Features of FFCe clockspring cable

**Insulation**
- insulating material: standard: PBT
- also available: PET, PPS, PEN, ...
- insulation thickness: 50µm to 100µm
- color: standard (natural) or pigmented on demand

**Conductors**
- number of conductors: 2 to 16
- conductor material: bare copper according to DIN / EN 13602 (optionally Cu - ETP 1 or Cu - OF)
- strength and elongation:
  - soft copper: 210 N/mm² - 280 N/mm², elongation > 20%
  - hard copper: > 300 N/mm², elongation < 2.5%
- conductivity at rt: 58,0 m/Ω mm²
- edge:
  - natural round (milled conductors) or cut copper film
- dimensional range:
  - conductor width: from 0.4 mm to 11 mm
  - conductor thickness: from 0.035 mm to 0.200 mm

**Examples for cross sections:**

<table>
<thead>
<tr>
<th>width</th>
<th>thickness</th>
<th>cross section</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.60mm</td>
<td>0.035mm</td>
<td>0.021mm²</td>
</tr>
<tr>
<td>1.80mm</td>
<td>0.035mm</td>
<td>0.063mm²</td>
</tr>
<tr>
<td>10.00mm</td>
<td>0.035mm</td>
<td>0.350mm²</td>
</tr>
<tr>
<td>0.60mm</td>
<td>0.100mm</td>
<td>0.060mm²</td>
</tr>
<tr>
<td>0.95mm</td>
<td>0.120mm</td>
<td>0.144mm²</td>
</tr>
</tbody>
</table>
Benefits

- Flat design
- Weight savings potential
- Lower overall systems cost savings
- Only two material components (no adhesive, only copper and extrusion material)
- Less space required
- Matrix technology for optimized layout (multiple usage of individual conductors)
- Reduction of connectors (direct contacting of components)
- Predefined positions of connectors and housings (shortened assembly time)
- Advantage of keeping the wire harness on the dry side of the door between door inner panel and trim panel

Features of FFCe for door

<table>
<thead>
<tr>
<th>Insulation</th>
<th>Conductors</th>
</tr>
</thead>
<tbody>
<tr>
<td>insulating material:</td>
<td>number of conductors:</td>
</tr>
<tr>
<td>according to customer</td>
<td>2 to 32</td>
</tr>
<tr>
<td>requirements e.g. TPU, PVC,</td>
<td>conductor material:</td>
</tr>
<tr>
<td>PP, PBT, ...</td>
<td>bare copper according to</td>
</tr>
<tr>
<td>insulation thickness:</td>
<td>DIN / EN 13602 (optionally</td>
</tr>
<tr>
<td>50µm to 200µm</td>
<td>Cu-ETP 1 or Cu-OF)</td>
</tr>
<tr>
<td>color:</td>
<td>strength and elongation:</td>
</tr>
<tr>
<td>standard (natural) or</td>
<td>soft copper: 210 N/mm² -</td>
</tr>
<tr>
<td>pigmented on demand</td>
<td>280 N/mm², elongation &gt; 20%</td>
</tr>
<tr>
<td></td>
<td>hard copper: &gt; 300 N/mm²,</td>
</tr>
<tr>
<td></td>
<td>elongation &lt; 2,5%</td>
</tr>
<tr>
<td></td>
<td>conductivity at rt:</td>
</tr>
<tr>
<td></td>
<td>58,0 m/Ω mm²</td>
</tr>
<tr>
<td></td>
<td>edge:</td>
</tr>
<tr>
<td></td>
<td>natural round (milled</td>
</tr>
<tr>
<td></td>
<td>conductors) or cut copper</td>
</tr>
<tr>
<td></td>
<td>film</td>
</tr>
<tr>
<td>dimensional range:</td>
<td>conductor width: from 0,4</td>
</tr>
<tr>
<td></td>
<td>mm to 11 mm</td>
</tr>
<tr>
<td></td>
<td>conductor thickness: from 0,035 mm to 0,350 mm</td>
</tr>
</tbody>
</table>
The flexible extruded flat conductor (Flat Flex) is built of foil-like strips of copper of different width, which are electrically insulated through a thin unglued synthetic layer, assembled together into a strap.

The manufacturing of our Flat Flex is carried out on up-to-date production lines according to a specific extrusion process, that was developed by I&T. In contrast to laminated flat cables we do not use any adhesives for the production of our cables.

The new flexible manufacturing method allows to satisfy different customer needs. Different system concepts allow I&T to realize a wide range of products.

The main customer of I&T’s FFCe is the automotive industry. Headliners, doors and seats are proper for this new technology. But also the non-automotive industry shows more and more interest in our products.

**Insulating material:** according to customer requirements e.g.: TPU, PVC, PP, PBT, ...

**Color:**
- a) standard (natural or translucent)
- b) according to customer requirements (with color batch e.g.: black)

**Conductor material:**
- Requirement: DIN / EN 13602
- Abbreviation: Cu - ETP 1 oder Cu - OF
- Tensile strength: according to customer requirements ranging from soft to hard
- Conductivity if RT: 58,0 m/Ω mm²
- Surface: copper blank, tin-plated, silver-plated
- Edge layout: milled conductors, natural mill edge

**Dimensional range:**
- Width: from 0,4 mm to 19,32 mm
- Thickness: from 0,035 mm to 0,200 mm

**Manufacturing process:** extrusion

**Temperature range for standard product**

<table>
<thead>
<tr>
<th>Lower operating temperature</th>
<th>Higher operating temperature</th>
<th>Permanent usage temperature</th>
<th>Short-time temperature</th>
<th>Overload temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>-40 °C</td>
<td>+110 °C</td>
<td>-40 °C to +110 °C</td>
<td>+135 °C</td>
<td>+160 °C</td>
</tr>
</tbody>
</table>

