Five Year Projections of the Global Flexible Circuit Market

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Summary
A new market research process has been developed to estimate the global market size of all kinds of flexible circuits for the next five years. Conventional flex circuits and advanced flex circuits are studied individually and reported on separately. All of the major business segments that currently use flex and those applications in the future that will require flex circuits were examined as the means of interconnect due to packaging constraints, weight considerations, cost goals or density requirements. A series of interviews with the manufacturers of the end products and tear down analyses of current products have been conducted to ascertain the design trends of the flexible circuits for the future. Layer construction, circuit density, size, dielectric materials and further treatments were reviewed for each piece of flexible circuit in the electronic products. Based on the projection numbers of the electronic products, the flexible circuit demands have been estimated for the next five years and are available by applications, constructions, base materials, circuit densities and more.

All of the applications are categorized into eight different segments, which cover the vast majority of the flex circuits produced, to estimate the size of the global flexible circuit market. Each segment is broken down into the sub-units that uses flex. Each sub-unit summarizes the volume of flex used in square meters and the revenues they are expected to generate. Further identified are the number of conductive layers and the level of density it incorporates. Additionally, the current interconnect technology utilized is included as well as the direction future products will trend. The flex circuit analyses also include base materials, various cover layers and constructions such as polyimide, polyester, TAB, thick film conductors and more.

Introduction
The global market of flexible circuits have been growing rapidly in the last decade based on the remarkable growth of consumer electronics and extreme miniaturizations of the portable products such as cellular phones and digital cameras. On the other hand, both manufacturers and customers of the flexible circuits have experienced serious imbalances between demands and supply in the last years.

This dictates that accurate forecasts are required in the market. Unfortunately, most available estimation processes for global projections have been made by interviewing the vendors, and the numbers have not been very accurate. Usually the projections are provided by revenue because the numbers come from the business plans of the flex manufacturers. Very frequently, the revenues of the flex manufacturers include not only bare flexible circuits, but also components and assembling costs, causing the average unit prices to be considerably higher than bare flex circuits.

Most of the available published market research reports estimate the global flexible circuits market and its projection by revenue as it is most difficult to estimate the market size of the flex circuits in volume terms. The data is complicated as major flex manufacturers have many overseas productions; and it is difficult to eliminate the double counting of the numbers. Further complicating the data interpretation is that flex circuits have a wide price range and it is often very difficult to estimate the volume.

A new market research process has been developed to estimate the global market size of all kinds of flexible circuits by volume and revenue over the next five years.

Methodology to Estimate the Global Flex Market Size
The new market estimation process starts from the end product side. Firstly, five projections are made for each electronic product such as cellular phones or personal computers. The design trend of the electronic product is also studied to understand the wiring and packaging trends. Many tear down analyses have been conducted to confirm the wiring technology and design trend of the wiring and packaging with the flexible circuits in the electronic products. Each flexible circuit is categorized by layer construction, materials, circuit density, circuit sizes, etc. The five year demands of the flexible circuits for each part can be estimated from the size of the circuit and projection of the application. Finally, the total volume of the flexible circuits for the application is calculated by summing the volume of the circuit parts. The price information was collected for all kinds of flexible circuits to have the 5 year projection by revenue. Price down rates in the market was introduced for the correction of the total revenue.

Example of the projection (e.g., cellular phones)
Fig. 1 summarizes the global projection for the total cellular phone market through 2010. Cellular phones made a remarkable growth in the last decade globally. A further growth is estimated in the next five years. The design trends of the cellular phones are more functions in thinner and lighter bodies. The majority of the cellular phones will be clam shell type or slide type with camera modules. The new designs will consume more flexible circuits. On the other hand, the cellular phone manufacturers are requesting flexible circuit manufacturers for simpler circuit constructions to reduce the costs.

![Fig. 1 Global Projection of Cellular Phones (DKN Research)](image)

Figure 2 - shows an example of the tear down analysis of the clam-shell type cellular phones. Several differences of the design policies can be observed between the models. Six to ten flexible circuits are used in one clam shell type cellular phone. There are many kinds of flexible circuits depending on the purpose of the wiring. Majority of the flexible circuits are single sided and double sided. Multi-layer rigid/flex construction is used for the display modules and camera modules. Sometimes, camera modules or hinge cables are connected to the main multilayer rigid/flex designed for display modules to eliminate connectors. However, the cellular phone manufacturers have been minimizing the usages of the multi-layer rigid/flex to reduce the wiring cost. They use more single and double side flexible circuits with connectors instead.

