SGS-THOMSON MICROELECTRONICS

APPLICATION NOTE

SOLDERING RECOMMENDATIONS and PACKAGING INFORMATION

by the Micro Divisions

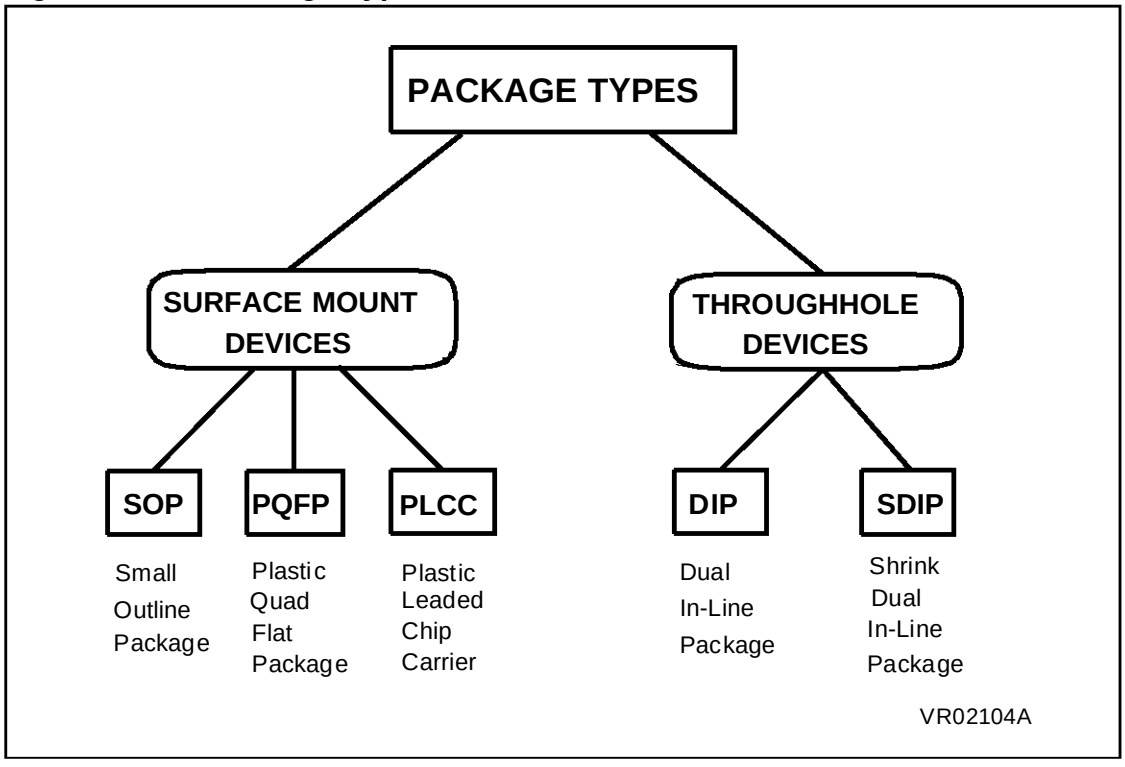
INTRODUCTION

SGS-THOMSON supports various package types to adapt MCUs to customer requirements. Beside the available mounting technology (SMD or Throughhole), the choice is often driven by technical and economical concerns. This application note describes the various package types used for MCUs, introduces the various mounting technologies and gives soldering recommendations.

1 PACKAGE TYPES

Each package should be produced and used in an overall economic way up to a **maximum pin count**.. Here is a graph showing the different packages available for **Surface Mount Devices** and for **Throughhole devices.**

Figure 1. MCU Package Types



PACKAGE TYPES

The different packages available at SGS-THOMSON (for 8 Bits MCU Devices) are detailed in the following table:

Number of Pins	16	20	24	28	40	42	44	52	56	64	68	80	84	100
SOP	•	•		•										
PQFP (14x14)								•		•				
PQFP (14x20)												•		•
PLCC							•				•		•	
DIP (300)	•	•												
DIP (600)			•	•	•									
SDIP						•			•					

Through **H**ole **T**echnology (THT) and **S**urface **M**ount **T**echnology (SMT) imply different soldering technologies leading to different constraints.

In THT, the package body is exposed to relatively low temperatures (< 150 °C) because the lead extremities are only dipped in the soldering alloy whereas in SMT, the whole package body is exposed to a very high temperature (> 200 °C) during reflow soldering process.

Furthermore, molding compounds used for integrated circuit encapsulation absorb moisture from the ambient medium. During rapid heating in **solder reflow process** (see further for more details), this absorbed moisture can vaporize, generating pressure at lead frame pad / silicon to plastic interfaces in the package, with a risk of package cracking and potential degradation of device reliability.