Other operable temperature ranges with alternative materials possible
Advantages of Flat Flex:

• **client-specific**: two or more conductors possible; Cu-flat-wire as well as round-wire as conductor material possible; different insulation materials possible; imprinting of insulation possible;

• **cost-saving**: continuous extrusion process

• **weight-reducing**: whole cable thickness only 0.120mm

• **space-saving**

• **environment-friendly**: totally adhesive free

• **processing can be automated**

**Extract of qualification tests:**

- Flame resistance: Tested according to ISO/WD 6722
- Abrasion resistance: Tested according to ISO/WD 6722
- Dynamic flex-strain: Tested according to DIN 72551, part 5, chap.3.6.4
- Electric strength: Tested according to ISO/WD 6722
- Chemical resistance: Tested according to LV112
- 3000 hours long-time aging test

**sizes and tolerances for standard product qualified for automotive industry**

<table>
<thead>
<tr>
<th>Description</th>
<th>Sizes and Tolerances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cable width</td>
<td>(+/- 0.4 mm)</td>
</tr>
<tr>
<td>Conductor pitch (minimal allowed pitch)</td>
<td>(KB) 0.70 mm</td>
</tr>
<tr>
<td>Conductor width 1 (minimal allowed width)</td>
<td>(LA) 1.54 mm (+/- 0.05 mm)</td>
</tr>
<tr>
<td>Conductor width 2 (minimal allowed width)</td>
<td>LB min. 1.54 mm (+/- 0.05 mm)</td>
</tr>
<tr>
<td>Border size</td>
<td>LB max. 19.32 mm (+/- 0.05 mm)</td>
</tr>
<tr>
<td>Grid dimension</td>
<td>S 1.00 mm (+/- 0.10 mm)</td>
</tr>
<tr>
<td>Conductor thickness (min. thickness)</td>
<td>R 2.54 mm (+/- 0.15 mm)</td>
</tr>
<tr>
<td>Conductor thickness (max. thickness)</td>
<td>LD min. 0.10 mm (+/- 0.005 mm)</td>
</tr>
<tr>
<td>Conductor thickness (max. thickness)</td>
<td>LD max. 0.20 mm (+/- 0.005 mm)</td>
</tr>
<tr>
<td>Convolution radius (min. allowed convolution)</td>
<td>milled free of burs</td>
</tr>
<tr>
<td>Convolution angle (min. allowed angle)</td>
<td>r 0.2 mm</td>
</tr>
<tr>
<td>Insulation thickness (onesided)</td>
<td>a 45 Grad (+/- 5 Grad)</td>
</tr>
<tr>
<td>Cable thickness total per conductor thickness</td>
<td>ID 0.175 mm (+/- 0.02 mm)</td>
</tr>
<tr>
<td>Conductor surface</td>
<td>KD 0.55 mm 0.45 mm (+/- 0.05 mm)</td>
</tr>
</tbody>
</table>

**FLAT FLEXIBLE CABLE extruded**

**Advantages of Flat Flex**:

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- 3000 hours long-time aging test
**Benefits**
- Flat design
- Weight savings potential
- Lower overall systems cost savings
- Only two material components (no adhesive, only copper and extrusion material)
- Less space required
- Matrix technology for optimized layout (multiple usage of individual conductors)
- Reduction of connectors (direct contacting of components)
- Capability of automated assembly onto the headliner
- Different alternatives to mount the wire harness onto the headliner (hot-melt adhesive, adhesive tape, clips, hook and loop fastener)
- Predefined positions of connectors and housings (shortened assembly time)

**Features of FFCe for headliner**

**Insulation**
- **insulating material:** according to customer requirements e.g. TPU, PVC, PP, PBT, ...
- **insulation thickness:** 50µm to 200µm
- **color:** standard (natural) or pigmented on demand

**Conductors**
- **number of conductors:** 2 to 32
- **conductor material:** bare copper according to DIN / EN 13602 (optionally Cu - ETP 1 or Cu - OF)
- **strength and elongation:**
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- **conductivity at rt:** 58,0 mΩ mm²
- **edge:** natural round (milled conductors) or cutted copper film
- **dimensional range:**
  - conductor width: from 0,4 mm to 11 mm
  - conductor thickness: from 0,035 mm to 0,350 mm
Features of FFCe for seat

Insulation
- insulating material: according to customer requirements e.g. TPU, PVC, PP, PBT, ...
- insulation thickness: 50µm to 200µm
- color: standard (natural) or pigmented on demand

Conductors
- number of conductors: 2 to 32
- conductor material: bare copper according to DIN / EN 13602 (optionally Cu - ETP 1 or Cu - OF)
- strength and elongation: soft copper: 210 N/mm² - 280 N/mm², elongation > 20%
  hard copper: > 300 N/mm², elongation < 2,5%
- conductivity at rt: 58,0 m/Ω mm²
- edge: natural round (milled conductors) or cutted copper film
- dimensional range: conductor width: from 0,4 mm to 11 mm
  conductor thickness: from 0,035 mm to 0,350 mm

Benefits
- Flat design
- Fewer space required
- Weight savings potential
- Matrix technology for optimized layout (multiple usage of individual conductors)
- Reduction of connectors (direct contacting of components)
- Integration of electrical and mechanical components, e.g. seat position sensors (adding value to the wire harness)
- Manufacturing advantage through reduction of assembly time (felt mat as module carrier)
- Price advantage through high automated harness production (combined with assembling advantage)
- Lower overall systems cost savings