



**LUPHI**TOUCH  
Outstanding HMI Solutions Company

**LUPHI ELECTRONICS TECHNOLOGY CO., LTD.**

## Membrane Switch Design Guide

**DONGGUAN LUPHI ELECTRONICS TECHNOLOGY CO., LTD.**

<http://www.luphitech.com> | <http://www.luphitouch.com> | <http://www.luphikeypad.com>

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## Introduction of LUPHITOUCH

Dongguan LuPhi Electronics Technology Co., Ltd.(short for LUPHI bellow) is established in 2008. It located in Ziliang High-Tech Industrial Park, Huaide, Humen of Dongguan. The factory area is about 3500 square meters. It closely neighbors to Shenzhen, Guangzhou and Hongkong. To Shenzhen airport is just about 30 minutes and to Guangzhou Baiyun Airport is just about 1 hour. LUPHI is a newly high-tech enterprise for human machine interface technology and metal, plastic molding, electronics product development, design and assembly.

Our main business and products include designing and manufacturing various kinds of super big size membrane switches, membrane keypads, graphic overlays, membrane circuits, various kinds of backlit membrane keypads like the LED backlit membrane switches, EL backlit membrane switches, LGF backlit membrane switches, the high-tech capacitive membrane switches and nameplates, labels, PCBA, integrated assemblies and turnkey assemblies.

At the beginning of establishing of LUPHI, we made the factory planning as per international standard. We made a big investment to imported many new and high accuracy big size semi-auto silk screen printing machines, high-performance pneumatic punching machines, hot embossing machine, high accuracy laser cutting machine, auto die cutting machine etc. LUPHI always regards the quality as our life. We established our inner testing room. We have the life testing instruments, 2D measurement instrument, high-low temperature environment test equipment, friction tester, dropping tester, electrical function testing instruments, ink adhesion tester etc. In addition, we also have the high clean room and anti-static clean booth to ensure the product reliability and stability for those high-accuracy and anti-static required products.

80% customers of LUPHI are from USA, Australia, UK, Germany, Austria, France, Italy, Belgium, Sweden, Russia, Ukraine etc. countries and areas. We know the overseas customers' requirements and business procedures very well. On this basis, we established our own perfect business development, engineering development & design, artwork making, production and quality control system.

We promise to use high quality raw materials to ensure our products achieve the quality goal of our customers. For example, we use Autotype PET, Lexan PC from GE, Korea Changsung silver paste, ACHESON silver paste, Japan JUJO inks, Nicomatic, CJT connectors, 3M adhesive, Luxking spacers etc.

LUPHI is dedicated to be the standard founder and leader for the membrane switches industry in China!

Warmly welcome you to visit us and discuss business!

## Introduction of Membrane Switch

### What is membrane switch/membrane keypad?

A membrane switch is an electrical switch for turning a circuit on and off. It differs from a mechanical switch. Membrane switch is very thin and soft. The touch surface material usually is PET or PC. The circuit can be PET, FPC or even PCB. Membrane switches are user-equipment interface utilities that allow for the communication of commands from users to electronic devices.

### Features and Benefits of Membrane Switches:

- 1) Very thin and light can be assembled on many different materials surface, like plastic, metal, rubber etc.
- 2) The overlay material usually are PET and PC. They are easy clean and sterilized;
- 3) Waterproof and anti-UV for outdoor application, and also can use antifungal material for medical special application;
- 4) Multicolored (can be silk screen printed or digital printed graphic);
- 5) Economical and cost saving compared with touch screen panels;
- 6) Can be customized to any shapes to fit into your design;
- 7) Low tool cost and short prototype manufacturing;
- 8) The circuit can be assembled with LEDs, resistors, capacitors, connector etc. electronic components;
- 9) Flexible and diverse types of keypad assemblies: assembled with rubber, PMMA/PC/SS Panel/Al Panel, PCB, FPC etc.
- 10) Can be friendly interface and also can be designed backlit to convenient of the night or dark environment using;
- 11) Flexible can be used one curved surface;
- 12) Low cost and long life of buttons, can be more than 1,0000,000 times;

### > Membrane Switches / Membrane Keypads Structure

- 1) 4 layers structure: Graphic overlay + Spacer + Circuit(can be PET circuit or FPC circuit) + Back Adhesive
- 2) 6 layers structure: Graphic overlay + Spacer: Dome Retainer + Spacer + Circuit(can be PET circuit or FPC circuit) + Back Adhesive;
- 3) Other Structure
  - 3.1) Overlay + Rubber Adhesive + Rubber Keypad + Rubber Adhesive + Retainer + Spacer + Circuit + Back Adhesive;
  - 3.2) Overlay + Spacer + Retainer + PCB Circuit;

And also there are many other kinds of structures for the interface keypads structure. It based on customer's real needs and we can design the suitable and economical structure for our customer's final application.

### What kind of membrane switches we can manufacture?

- 1) [Flex & Rigid Membrane Switches;](#)
- 2) [Backlit Membrane Switches;](#)
- 3) [Capacitive Membrane Switches/Foil Circuits;](#)
- 4) [Rubber Keypad Membrane Switches;](#)
- 5) [Backplane Membrane Keypads;](#)
- 6) [Waterproof and/Or Anti-UV Membrane Switches;](#)
- 7) [Antibacterial Membrane Switches;](#)
- 8) [Graphic Overlays/Labels/Tags;](#)

## Application Markets and Areas

LUPHI TECH is a professional membrane keypads, graphic overlays, rubber keypads, LCDs/Touchscreens and integrated assemblies supplier in China with factory size over 3500 square meters. LUPHI is also ISO9001:2008 and ISO13485:2012 certified. With over 8 years OEM experiences served for the following industries:

- [Medical and Healthcare Devices](#)
- [Telecommunication & Networking Devices](#)
- [Machinery](#)
- [Instruments & Meters](#)
- [Industrial Control](#)
- [Aviation & Marine Control](#)
- [Automobile & Rail Transit](#)
- [Household Appliances](#)

## > Make your devices be more competitive

Our production facilities meet strict quality standards and are certified to industry certifications including ISO9001:2008 and ISO13485:2012.