2 SMD PRESENTATION

Unlike throughhole technology that inserts leads into the printed circuit board, SMD package is attached directly onto mounting pads of the substrate. **Surface Mount Technology** is extensively used in electronic applications because it has the following advantages:

– Packages are smaller and support higher pin counts

– Packages are light and compact, thus reducing systems sizes

– Mounting can be done on either side of the PCB

– No cost for drilling holes into the PCB

– Surface mount technology also comes along with a few disadvantages:

– Increased sensitivity to soldering heat because of their thinner dimension

– Soldering conditions harder to determine (use of finer structures and higher pin count)

Handling SMDs

Though the intrinsic reliability of SMD packages is now excellent, the use of inappropriate techniques or unsuitable tools during **mechanical handling** can affect the long term reliability of the device, or even destroy it.

When handling a SMD package, it is strongly recommended to use adapted tools such as vacuum pipes to avoid touching the pins as much as possible. Manual handling could affect lead coplanarity and generate solderability problems. It is also not allowed to widen the interval between two consecutive pins.

3 SOLDERING

a) Soldering methods

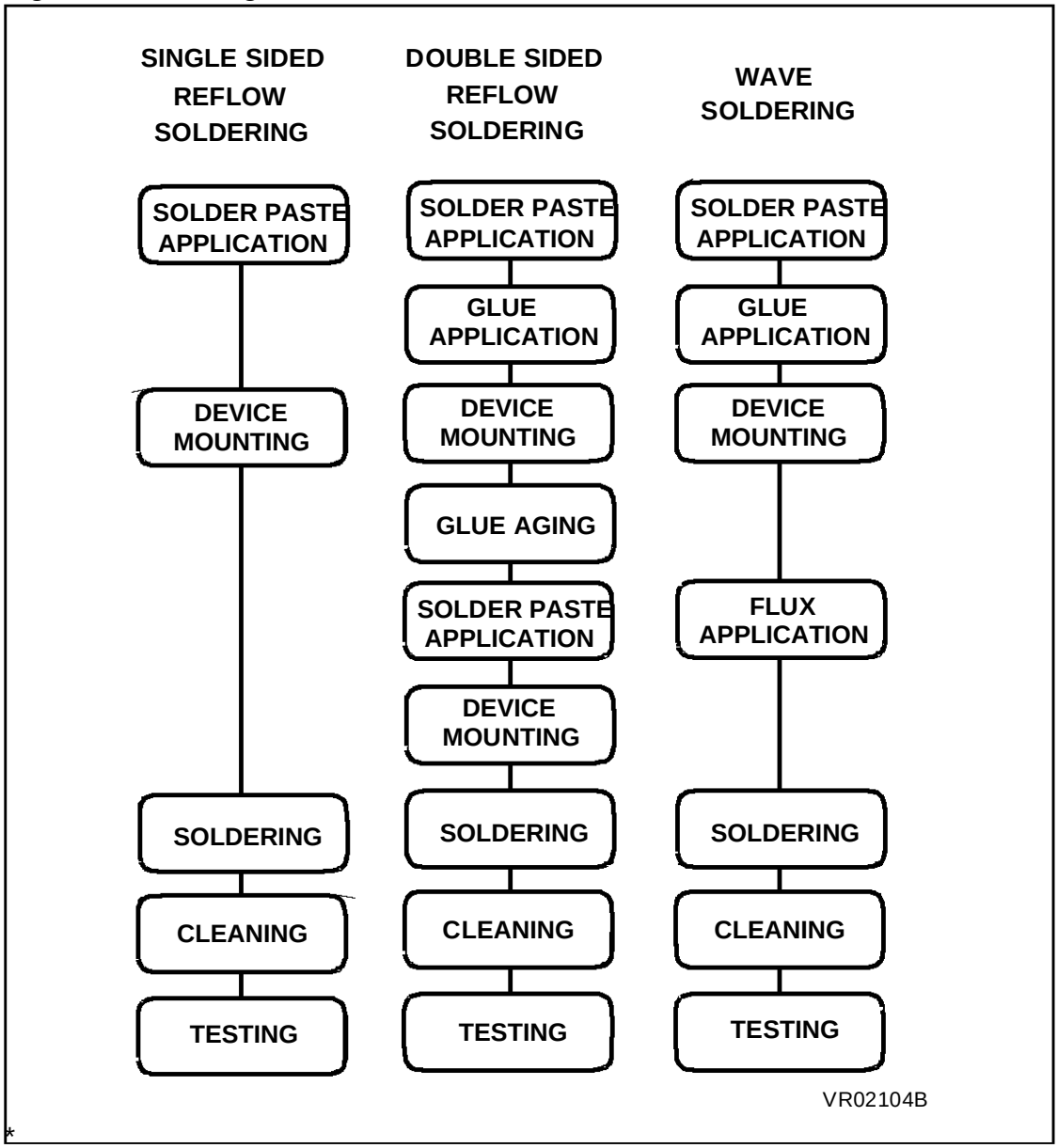
There are 3 main soldering methods (which are detailed on the following graph):

