FPC Technical Guide

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FPC quick delivery course

Characteristic

Single sided FPC  • This product is the highly economical FPC that utilizes the characteristics of FPC at a maximum for standard configuration.

Double sided FPC  • More complex wiring is available than single sided FPC.

Multi-layer FPC  • As the harness part can be folded or inflected, three-dimensional allocation in chassis and use for operation part are available.

Standard materials

・ **Base material** [polyimide] : 12.5μ m～50μ m
・ **Copper foil** : 9μ m～35μ m (Electrolytic or Rolled)
・ **Cover material** : Coverlay, Solder resist
・ **Surface finishing** : Electrolytic gold plating, Electroless gold plating, Solder plating etc

Example of use application

<table>
<thead>
<tr>
<th>Single sided FPC</th>
<th>Double sided FPC</th>
<th>Multi-layer FPC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply of data / document by FHX</td>
<td>Supply of data / document by FHX</td>
<td>Supply of data / document by FHX</td>
</tr>
<tr>
<td>0m day</td>
<td>1m day</td>
<td>4m day</td>
</tr>
<tr>
<td>0.5m day</td>
<td>2m day</td>
<td>6m day</td>
</tr>
<tr>
<td>1m day</td>
<td>3m day</td>
<td>5m day</td>
</tr>
</tbody>
</table>

* The delivery date of pre-punch specification is same as that of bolt-side FPC.

How to estimate and payment

Payment by “PayPal” is possible.
Request a quote from the following URL.
http://www.yamashita-net.co.jp/en/contact/estimate_yfc.html

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Yamashita Materials Corporation  Circuitec Company  Sales Department
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YFC Cable
(Yamashita Flexible Circuit Cable)

Characteristic

- The response by small lot is enabled by our FPC production know-how.
- Even the FPC can be responded without drawing with high flexibility, the product is good for repeated bending.
- The product with requested length, number of cores and terminal pitch can be produced without initial cost.
- This product is superior in corrosion resistance and contact stability.
- Correspond to the 1.0mm pitch, 0.5mm pitch, and 0.3mm pitch (zigzag connection).
- The gold plating specification can support lead-free product.

Standard layer configuration

- Thickness of coverlay (Polyimide / adhesive) : 25µm/25µm
- Thickness of copper foil : 18µm or 35µm
- Thickness of base polyimide : 25µm
- Thickness of adhesive of stiffening plate : 40µm
- Polyimide stiffening plate : 75µm or 180µm and more.

Example of use application

0.3mm pitch terminal area standard pattern size (mm)

How to estimate and payment

Payment by “PayPal” is possible.
Request a quote from the following URL.
http://www.yamashita-net.co.jp/en/contact/estimate_yfc.html
Characteristics of each type/layer structure

【Under development: PTFE-based and Low dielectric cover-layer】
- PTFE-based FPC of 100μm thickness
- Insulation cover with low dielectric cover-layer
- This is Structure of most low-loss

<table>
<thead>
<tr>
<th>Thickness [μm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 Polyimide</td>
</tr>
<tr>
<td>25 Low dielectric adhesive</td>
</tr>
<tr>
<td>RF line 28 Conductor</td>
</tr>
<tr>
<td>100 Poly tetra fluoro ethylene</td>
</tr>
<tr>
<td>GND 28 Conductor</td>
</tr>
<tr>
<td>25 Low dielectric adhesive</td>
</tr>
<tr>
<td>12 Polyimide</td>
</tr>
</tbody>
</table>

【LCP-based and Low dielectric cover-layer】
- LCP-based FPC of 50μm thickness
- Insulation cover with low dielectric cover-layer
- This low-loss FPC is possible mass production

<table>
<thead>
<tr>
<th>Thickness [μm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 Polyimide</td>
</tr>
<tr>
<td>25 Low dielectric adhesive</td>
</tr>
<tr>
<td>RF line 28 Conductor</td>
</tr>
<tr>
<td>50 Liquid crystal polymer</td>
</tr>
<tr>
<td>GND 28 Conductor</td>
</tr>
<tr>
<td>25 Low dielectric adhesive</td>
</tr>
<tr>
<td>12 Polyimide</td>
</tr>
</tbody>
</table>

【LCP-based and General cover-layer】
- LCP-based FPC of 50μm thickness
- Bending resistance and heat resistance is excellent in the range of LCP-based