![Figure 2 - Tear down of clam shell type cellular phones](image)
The packaging technology of the driver ICs has been moving from COF to COG, and the flexible substrates have been moving from fine line single-sided boards with ACF connections to double-sided circuits with flip chip connections for power controller ICs accordingly. There have been several varieties with the design of the layer constructions of the flexible hinge cables according to the design policies of the cellular phone manufacturers. The hinge cables have to be capable for both high flexibility and shielding. The cellular phones consume more flexible circuits for general wiring because of the limited spaces.

The projection of the flexible circuits by volume for each wiring module is calculated by multiplying the number of the end products to the size of the flexible circuit of the module. Fig. 3 summarizes the flexible circuit projection of the cellular phone market from 2004 to a projected 2010 by volume. The total consumption of the flexible circuit for the cellular phones will increase the market share of the whole industry in the next five years.

2006 Global Projection for Flexible Circuits

All electronic products are categorized in to the following eight end-use market areas. Detailed analysis and flex projections were made for each product.

1. Personal computers (e.g., Desk tops, laptops, etc.)
2. PC Peripherals (e.g., Disc drives, PDAs, printers, etc.)
3. Cellular phones
4. Audio & Video (e.g., Flat TV, MP3, DSC, VCR, DVD, etc.)
5. IC substrates
6. Medical devices (e.g., Ultra-sound probe, monitors, disposal sensors, etc.)
7. Automobile (e.g., Power trains, navigators, etc.)
8. Industrial & Avionics

The flexible circuits have been categorized by layer constructions, circuit densities, base materials, coverlay types, sizes, etc.

The entire projection data covers:
- All flexible circuits including TAB and COF substrates.
- Copper and the other metal & alloy circuits
- Thick film circuits made by screen-printing of conductive pastes.
- This data does not include the substrates of IC cards and RFID tags to avoid confusion as these applications have extremely low prices and large volumes.

5 Year Projections of Many Kinds of Flexible Circuits
The market projections of all kinds of flexible circuits by volume are summarized in Fig. 4. The total revenue of the projection is illustrated in Fig. 5.

The following market trends have been observed through the numerical analysis.

- 32.7 million square meters of flexible circuits have been produced in 2005.
- 59.1 million square meters of flexible circuits will be produced in 2010.
- The global market will have 12.6% growth rate per year.
- The global revenue of the flex PWB market was estimated over 8 billion US dollars in 2005.
- It will grow to over 14 billion US dollar in 2010.
- Polyimide film is today and will remain the major dielectric flex material as the base layer and cover layer for the flexible circuits. Polyester films will maintain the second position.
- Film base coverlay will keep the major share with the traditional flexible circuits.
- Photoimageable coverlay will grow significantly, especially with the high density flexible circuits.
- Those other materials (e.g., LCP and PEN) will have only a relatively small share in the market in the next 5 years.
- Adhesiveless polyimide laminate will have higher growth rates than traditional adhesive based laminates.
- Personal computers and peripherals represent the largest share of the global flexible circuit market by volume. But, their growth rates are relatively low.
- Cellular phones have the largest share by revenue because of the higher unit prices.
- Cellular phones will maintain higher growth rates than the PC markets.
- The audio/video applications will be the third largest category for the flex circuits. Portable products and flat panel displays will continue to consume large volumes of flexible circuits.
- Automobile, industrial application and aerospace will keep current market share with stable growth rates.

More Projections

![Fig. 6 Global Projection of Flexible Copper Laminates (DKN Research)](image)

Projections can be customized by modifying the original data base of the flexible circuits which includes broad information. Fig. 6 is an example. It summarizes the global volume projection of the base copper/dielectric laminates. The total market demand of the adhesiveless copper laminates by volume is larger than adhesive based laminates in 2005. The adhesive based laminates will have a moderate growth in the next five years. The adhesiveless laminates, especially sputtering type laminates, will have larger growth rates than conventional adhesive base laminates. Liquid base polyimide resin will have a higher growth rate for the ultra high density flexible circuits, but it is still a minor part in the whole market.

Advanced Flexible Circuits - 5 year Projections

A similar analysis was conducted on the advanced flexible circuits. Several different trends have been observed. The definition of advanced flex circuits is higher circuit density of 150-micron pitch, smaller via holes than 150-micron diameter or multi-layer constructions with higher density than 250-micron pitch. Multi-layer rigid/flex with fine traces are also included.

