



E-SWITCH™

Switch Basics *and Applications*



Introduction

Basic Switch Types and Applications

Switch Function - Mechanical

Poles and Throws, Mechanical Characteristics

Switch Function - Electrical

Voltage and Current Ratings, Contact Resistance

Process Applications

Hand Solder, Wave Solder, SMT



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Basic Switch Types

- *Push-Button and Toggle Switches*
- Power Switches
- Slide Switches
- Rotary Switches
- Key Lock Switches
- *Tact Switches and Domes*



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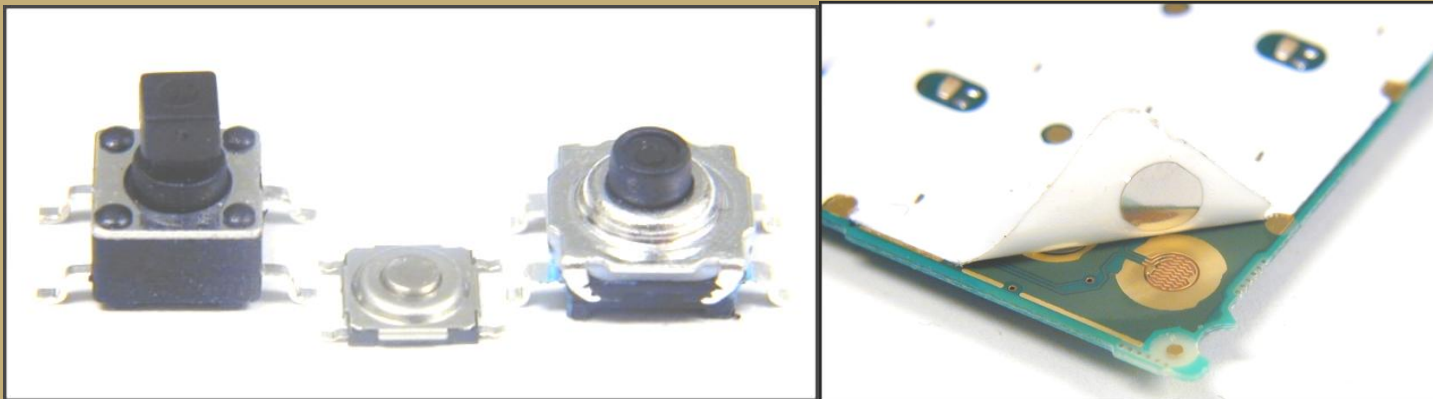


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Tact Switches and Domes

- **TYPICAL APPLICATIONS**

- Low power, miniature devices, digital switching - pda's, cell phones etc.
- Tactile operator feedback required- switch confirmation, felt "click" when the switch is depressed
- Long life typically required, SMT and wash tight capability

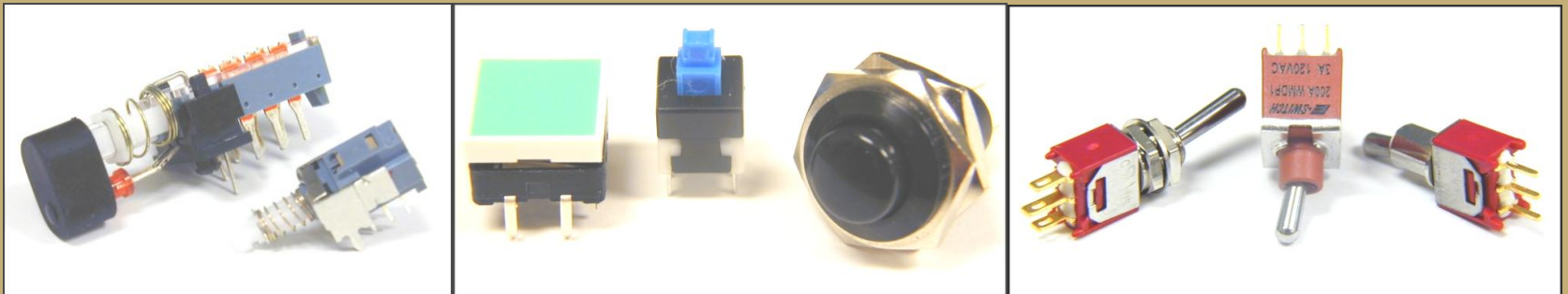




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Push-button and Toggle Switches

- **TYPICAL APPLICATIONS**
 - Medium power, bench-size devices, analog switching - audio, measurement equipment etc.
 - Mechanical latching operation and Agency Approvals option
 - Design typically has substantial amount of self-cleaning capability due to contact wipe action