Contact us for more information about our capabilities for custom manufacturing for the medical industry.

## Common Used Raw Materials and Accessories

PET: Autotype, Reflex, Dupont;

PC: GE Lexan;

Ink: SEIKO, JUJO, DUBUIT, PROELL, NORCOTE UV

Silver Paste: CHANGSUNG, ACHESON, FUJIKURA, OTTI;

Adhesive: 3M, Luxking;

Metal Domes: Nicomatic, MEMCON, TRUETONE, HUNGTAI;

LEDs: Nicomatic, MEMCON, Everlight, Kingbright, LITEON;

Connector: Nicomatic, MEMCON, CJT, FCI;

OCA: Mitsubishi, 3M;

## Overlay Design

### OVERLAY MATERIALS SELECTION:

A variety of overlay materials are used in membrane switches application. The most commonly used base material is polyester (PET). PET is a material that has superior life cycle and chemical resistance properties in comparison to other flexible materials. In life cycle testing, PET shows no signs of wear at 1,000,000 cycles. In addition, polycarbonate (PC) offered pricing advantages. PC is still used for certain applications, however, the life cycle data shows that it begins to crack as early as 40,000 cycles. So, in LUPHI TECH we usually suggest to use PET material in most applications. Both PET and PC are available with a variety of textures and hard coatings. In their uncoated, glossy form both materials are very susceptible to scratching. For this reason gloss materials should always be hard coated. Specialty materials have also been developed that offer some of the benefits of both PET and PC.

For PET materials we suggest to use Autotype and Reflex brands for the graphic overlay application. For example the F150, F200, V150, V200, EBG180, EBG130, EBA180, EBA130, XE-F150, XE-F200, XE-V150, XE-V200, AutotexAM, Reflex etc.

Therein, the XE series Autotype PET materials are suggested for the outdoor application, marine control application membrane switches. It is a kind of UV resistant PET material. EBG/EBA are suggested to membrane switches which have the anti-scratch requirements and AutotexAM/Reflex PET are suggested for medical devices application membrane switches, because of that they are anti-bacterial PET materials.

Check Appendix A for the datasheets web links or contact your LUPHI TECH's salesman or engineer for additional information.

### Buttons Treatment on Graphic Overlay:

The buttons on membrane switch are the directly and frequently pressed part. It requires that the buttons should have very good tactile feeling and bounce time. For membrane switch, the buttons can be flat, embossing. Can be silver conductive pads and also can assembled with metal domes.



**Flat buttons:** the buttons areas are on the same horizontal level with the other graphic overlay area. On the backside of the graphic overlay prints the silver or carbon conductive pads which contacted with the conductive pads on the bottom circuit layer, then trigger function. Also can not print silver or carbon conductive pads on the backside overlay, to design the membrane switch be 6 layers with top and bottom two circuit layers, then the conductive pads will be printed on the top and bottom circuit layers.

**Embossing Buttons:** usually the users need the keypad have a good tactile feeling and also want to get a click sound when they press the buttons, then make the buttons embossed and assemble the metal domes under the overlay. The embossing type also can be many types.

For example, round embossing, flat embossing, pillow embossing etc. The embossing area also can be the whole button or just part of it, for example just emboss the button borders or make blind dot embossing on the whole embossed buttons.





## Colors Matching and Printing:

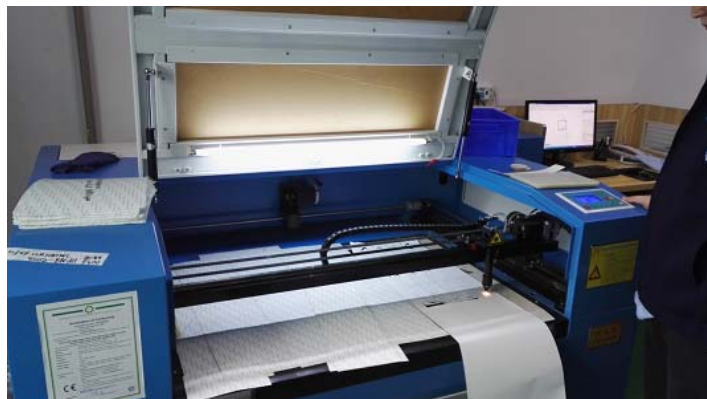
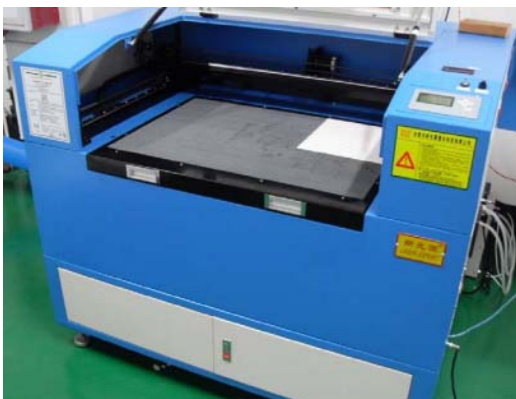
There are many systems that a customer can use to communicate color requirements to us. Pantone Matching System (PMS) and RAL color matching system are the most popular color standards. It identifies colors by specific numbers. This system was originally devised for use in the offset printing industry, but has become a common tool for all types of printing. The Pantone System is very popular because it is inexpensive and simple to use. For digital printed overlay, also can use CMYK color matching system to confirm the colors.

