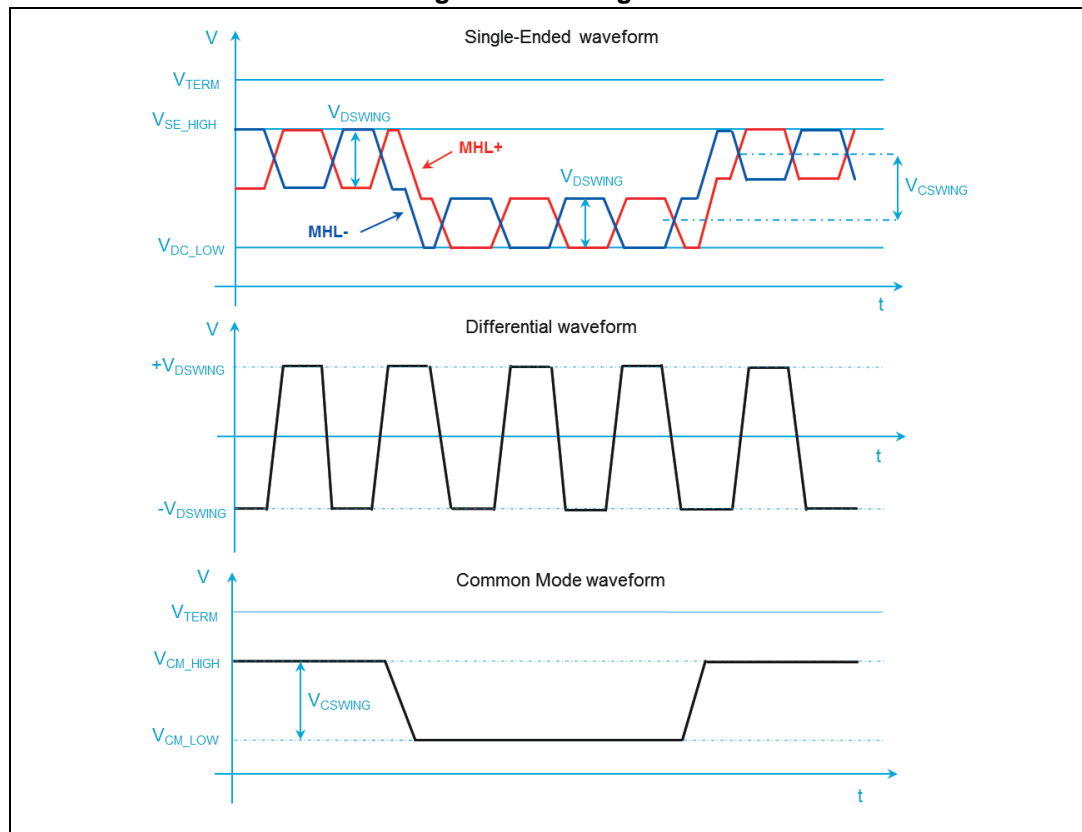
MHL 2.0 maximum data rate is 3 Gbps and goes up to 6 Gbps in the latest version (3.0). The clock is embedded in common mode up to 75 MHz for 1080 p/ 60 Hz video resolution. The connector is  $\mu$ USB standard ([Figure 2](#)).

**Figure 2. MHL connector**



[Figure 3](#) describes signals found on the link.

Figure 3. MHL signals



Due to the fast transition time, about 200 ps [from 20% to 80%], the risk of EMI is important and can give some issues in mobile applications such as antenna desense. In this case, common mode filters on the data lines are recommended. Furthermore, the common mode clock signal radiates.

Moreover, these lines are directly exposed via USB connector to exterior stresses, so they need to be protected.

