

LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY
- LIGO -
CALIFORNIA INSTITUTE OF TECHNOLOGY
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Technical Note	LIGO-T060280-00 - D	11/8/06
PRINTED CIRCUIT BOARDS FOR ULTRA HIGH VACUUM		
Daniel Sigg		

Distribution of this draft:

all

This is an internal working note
of the LIGO Project.

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1 INTRODUCTION

This document describes the fabrication and construction of printed-circuit boards (PCB) which are operating in ultra high vacuum (UHV).

2 MATERIALS

A list of materials to construct a UHV compatible PCB is given below.

Table 1: Materials

Component	Material
Board	Rogers RO3003 ceramic-filled PTFE composite Circuit-board house: for example www.cirrex.com
D-sub connector	ERNI Construction: steel Insulator: LCP (liquid crystal polymer) For example: 204478, 204466 (through hole) or 154244, 174417 (SMT)
LEMO connector	LEMO 00-series Construction: nickel plated brass Insulator: PTFE (teflon) For example: LEMO EPY.00.250.NTN
Solder	Kester Sn96.5Ag3.0Cu0.5 (lead-free) Composition: tin (96.5%), silver (3%) and copper (0.5%) Flux: no-clean or rosin For example: 24-7068-7601 (wire) or 57-3443-9809 (paste)

See Appendix for data sheet on Rogers 3003 materials and solder.

3 MANUFACTURING

3.1 BOARD CONSTRUCTION

The following assembly instructions should be provided to the circuit-board house:

- i)* board material is Rogers RO3003,
- ii)* no silk screen, no solder mask,
- iii)* finish is electrolytic gold (hard gold).

3.2 PCB ASSEMBLY

A lead-free solder based on tin/silver/copper has to be used (see section 2). All parts and the entire assembly process should follow lead-free guidelines.

4 CLEANING

4.1 STEP 1: FLUX REMOVAL

A cleaning step to remove any remaining flux. Use an ultrasonic cleaner set to 50°C and immerse for 1 hour in an aqueous flux remover. The required flux remover is Chemtronics ES132 (Flux-Off® Aqueous Flux Remover) which should be diluted with de-ionized water at a ratio of 1:10. See the appendix for data sheet and MSDS. After cleaning, rinse assembled PCB in de-ionized water and let dry.

