APPLICATION NOTE

Application Guidelines for Board Mounted Power Modules

AN04-001 Soldering and Cleaning Guidelines for Board-Mounted Power Modules

Introduction

Board-mounted power modules are purchased by many different and diverse customers for a broad range of applications. there are just as many different soldering techniques and cleaning processes. If a power module is exposed to an excessive amount of heat or an inappropriate cleaning process, the reliability, appearance, and testability of the power module or of the finished circuit card can be greatly affected. All of the ABB power modules are designed to be compatible with hand-soldering, wave-soldering, and post solder cleaning processes. However, some limitations do exist. This document outlines the recommended soldering and cleaning procedures for ABB board-mounted power modules. If soldering or cleaning guidelines are listed in a data sheet for a specific device, then the data sheet overrides this application note.

Hand Soldering

Hand soldering is the least preferred method due to the variability of the amount of solder applied, the time the soldering iron is held on the joint, the temperature of the iron, and the temperature of the solder joint. The hand-soldering guidelines listed in 1 were developed for small-diameter terminals (0.050 in. or smaller) and for large-diameter terminals (greater than 0.050 in.)

These guidelines may require modification to optimize the soldering time for your particular circuit board or soldering iron. The exact soldering time and temperature for your specific application can be determined by mounting a thermocouple to the power module terminal next to the potting material or case using high-temperature solder (i.e., 95/5 or similar). The minimum soldering time is defined as the time required for the terminal to reach 125 °C. The maximum soldering time is the time required for the terminal to reach 165 °C. The power module's internal temperature must stay below the critical continuous temperature of 183 °C.

Parameter	Terminal Diameter	
	0.031 in.	**0.062 ijn.**
Test Board:		
Via Drill	0.050 in.	0.100 in.
Copper	2 oz.	2 oz.
Soldering Iron:		
Wattage	70	70
Tip Size	1/8 in. wide	1/8 in. wide
Tip Temperature	425°C	425°C
Soldering Time		
Minimum	2 seconds	4 seconds
Maximum	4 seconds	10 seconds

Table 1 Power Module Hand Soldering Guidelines

Wave Soldering

Wave soldering is the most popular mass soldering method for the solder attachment of through-hole component leads. Power modules are designed to be compatible with single-wave or dual-wave soldering machines. The suggested soldering process will keep the power module's internal temperature below the critical continuous temperature of 183 °C. The typical recommended preheat temperature range is 90 °C to 105 °C on the top side (component side) of the circuit board. The circuit-board bottom side preheat temperature is typically recommended to be greater than 120 °C, and preferable within 100 °C of the solder-wave temperature. A maximum preheat rate of 4 °C/s is suggested. The maximum recommended solder pot temperature is 250 °C, with the solder-wave dwell time of 3 seconds typical and 6 seconds maximum.

IR Reflow

Standard board-mounted power modules cannot tolerate the temperatures of IR ovens. The warranty is null and void if a module is put through an IR reflow oven. The exceptions are surface-mounted modules, Refer to the specific data sheets for the recommended IR reflow process.

Solder Balls/Cleanliness of Open Frame (Uncased/Unpotted) Power Modules

The open frame (uncased/unpotted) power modules will meet the solder balls requirement per ANSI specification J-STD-001B, which states the solder balls must neither be loose nor violate the power module minimum electrical spacing. The cleanliness designator, as defined in the J specification for the open frame power modules, is C00.

Cleaning Process

Converters with heat plate mounted on them should rarely be subjected to a cleaning process since the cleaning fluid may remove the thermal paste compound applied between the components and the heat plate assembly.

Post solder cleaning is usually the final circuit-board assembly process prior to electrical-board testing. The result of inadequate circuit-board cleaning can affect both the reliability of a power module and the testability of the finished circuit-board assembly. Power modules are compatible with most cleaning processes when a few basic rules are followed.

Cleaning materials are chosen based on their appropriateness in removing the specific flux residue and their compatibility with assembly materials, cleaning equipment, and the circuit-board component materials. Typical cleaning materials fall into one of the following four categories: water (deionized or tap), aqueous detergent, aqueous emulsion, or solvent.

Historically, the electronics industry used solvents that are now being restricted in their use or eliminated in consideration of environmental and occupational health and safety reasons. Nonflammable chlorocarbon or fluorocarbon solvents blended with other solvents were developed to remove rosin-based fluxes and pastes, or the synthetic activated (SA) fluxes. The chlorocarbon solvents generally used are trichloroethane, trichloroethylene, or perchloroethylene, while the fluorochlorocarbon solvent is based on trichlorotrifluoroethane (Fluorocarbon 113 or Freon TF). These solvents can remove nonionic or nonpolar organic contaminants (i.e., rosin, oils, organic film) much more readily than ionic contaminants. The nonhalogenated, flammable solvents such as alcohol, aromatic hydrocarbons, or ketones find a limited usage today due to their flammability and the safety involved in cleaning with these solvents.