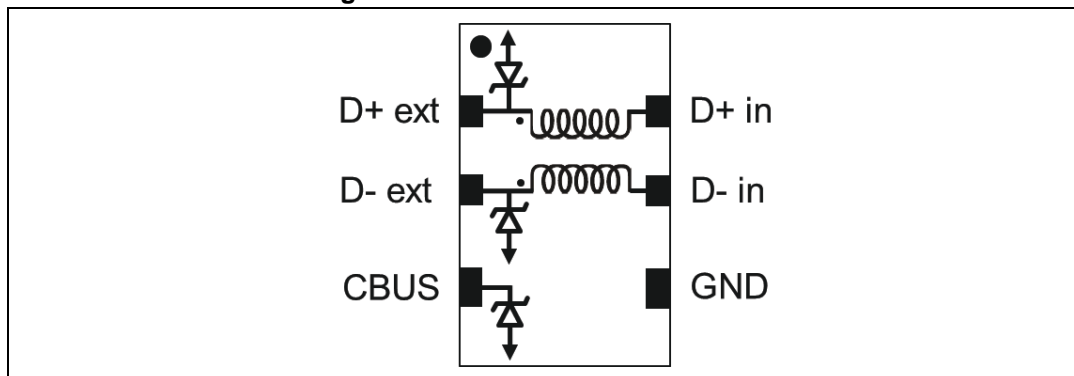
The filter has to be chosen by taking into account the above constraints:

- **Data rate and voltage levels:** they give the minimum differential bandwidth, which is compliant with the eye diagram template.
- **Clock:** in order to keep the integrity of this common mode signal, the filter has to get low attenuation at the clock signal frequency.
- **Rejection:** the common mode rejection has to be better than -15 dB in the targeted frequency range where the device can have some issues (about 900 MHz in mobile applications).
- **Protection:** the filter can include the voltage-clamp function to secure MHL transmitter, in fact the application complies with the IEC61000-4-2 standard.

## 2 Solutions offered by STMicroelectronics

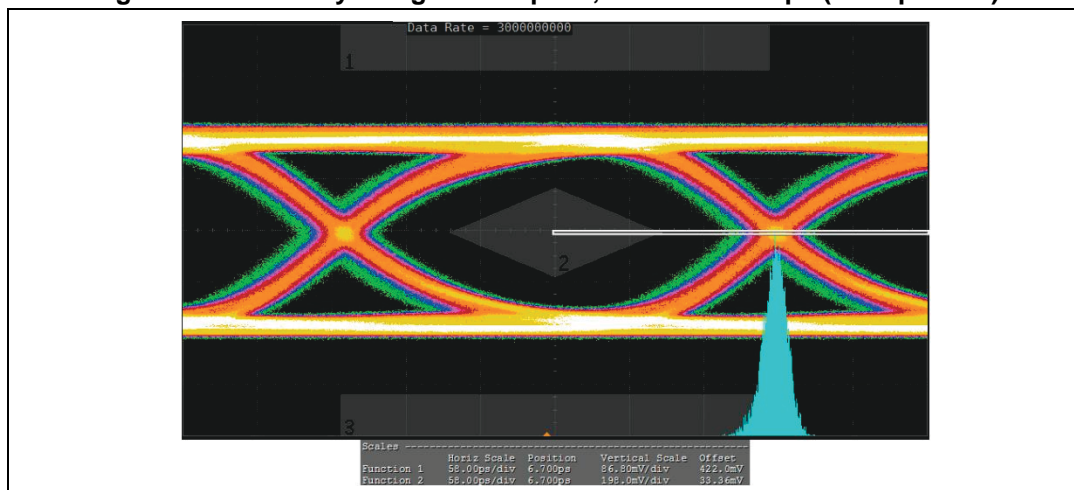
The ECMF02-3HSM6 is a common mode filter including ESD protection (see [Figure 4](#)).