(1) Single Sided Reflow Soldering

(2) Double Sided Reflow Soldering

(3) Wave Soldering

Figure 2. Soldering Methods



*

Bending leads. In all processes it is important to avoid straining the package and particularly the area where the leads enter the encapsulating resin. If the package / lead interface is strained the resistance to humidity and thermal stress will be compromised, affecting device reliability.

Insertion. When mounting devices on a printed circuit board the golden rule is, again, to avoid stress. In particular, adhere to the specified pin spacing of the device: do not try to bend the leads to fit non-standard hole spacing.

b) Soldering recommendations

The following recommendations must be followed for soldering each package type:

	WAVE SOLDERING	REFLOW SOLDERING
SOP	+	++
PLCC	Impossible	++
PQFP	Not Advised	++
DIP	++	Impossible

Reflow soldering with DIP and **wave soldering with PLCC** are strictly impossible due to the lead configuration.

Wave soldering with PQFP is not recommended because it's difficult to avoid solder bridges when leads pass through the double wave.

c) Reflow soldering conditions

The greater danger during reflow soldering is **overheating**. If an integrated circuit is exposed to high temperature for an excessive period it may be damaged and its reliability reduced.

It is also important to use suitable fluxes for the soldering baths to avoid deterioration of the leads or package resin. Residual flux between the leads or in contact with the resin must be removed to guarantee long term reliability. The solvent used to remove excess flux should be chosen with care. In particular, trichloroethylene (CHCl: CCl_2) - base solvents should be avoided because the residue could corrode the encapsulating resin.

High quality, low defect soldering requires identifying the **optimum temperature profile** for reflowing the solder paste, therefore optimizing the process. The heating and cooling rise rates must be compatible with the solder paste and components.

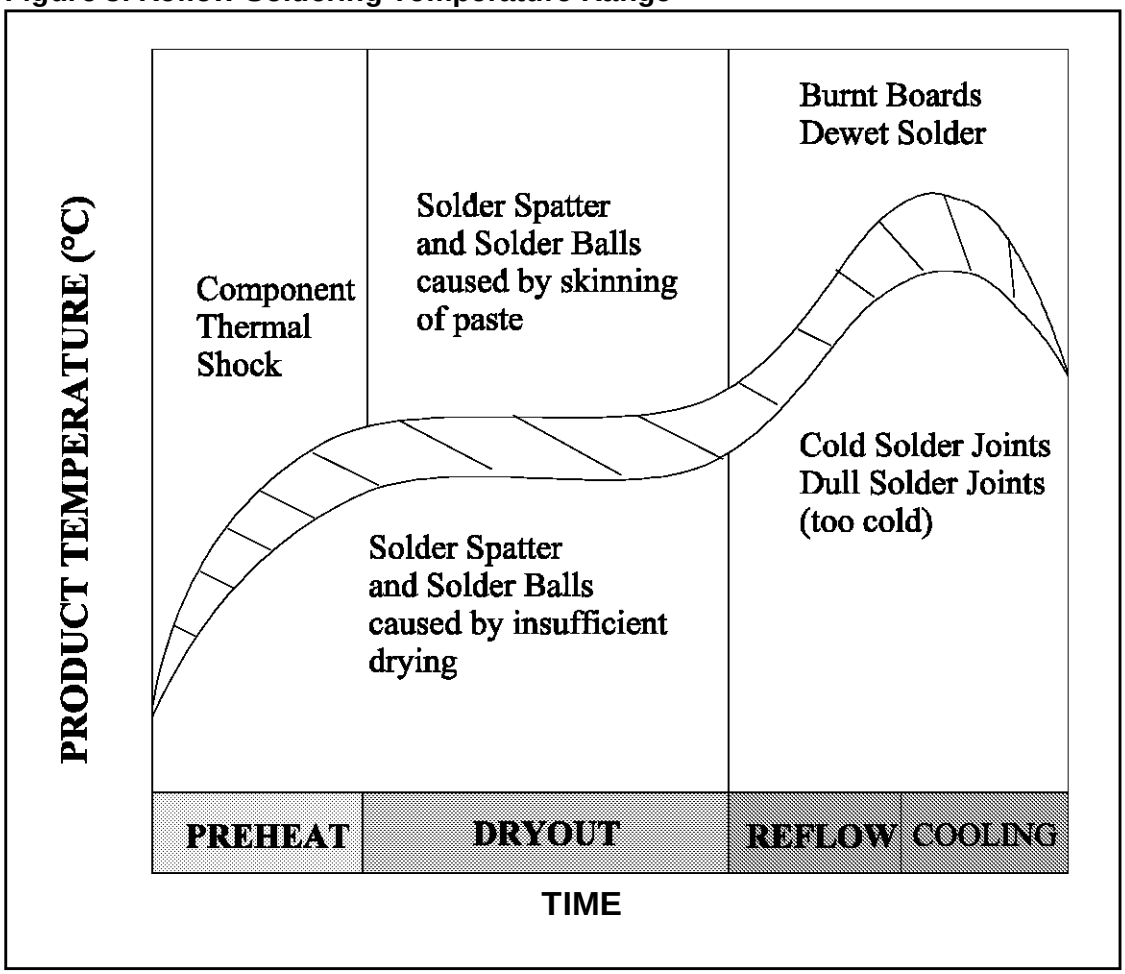
A typical profile consists of a preheat, dryout and reflow sections.

