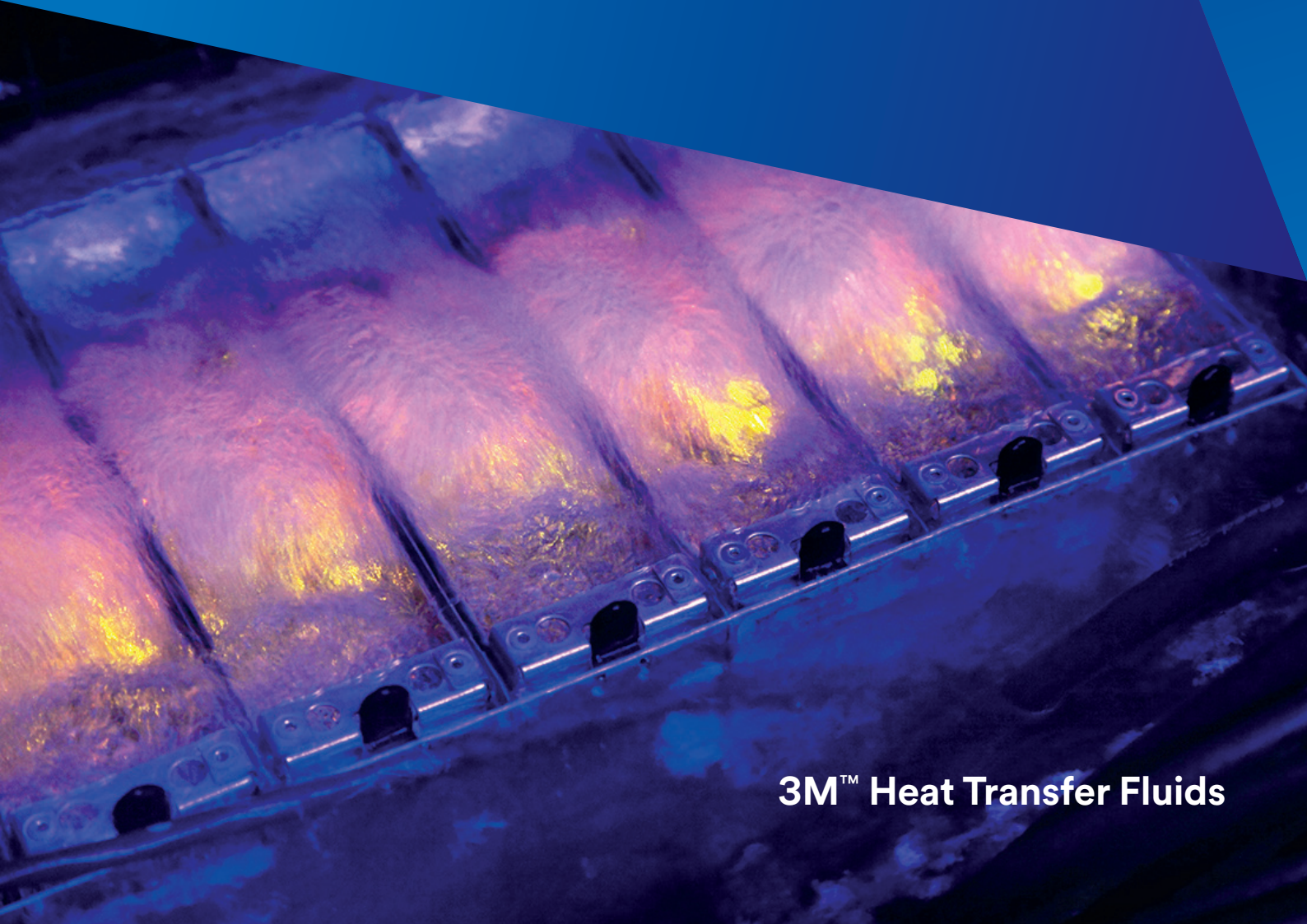


3M Science.
Applied to Life.™

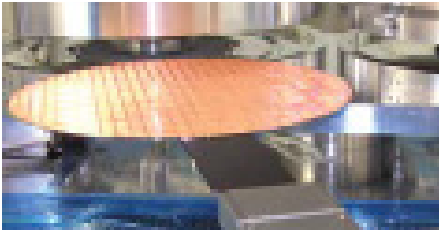
Turn down the heat... turn up the performance.

When temperatures rise, choose time-tested 3M™ Heat Transfer Fluids

For over 60 years, 3M has studied the science of heat transfer to develop a portfolio of solutions to keep equipment and processes cool. Our two families of heat transfer fluids – 3M™ Novec™ Engineered Fluids and 3M™ Fluorinert™ Electronic Liquids have unique properties including non-flammability, high dielectric strength, inertness, non-corrosiveness and low viscosity. These give them the performance, safety and versatility for a wide range of applications and industries.



3M™ Heat Transfer Fluids



Semiconductor manufacturing

Semiconductor manufacturing requires precision. The smallest variation in temperature during manufacturing can have big impacts on yield. 3M™ Novec™ and 3M™ Fluorinert™ fluids are engineered to remain stable over time, offering consistent performance and uniform temperatures across all steps of production. What's more, unlike aqueous coolants such as deionised (DI) water, 3M fluids offer wider operating temperature ranges, require less maintenance and will not damage electronic equipment or wafers in the event of leaks or other failures.