Figure 4. ECMF02-3HSM6 schematic



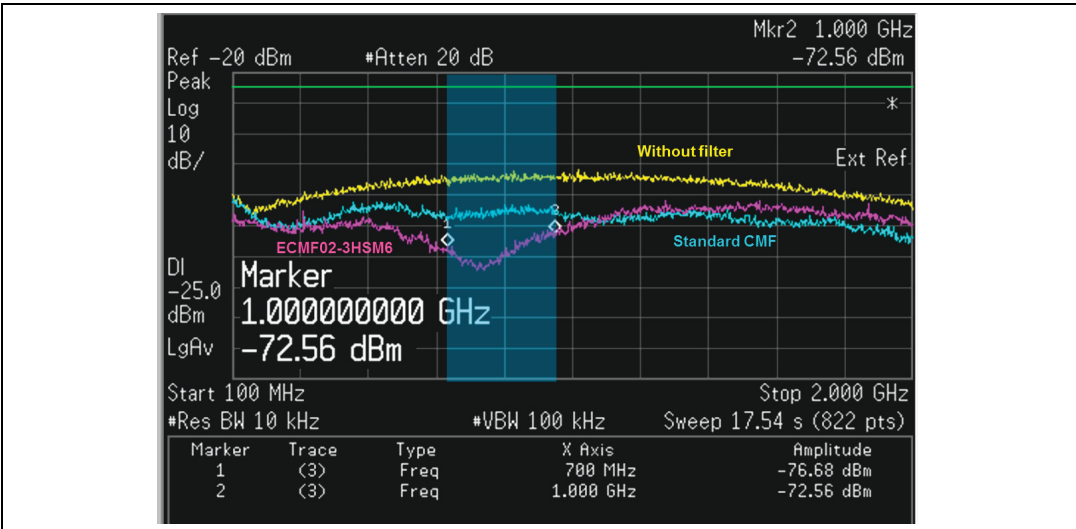
It complies with the MHL standard; its differential bandwidth fulfills the eye diagram template up to MHL 2.0. [Figure 5](#) shows an example at 3 Gbps.

Figure 5. MHL 2.0 eye diagram template, data rate 3 Gbps (1080 p/60 Hz)



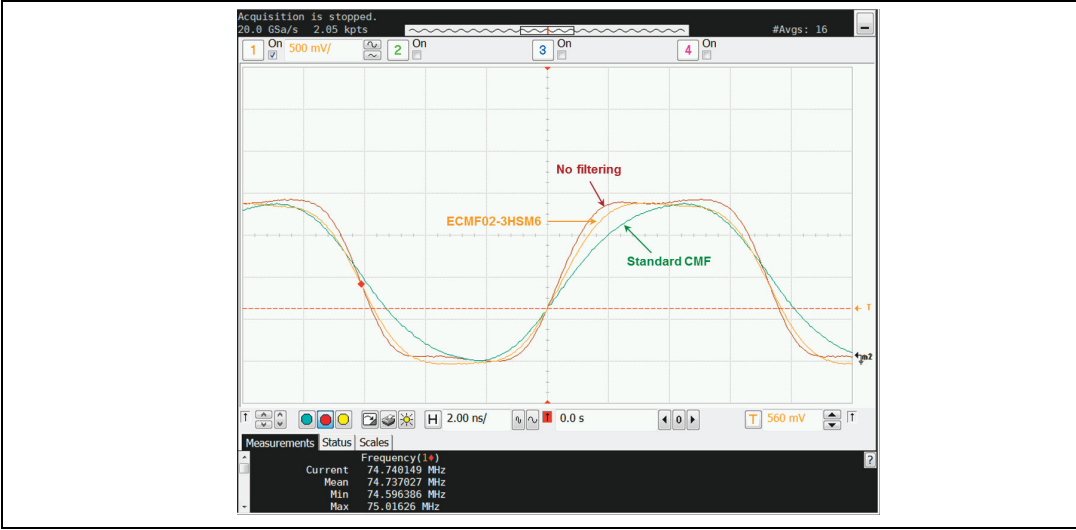
This device offers a good common mode rejection. [Figure 6](#) shows the spectral content comparison between the standard common mode filter and the ECMF02-3HSM6 without filtering. This device is placed on a differential link at 2.25 Gbps where the skew is present, due to different trace lengths. The difference on the noise level in the frequency range (700 MHz to 1 GHz) goes up to 15 dB, which is not negligible when the designer has some antenna desense issues in a mobile application.