The most critical parameter in the **preheat section** is to minimize the rate of temperature rise to less than 2°C / second, in order to minimize thermal shock on the semiconductor components.

Dryout section is used primarily to ensure that the solder paste is fully dried before hitting reflow temperatures.

Solder reflow is accomplished in the **reflow zone**, where the solder paste is elevated to a temperature greater than the melting point of the solder. Melting temperature must be exceeded by approximately 20 ° C to ensure quality reflow.

Figure 3. Reflow Soldering Temperature Range



In reality the profile is not a line, but rather **a range of temperatures** all solder joints must be exposed. The total temperature deviation from component thermal mismatch, oven loading and oven uniformity must be within the band.

Here are the recommended profiles for **reflow** and **wave soldering**.

Figure 4. Recommended Reflow Soldering Profile

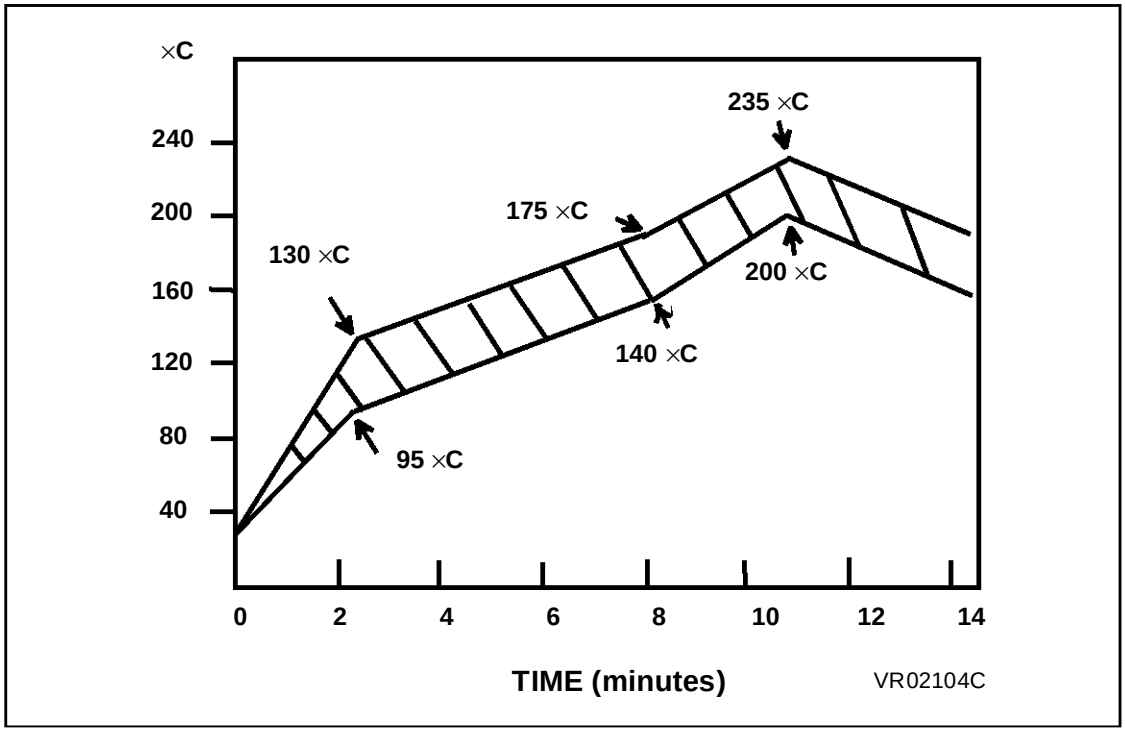
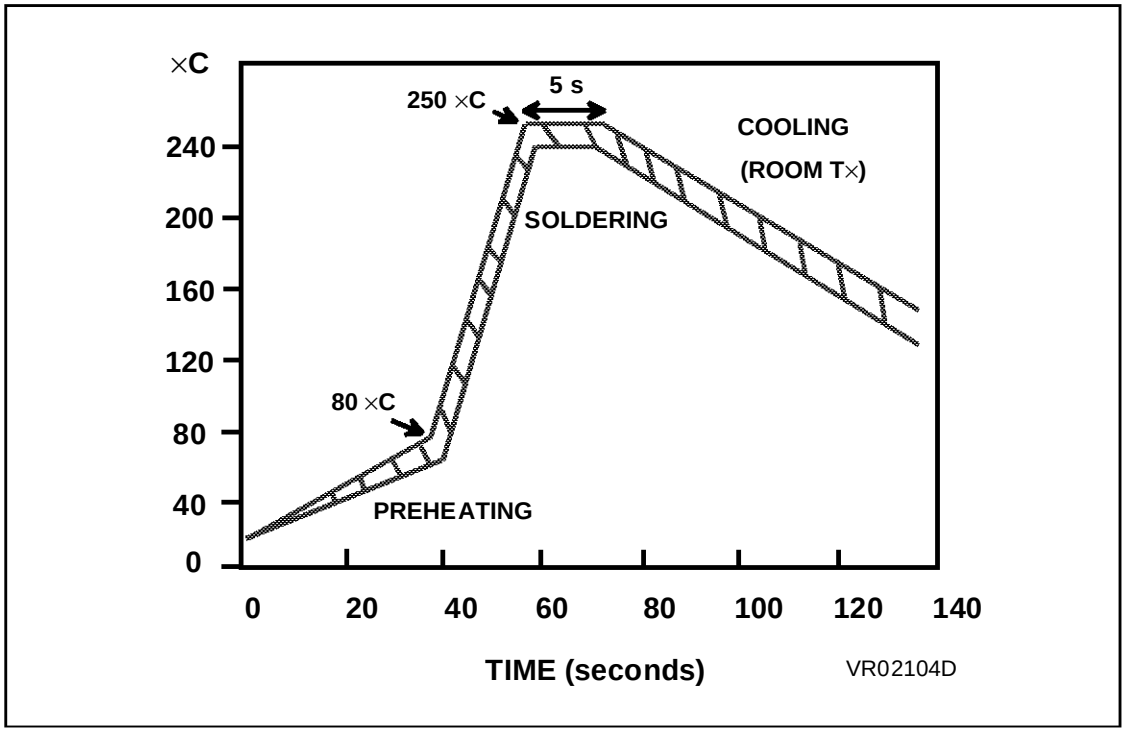


Figure 5. Recommended Wave Soldering Profile



4 SMD GLUABILITY

We strongly recommend our customers to follow glue application specifications from their glue supplier. We also recommend 100% glue polymerization for optimal glue efficiency.

Figure 6. Recommended profiles for glue polymerization using regular oven and linear flow oven