4.2 STEP 2: BAKING PREP

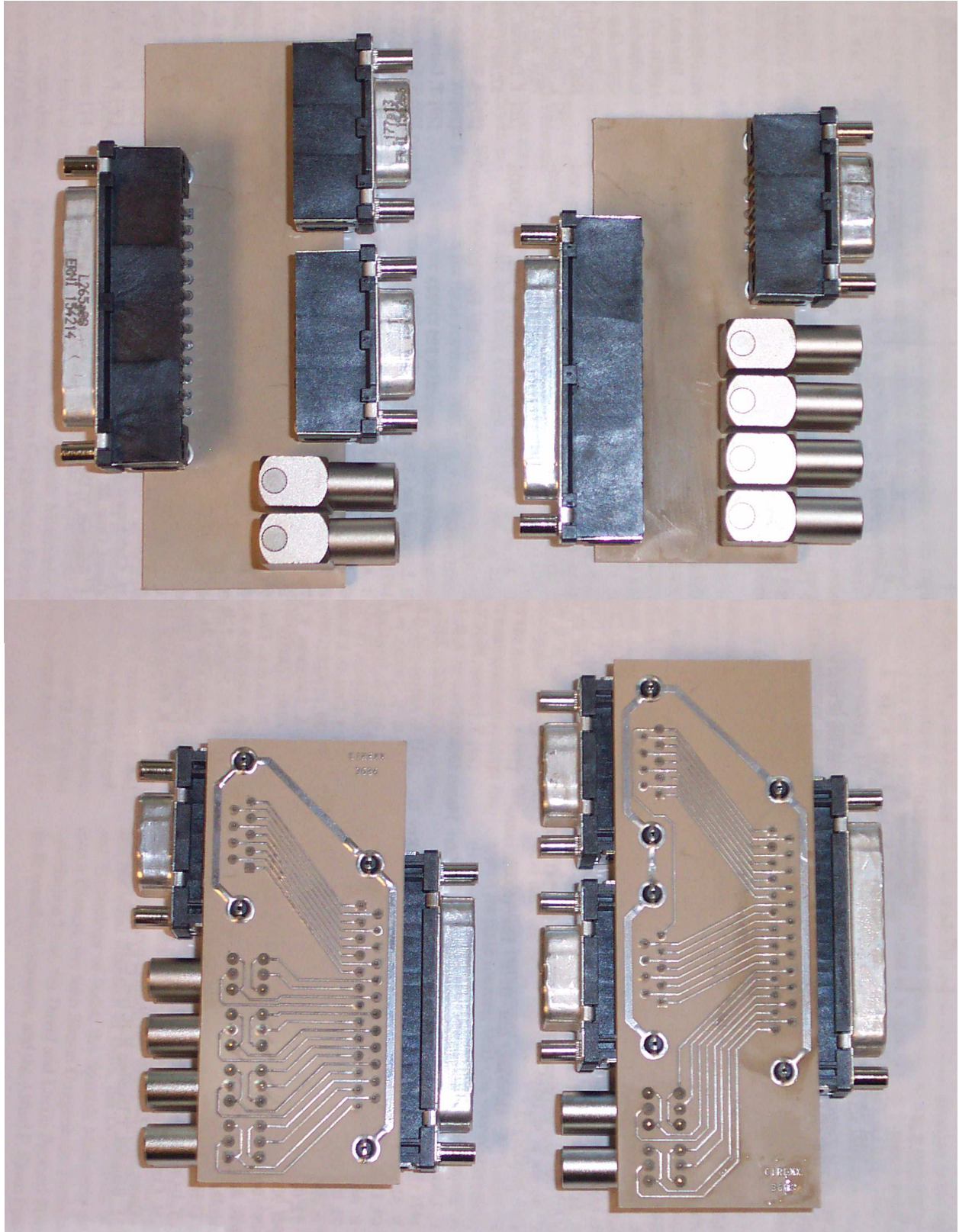
A cleaning step to prepare for baking. The assembled PCB should be immersed in isopropyl alcohol for 30 minutes using an ultrasonic cleaner. After cleaning, rinse assembled PCB in de-ionized water and let dry. One can use a heat lamp at ~85°C to accelerate the drying process.