The total projection of the advance flexible circuits is shown in Fig. 7. The major trends could be summarized as follow.
- 13.3 million square meters of advanced flexible circuits have been produced in 2005.
- 27.5 million square meters of advanced flexible circuits will be produced in 2010.
- The advanced flex circuit market will have 15.6% growth rate per year by volume.
- The advanced flex had 40% share by volume in the global flexible circuit markets in 2005; but it is projected to grow to 46% share by volume in 2010.
- The advanced flex circuit markets had 70% share by revenue in 2005; and it is projected to grow to 73% share by revenue in 2010.
- Personal computer applications have a lower share with advanced flexible circuits than other end use markets. Most of the flexible circuits in PCs do not need high density traces or complicated constructions.
- Disc drives of PC peripherals will maintain high growth rates with the new applications of micro drives.
- PDA will maintain high growth rates with new functions and consume more flexible circuits.
- Cellular phone applications will continue to increase its share with advanced flex circuits. It will grow rapidly by the global growth with the trends of miniaturization and more functions such as camera and clam shell shapes.
- Audio video applications will have relatively high growth rates. The booming flat panel TV markets will continue to be the leading application.
- New portable electronics such as digital cameras, MP3 and DVD will generate new flex markets, but their growth rates can not remain at today’s growth rates for a long time.
- Most of the advanced flexible circuits consume adhesiveless copper laminates as the base materials.

IC substrate will have stable growth. Flexible substrates have a small share in the whole IC packaging market. The trend will be affected drastically by the technology directions of the few major semiconductor companies.

Medical products have been consuming various flexible circuits, and its volume has been growing rapidly. However, the total volume will remain a relatively small share of the global flex circuit market over the next five years. There could be some possibilities that new innovative disposable devices such as pill camera will consume larger volumes of advanced flexible circuits.

Automobile devices will consume small amounts of flexible circuits. Main electronic devices such as ECU can not have a high growth rate because of the saturated market. New devices such as navigation devices and sensor systems will have higher growth rates, but consumptions of flexible circuits are expected to be limited.

Industrial and avionics applications will maintain several percent share in the global flex market. They will keep small but stable growth in the next 5 years.

**Conclusion**
The new research process for the global projection of the flexible circuits was examined. The capabilities of the process have been demonstrated with detailed projections provided according to the requirement.

Projections can be customized to meet individual interests.
– by base materials
– by laminate types
– by coverlay types
– by constructions
– by circuit densities
– by manufacturing processes
– by assembling types
– by applications such as display modules or IC substrates
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Agenda

- Background
- Methodology
- Example of the study
- Five years projection of the flexible circuits
- Five years projection of the flexible materials
- Value of the data base
- Conclusion
Background

- No agency has produced a comprehensive flexible circuit projection report.
- Usually projections are provided by revenue, the numbers come from the business plans of the flex manufacturers.
- Very frequently the revenues include not only bare flexible circuits, but also components and assembling costs.
- It is difficult to estimate the market size of the flex circuits in volume terms.
  - A wide price range makes it very difficult to estimate the volume.
- The data is complicated as major flex manufacturers have many overseas productions which leads to double counting.
The market estimation process starts with an analysis of the end product.

- Review design for wiring and packaging.
- Tear down to determine packaging.
- Determine construction for density, layer count, materials, etc.
- Obtain unit market price for each construction.
- Project demand by size of circuit and application.
- Calculate the revenue for each of the flex circuits.
- Sum and edit all of the various demands.
End Products

- Personal computers (e.g., Desk top, laptop, etc.)
- PC Peripherals (e.g., Disc drive, PDA, printer, etc.)
- Cellular phones
- Audio & Video (e.g., Flat TV, MP3, DSC, VCR, DVD, etc.)
- IC substrates
- Medical devices (e.g., Ultra-sound probe, monitors, disposal sensors, etc.)
- Automobile (e.g., Power train, navigator, etc.)
- Industrial & Avionics
Example of the study

**Fig. 1 Global Projection of Cellular Phones**
(Mar. 2006, DKN Research)

- **Total**
- **Camera phone**
- **Clam-shell type**

Year

- 2004
- 2005
- 2006
- 2007
- 2008
- 2009
- 2010
Example of the Study – Tear Down