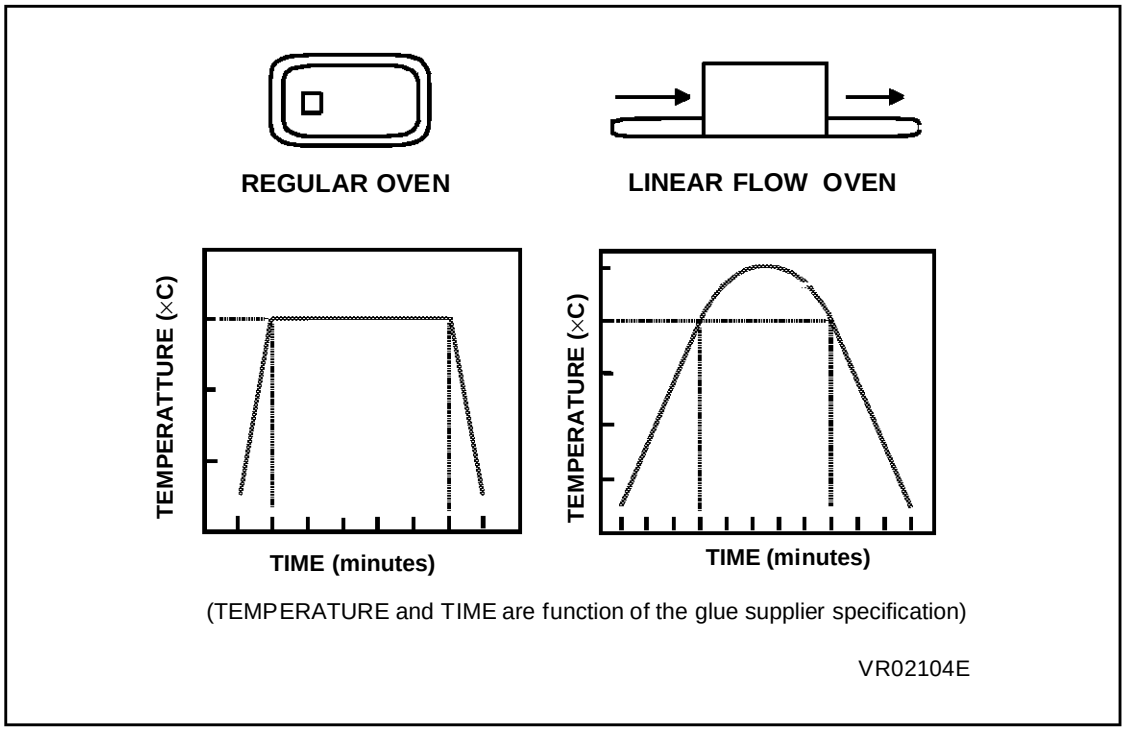
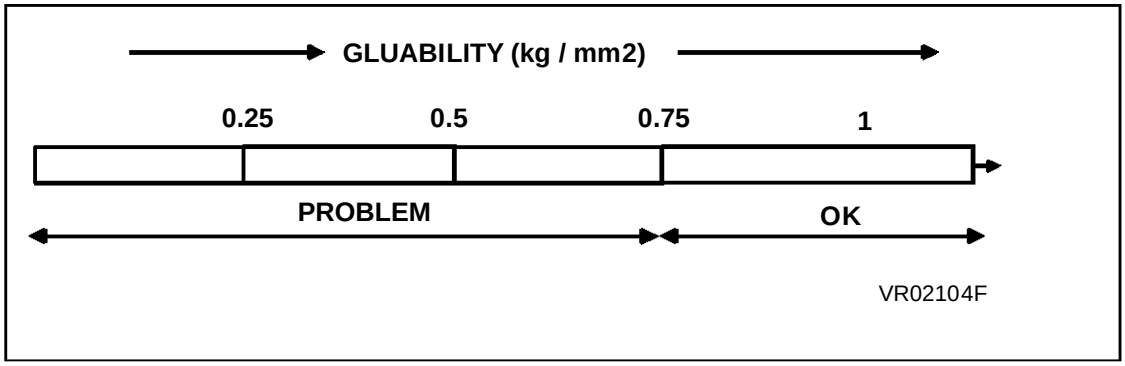


Figure 7. Gluability Evaluation with a Shear Test.



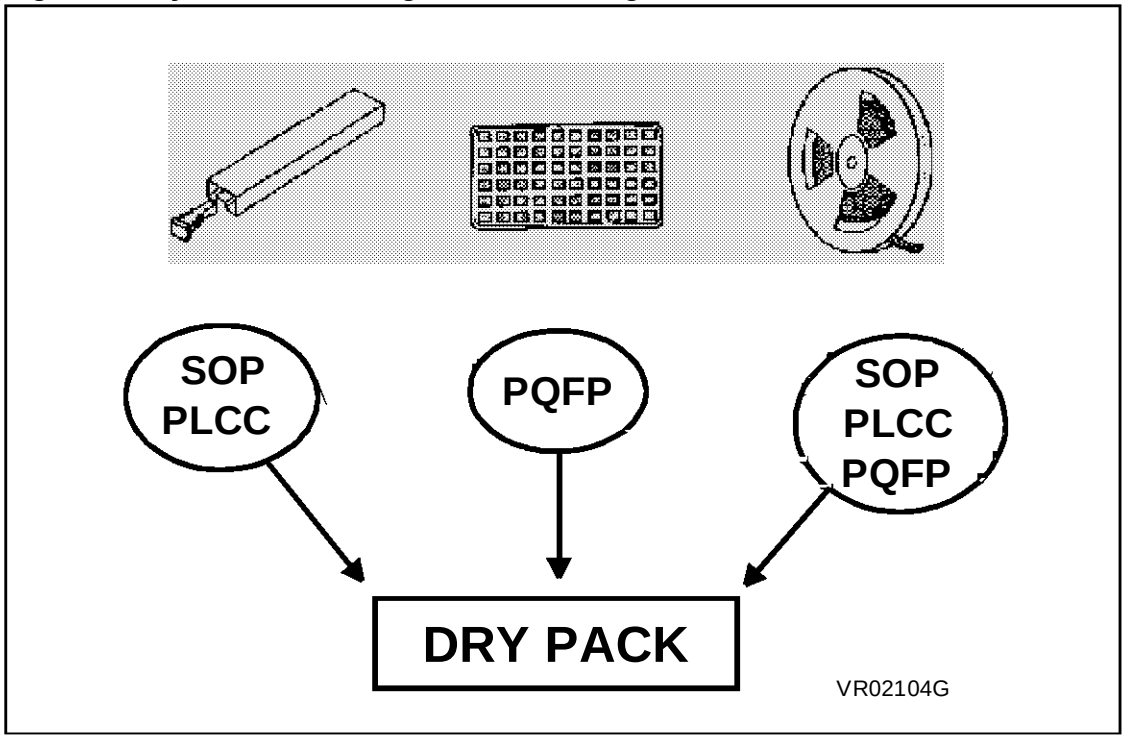
Various tests have shown that glue shear test specification limit is 0.75 kg / mm^2 minimum. Customer complaints usually happen when values are below 0.5 kg / mm^2. It has been verified that below 0.25 kg / mm^2 components fall from PCB during handling. General capability in plastic SMD is greater than 1 kg / mm^2.

