

High data rate on FFC for SpaceWire & SpaceFibre

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Summary

- FFC introduction
- Transmission line on FFC
- High data rate FFC demonstrator : the media
- High data rate FFC demonstrator : the connectors
- High data rate FFC demonstrator : evaluations (mechanical & electrical)
- improvements
- Conclusion



Designed for **board-to-board interconnections** in electronic systems, Axojump[®] Flat Flexible Cables (FFC)

- Made up of flat tin or gold plated copper conductors
- Insulated with Polyester or Polyimide tapes.
- From 0.30 mm pitch to 1.25 mm
- Customized shapes for mechanical retention
- Compatible with ZIF and LIF connectors and hot bar
- For power application:
 - Better thermal dissipation (more exchange surface)
- For signal application:
 - Low skew (same propagation velocity)

0.50 MM PUNCHED FLAT FLEXIBLE CABLE

≻ High flex life and low bend radius



FFC introduction : The FFC machine



Figure 4. continuos reel to reel process . (photo copyright Axon)



Transmission line on FFC

The basement : the differential strip line

- Differential Zc depends mainly on :
 - Dielectric constant (e)
 - Dielectric thickness (h)
 - Conductors width (w)
- Why FFC is a good candidate ?
 - e very stable in the same plane
 - h very stable (lamination process)
 - *w* very accurate
 - Skin effect



$$Zd = \frac{120}{\sqrt{\varepsilon r}} \ln(\frac{1,9(2h+t)}{0,8w+t}) (1 - 0,347 \, e^{(-2,9\frac{d}{2h+t})})$$



High data rate FFC demonstrator : the media

FFC design is based on product ever manufatured for digital link on video TV set.

Adapted to fit on SpaceWire cable desing :

- AWG29 CuAg conductors
- 4 differential Stripline Zc_{diff} =100 Ω separated by GND conducteur
- 360° shielding
- ~1mm <u>solid dielectric</u>
- ~ 34g/m









High data rate FFC demonstrator : the media

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- The conductors striping is made inline
 could be perform by LASER too
- LASER stripping is performed on the shield at dedicated area to allow the bonding with the connector backshell.





High data rate FFC demonstrator : the connector

Heritage of MicroMach[®] design (ESCC3409 002) in flat shape:

- Same 100Ω cavities
- Twist pin contacts
- Guide pins
- Hardware
- Active ground planes of Male & Female are in contact together (not the case for μD)







High data rate FFC demonstrator : the connector



High data rate FFC demonstrator : the connector

Flex PCB Panel Mount

- Compact & flexible solution
- 4x 100Ω differential impedance with a full ground plane
- Compatible with Axon's **solderless** PCB connection (interposer)





Wired Panel Mount

- Easy to integrate
- Flexible
- Matched impedance







High data rate FFC demonstrator : mechanical evaluation

Evaluations performed on prototype:

- Vibration evaluation (ESCC3401§9.11 levels):
 - passed (with 1st interposer prototype) OK





High data rate FFC demonstrator : electrical evaluation

Differential characteristic impedance

- 1030hms diff.
- Ringing <2 Ohms diff
- Not affected by metallic parts (100% shielded)

Signal integrity on 2m length:

- Skew <5ps
- 3Gb/s NRZ (e.g. SpaceFibre)
- Pass CAT6A 10Gb/s ("TT" Ethernet)





High data rate FFC demonstrator : electrical evaluation

hard" folding : to test routings

- For cable routing in its environment : manual folds <5mm bent radius
- Zc<2 Ω mismatching







High data rate FFC demonstrator : electrical evaluation



Eye Pattern not affected by the 10 folds





SpaceFibre 6,25Gb/s on full 2m link : PASS







Shielding effectiveness performed by axon' & Airbus DS





Shielding Effectiveness results by axon'

- LowMass space wire cable on MicroMach ____
- FFC on flat MicroMach _____
- SpaceWire MD9 connectors_____







Shielding Effectiveness results by Airbus DS



Similar behaviour are observed for the classic cable shielding technology and for the FFC one.



- We have to improve :
 - Shield on more important lengths : *new production method is on going*
 - Maximum temperature limitation : production with HT° dielectric is on going (#80°C on prototype re-design goal 125-150°C)
 - Perform full thermal environment evaluation (thermal ageing & cycling)

- Addition of EMI clip on connector : *evaluation ever performed on MD* (*Dclick*)
- Design of dedicated fixations (FFC stacking, Fixation on fold)



- FFC for launchers with ArianeGroup:
 - On going activity ESA ITT Harness project number AO10119
 - collaboration with ArianeGroup & AirbusDS
 - Working on 2 layers Shielded FFC media
 - Power and LF signals (AWG18 &22)
 - Crimp/solder free connectors (based on ESCC3401/092, 93 & 94 : Dclick)
- Fast-lock interconnections and "connectorless" for FFC
 - on going activity ESA no. 1000031618)
 - Direct connexion on FFC tracks
 - For Power & LF signal



- Signal integrity on FFC exhibits improvement regarding twisted pairs:
 - mainly thanks to very low skew <5ps/m against <100ps/m (SpaceWire Low Mass Cable ESCC3902-004)
 - 2m link SpaceFibre passed electrical specification @6Gb/s
- Similar EMC behavior between flat and classic SpaceWire harness
- It demonstrates Flat Cable technology should be as appropriate as the classic cable technology.



THANKS FOR YOUR ATTENTION