**Figure 6. Noise level comparison without filter, with CMF standard and with ECMF02-3HSM6**



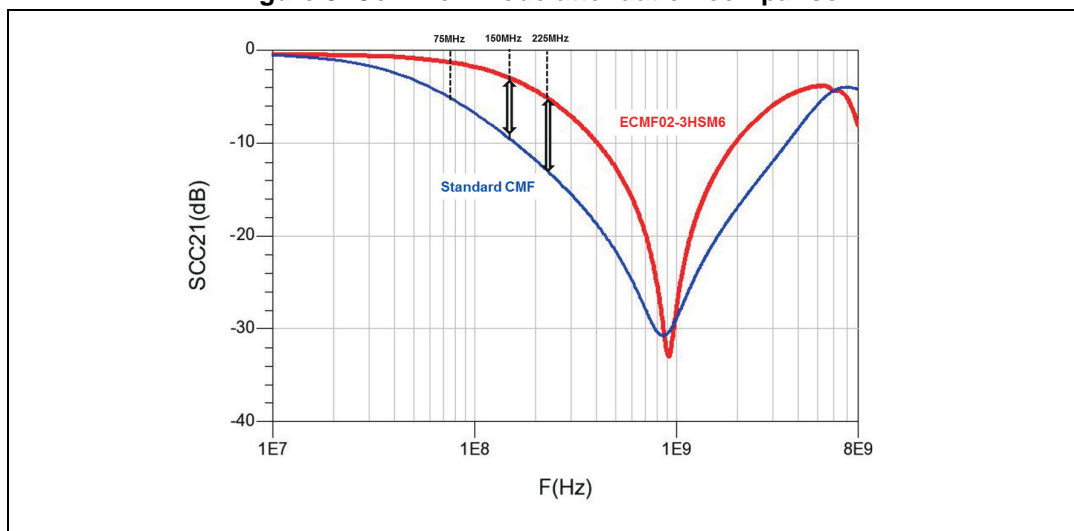
The filter has also a low common mode attenuation to keep the perfect integrity of the clock signal transmitted at 75 MHz. [Figure 7](#) shows the comparison on a 75 MHz signal without filtering (best case), with CMF standard and with the ECMF02-3HSM6. Rise and fall times are affected by the highest attenuation of CMF standard.

**Figure 7. 75 MHz signal rise and fall time comparison**



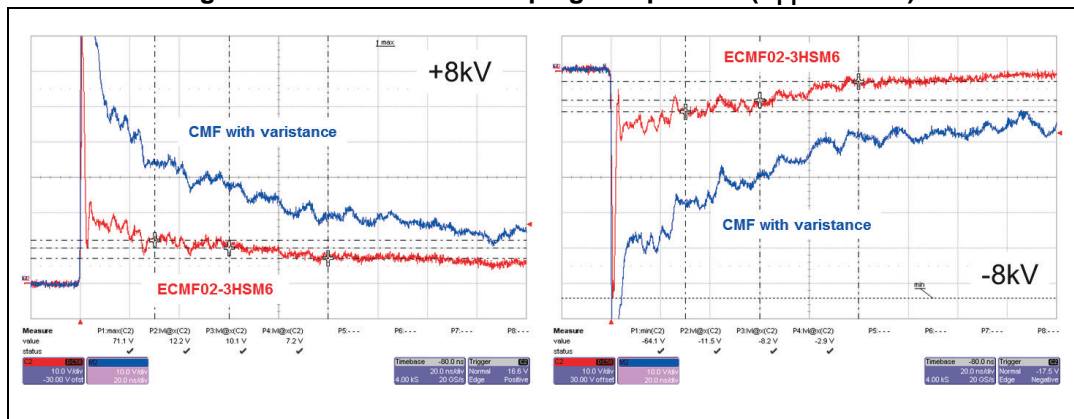
[Figure 8](#) compares the common mode attenuation and shows - 5 dB for CMF standard at 75 MHz, versus -1 dB for the ECMF02-3HSM6. At the 2<sup>nd</sup> and the 3<sup>rd</sup> harmonic of the clock frequency, the difference between the two devices goes up to 8 dB.

Figure 8. Common mode attenuation comparison



The attenuation in the GSM frequencies and the clock signal integrity are very difficult to get due to the technology with CMF standard. Indeed, the attenuation curve has to be translated into high frequencies, limiting the attenuation performance in the frequency range.

ESD protection on the data lines as well as on CBUS line is a benefit given by the ECMF02-3HSM6. Its sharp clamping allows the transmitter to be protected against various surges such as ESD strikes. Furthermore, clamping robustness is guaranteed for more than one thousand discharges. [Figure 9](#) shows the clamping response comparison between the ECMF02-3HSM6 and CMF including MOV devices at 8 kV in contact mode. Clamping levels are much better with the silicon solution. Moreover, the difference is more important when ESD strike level is lower.

Figure 9. IEC61000-4-2 clamping comparison ( $V_{PP} = \pm 8$  kV)

[Figure 10](#) shows responses at 1 kV.