5 DRY PACKING

Quality and reliability of SMDs after soldering depends heavily on **moisture absorption during storage**. A specific packing, called Dry-Pack, was implemented for defined conditions at the delivery. Time and environment will modify the amount of absorbed humidity. Moisture sensitive Surface Mount Devices (SOP, PLCC, PQFP) are dry packed to protect them from moisture absorption during shipment / storage and then to reduce failure risks mainly due to popcorn effect.

Pop-corn effect. Pop-corn effect is the cracking of the package during the soldering cycle. It has got a growing importance due to the trends towards larger die size in integrated circuits. This phenomenon is mainly caused by the moisture absorbed by the epoxy molding. When the package is exposed to high temperatures, as in most SMT soldering processes, the water at the interface between plastic and die pad vaporizes suddenly, generating high internal pressure. Cracks may occur in the molding compound depending on the absorbed moisture level, soldering temperature and time, die size, package structure and molding compound characteristics.

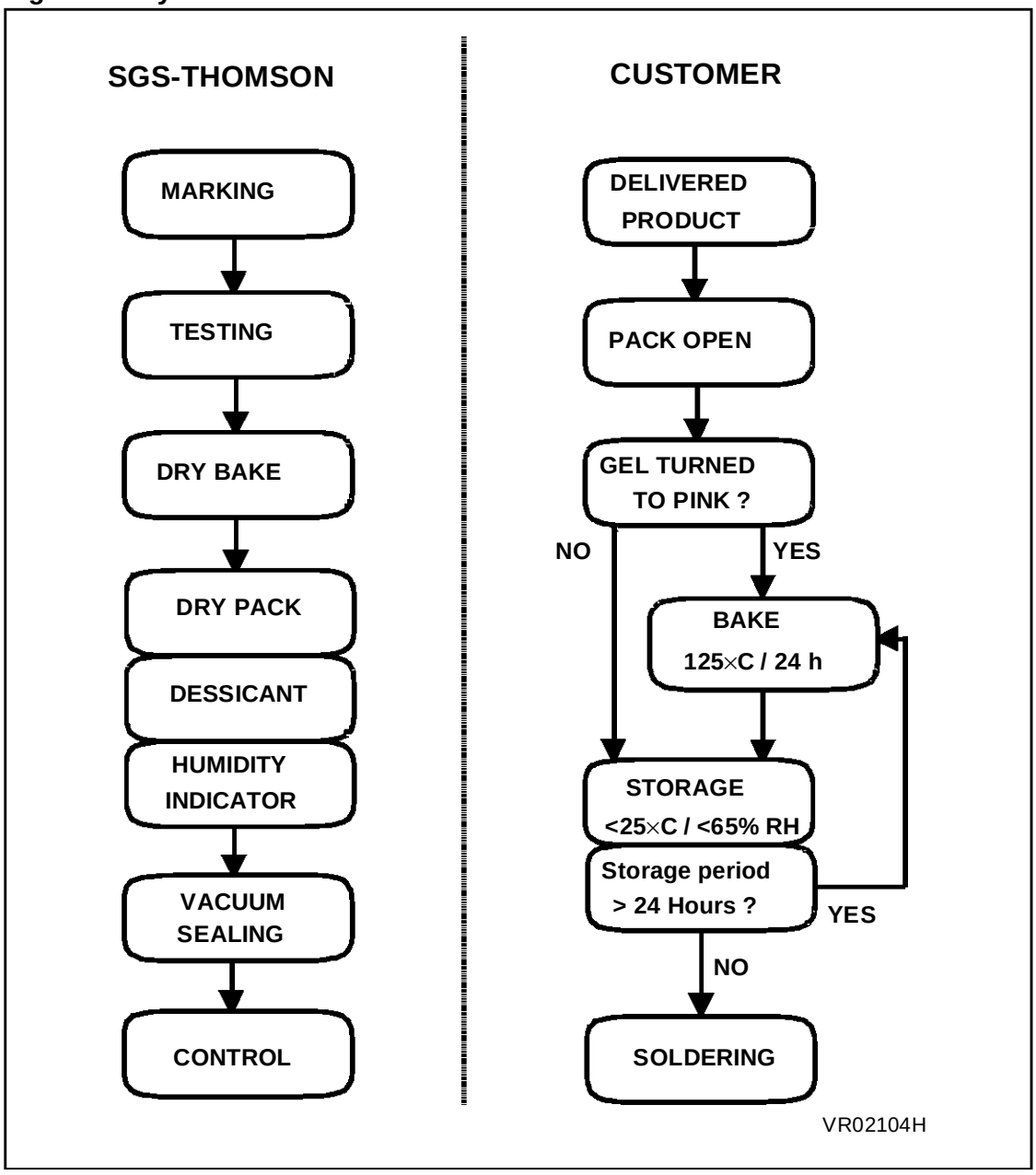
Figure 8. Dry Pack according to SMD Package