For cleaning operations in which encapsulated power modules are directly exposed to solvents, the exposure time in the vapor/immersion zone should be less than 3 min. due to the compatibility of the potting material. Either batch or in-line solvent cleaning machines can be used as long as the maximum 3 min. exposure time is observed.

If a water-soluble flux has been used for soldering, its residues can be cleaned with water only, or water and detergent. In the case of rosin-based fluxes or pastes, a substantial concentration (4%—10% by volume) of alkaline detergent in water is needed to remove those residues. Commercially available detergents for aqueous detergent cleaning systems are based on alkanolamines, such as monoethanolamine, and are acceptable for use with all encapsulated or open power modules. Since these detergents are alkaline, thorough rinsing of the detergent residue from the board is imperative. Synthetic-activated fluxes cannot be cleaned with aqueous detergent.

An aqueous emulsion cleaner utilizes a 50:50 mixture of water and a solvent emulsion of terpene hydrocarbons. In a spray-cleaning operation, a concentrated solution of the terpene hydrocarbon solvent is usually used to avoid excessive foaming. this concentrated solution can effectively remove rosin-based solder paste residues. Encapsulated power modules must be limited to 3 min. exposure times in the concentrated forms of this cleaner. It is also recommended that the cleaner be thoroughly rinsed from under the power module. spray pressures of 50 psi. at the nozzle are acceptable.

When high-activity flux (synthetic activated or organic activated) with a halide (chloride,…) activator is used, the standoffs incorporated into the modules are generally sufficient to achieve effective cleaning. However, depending on the size of the module, the location of the module on the board, and the component density adjacent to the module, the standoff height may need to be increased. Nylon washers placed over the terminals can be used as standoffs. Recessed standoffs, as on the JW series, are not sufficient for SA fluxes. When the extra standoffs are attached to the module through the heat sink mounting position, a maximum of 5 in.-lb. torque must be observed. It is recommended that an ionic residue test be used with all high-activity fluxes to determine the cleanliness level and the optimum standoff height.

In aqueous cleaning, it is preferred to have an in-line cleaner system consisting of several cleaning stages (prewash, wash, rinse, final rinse, and drying). Deionized (DI) water is recommended for aqueous cleaning; the minimum resistivity level is 1 MΩ-cm. Tap-water quality varies per region in terms of hardness, chloride, and solid contents; therefore, the use of tap water is not recommended for aqueous cleaning.

PWB Cooling Prior to Cleaning

Power modules and their associated application PWB assemblies should not be wash-cleaned after soldering process until the power modules had an opportunity to cool to room ambient (25 °C). This will prevent vacuum absorption of the cleaning liquid into the module between the pins and the potting during cooling.

Drying

The drying section of the cleaner system should be equipped with blowers capable of generating 1000 cfm—1500 cfm of air so that the amount of rinse water left to be dried off with heat is minimal. Handheld air guns are not recommended due to the variability and consistency of the operation. For open power module constructions with magnetic structures (transformers and inductors) that have unpotted windings, a baking process of 100 °C for 30 min. is recommended for the assembly to ensure that the moisture and other potential foreign contaminants are driven out from the open windings. If the assembly is immediately tested after wash, temporary low insulation-resistance values and the resultant errors in testing can occur, particularly in a JIT environment. Once the transformer has been allowed to dry, the unit will return to its prewash insulation-resistance values.

Product-specific Precautions—Potted QW and QHW Modules

Potted Q modules require unique cleaning and application precautions. These modules may trap cleaning liquid within the device due to the package design and the method of internal PWB mounting within the potted Q device.

Potted Q modules are susceptible to the seal at the bottom surface of the case/fastener insert interface breaking when heat sinks are mounted due to stresses on the fastener sleeves. This means that cleaning liquid can be absorbed from below through the break between the insert and the potting. Potted Q modules with heat sinks should be dried in the same manner as is recommended for unpotted modules, i.e. at 100 °C for 10 minutes.

Threaded objects or other components should not be inserted into the threaded holes from the under-surface side of these modules. The threaded fasteners are designed to mount heat sinks onto the top surface of the module with fasteners inserted through the heat sink. Such objects at the underside can lead to cleaning solution entrapment in the fastener hole area and subsequent ingestion of the liquid into the module and failure.

Metal Case Product Post-wash Discoloration (MK005, MK010, LW016, LW020, and LW025)

There may be a slight discoloration of metal case modules when using a caustic detergent wash. This only impacts the appearance and does not affect the operation of the module.

Note: Please consult ABB on any other soldering/cleaning processes not mentioned in this application note.

Contact Us

For more information, call us at

1-877-546-3243 (US)

1-972-244-9288 (Int'l)

ABB
601 Shiloh Rd.
Plano, TX USA

abbpowerconversion.com