Cell Phone

Cell Phone
Example of the Study – Tear Down

- Main Display Module
- COG, D/S Fine
- LED Backlight Module
- S/S Low Density
Example of the Study – Tear Down

- Camera Module
  4 Layer R/F Fine

- Sub Display Module
  COF, S/S Ultra-fine

- Hinge Cable Module
  S/S, Fine, Carbon Shield
Example of Study – Tear Down

Sub-display Module
COF, S/S, Ultra-fine

Main Board with Hinge Cable
4 Layer R/F, Fine
Example of Study – Tear Down

LED Back Light Module
S/S Low Density

Main Display Module
COG, D/S, Fine

Key Pad Module
D/S, Fine
Example of Study - Calculations

- **Demand by Volume**
  - \( D = N \times P \times 0.01 \times S \times 0.0001 \)
  - \( D \) Demand (Square Meters)
  - \( N \) Projection of End Product (Units)
  - \( P \) Possibility of Flex Circuit & Yield (%)
  - \( S \) Size of Flex Circuit (Square CM/Piece)

- **Demand by Revenue**
  - \( R = D \times C \)
  - \( R \) Revenue (US$)
  - \( D \) Demand by Volume (Square Meters)
  - \( C \) Unit Price (US$/Square Meters)
  - Price down for each year is included
Fig. 3 Flex Circuit Projection by Volume for Cellular Phones (Feb. 2006, DKN Research)
Fig. 4 Global Flex Circuit Projection by Volume
(Mar. 2006, DKN Research)

Year:
- 2004
- 2005
- 2006
- 2007
- 2008
- 2009
- 2010

Categories:
- Industrial/Avionics
- Automobile
- Medical
- IC Substrates
- Audio Videos
- Audio Videos
- Cellular Phones
- PC Peripherals
- PC

Volume:
- 0
- 10,000
- 20,000
- 30,000
- 40,000
- 50,000
- 60,000
- 70,000
Fig. 5 Global Flex Projection by Revenue
(Mar. 2006, DKN Research)
Results - Global Revenue

Fig. 4 Global Flex CircuitProjection by Revenue
(Mar. 2006, DKN Research)

Year

Industrial/Aviationics
Automobile
Medical
IC Substrates
Audio Videos
Cellular Phones
PC Peripherals
PC
Results – Material Usage

Fig. 6 Global Projection of Flexible Copper Laminates
(Mar. 2006, DKN Research)
Results – Total Advanced Flex

Fig. 7  Global Projection of the Advanced Flex Circuits by Volume (Mar. 2006, DKN Research)
Results – Advanced Flex Applications

Fig. 1: Global Advanced Flex Circuit Projection by Volume
(Mar. 2006, DKN Research)

Year

0 5000 10000 15000 20000 25000 30000

Industrial/Aviionics
Automobile
Medical
IC Substrates
Audio Videos
Cellular Phones
PC Peripherals
PC
Fig. 6 Global Projection Of Advanced Flex Circuits by Revenue (Mar. 2006, DKN Research)
Results – Conventional vs Advanced Flex

Demand Ratio between Conventional Flex and Advanced Flex (Jul. 2006, DKN Research)

Year

2004 2005 2006 2007 2008 2009 2010

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Value of the Data Base

- The current interconnect technology utilized is included as well as the direction future products will trend.
- The flex circuit analyses also include base materials, various cover layers and constructions such as polyimide, polyester, TAB, thick film conductors and more.
  - All flexible circuits including TAB and COF substrates.
  - Copper and the other metal & alloy circuits
  - Thick film circuits made by screen-printing of conductive pastes.
  - This data does not include the substrates of IC cards and RFID tags to avoid confusion as these applications have extremely low prices and large volumes.
- The data can be sorted by:
  - Material types
  - Constructions
  - Circuit density
  - Manufacturing process
  - Assembly
  - Application type
Conclusions

- The flex market is growing – 59 million square meters by 2010.
- Revenues will be over 14 Billion US by 2010.
- Polyimide film will retain the major material used.
- Adhesiveless materials will have high growth.
- Personal computers and peripherals are highest volume segment.
- Cellular phones are the revenue leader.
- Advanced flex will grow faster than conventional.
- Disc drives, cellular phones, flat panel TV and portable electronics will drive demand for advanced flex.
- Adhesiveless materials dominate the base materials.
Conclusions

- Medical applications will grow the demand for advanced flex.
- Automotive and Industrial applications only have limited usage of advanced flex.
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