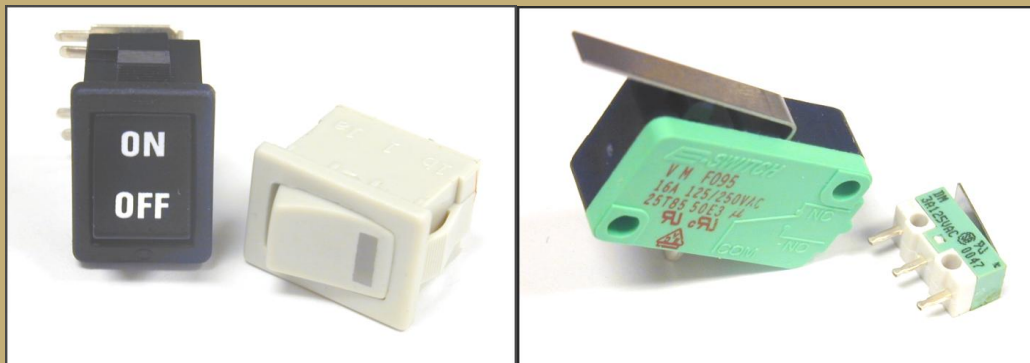


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Power Switches

- **TYPICAL APPLICATIONS**

- High power, on-off switching, consumer, industrial - audio, measurement equipment etc.
- Mechanical latching operation typical, indicator lighting option
- Most are “snap action” type construction, with minimal contact wipe
- Agency approvals required (UL, CSA, CE etc.)



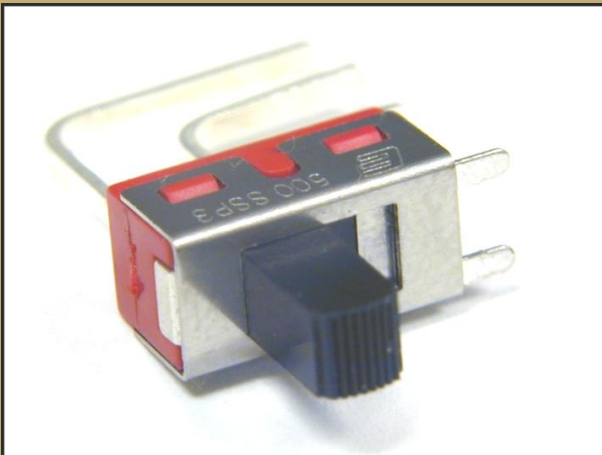
Agency Approvals/ Symbols			
 England British Electrotechnical Approved (BSA) BEAB File #8003	 Italy Istituto Italiano del Marchio di Qualità (IMI)	 Sweden SIS-MKI	 European Community Europe's Harmonized Standards
 Canada Canadian Standards Association	 The Netherlands N.V. KEMA	 Switzerland Schweizerischer Elektrotechnischer Verein (SEV) File #23301 per UL 1004 for special case switches	 TÜV Organisation of Technical Inspection
 Denmark DE-MKI	 Norway NEMKO	 USA Underwriters Laboratories Inc.	 UL-CUL Recognized Testing Agreement
 Finland ELEKTROTEKNIN TUTKIMUSKESKUS	 Austria Österreichischer Verband für Elektrische Anlagenbau	 Germany DVE: Verband Deutscher Elektrotechniker	



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Slide Switches

- **TYPICAL APPLICATIONS**
 - Low power, on-off switching, consumer, industrial - audio, measurement equipment, toys, low-cost applications etc.
 - Self cleaning contacts due to wiping action (typically)
 - Unique switching contact groups available



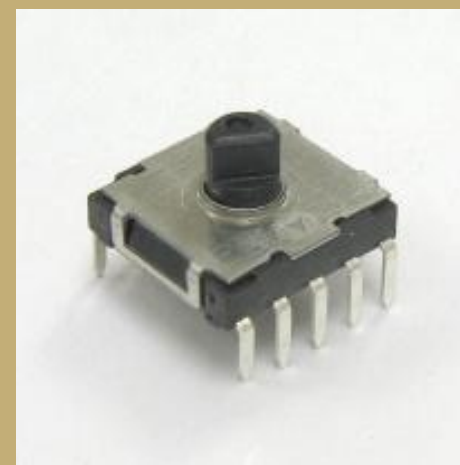
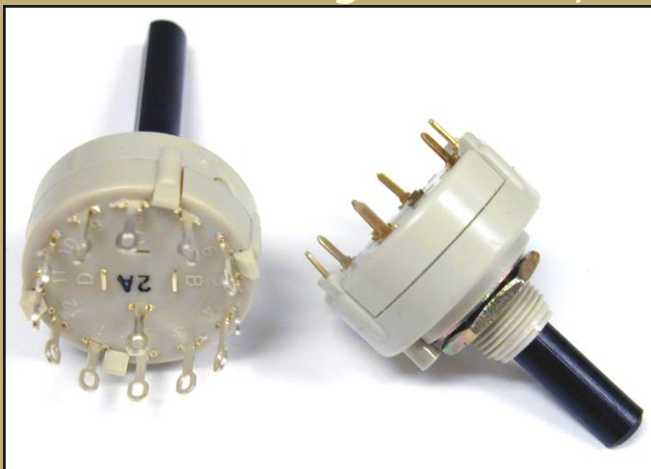


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Rotary Switches

- **TYPICAL APPLICATIONS**

- Low power, on-off switching, digital, industrial - audio, measurement equipment etc.
- Several contact groupings available, up to 4 poles
- Self cleaning contacts, due to wiping action





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Key Lock Switches

- **TYPICAL APPLICATIONS**

- High power, on-off switching, consumer, industrial - safety lock-out capability
- Multiple positions available
- Most are “sliding action” type construction, with substantial contact wipe
- Agency approvals available (UL, CSA, CE etc.)