Data centres and high-performance computing

Data centres form the backbone of today's wired world, and high-performance supercomputers enable the research that drives tomorrow's advances. Air cooling these powerful servers comes at a high cost – fans and chillers consume enormous amounts of electricity, which negatively impacts our environment and your bottom line. By switching to immersion cooling with 3M heat transfer fluids, you can cut costs and shrink your data centre size and energy footprint.



Military and aerospace

Mission-critical electronics for military and aviation applications are highly sensitive, requiring efficient and reliable cooling to perform at their best. 3M Novec and Fluorinert fluids are tough enough to stand up to demanding applications and environments while being easier to handle thanks to being non-flammable and less messy than oil-type coolants. They have excellent materials compatibility and can be used in high-end avionic spray cooling systems.



Power electronics

Voltage-changing power electronics – power inverters, thyristors and variable-speed drives – provide the precise control needed for high performance equipment. Safe for contact with electronics, heat transfer fluids from 3M give you the ability to uniformly and efficiently cool these devices through single-phase and two-phase immersion cooling.



Pharmaceutical and chemical processing

Secondary loop and freeze drying processes used in the pharmaceutical and chemical industries can also benefit from the unique properties of 3M heat transfer fluids. Unlike the solvents and oils typically used in these applications, Novec and Fluorinert fluids are non-flammable and have high margins of safety for workers.



Automotive electrification

The promise of electric vehicles (EV) depends on the mass production of efficient, reliable drivetrains that use power electronics to transfer energy from batteries to wheels. Novec fluids are dielectric, non-flammable and enable direct cooling of electrical components. Novec fluids are being used in some of the most advanced EV high power charging solutions on the market today.








Electronics reliability testing

With properties including high thermal stability and dielectric strength, inertness and non-corrosiveness, 3M™ Fluorinert™ liquids are ideal for electronics reliability testing. Components can be tested both physically (leak and thermal shock testing) and electrically while immersed in the liquid. Tested devices will dry quickly with no residue or post-test cleaning required.

Selecting the right fluid for your unique cooling needs.

Both 3M™ Novec™ Engineered Fluids and 3M™ Fluorinert™ Electronic Liquids offer top-tier thermal management performance backed by 3M's research and expert guidance. While physical properties differ between the two families of heat transfer fluids, both offer unique advantages.

Engineered for:	To give you:
 Dielectric performance	Suitability for direct contact with live electronics*
 Versatility	A wide range of operating temperatures and stable performance
 Health and Safety	Non-flammability and a wide margin of worker safety especially compared to trichloroethylene (TCE) and methylene chloride (MeCl)
 Compatibility	The ability to use the fluids in systems made from a wide range of materials*
 Clean evaporation	Quick drying with no mess or residue

*Check with your 3M representative for full details.



3M™ Fluorinert™ Electronic Liquids

Fluorinert liquids have set the industry standard for direct contact electronics cooling for over 60 years. These fully-fluorinated liquids have exceptionally high dielectric strength, making them ideal for sensitive applications.

While they are non-ozone depleting, Fluorinert liquids have high global warming potentials (GWP) and users should take care to manage and minimise emissions of these materials.

3M™ Novec™ Engineered Fluids

Building on 3M's extensive heat transfer expertise, Novec fluids offer outstanding performance and safety properties plus enhanced environmental sustainability thanks to their low-GWP and non-ozone depleting chemistries.

Novec fluids have slightly higher solvency compared to Fluorinert liquids, so materials that come into direct contact with the fluids should be checked for compatibility before use. Novec fluids also have lower dielectric strengths than Fluorinert liquids, so be sure to evaluate your application and select the right 3M heat transfer fluid for your needs.

3M™ Heat Transfer Fluids properties

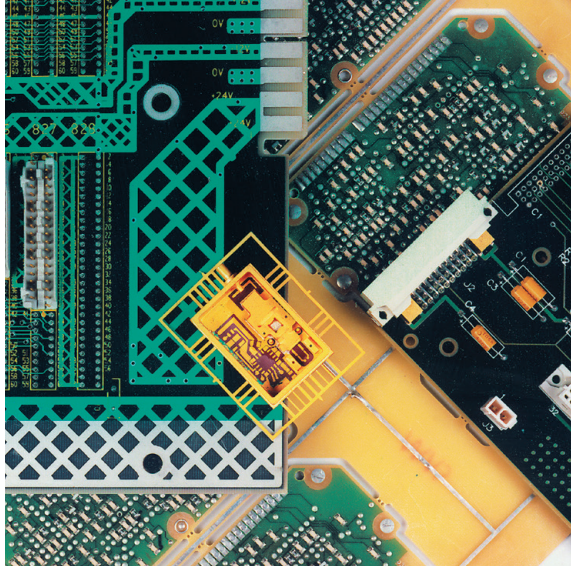
3M heat transfer fluids, sold under the 3M™ Novec™ Engineered Fluids and 3M™ Fluorinert™ Electronic Liquids brands, are available in a wide range of boiling points (34°C up to 175°C) and freezing points (-38°C down to -138°C), to meet your specific requirements.