<table>
<thead>
<tr>
<th>Thickness [μm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 Polyimide</td>
</tr>
<tr>
<td>25 Adhesive</td>
</tr>
<tr>
<td>RF line 28 Conductor</td>
</tr>
<tr>
<td>50 Liquid crystal polymer</td>
</tr>
<tr>
<td>GND 28 Conductor</td>
</tr>
<tr>
<td>25 Adhesive</td>
</tr>
<tr>
<td>12 Polyimide</td>
</tr>
</tbody>
</table>

S21 measurement results

Note, Data are measured values, it is not a guaranteed value

In development: PTFE-based and Low dielectric cover-layer
LCP-based and Low dielectric cover-layer
LCP-based and General cover-layer
Reference: PI-based and General cover-layer

【Evaluation sample specification】
Impedance: single 50 ohm
Signal length: 100mm
Measurement probe: GSG250μm pitch
Features of the product

- It is possible to perform characteristic impedance with the high-precision pattern formation technology.
- Low dielectric material is used for the insulating layer, and low-roughness foil is used for the conductor, and it is possible to manufacture FPC suitable for high-speed transmission.
- Since it is a stripline structure with countermeasure for shielding, the role as an alternative to a coaxial cable may be expected.
- By using LCP for insulation and the adhesive layer, changes in the transmission loss by moisture absorption can be controlled.
- By using 100μm-thick LCP as the base material, it becomes possible to set a wide range of characteristic impedance.

Schematic diagram of layers and the result of TDR measurement

Comparison and evaluation of the transmission loss in the normal state and after moisture absorption treatment

**S11 (reflection) measurement result**

**S21 (loss) measurement result**
Features of the product

- Since LCP, which has a lower dielectric property than polyimide, also has a low dielectric dissipation factor, signals hardly damp even in a long circuit, and it is possible to transfer signals precisely.
- All LCP substrates also have excellent long-term heat resistance and comply with MOT of UL Standards (796F).

Test method: Check the state after a 240-hour degradation test at 230°C by winding around a pin gage whose diameter is 6.275mm 5 times.

Examples of product layer configuration

<table>
<thead>
<tr>
<th>Test item</th>
<th>Processing conditions</th>
<th>LCP50μm, Cu18μ</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative dielectric constant</td>
<td>2GHz 10GHz</td>
<td>3.0 3.0</td>
<td>-</td>
</tr>
<tr>
<td>Dielectric dissipation factor</td>
<td>2GHz 10GHz</td>
<td>0.0008 0.0016</td>
<td>-</td>
</tr>
<tr>
<td>Water absorption</td>
<td>Immersion at 25°C for 50h</td>
<td>0.04 0.05</td>
<td>%</td>
</tr>
<tr>
<td>Dimensional stability</td>
<td>After etching</td>
<td>MD TD</td>
<td>%</td>
</tr>
</tbody>
</table>
Conduction noise controlling FPC

Features of the product

- This is an FPC which incorporates a noise controlling film "SPINPEDA®" manufactured by Shin-Etsu Polymer Co., Ltd. into the cover layer.
- It is effective for reducing crosstalk between wirings such as the power source and signals.
- It is effective in a wide range of high-frequency band, and utilization as an alternative to a bypass capacitor.

Examples of the purposes of use

- Cable for hi-speed communication

Crosstalk evaluation

Port allocation

Layer configuration

S41 result of far end crosstalk

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Characteristics of product

- The characteristic impedance control is enabled by high-accuracy pattern forming technology.
- The reflection of electric signal in a pattern is prevented and the high-speed transmission circuit can be also supported by interfacing the characteristic impedance.

Actual performance

<table>
<thead>
<tr>
<th></th>
<th>Microstrip line</th>
<th>Coplanar waveguide</th>
<th>Strip line</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single end</td>
<td>25, 50, 75 Ω</td>
<td>50 Ω</td>
<td>50 Ω</td>
</tr>
<tr>
<td>Differential</td>
<td>100 Ω</td>
<td>100 Ω</td>
<td>100 Ω</td>
</tr>
<tr>
<td>Tolerance</td>
<td>±10 %</td>
<td>±10 %</td>
<td>±10 %</td>
</tr>
</tbody>
</table>

Example of use application

- Optical communication module
- LVDS communication cable
- Hard disk inspection device

Used materials

- Polyimide (PI)
- Liquid crystal polymer (LCP)

Measurement of characteristic impedance

- The characteristic impedance can be measured by creating a test coupon in a work piece.