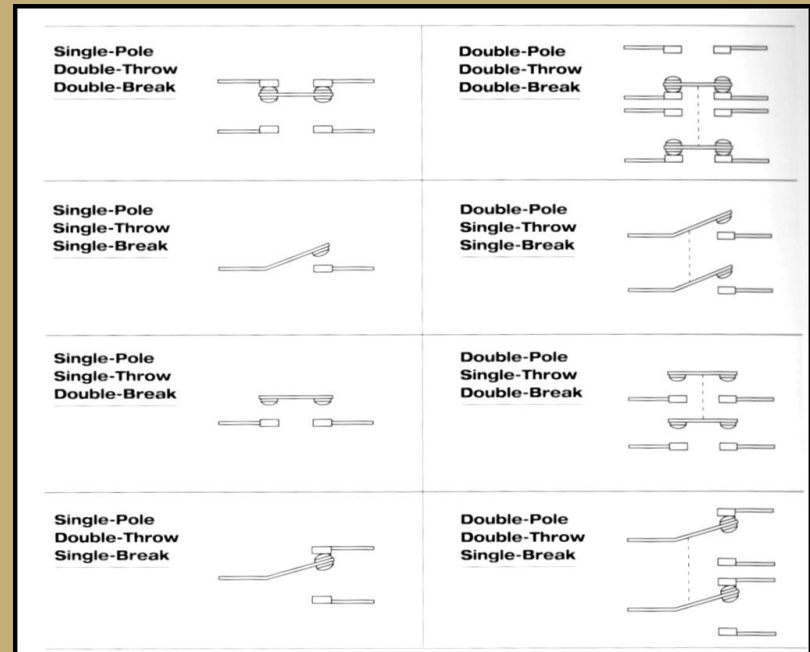




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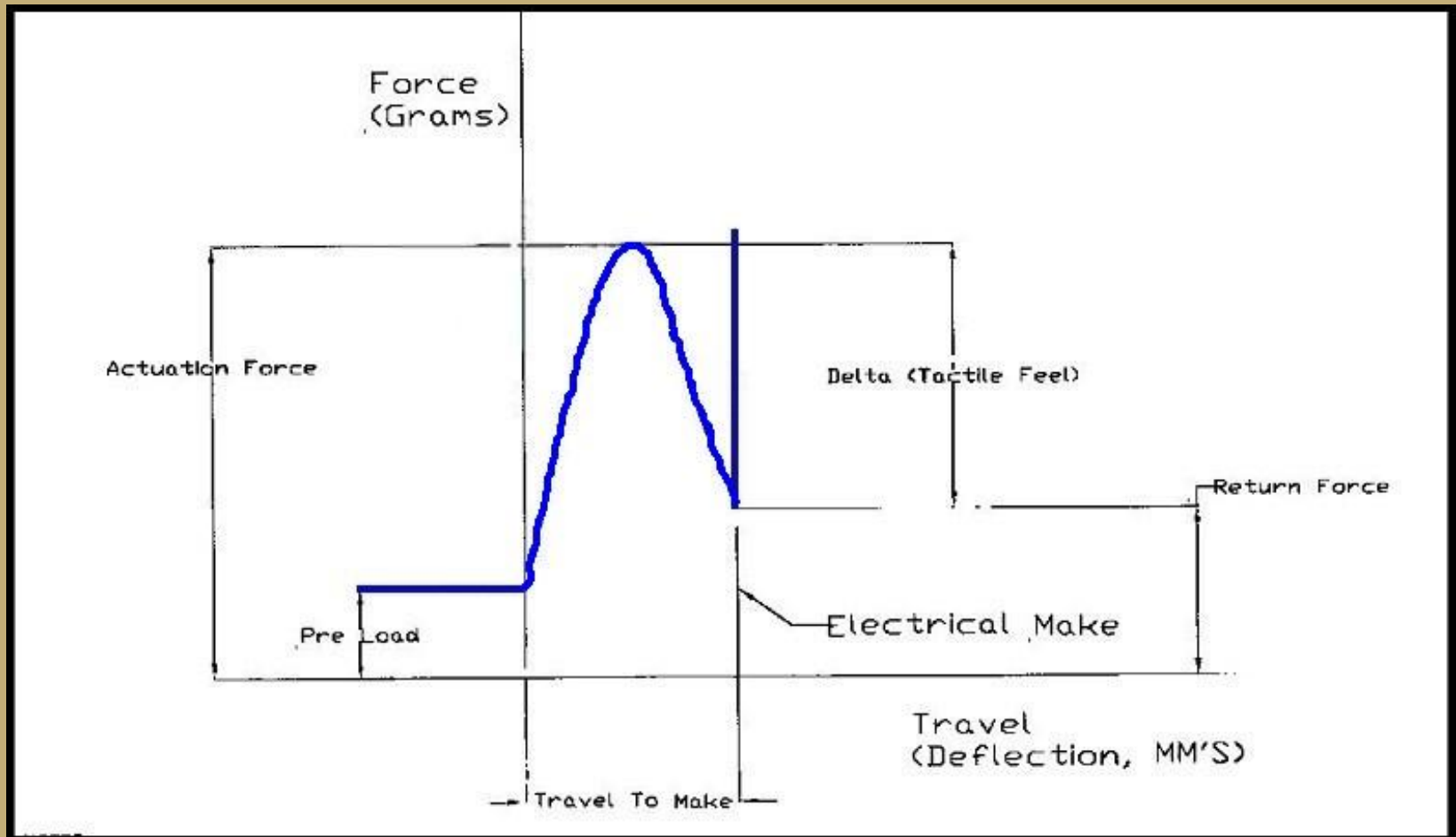
Switch Function Mechanical