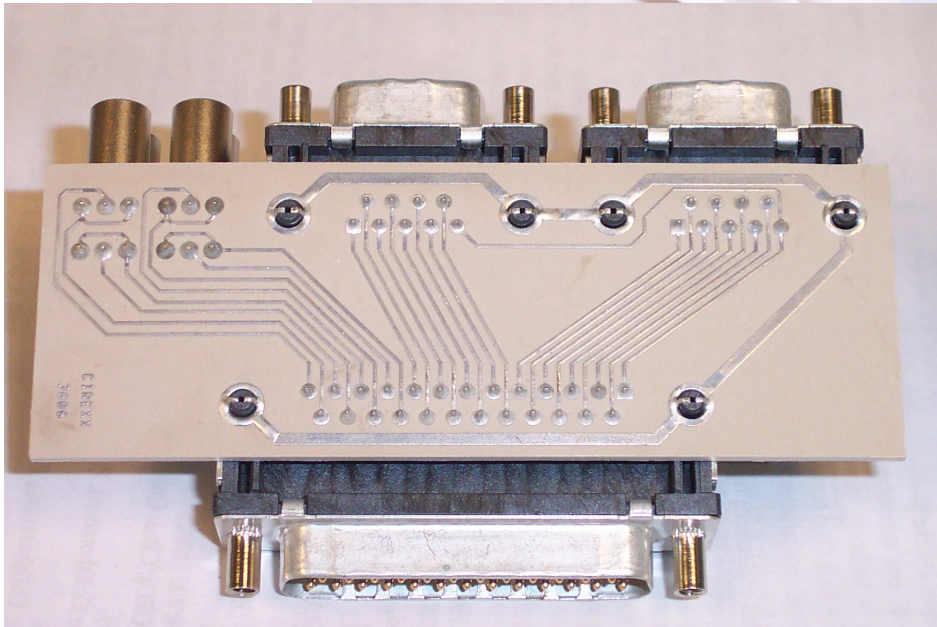
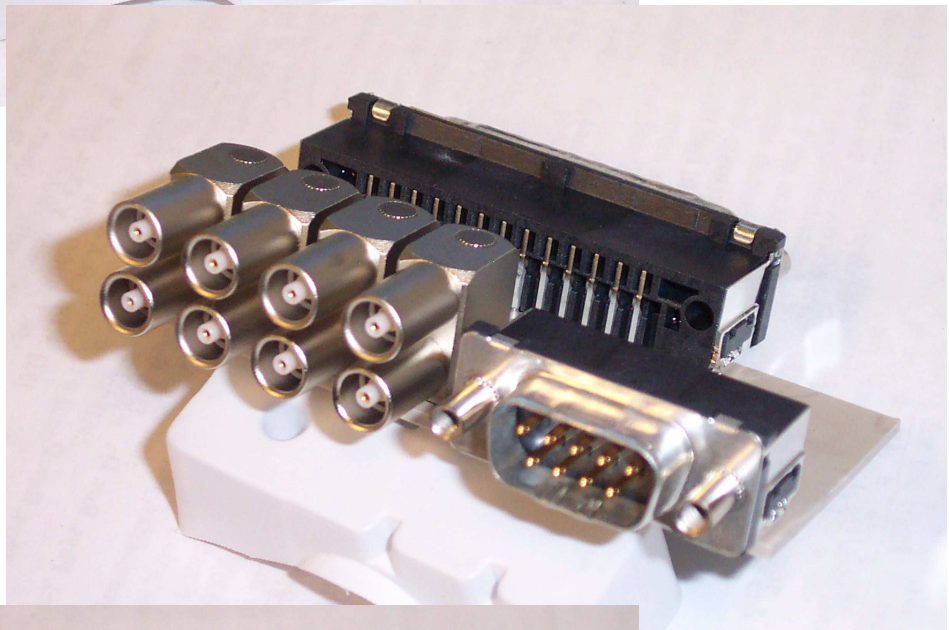
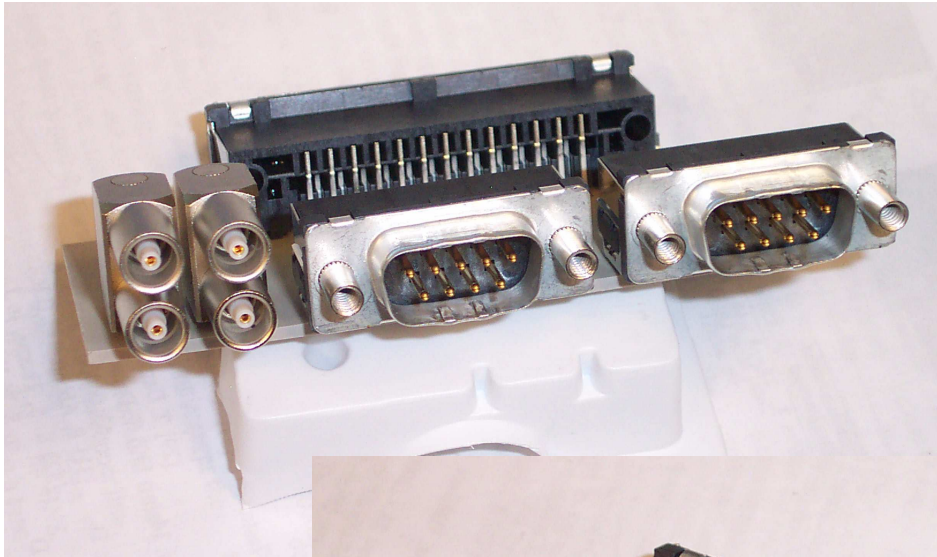
4.3 STEP 3: BAKE

The bake temperature should be as high as allowed by the used components. The materials in section 2 easily allow for 150°C. Additional components should be selected to allow for the same temperature or for at least 120°C. The assembled PCB should be at temperature for 48 hours. All applicable vacuum bake procedures have to be followed (RGA scan, packaging, etc.).

APPENDIX A PICTURES

A couple of pictures of the LEMO adapter board (D060191) after cleaning but before baking.