Color samples or the completed printed graphic overlay samples are supplied to customers when requested. We supply a sample of the actual ink to be used in production applied to the same substrate from which the part will be made. We provide this service at no charge in conjunction with an order.

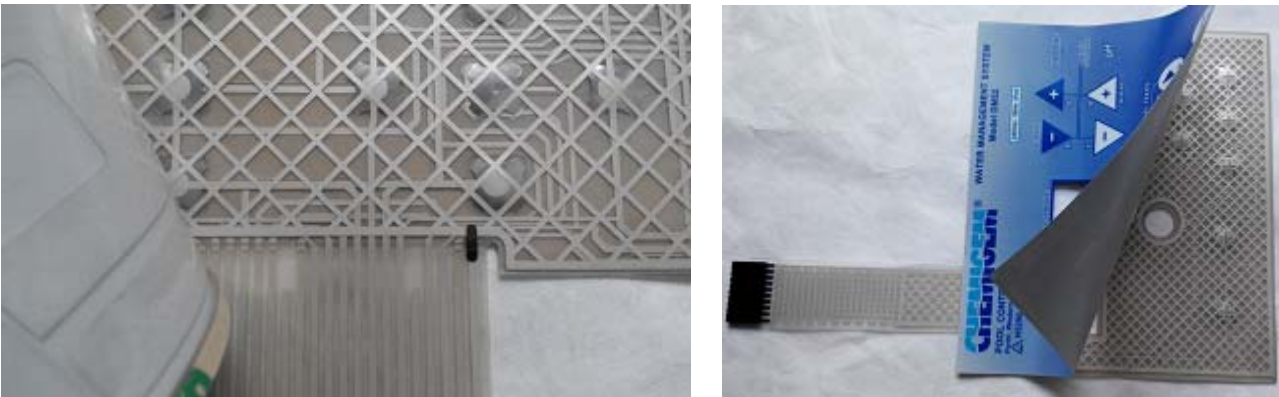


**Mechanical Tolerances:** Steel rule dies are usually used to fabricate the various layers of a membrane switch. Standard tolerances should be  $\pm .015$ ". Tolerances of  $\pm .010$ " can be held on critical dimensions such as the perimeter or cutouts. Hole center to hole center tolerances of  $\pm .005$ " can be held. Tolerances on very large parts will be greater. Tighter tolerances can be held by laser cutting or with the use of hard tooling. The switch layers under the overlay will typically be fabricated smaller than the overlay. This allows for die cutting and assembly tolerances. All layers will typically be  $.015$ " inset from the overlay at all edges and cutouts.

**Laser Cutting:** The various layers of a membrane switch can be cut out by using a numerically controlled laser. This technology offers two advantages. Tighter mechanical tolerances can be held, and no tooling is required. While laser cutting is a more expensive process than die cutting, in many low and medium volume applications it is quite cost effective. **ESD/RFI Shielding:** Several options are available for shielding membrane switches. The most common are printed carbon, printed silver, and aluminum foil. From a functional standpoint, the main difference among these materials is their conductivity. Either carbon or silver can be printed on the top of the top circuit to act as a shield.



**ESD/RFI Shielding:** Several options are available for shielding membrane switches. The most common are printed carbon, printed silver, and aluminum foil. From a functional standpoint, the main difference among these materials is their conductivity. Either carbon or silver can be printed on the top of the top circuit to act as a shield.



These shields have the advantage of not adding any additional layers to the switch construction. Carbon shields are less expensive than silver shields. Silver is usually printed in a grid pattern to reduce cost. A layer of aluminum foil can also be added above the top circuit. This material is the most conductive shield available. However, it does add two layers to the switch construction. The shield is usually connected to the ground through the connector, or by means of a tab with a slot for a fastener. The customer should express their shielding requirements in Ohms per square inch.

**Tail Exit Point:**

Flexible membrane switches are connected by means of a flexible tail that is cut from the circuit material. We have a great deal of flexibility in selecting the exit point. The tail cannot exit under or within .125" of the active keypad area. The tail end connection can be Female connector, male connector and ZIF connection.



**Rigid & Flex Circuits:**

The circuit of membrane switches can be flex and rigid. It depends on the customer end application and also related to the cost budget and other considerations. For example, life, resistance, connection type on main board etc

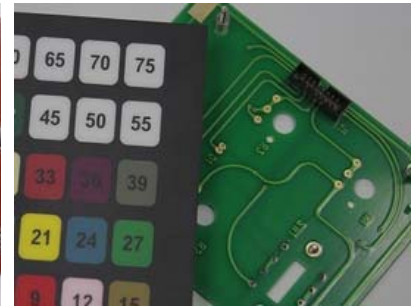
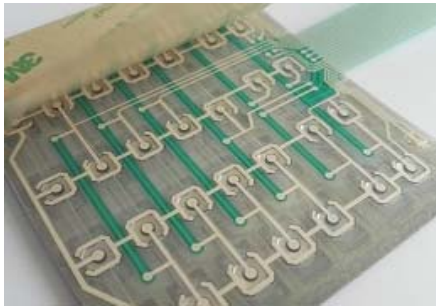
For the flex circuit membrane switches, there are two types. They are silver printed PET circuit and copper etched FPC circuit. Their difference and advantages & disadvantages listed below:

Items	Silver Printed Circuit
Material	PET (Polyester)
Conductor	Printed silver
Contact Fingers	Silver and Carbon
Contact Buttons Pads	Silver
Life & Reliability	normal
Stability	Normal



Resistance	low
Cost	low
Lead Time	2-3 days
Pitch	0.5mm (not suggested), 1.0mm,1.27mm,2.54mm

Usually if the membrane switches need assembled many LEDs, then we suggest to use FPC circuit, it can get more stable LED soldering quality. For the normal application the PET circuit is enough, which is more economical. In addition if the conductor pitch is 0.5mm, although we also can print it, but we still suggest to use FPC circuit. Because of that 0.5mm pitch is too small and it is easy to occur the short circuit problem.