- **Switch Construction** - Poles and Throws
- *Most Common*
- Single Pole - Single Throw, Single Pole - Double Throw
- Double Pole - Single Throw
- Double Pole - Double Throw



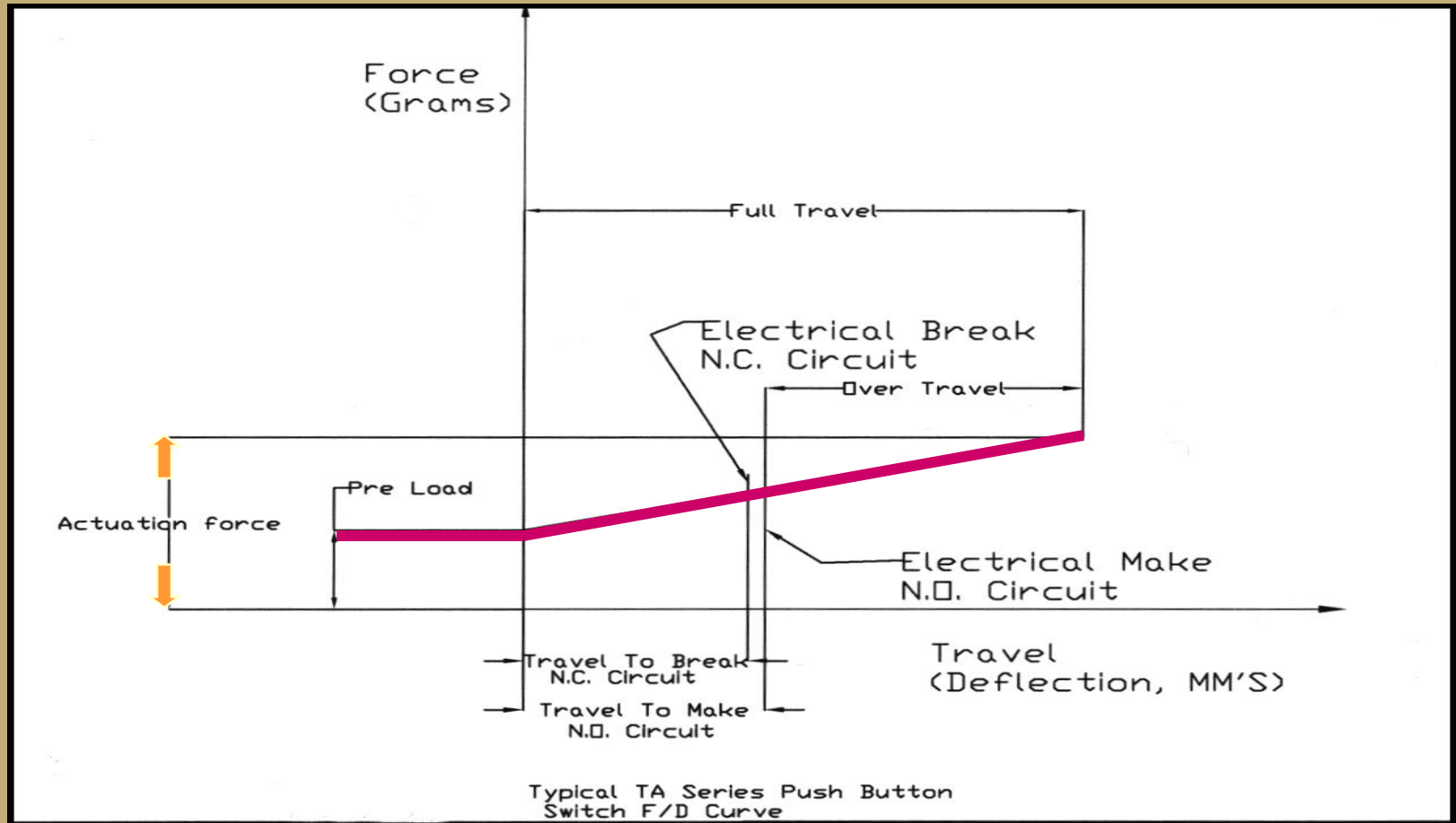
Switch Function Mechanical

- **FORCE / DEFLECTION CURVE - Tact or Dome**



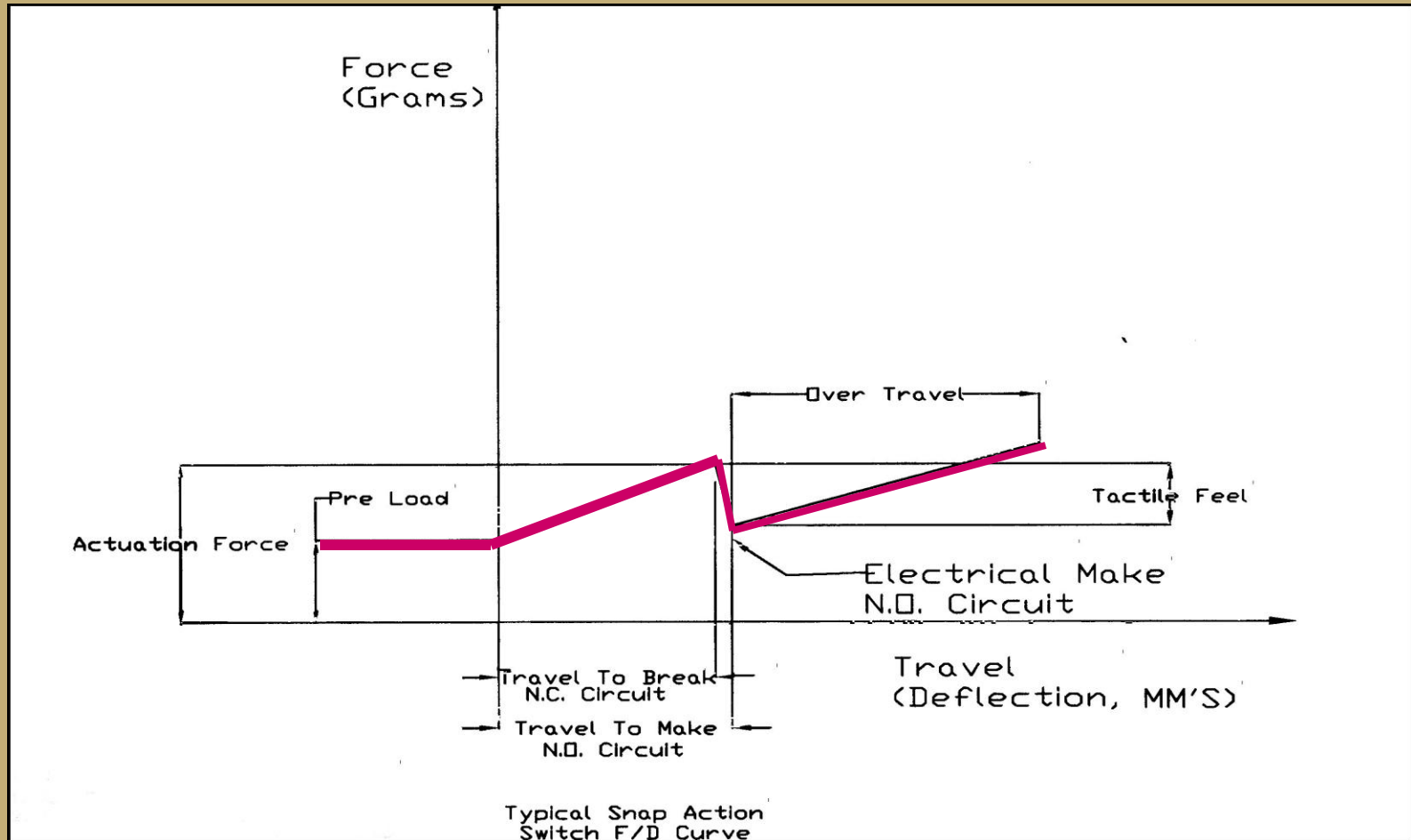
Switch Function Mechanical

- **FORCE / DEFLECTION CURVE - Push Button**



Switch Function Mechanical

- **FORCE / DEFLECTION CURVE - Snap Action**





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Switch Function Electrical

- **CONTACT RATING**
- Volts AC or Volts DC - measured in VAC or VDC
- Current Rating - measured in milliamps or amps
- Electrical Life (cycles under load)
- Contact Resistance - milli-ohm measurement
- Contact Material - gold or silver (typically alloyed)



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Switch Function Electrical

- **INSULATION RATING**
- Insulation Resistance - Meg-ohms
- Dielectric Withstanding - Volts AC or DC
- (Dielectric Withstanding) - High-pot



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Process Applications

- **HAND SOLDER**
- **15 - 30** watt solder iron typical
- Typical solder iron tip temperature – 650-700 F
- Typical solder dwell time - 3 seconds
- No-clean fluxes generally used, if not, cleaning is required (bottom-side only)