APPENDIX B MATERIAL SPECIFICATION AND MSDS

RO3000® Series High Frequency Circuit Materials

Features and Benefits:

- Low dielectric loss for high frequency performance (RO3003). Laminate can be used in applications up to 30-40 GHz.
- Excellent mechanical properties versus temperature for reliable stripline and multilayer board constructions.
- Uniform mechanical properties for a range of dielectric constants. Ideal for multilayer board designs with a range of dielectric constants. Suitable for use with epoxy glass multilayer board hybrid designs.
- Stable dielectric constant versus temperature and frequency for RO3003. Ideal for band pass filters, microstrip patch antennas, and voltage controlled oscillators.
- Low in-plane expansion coefficient (matched to copper). Allows for more reliable surface mounted assemblies. Ideal for applications sensitive to temperature change and excellent dimensional stability.
- Volume manufacturing process for economical laminate pricing.

Typical Applications:

- Automotive Collision Avoidance Systems
- Automotive Global Positioning Satellite Antennas
- Cellular and Pager Telecommunications Systems
- Patch Antennas for Wireless Communications
- Direct Broadcast Satellites
- Datalink on Cable Systems
- Remote Meter Readers
- Power Backplanes

RO3000® High Frequency Circuit Materials are ceramic-filled PTFE composites intended for use in commercial microwave and RF applications. This family of products was designed to offer exceptional electrical and mechanical stability at competitive prices.

RO3000® series laminates are PTFE-based circuit materials with mechanical properties that are constant regardless of the dielectric constant selected. This allows the designer to develop multilayer board designs that use different dielectric constant materials for individual layers, without encountering warpage or reliability problems.

The dielectric constant versus temperature of RO3000 series materials is very stable (Charts 1 and 2). These materials exhibit a coefficient of thermal expansion (CTE) in the X and Y axis of 17 ppm/°C. This expansion coefficient is matched to that of copper, which allows the material to exhibit excellent dimensional stability, with typical etch shrinkage (after etch and bake) of less than 0.5 mils per inch. The Z-axis CTE is 24 ppm/C, which provides exceptional plated through-hole reliability, even in severe thermal environments.

RO3000® series laminates can be fabricated into printed circuit boards using standard PTFE circuit board processing techniques, with minor modifications as described in the application note "Fabrication Guidelines for RO3000® Series High Frequency Circuit Materials."

Available claddings are ½, 1 or 2 oz./ft² (17, 35, 70 µm thick) electrodeposited copper foil.

RO3000® laminates are manufactured under an ISO 9002 certified system.

Chart 1: RO3003™ Laminate Dielectric Constant vs. Temperature

The data in Chart 1 demonstrates the excellent stability of dielectric constant over temperature for RO3003® laminates, including the elimination of the step change in dielectric constant, which occurs near room temperature with PTFE glass materials.

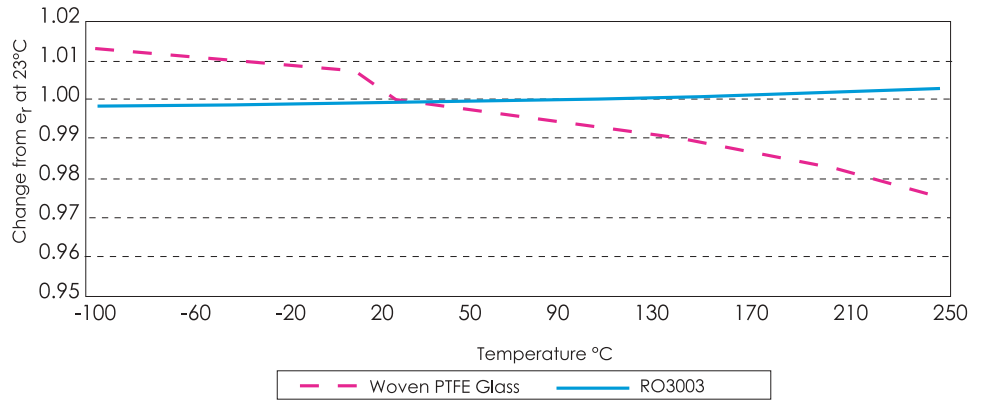


Chart 2: RO3006™ and RO3010™ Laminate Dielectric Constant vs. Temperature

The data in Chart 2 shows the change in dielectric constant vs. temperature for RO3006® and RO3010® laminates. These materials exhibit significant improvement in temperature stability of dielectric constant when compared to other high dielectric constant PTFE laminates.