*SMD products are contained in **tubes**, on **trays** or on **tape**, and are then vacuum sealed in an hermetic bag.*

Opening the package will stop the ideal conditions and start the influence of the normal environment. The following diagram shows the recommended handling flow.

Figure 9. Dry Pack Flow Chart



Storage Conditions

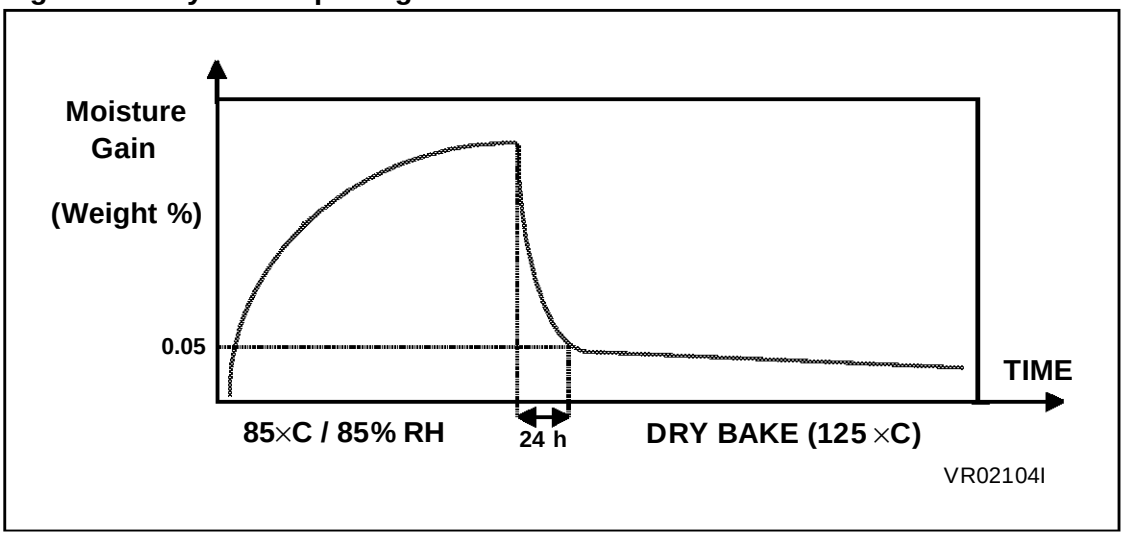
Parts with Dry Pack are recommended to be stored in Dry Boxes (i.e. cabinets under nitrogen atmosphere). When no dry boxes are available, the following environmental conditions are recommended for storage:

TEMPERATURE	5 → 30 °C
HUMIDITY	60% maximum

Dust should also be minimized. There should be no vibration or shock which could distort the packing container. To avoid excess weight packing, containers should not be stacked on top of each other.

Dry Pack Opening. After opening a dry pack, soldering should be done within a 24 hours period. SMD products stored over the specified storage period need to be baked at 125° for 24 hours (under nitrogen atmosphere). Devices packed in **tubes** or in **tapes** must be transferred to metal tubes before baking whereas **trays are bakable**.

Figure 10. Dry Pack Opening Recommended Procedure



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