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Process Applications

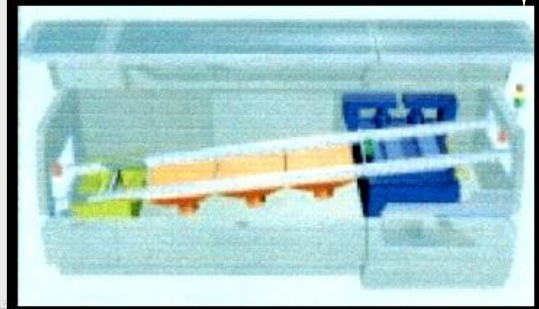
- **WAVE SOLDER**
- Typical solder temperature - 500 F. (260 C.)
- Typical solder dwell time - 3 seconds
- Typical belt speed - 20 inches/minute
- Typical preheat temperature - 266 F. (130 C.)
- OA (organic acid) water wash fluxes generally used
- Water wash or hand cleaning required

Process Applications

- **TYPICAL WAVE SOLDER EQUIPMENT**



- WAVE ZONES (3)
- **FLUX**
- **PREHEAT**
- **WAVE SOLDER**

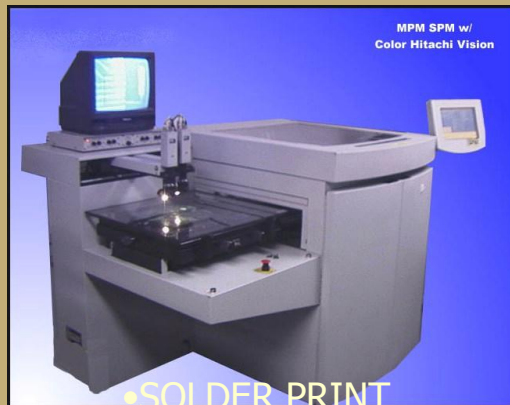




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Process Applications

- **SMT**
- Typical max temp - 464 F (240 C)
- Typical belt speed - 20 inches/minute
- No-clean or OA fluxes typically used



Process Applications

- SMT TYPICAL SOLDER REFLOW PROFILE**

Figure 1. JEDEC Recommended Lead-Free Reflow Profile

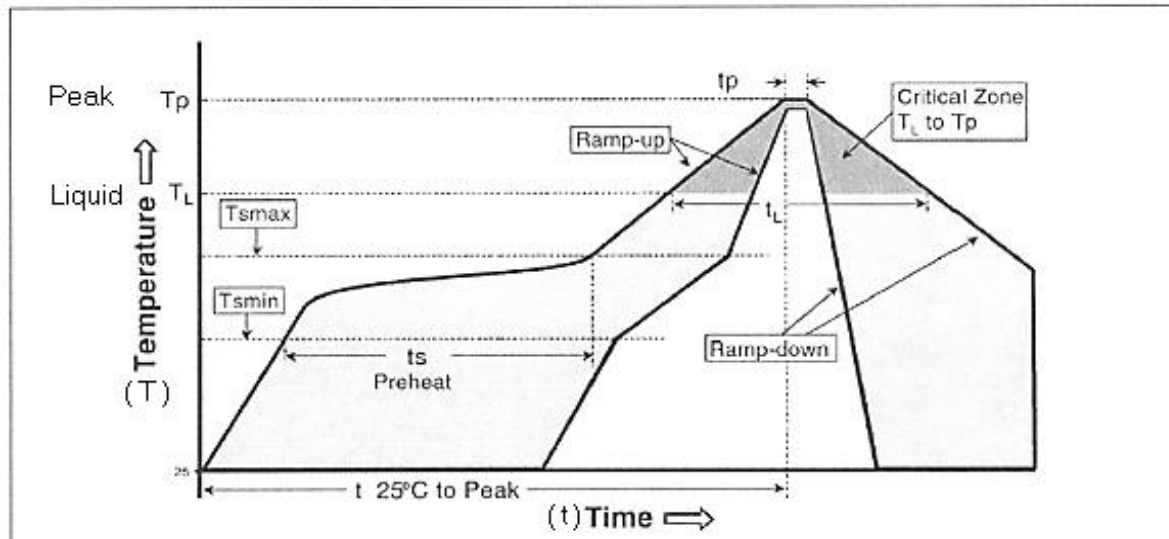


Table 1. Lead-Free Reflow Profile Parameters

Profile Parameter	Lead-Free Assembly, Convection, IR/Convection
Ramp-up rate (T_{smax} to T_p)	3 °C/second max.
Preheat temperature (T_{smin} to T_{smax})	150 °C to 200 °C
Preheat time (t_s)	60 – 180 seconds
Time above T_L , 217 °C (t_L)	60 – 150 seconds
Peak temperature (T_p)	240 C - Typical (464 F)
Time within 5 °C of peak temperature (t_p)	20 - 40 seconds
Ramp-down rate	6 °C/second max.
Time 25 °C to peak temperature	8 minutes max.