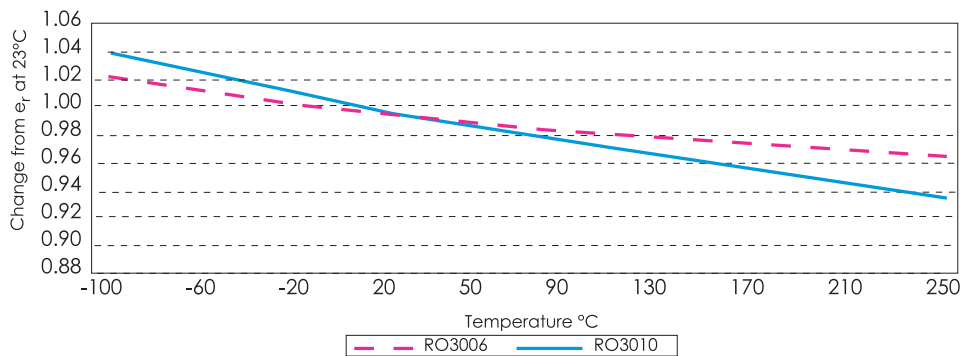
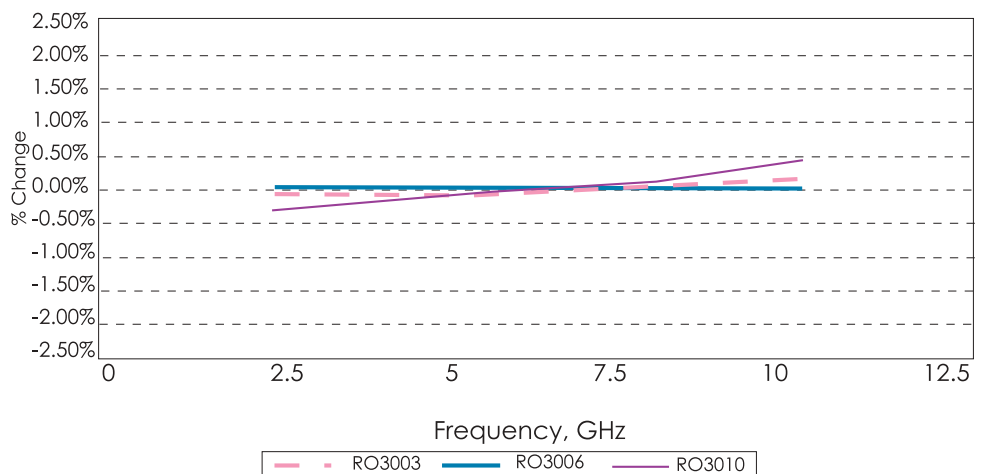


Chart 3: Dielectric Constant vs. Frequency for RO3000® Series Laminate

Chart 3 demonstrates the stability of dielectric constant for RO3000® series products over frequency. This stability simplifies the design of broad-band components as well as allowing the materials to be used in a wide range of applications over a very broad range of frequencies.



The data in Charts 1, 2 and 3 was produced using a modified IPC-TM-650, 2.5.5.5 method. For additional information request Rogers T.R. 5156 and T.M. 4924.

Typical Values

RO3000® Series High Frequency Laminates

PROPERTY	TYPICAL VALUE ⁽¹⁾			DIRECTION	UNIT	CONDITION	TEST METHOD
	RO3003	RO3006	RO3010				
Dielectric Constant ϵ_r	3.00±0.04 ⁽²⁾	6.15±0.15	10.2±0.30	Z	-	10GHz 23°C	IPC-TM-650 2.5.5.5
Dissipation Factor	0.0013	0.0020	0.0023	Z	-	10GHz 23°C	IPC-TM-650 2.5.5.5
Thermal Coefficient of ϵ_r	13	-160	-280	Z	ppm/°C	10GHz 0-100°C	IPC-TM-650 2.5.5.5
Dimensional Stability	0.5	0.5	0.5	X,Y	mm/m	COND A	ASTM D257
Volume Resistivity	10 ⁷	10 ³	10 ³		MΩ•cm	COND A	IPC 2.5.17.1
Surface Resistivity	10 ⁷	10 ³	10 ³		MΩ	COND A	IPC 2.5.17.1
Tensile Modulus	2068 (300)	2068 (300)	2068 (300)	X,Y	MPa (kpsi)	23°C	ASTM D638
Water Absorption	<0.1	<0.1	<0.1	-	%	D24/23	IPC-TM-650 2.6.2.1
Specific Heat	0.93 (0.22)	0.93 (0.22)	0.93 (0.22)		J/g/K (BTU/lb/°F)		Calculated
Thermal Conductivity	0.50	0.61	0.66	-	W/m/K	100°C	ASTM C518
Coefficient of Thermal Expansion	17 24	17 24	17 24	X,Y Z	ppm/°C	-55 to 288°C	ASTM D3386-94
Td	500	500	500		°C TGA		ASTM D 3850
Color	Tan	Tan	Off White				
Density	2.1	2.6	3.0		gm/cm ³		
Copper Peel Strength	3.1 (17.6)	2.1 (12.2)	2.4 (13.4)		N/mm (lb/in)	After solder float	IPC-TM-2.4.8
Flammability	94V-0	94V-0	94V-0				UL
Lead-Free Process Compatible	Yes	Yes	Yes				