#### Loop Resistance:

The loop resistance of a switch is a function of trace width and length. In almost all applications the maximum loop resistance is less than 100 Ohms.



**Windows :** The overlay materials used in membrane switches begin the process clear. Colors are screen printed on the back of the overlay material. Areas that do not have color printed on them become windows. As mentioned in the section on hardcoats, window areas can have a variety of hardcoats or textures added to them. It is recommended that small discrete LED annunciator windows have the same texture as the background. Larger windows for LEDs, LCDs, or VFDs may need a window with less light diffusing characteristics. Window coatings in general are a trade-off between anti-glare characteristics and optical clarity. The closer the display is to the overlay the less effect the coating will have on display readability.



### Insertable Legends (Pocket Design):

In some applications it is desirable to have the ability to customize some of the replaceable legends and symbols, either when the switch is assembled to the end product, or in the field. Then under such kind of application, the pocket design membrane switch is necessary. Design a clear window on the membrane switch and leave an insertable slot at the keypad side or on the backside of keypad. Then the separate printed replaceable label can be inserted into that “pocket window”.

Eg.:



### Backlighting Design:

Backlight Membrane Switches means that there is light source from the backside to light the graphic overlay and provide the indication information to users or when the product used in the night or dark environment it can light the graphic and make the users or workers make buttons press operation correctly and avoid pressing wrong buttons.

There are several types of backlighting ways for the membrane switches. They are:

- 1) LED backlighting membrane switches;
- 2) EL lamp backlighting membrane switches;
- 3) LGF(Light Guide Film) backlighting membrane switches;
- 4) Fiber backlighting membrane switches (seldom used in nowadays due to its complex manufacturing process and very high cost. It has been replaced by EL lamp backlighting and LGF backlighting technology);



For the LED backlighting keypads, the graphic overlay is lighted by the backside LEDs which are assembled on the flex or rigid circuit layer. By this way, it is very simple and also economical. But it couldn't get a even lighting effect on surface. For this backlighting method, the LEDs can be assembled under centered buttons also can be assembled beside of the buttons or other areas. For the products need each button be backlit, usually design the LEDs under the center of the buttons, then use the center holed metal domes and print transparent color on the graphic overlay. By this way the center button will be much brighter than sides of it. But this way is easy to achieve and also its cost is the lowest. This is suitable for the products no very high requirement for the evenness of the backlighting.

For the EL lamp backlighting membrane keypads, the graphic overlay will be backlit by the EL lamp layer under the overlay. EL( Electroluminescence):Electroluminescence means luminescence produced by high energy generated from



electrons which are accelerated within phosphors when an alternating current is applied to a luminous layer consisting of phosphor powder. EL lamp's light is very even and the manufacturing process is also simple. But the end users need design an additional connection port for the EL lamp layer. Also this kind of backlighting keypad need another driver to match the EL lamp in the keypad. We can provide the EL driver to match our EL lamp backlighting membrane keypads.

As to the LGF backlighting membrane keypads, it is the current most popular backlighting technology. LGF is light guide film. LGF itself is not a light source. It couldn't produce the light. It still need the LEDs assembled on the circuit layer to

produce the light source. But LGF can guide the light from the LEDs to top overlay evenly. For this backlighting keypad, it can save the LEDs quantity and it also can get a even backlighting effect with less LEDs. But by this way the difficulty is adjusting the refraction dots on the LGF layer. Adjust the direction of dots, density, position etc. And its tool fees is higher.



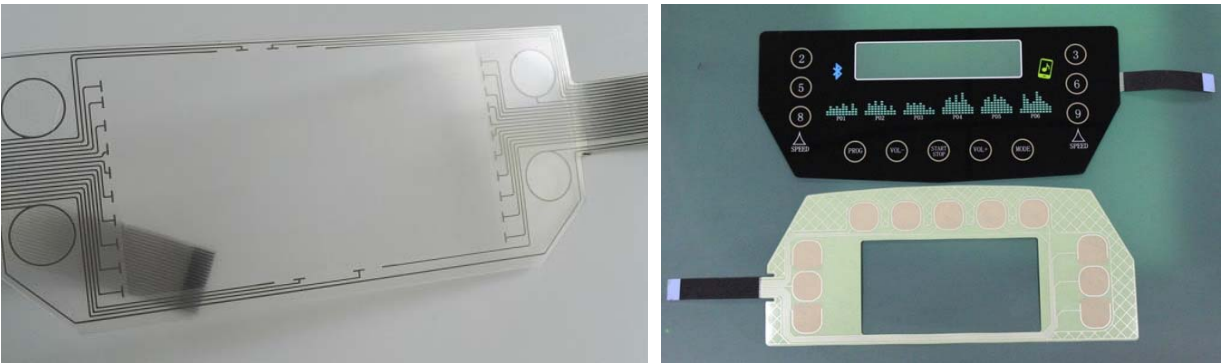
Below is their difference and advantages & disadvantages for your reference:

Item	LED Backlighting	EL Lamp Backlighting	LGF Backlighting
Manufacturing Ddifficulty Level	Easy	Easy	Difficulty
Backlighting Uniformity	Bad	Much Better	Better
Tool Cost	Low	Middle	High
Product Cost	Normal	Higher	Middle

Capacitive Membrane Switch Design:

Capacitive touch membrane keypad consists of one or more capacitive touch buttons(sensors). We print the capacitive touch buttons/sensors on PET circuit with the transparent conductive ink. We also use ITO etching technology to make the capacitive touch buttons/sensors. Through the customized IC chip to control the touch function wanted. Except for the capacitive touch keypads we also manufacture the capacitive touch sensor circuits.

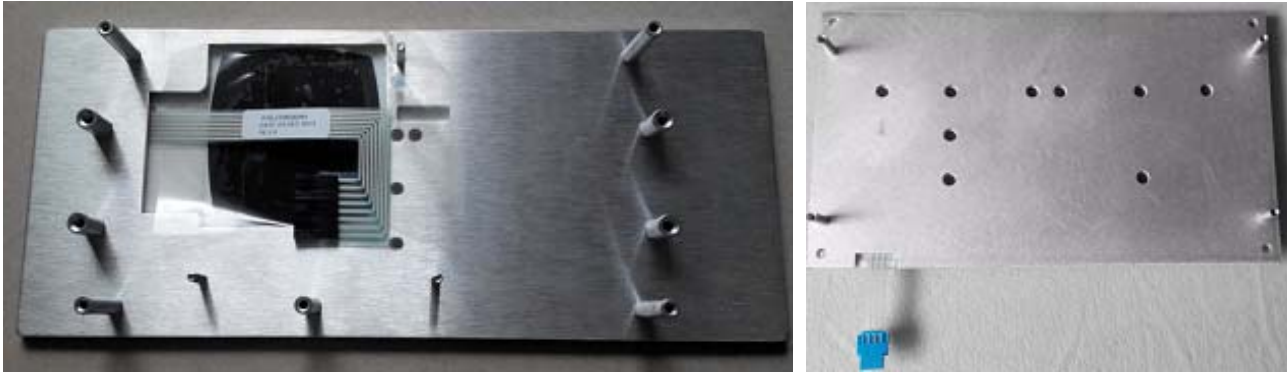
By capacitive touch technology, the overlay materials can be very diverse and not only limited to PET or PC super thin films. For the normal membrane keypads, the function triggered by the mechanical buttons (metal domes or Polydomes) and also the common membrane keypads only can use PET, PC film for the graphic overlay. Use a heavy force to press the buttons to make the conductive pads of the Polydome or metal domes connected to the conductive pads on circuit layer, then become a loop circuit and occurs the function. But for the capacitive touch membrane keypads or circuits, it is different. The overlay material can be thick glass, PMMA, Polycarbonate panel etc. It no longer limited to very thin film material. In addition, for the capacitive touch keypad no longer need heavy force to press buttons, you only need tiny touch the buttons, then the sensor pad can connect the circuit loop and occur the function.





### Backplane Membrane Keypads

Membrane switch/membrane keypad is flexible; it can be assembled on any machines, equipments, devices. But sometimes it needs a back support panel to enhance its inflexibility, or at customer end machine there is a cabinet and need screws and backplane to install the keypad on the machine or device by the screws, then under such kind of application the membrane keypad with backplane and even with screws are necessary. If just need enhance the keypad's inflexibility, you can add a PMMA/PC/FR4 etc. other back support panel. If you designed your cabinet with screw holes and the keypad module need be embedded assembly, then need use hardware back panels, like stainless steel panel, Al panel etc. And also most times need assemble the screws, bolts on the metal back panel.



### Adhesives Selection:

For the membrane switch product, there are many kinds of adhesives can be used. For example 3M, Luxking etc. In LUPHITOUCH manufactured keypads, we usually use Luxking adhesive as the spacer and 3M adhesives as the back adhesive. But for spacer's adhesive selection it is not fixed. Usually we use Luxking brand adhesive which can meet 90% of application requirements, for some special designed keypads, for example the adhesive sides are very narrow, then we will use 3M adhesive for the spacer. For the back adhesive, it also need be selected based on the final application, based on what kind of material for the keypad will be installed on. As we know the membrane switch usually be installed on metal, plastic, rubber etc. material surface, then we should select the proper adhesive as per such kind of situation. When assemble the membrane switch to your device, please clean your assembly surface first, then peel off the release paper on the back adhesive, then make lamination assembly.