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Process Applications

- **SMT TYPICAL SOLDER REFLOW PASTE**
 - **Sn/Ag/Cu** - (tin, silver, copper)
95.5/3.9/0.6 - Solid 216 C / Liquid 217 C (422 F)
 - (Sn/Pb – 63/37) – Solid 182 C / Liquid 183 C (362 F)

Process Applications

- **TYPICAL WATER WASH** (high-pressure water)
- Requires "WASH SEALED" switch, typical wash temp - 150 F
- Typical Zones -- PREWASH -- WASH -- WASH -- RINSE -- DRY



Basic Switch Categories

- **Non-Sealed**

No Special Construction To “Seal” Switch

- **Flux Resistant**

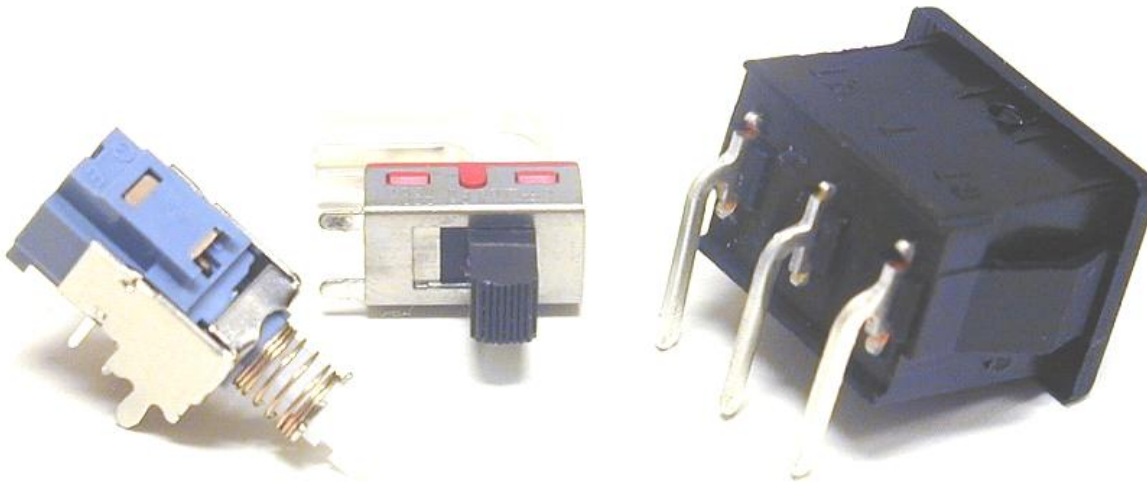
Typically Epoxy or RTV Used To Seal Terminals

- **Wash Tight**

Switch Construction Specifically Designed To Allow Machine Washing

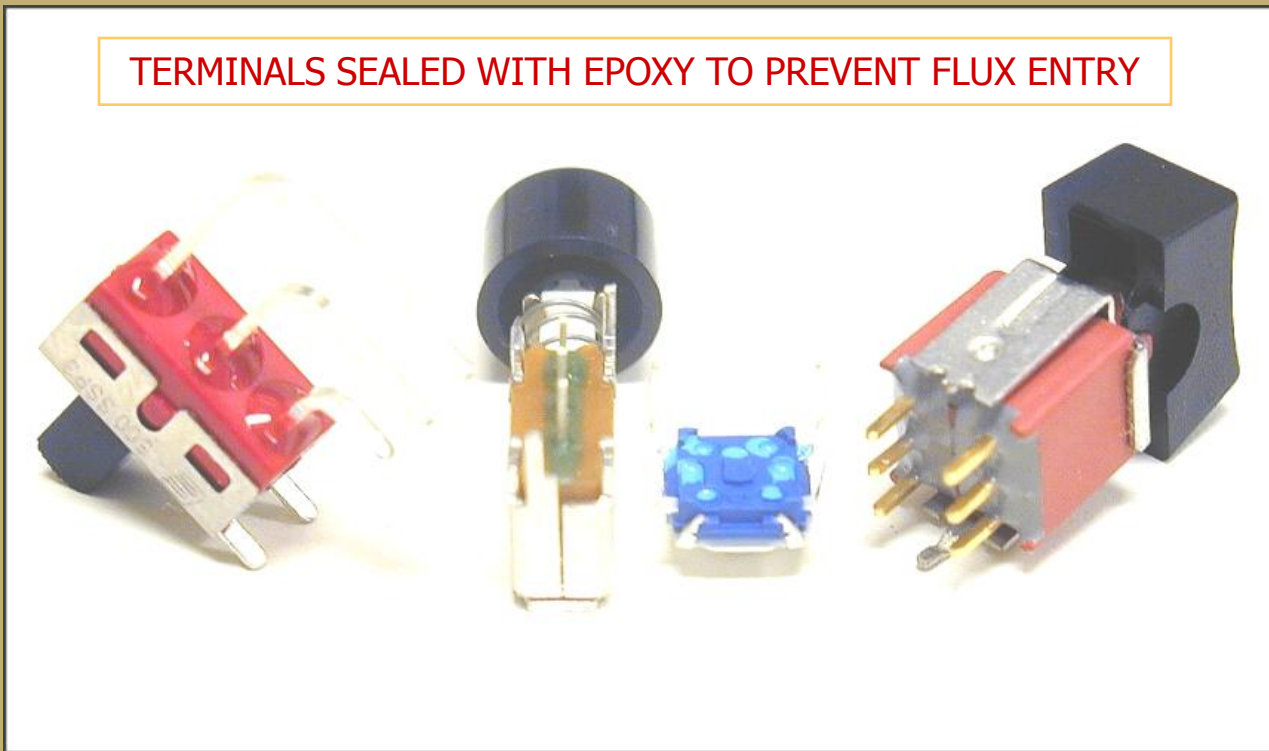
Non-Sealed

NO SPECIAL SWITCH CONSTRUCTION TO PREVENT FLUID ENTRY



Flux Resistant

TERMINALS SEALED WITH EPOXY TO PREVENT FLUX ENTRY



Wash Tight (TL6700, TL6100, TL6110, TL6120, 100A, 200A, 200B, 300A, 400A)

SWITCH SPECIFICALLY DESIGNED TO PREVENT WASH WATER ENTRY



Note : "Wash Tight" is NOT the same as "WATERPROOF".