(1) References: Internal T.R.'s 1430, 2224, 2854. Tests at 23°C unless otherwise noted. Typical values should not be used for specification limits.

(2) The nominal dielectric constant of an 0.060" thick RO3003® laminate as measured by the IPC-TM-650, 2.5.5.5 will be 3.02, due to the elimination of biasing caused by air gaps in the test fixture. For further information refer to Rogers T.R. 5242.

STANDARD THICKNESS:		STANDARD PANEL SIZE:	STANDARD COPPER CLADDING:
RO3003: 0.005" (0.13 mm) 0.010" (0.25 mm) 0.020" (0.50 mm) 0.030" (0.75 mm) 0.060" (1.52 mm)	RO3006/3010: 0.005" (0.13 mm) 0.010" (0.25 mm) 0.025" (0.64 mm) 0.050" (1.28 mm)	RO3003: 12" X 18" (305 X 457mm) 24" X 18" (610 X 457mm) 24" X 36" (610 X 915mm) RO3006/3010: 18" X 12" (457 X 305mm) 18" X 24" (457 X 610mm) 18" X 36" (457 X 915mm) 18" X 48" (457 X 1.224m)	½ oz. (17µm), 1 oz. (35µm), 2 oz. (70µm) electrodeposited copper foil.

CONTACT INFORMATION:

USA:	Rogers Advanced Circuit Materials - ISO 9000:2000 certified	Tel: 480-961-1382	Fax: 480-961-4533
Belgium:	Rogers NV - Gent - ISO 9000:2000 certified	Tel: +32-9-2353611	Fax: +32-9-2353658
Japan:	Rogers Japan Inc.	Tel: 81-3-5200-2700	Fax: 81-3-5200-0571
Taiwan:	Rogers Taiwan Inc.	Tel: 886-2-86609056	Fax: 886-2-86609057
Korea:	Rogers Korea Inc.	Tel: 82-31-716-6112	Fax: 82-31-716-6208
Singapore:	Rogers Technologies Singapore Inc.	Tel: 65-747-3521	Fax: 65-747-7425
China:	Rogers (Shanghai) International Trading Co., Ltd	Tel: 86-21-63916088	Fax: 86-21-63915060

The information in this data sheet is intended to assist you in designing with Rogers' circuit material laminates. It is not intended to and does not create any warranties express or implied, including any warranty of merchantability or fitness for a particular purpose or that the results shown on this data sheet will be achieved by a user for a particular purpose. The user should determine the suitability of Rogers' circuit material laminates for each application.

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275

No-Clean Cored Wire

For Lead-bearing and Lead-free alloys

Product Description

Kester 275 No-Clean Flux for cored solder wire was developed to provide superior wetting performance for hand soldering in the electronics industry. The chemistry is based on some of the same principles that have been safely used for years in mildly activated rosin fluxes. The use of 275 No-Clean Flux results in an extremely clear post-soldering residue without cleaning. The unique chemistry in Kester 275 was also designed to reduce spattering common to most core fluxes. Kester 275 can be used for both lead bearing and lead-free soldering.

