



# Fluorinert™ Electronic Liquids

## For Vapor Phase Reflow Soldering

### Application Information

#### Introduction

3M™ Fluorinert™ liquids are a family of clear, colorless, odorless perfluorinated fluids having a viscosity equivalent to water but approximately 75% greater density. These products are thermally and chemically stable, compatible with sensitive materials (including metals, plastics and elastomers), non-flammable, practically non-toxic and leave essentially no residue upon evaporation.

The dielectric strength of perfluorinated liquids is high—in excess of 35,000 volts across a 0.1 inch gap. Water solubility is on the order of a few parts per million. The nominal boiling point of each fluid in this series is determined during their manufacture; Fluorinert liquids are available with boiling points ranging from 30°C to 215°C, and pour points as low as -101°C.

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#### Application

Vapor phase or condensation heating is a direct contact process that takes place in a zone of heated, saturated vapor. Heat is transferred when the hot, saturated vapor condenses on a surface and gives up its latent heat of vaporization. This heating mode has been adapted to mass reflow soldering, paint and polymer coating and polymer fusing, where it provides precise temperature control in a clean, non-oxidizing and non-flammable environment.

Adaptable to either batch or in-line continuous equipment, vapor phase soldering (VPS) offers speed, efficiency and high reliability. With proper system design and process control, zero-defect reflow soldering is feasible. High reliability soldering minimizes the high cost and delay of defective board rework.

Vapor phase soldering offers a higher rate of heat transfer than other reflow heating modes, conducting energy uniformly without dependence on circuit assembly mass, geometry, color or composition. Component temperature never exceeds the vapor temperature in a vapor phase system—a significant benefit for complex board architectures and low-mass, heat-sensitive devices, including surface mount technology. And it allows lower temperature processing than infrared or hot air processing.

Fluorinert liquids offer a unique combination of properties that make them ideal for electronics applications, including vapor phase soldering. These products have essentially no chemical reactivity, offer excellent dielectric properties, are non-flammable and leave essentially no residue—characteristics that are important to condensation reflow soldering performance. The saturated vapor generated from boiling Fluorinert liquid is very dense and easily contained. Elimination of oxygen allows for use of mild flux compounds, simplifying the cleaning of finished circuit boards.

Application  
(Continued)

Vapor phase heating applications for 3M™ Fluorinert™ liquids include:

- **BGA attach**
- **Conventional through-hole or SMT circuit assembly reflow**
- **Fluxless fusion of circuit board electroplating**
- **Fusing tin or tin/lead on device leads**
- **Assembly of metal components having complex geometric shapes**
- **Attaching through-hole components, lead frames, edge connectors**
- **Heat curing of plastics, epoxies and conductive inks**
- **Heat fusing powdered epoxies**

Typical  
Properties  
(Not for Specification  
Purposes)

All values determined  
at 25°C unless  
otherwise specified

Fluorinert Liquid	FC-43	FC-70	FC-5312
Typical Boiling Point, °C	174	215	215
Pour Point, °C	-50	-25	-25
Density, g/cm <sup>3</sup>	1.88	1.94	1.93
Kinematic Viscosity, cs	2.8	14.0	12.6
Vapor Pressure, torr	1.3	<0.1	<0.1
Specific Heat, cal/g - °C	0.25	0.25	0.25
Heat of Vaporization @ Boiling Point, cal/g	17	16	16
Thermal Conductivity, watts/(cm <sup>2</sup> ) (°C/cm)	0.00066	0.00070*	0.00070*
Coefficient of Expansion cm <sup>3</sup> /(cm <sup>3</sup> )(°C)	0.0012	0.0010	0.0010
Surface Tension, dynes/cm	16	18	18
Dielectric Strength, KV(2.54 mm gap)	42	40	40
Dielectric Constant, (1KHz)	1.90	1.98	1.98
Volume Resistivity, ohm-cm	3.4x10 <sup>15</sup>	2.3x10 <sup>15</sup>	2.3x10 <sup>15</sup>
Solubility of Water ppm (wt.)	7	8	8
Solubility of Air ml gas/100 ml liquid	26	22	22
Average Molecular Weight	670	820	820

\* Estimated values

Fluorinert Liquid  
Selection Guide

Fluorinert Liquid	Boiling Point	Typical Solders
FC-43	174°C	70 Sn/18 Pb/12 In 100 In 58 Sn/42 In 58 Bi/42 Sn
FC-70 FC-5312	215°C	63 Sn/37 Pb 60 Sn/40 Pb 62 Sn/36 Pb/2 Ag

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## 3M™ SF-2 Series Secondary Fluids

3M SF-2 Series products are secondary fluids for batch style and in-line vapor phase soldering systems requiring a secondary fluid blanket. SF-2 products are heated to form a thin vapor blanket that stabilizes above the primary 3M™ Fluorinert™ liquid vapor zone to help prevent aerosol formation and vapor loss of the primary liquid to the atmosphere.

Unlike alternative secondary fluids, such as CFC-113, 3M SF-2 products are non-ozone depleting perfluorocarbons, containing no hydrogen or chlorine. These inert perfluorocarbons have low solvent properties and are fully compatible with the reflow.

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## Toxicity Profile

Fluorinert liquids are non-irritating to the eyes and skin, and are practically non-toxic orally. They also demonstrate very low acute and sub-chronic inhalation toxicity. These products are not mutagens or cardiac sensitizers.

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## Safety and Handling

Fluorinert liquids are nonflammable, and are highly resistant to thermal breakdown and hydrolysis in storage and during use. Recommended handling procedures are given in the Material Safety Data Sheets, which are available upon request.

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## Environmental

Fluorinert liquids have zero ozone depletion potential. These materials are not defined by the U.S. EPA, nor regulated, as volatile organic compounds (VOCs) and do not contribute to ground-level smog formation.

Fluorinert liquids, which are perfluorocarbon (PFC) materials, have high global warming potentials and long atmospheric lifetimes. As such, they should be carefully managed to minimize emissions.

3M recommends that users of Fluorinert liquids further limit emissions by employing good conservation practices, and by implementing recovery, recycling and/or proper disposal procedures. 3M offers a program for used fluid return. Specific guidelines for the safe handling and use of 3M products are provided in the Material Safety Data Sheets.

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## Resources

3M has representatives in virtually all regions of the world where electronics are manufactured. In addition, 3M products are supported by global technical and customer service resources, with fully-staffed technical service laboratories in the U.S., Europe, Japan and Southeast Asia. Users benefit from 3M's broad technology base and continuing attention to product development, performance, safety and environmental issues. For assistance, contact:

### **3M Specialty Materials**

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