Measurement of characteristic impedance

Measurement frequency [GHz]

Transmission loss [dB]

[ Microstrip line : Single]

[ Coplanar waveguide : Differential ]

[ Strip line : Single ]

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Yamashita Materials Corporation. Circuitec Company Sales Department
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Characteristics of product

- Increase flexibility by mesh the GND of the microstrip line.

Actual performance

<table>
<thead>
<tr>
<th>Microstrip line</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Single end</td>
<td>50, 75 Ω</td>
</tr>
<tr>
<td>Differential</td>
<td>100 Ω</td>
</tr>
<tr>
<td>Tolerance</td>
<td>±10 %</td>
</tr>
</tbody>
</table>

Spring-back measurement

- Mesh size is 0.1mm × 0.1mm.
- Measuring the repulsive force in a state such as that in FIG.

<table>
<thead>
<tr>
<th>Result</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>GND : Mesh</td>
<td>22 g</td>
</tr>
<tr>
<td>GND : Solid</td>
<td>54 g</td>
</tr>
</tbody>
</table>

Comparison of transmission loss S21

* This data is a measured value, it is not a guaranteed value.

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Flexible high heat dissipation FPC

Features of the product

- FPC uses "ECOOL-F", a thick copper foil flexible copper-clad epoxy laminate manufactured by Panasonic.
- With the copper foil and the polyimide film, it has heat dissipation equivalent of metal substrate (1.0t).
- Bent formation is possible like normal flexible substrate.
- 3 types of copper foil thicknesses, 75μm, 105μm and 150μm are available.

Heat dissipating characteristics

- JPCA-TMC-LED02T 10.6.1 "plane-direction thermal resistance measurement method"
- In the state the sample is contained in the container for measurement hanged from the top plate, after turning out the LED, apply DC voltage 9.2±0.5V, and turn on the LED. When the temperature of the thermocouple is stabilized, the measurement is finished.

Examples of product layer configuration

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cover lay polyimide</td>
<td>12.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cover lay adhesive layer</td>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copper foil</td>
<td>35</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polyimide base</td>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copper foil</td>
<td>75</td>
<td>105</td>
<td>150</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Layer thickness</td>
<td>172.5</td>
<td>202.5</td>
<td>247.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Measurement sample
Features of the product

- This is an FPC which uses white heatproof resist ink, which realizes high optical reflectance and heat resistance.
- As an FPC, it has excellent flexibility and resistance to bending.
- It is possible to apply to high-definition resist apertures suitable for mounting on component.

Heat resistance test

Bending heating

<table>
<thead>
<tr>
<th>Pressurization</th>
<th>Continuous heating in bent state</th>
<th>temperature:150℃ × 1000Hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resist 20μm</td>
<td>FPC (PI/Cu:25/18μm)</td>
<td>spacer</td>
</tr>
</tbody>
</table>

Curvature radius (R=0.3)

<table>
<thead>
<tr>
<th>initial state</th>
<th>After heating (150℃ × 1000Hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No crack</td>
<td>No crack</td>
</tr>
</tbody>
</table>

Thermal discoloration

Heating temperature:125℃

<table>
<thead>
<tr>
<th>initial</th>
<th>250Hr</th>
<th>500Hr</th>
<th>750Hr</th>
<th>1000Hr</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heat dissipation test by radiation

<table>
<thead>
<tr>
<th>Normal FPC</th>
<th>Heat radiation FPC</th>
<th>Heat conduction + Heat radiation FPC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper</td>
<td>Copper</td>
<td>Copper</td>
</tr>
<tr>
<td>Resist</td>
<td>Resist</td>
<td>Resist</td>
</tr>
<tr>
<td>Base(Pi)</td>
<td>Base(Pi)</td>
<td>Base(Pi)</td>
</tr>
</tbody>
</table>

87.8℃

Temperature difference between the normal FPC

83.6℃

Adding the heat radiation

52.4℃

Adding the heat radiation element by the copper foil

Temperature difference

87.8℃ - 4.2℃

83.6℃ - 35.4℃

Evaluation conditions

- Measuring instrument: KONICA MINOLTA CM-3600d
- Method: SCI
- Thickness: 20μm
- Base material: Glass
Company name: Yamashita Materials Corporation

Head quarters: 3-5-13, Minami Shinagawa, Shinagawa-ku, Tokyo, 140-0004, Japan

President: Hiroki Yamashita

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Establishment: June 15, 1965

Capital fund: 250 million yen

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