### Engineering Artwork Drawing and Specifications:

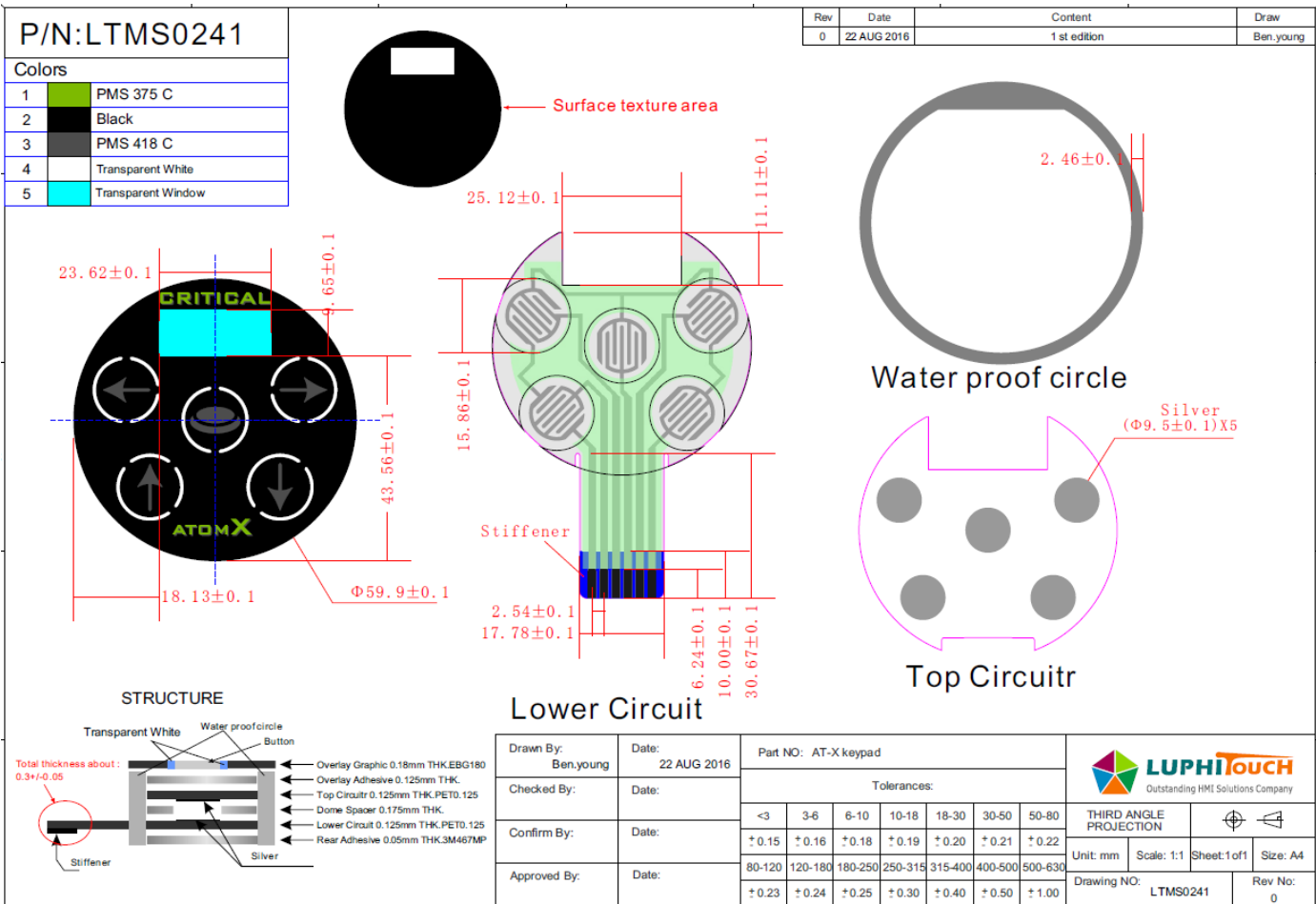
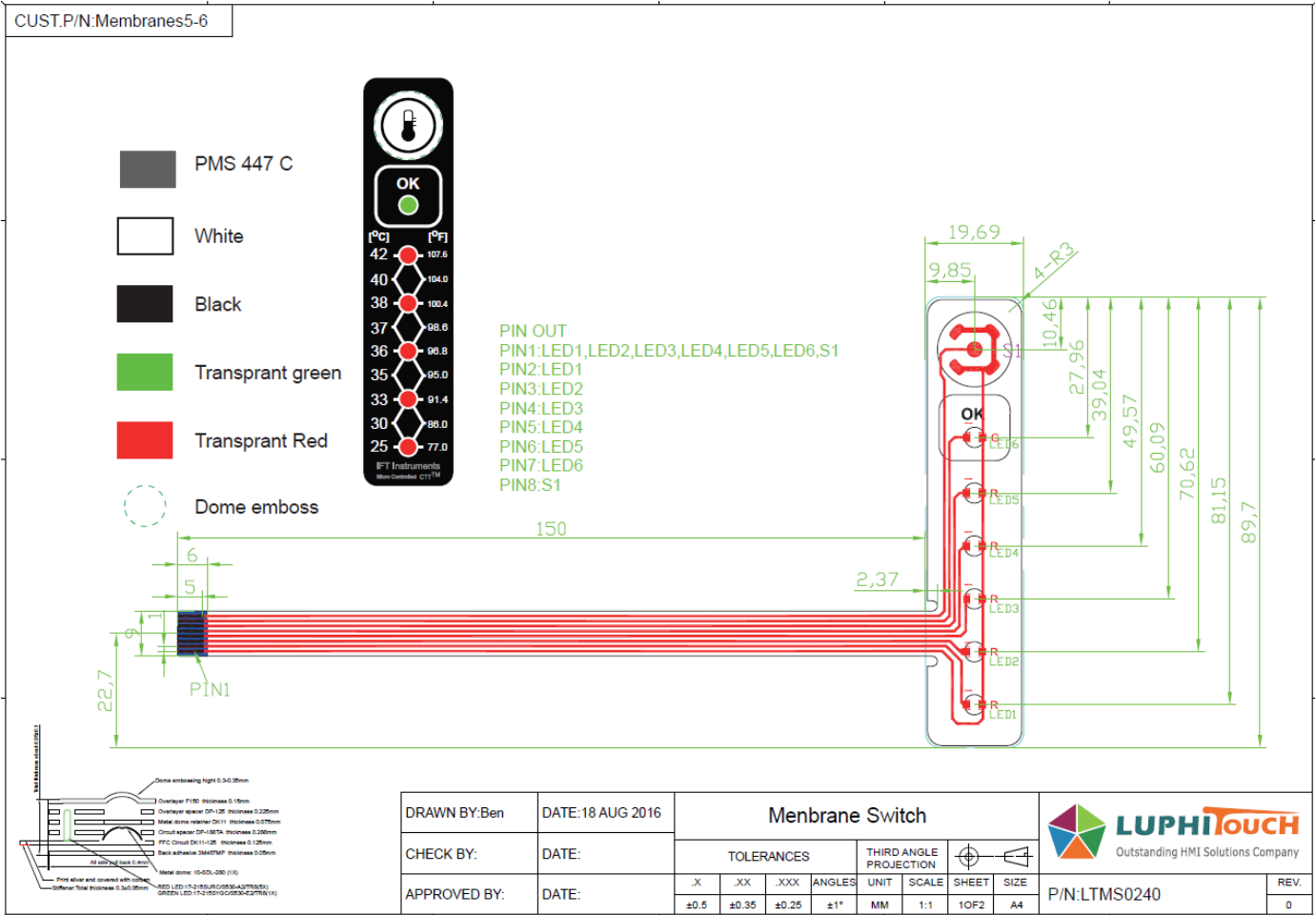
Our ability to manufacture a membrane switch which meets our customer's expectations is dependent on how well we understand your requirements. The customer should be sure to supply us with as much detail about his design requirements as possible. Then LUPHITOUCH's engineer will design our engineering artwork drawing based on our understanding to customer for checking and approval.