"Wash Tight" is intended to provide protection from water entry into the switch, under reasonable wash conditions. The ability of the switch to pass this criteria is based upon test data from the MIL-STD-202E Heated Fluorocarbon Immersion Test. This test cannot guarantee performance in all wash conditions, due to the wide range of varying machine conditions. Our testing indicates 40 PSIG wash pressure can be tolerated.



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Seal Test Standards

- IP 40 (sealed against solid objects > 1mm dia.)
- IP 50 (dust protected)
- IP54 (dust protected / splashing water protected)
- IP 60 (dust tight)
- IP 64 (dust tight / splashing water protected)
- IP 65 (dust tight / water jet protected)
- IP 67 (dust tight / water immersion protected)



Seal Test Standards

- MIL-Std-883C Method 1011 Test Condition A

Immersion in a +100 degree C. water bath -- 5 minutes

Immediately transfer to 0 degree C. water bath -- 5 minutes

REPEAT ABOVE 10 CYCLES

Measure Insulation Resistance Before and After Immersion

Disassemble Switch After and Examine For Evidence of Water

* Destructive Test (Most suited for design and R&D)



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Seal Test Standards

- MIL-Std-202E Method 112 Test Condition D

Immersion in a Fluorocarbon Liquid at +125 C for 20 Seconds

(note : a lower temp. (max. temp. the switch is rated for) may be necessary

A Steady Stream of Bubbles From The Switch Indicates a Leak

* Preferred Test Method (Non-Destructive, most suitable for production testing)



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“Process Sealed” Benefits

- Switch Processed Normally With Other Standard Components
(SIGNIFICANT COST-REDUCTION DUE TO REDUCED HANDLING AND TIME)
- Enhanced Contact Reliability Due To Sealing
(LONG-TERM CONTACT PERFORMANCE BENEFIT)

Seal Testing

- **Preferred Method** - Heated Fluorinert Bath



MIL-Std-202E Method 112 Test Condition D

A Fluorinert liquid bath is heated to 125 degrees C., or the switch maximum operating temperature, (usually 85 degrees C.). The device under test is lowered into the heated bath, causing the trapped air inside the device to expand. Any substantial leak path can then be readily identified by a stream of bubbles escaping from the switch body. The standard test time is 60 seconds, but may be reduced to 30 seconds for high-volume production testing, as failures typically occur within 15 - 20 seconds after submersion.

Passing of this test results in a switch that will meet most solder and wash processes, but unique wash circumstances will still prevail, and can lead to switch failures, such as extreme wash pressures, temperatures, thermal shock, etc. Correlation between the test and the actual wash process may be required.



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Switch Glossary of Terms

Actuator: The mechanical interface between the basic switch contacts and the means of operation, such as the operator's finger.

Actuation Force: The required force to change a circuit's electrical state.

Alternate Action Switch: A Pushbutton style switch where the change of the electrical state is maintained between actuations

Ampere: A unit of electrical current flow

Break Before Make: The term given to a double throw switch where the first circuit is opened before the second circuit is closed

Contact Bounce: Oscillation of the movable contact upon closure of the circuit

Contact Resistance: The resistance of current flow across closed contacts

Dielectric strength: The ability of an insulating material to resist voltage from arcing across its surface.

Insulation resistance: The resistance to current flow of the insulating materials between contacts

Make Before Break: The term given to a double throw switch when the second circuit is closed before the first circuit is opened



Switch Glossary of Terms

Momentary Action Switch: The term given to a switch where a circuit is continuously closed or open only when force is applied. The electrical state returns to it's normal position when the force is removed.

Normally Closed: The term given to a switch where a circuit is closed in the normal switch position

Normally Open: The term given to a switch where a circuit is open in the normal switch position

Over Travel: The distance an actuator travels after the circuit is closed

Pole: The term to denote a completely separate circuit, which passes through a switch at one time

Pre Travel: The movement of the actuator prior to closing the circuit

Throw: The term denotes the number of positions in which a given pole is closed

Travel to Make: The distance parallel to the designated direction of the actuator movement at which point a circuit is closed

Switch Abbreviations:

N.C.	Normally Closed circuit
N.O.	Normally Open circuit
SPST	Single Pole Single Throw
SPDT	Single Pole Double Throw
DPST	Double Pole Single Throw
DPDT	Double Pole Double Throw
MBB	Make Before Break
BBM	Break Before Make