3M™ Novec™ Engineered Fluids

	Unit	Novec 7000	Novec 7100	Novec 7200	Novec 7300	Novec 7500	Novec 7700	Novec 649	Novec 774
Boiling point	°C	34	61	76	98	128	167	49	74
Pour point	°C	-122	-135	-138	-38	-100	-50	-108	-78
Molecular weight	g/mol	200	250	264	350	414	528	316	366
Critical temperature	°C	165	195	210	243	261	290	169	195
Critical pressure	MPa	2.48	2.23	2.01	1.88	1.55	1.41	1.88	1.71
Vapour pressure	kPa	65	27	16	5.9	2.1	<0.1	40	15.7
Heat of vaporisation	kJ/kg	142	112	119	102	89	83	88	90
Liquid Density	kg/m ³	1400	1510	1420	1660	1614	1797	1600	1660
Coefficient of expansion	K ⁻¹	0.0022	0.0018	0.0016	0.0013	0.0013	0.0011	0.0018	0.0015
Kinematic viscosity	cSt	0.32	0.38	0.41	0.71	0.77	2.52	0.40	0.52
Absolute viscosity	cP	0.45	0.58	0.58	1.18	1.24	4.54	0.64	0.87
Specific heat	J/kg-K	1300	1183	1220	1140	1128	1040	1103	1130
Thermal conductivity	W/m-K	0.075	0.069	0.068	0.063	0.065	–	0.059	–
Surface tension	mN/m	12.4	13.6	13.6	15.0	16.2	18	10.8	12.3
Solubility of water in fluid	ppm by weight	~60	95	92	67	45	14	20	20
Solubility of fluid in water	ppm by weight	<5	12	<5	<295 ppb	<4 ppb	<1 ppb	–	–
Dielectric strength, 0.1" gap	kV	>25	>25	>25	>25	>25	~30	>40	>40
Dielectric constant @ 1kHz	–	7.4	7.4	7.3	6.1	5.8	6.7	1.8	1.9
Volume resistivity	Ohm-cm	10 ⁸	10 ⁸	10 ⁸	10 ¹¹	10 ⁸	10 ¹¹	10 ¹²	10 ¹²
Global warming potential	GWP	530	297	57	310	100	420	<1	<1

For test methods and variability, contact 3M Technical Service.

All values determined at 25°C unless otherwise specified.



3M™ Fluorinert™ Electronic Liquids

	Unit	FC-3284	FC-72	FC-770	FC-3283	FC-40	FC-43
Boiling point	°C	50	56	95	128	165	174
Pour point	°C	-73	-90	-127	-50	-57	-50
Molecular weight	g/mol	299	338	399	521	650	670
Critical temperature	°C	161	176	238	235	270	294
Critical pressure	MPa	1.94	1.83	2.47	1.22	1.18	1.13
Vapour pressure	kPa	35	30	6.6	1.4	0.29	0.19
Heat of vaporisation	kJ/kg	105	88	86	78	68	70
Liquid density	kg/m ³	1710	1680	1793	1820	1855	1860
Coefficient of expansion	K ⁻¹	0.0016	0.0016	0.0015	0.0014	0.0012	0.0012
Kinematic viscosity	cSt	0.42	0.38	0.79	0.75	2.2	2.5
Absolute viscosity	cP	0.71	0.64	1.4	1.4	4.1	4.7
Specific heat	J/kg-K	1100	1100	1038	1100	1100	1100
Thermal conductivity	W/m-K	0.062	0.057	0.063	0.066	0.065	0.065
Surface tension	mN/m	13	10	15	15	16	16
Solubility of water in fluid	ppm by weight	14	10	14	7	<7	7
Solubility of fluid in water	ppm by weight	<5	<5	<5	<5	<5	<5
Dielectric strength, 0.1" gap	kV	>40	>40	>40	>40	>40	>40
Dielectric constant @ 1kHz	–	1.9	1.8	1.9	1.9	1.9	1.9
Volume resistivity	Ohm-cm	10 ¹⁵	10 ¹⁵	10 ¹⁵	10 ¹⁵	10 ¹⁵	10 ¹⁵

For test methods and variability, contact 3M Technical Service.

All values determined at 25°C unless otherwise specified.

Let's get started – together.

3M is more than a brand – we're people who share your passion for solving problems and improving lives. We know the science of heat transfer, understand the regulatory landscape and have a global supply and support network ready to help you find solutions to your most critical challenges.

Not sure which solution is right for your application? We're here to help!

Contact us for answers to any questions you may have, including guidance on choosing between 3M™ Novec™ Engineered Fluids and 3M™ Fluorinert™ Electronic Liquids. We also offer general application advice, product data, information on purchasing test samples and more.

Visit [3M.co.uk/novec](https://www.3m.co.uk/novec) or contact your local 3M representative to get started today.

Safety data sheet: Consult Safety Data Sheet prior to use.

Regulatory: For regulatory information about this product, contact your 3M representative.

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