Eg.:

**Membrane Switch/Membrane Keypad Capabilities:**

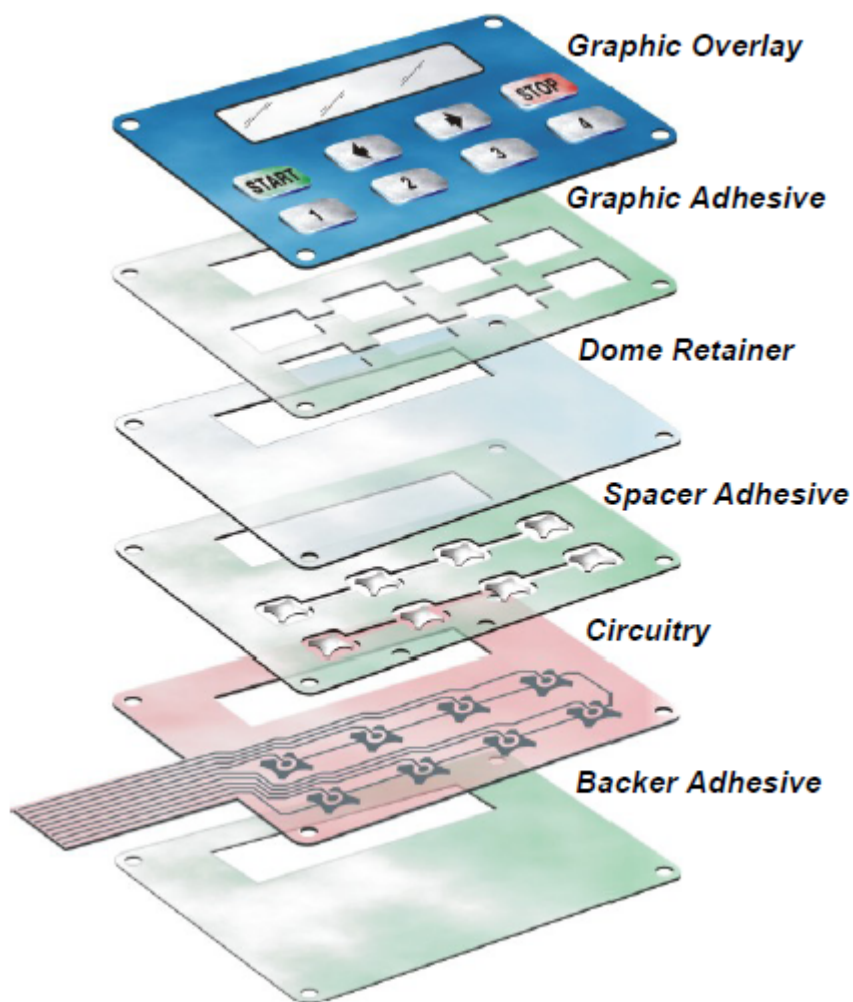
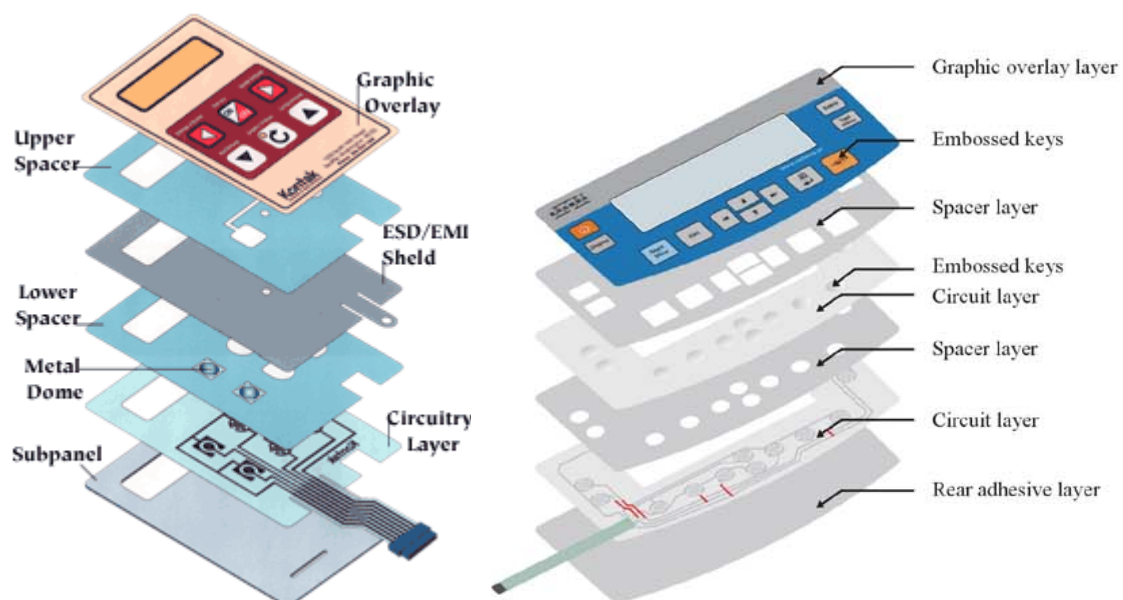
Item	Description	Technical capabilities
1	Max. Size:	1100mm x 2000mm
2	Overlay Material:	<b>PET:</b> Autotype (Autotex F150, F200, F280, V150, V200, V280, Autoflex EBG130, EBG180, EBG250, EBA130, EBA180, EBA250) Autotex : XEV150, XEF200; Autostat CT3、CT4、CT5、CT7 <b>DuPont, Toray PET</b> etc. Domestic Brand PET (Sichuan Dongfang) <b>PC: GE LEXAN</b> --8010 8B35 8B35F HP92S HP40 FR700 FR60 <b>Bayer PC</b> —Makrofol, /Bayfol, Marnot/ProTek Domestic Brand PC etc.
3	Spacer:	3M Adhesive, NITTO、TESA、SONY、SEKISUI、Domestic Adhesive
4	Back Adhesive:	3M(Mainly), Others(Little)
5	Silver Paste:	<b>CHANGSUNG:</b> CSP-3163, CSP-3352, CSP-5150; <b>ACHESON:</b> ED 725A(6S-61), <b>ED 427SS, ED 479SS, ED 976SS HV;</b> <b>FUJIKURA</b> and <b>OTTI</b>
6	Oil Ink:	SEIKO, JUJO, DUBUIT, PROELL, NORCOTE UV
7	Carbon Paste:	FUJIKURA, ACHESON ED 581SS, OTTI
8	Typical 6 Layers Metaldome Type Membrane Switch Structure	Overlay + Spacer + Dome Retainer + Spacer + Circuit Layer+ Back adhesive
9	Typical 4 Layers Polydome Type Membrane Switch Structure	Overlay + Spacer + Circuit + Back adhesive
10	Contact Resistance	0.5-10Ω
11	Insulation Resistance	≥10MΩ (100VDC)
12	Base Material Voltage Durable	2000V DC
13	Bounce Time	≤5ms
14	Working Current	≤100mA
15	Working Voltage	≤50VDC
16	Life	≥1,000,000 times
17	Key Travel	Flat type: 0.05mm-0.5mm, Tactile Type: 0.1-1.5mm
18	Working Temperature	-40℃-+80℃
19	Actuation Force	20-550g
20	Storage Condition	Temperature: -40℃~+85℃ ,Humidity: ≤98% RH
21	PET Circuit Tail Flexible Feature	180° to any angle