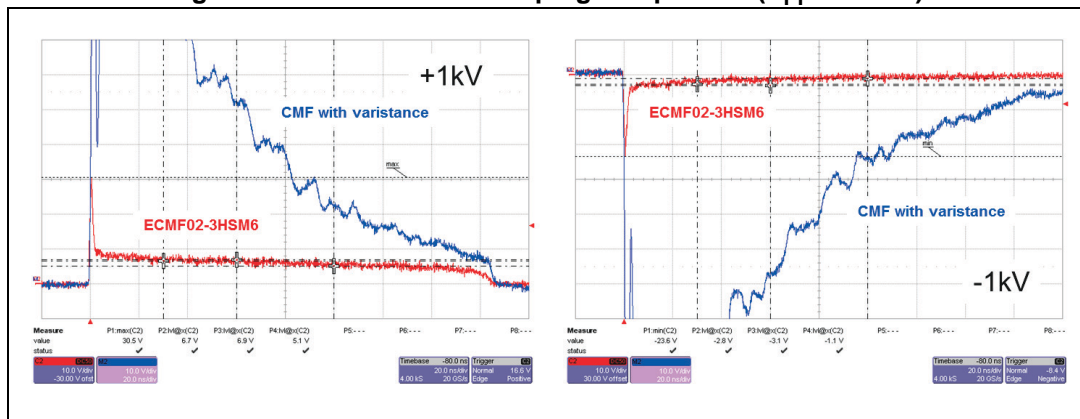
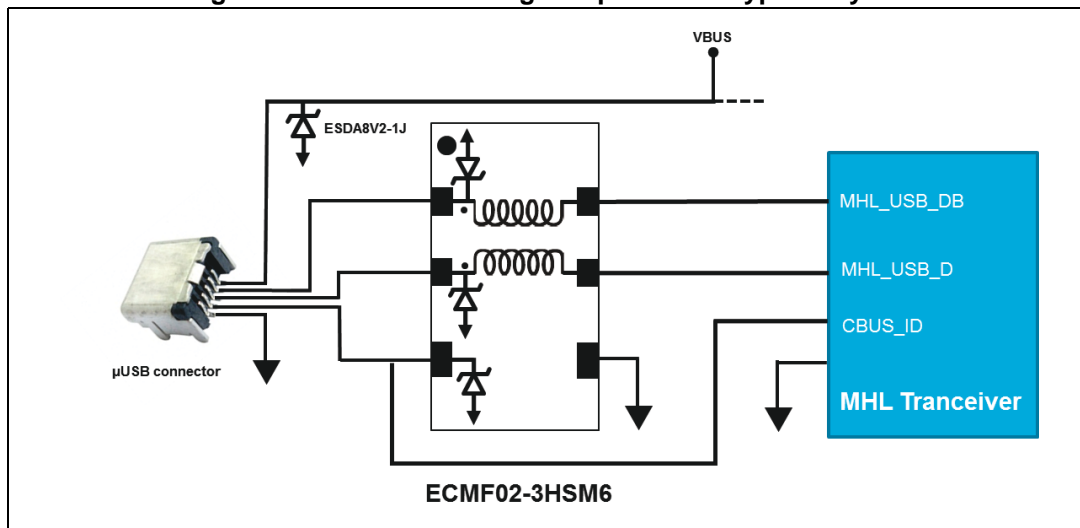
Figure 10. IEC61000-4-2 clamping comparison ( $V_{PP} = \pm 1$  kV)

Figure 11 shows a typical layout of the ECMF02-3HSM6. ESD protection has been added for VBUS.

Figure 11. MHL link filtering and protection typical layout



### 3 Conclusion

MHL link is very popular in mobile applications. It allows video, audio and data management to be on the same connector all together.

The used high data rates may induce EMI issues on Rx or other sensitive parts of the equipment. An adequate filter is mandatory to secure USB and MHL signal integrity. Furthermore, MHL connector can be exposed to ESD disturbances, therefore a reliable protection may help the equipment to be hardened.

STMicroelectronics has developed a dedicated common mode filter with integrated ESD protection to avoid these issues. The ECMF02-3HSM6 is compliant with MHL 2.0 standard and helps the designer to build a robust and reliable link.

## 4 Revision history

Table 1. Document revision history

Date	Revision	Changes
29-Jul-2014	1	Initial release.

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