Engineering Artwork Examples:





## Membrane Switches Structures Schematic:



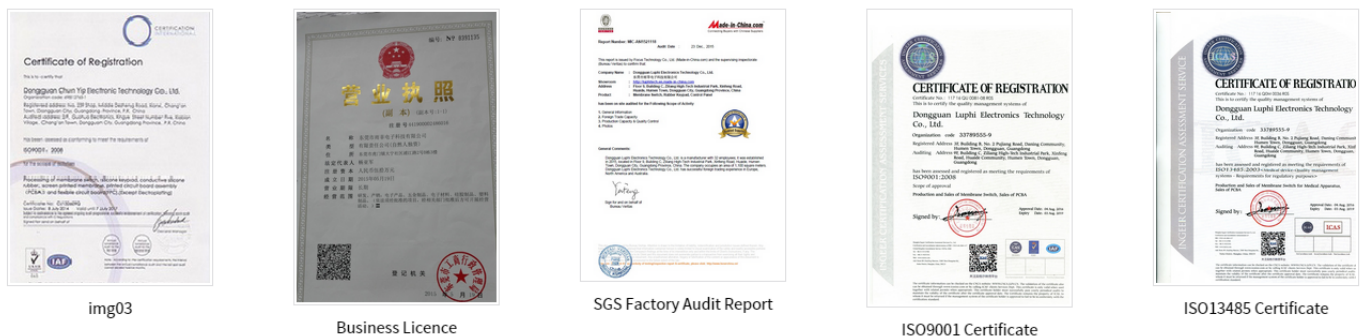
## Raw materials Brands of LUPHITOUCH Used:



## Some Application Cases:



## Certificates & Honours



## Contact us for Your Needs about the Membrane Switches:



LUPHITOUCH welcomes your inquiries, questions, comments and suggestions. Our salesman will reply you within 24hours. If you have an immediate inquiry or needs, please feel free to call our sales mobile phone number at +86-13437410111.

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