Performance Characteristics:

- Colorless translucent residues
- Improves wetting performance
- Excellent solderability and fast wetting to a variety of surface finishes
- Eliminates the need and expense of cleaning
- Low smoke and odor
- Low spattering
- Compatible with leaded and lead-free alloys
- Classified as ROL0 per J-STD-004
- Compliant to Bellcore GR-78

RoHS Compliance

This product meets the requirements of the RoHS (Restriction of Hazardous Substances) Directive, 2002/95/EC Article 4 for the stated banned substances. (Applies only if this core flux is combined with a lead free alloy)

Reliability Properties

Copper Mirror Corrosion: Low

Tested to J-STD-004, IPC-TM-650, Method 2.3.32

Corrosion Test: Low

Tested to J-STD-004, IPC-TM-650, Method 2.6.15

Silver Chromate: Pass

Tested to J-STD-004, IPC-TM-650, Method 2.3.33

Chloride and Bromides: None Detected

Tested to J-STD-004, IPC-TM-650, Method 2.3.35

Fluorides by Spot Test: Pass

Tested to J-STD-004, IPC-TM-650, Method 2.3.35.1

SIR, IPC (typical): Pass

Tested to J-STD-004, IPC-TM-650, Method 2.6.3.3

	<u>Blank</u>	<u>275</u>
Day 1	$1.6 \times 10^{10} \Omega$	$1.1 \times 10^{10} \Omega$
Day 4	$1.2 \times 10^{10} \Omega$	$9.2 \times 10^9 \Omega$
Day 7	$1.1 \times 10^{10} \Omega$	$8.6 \times 10^9 \Omega$

Spread Test (typical):

Tested to J-STD-004, IPC-TM-650, Method 2.4.46

Flux Core Solder	Area of Spread mm ² (in ²)	
	Sn96.5Ag3.0Cu0.5	Sn63Pb37
285 Mildly Activated Rosin	213 (0.33)	335 (0.52)
245 No-Clean	200 (0.31)	348 (0.54)
275 No-Clean	219 (0.34)	361 (0.56)

Application Notes

Availability:

Kester 275 is available in a wide variety of alloys, wire diameters and flux percentages. For most applications, Sn63Pb37 or Sn96.5Ag3.0Cu0.5 is used. Consult the alloy temperature chart in Kester's product catalog for a comprehensive alloy list. The standard wire diameter for most applications is 1.00mm (0.031in). Wire diameters range from 0.25 - 6.00mm (0.010 to 0.250in). A "Standard Wire Diameters" chart also is also included in Kester's product catalog. The amount of flux in the wire dictates the ease of soldering for an application. For tin/lead applications, core 50 or 58 (1.1 and 2.2% flux by weight) are recommended. For Lead-free and high-lead applications, core 58 or 66 (2.2 and 3.3% flux by weight) are recommended. Kester 275 is packaged on spools of different sizes to accommodate a variety of applications.

Process Considerations:

Solder iron tip temperatures are most commonly between 315-371°C (600-700°F) for Sn63Pb37 and Sn62Pb36Ag02 alloys and 371-427°C (700-800°F) for lead-free alloys. Heat both the land area and component lead to be soldered with the iron prior to adding Kester 275 cored wire. Apply the solder wire to the land area or component lead. Do not apply the wire directly to the soldering iron tip. If needed, Kester 959T no clean, liquid flux may be used as a compatible flux to aid in reworking soldered joints. Kester 959T is also available in Flux-Pens® for optimum board cleanliness.

Cleaning:

The 275 residues are non-conductive, non-corrosive and do not require removal in most applications. The flux residues are comparable to a conventional RMA except that the 275 residue is clear and colorless. If residue removal is required, call Kester Technical Support.

Storage, Handling, and Shelf Life:

Storage must be in a dry, non-corrosive environment. The surface may lose its shine and appear a dull shade of grey. This is a surface phenomena and is not detrimental to product functionality. Flux cored solder wire has a limited shelf life determined by the alloy used in the wire. For alloys containing > 70% lead, the shelf life is two years from date of manufacture. Other alloys have a shelf life of three years from date of manufacture.

Health & Safety:

This product, during handling or use, may be hazardous to health or the environment. Read the Material Safety Data Sheet and warning label before using this product.

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Material Safety Data Sheet

acc. to ISO/DIS 11014

Printing date 06/03/2006

Reviewed on 06/03/2006

1 Identification of substance**Product details****Trade name: 275 CORE***Application of the substance / the preparation: Flux cored solder***Manufacturer/Supplier:**Kester
515 E. Touhy Ave.
Des Plaines, IL 60018Tel.(847) 297-1600
Fax.(847) 390-9338**Information department:**

MSDS Coordinator

Tel. (847) 699-5755

Emergency information:

CHEMTREC 24-Hour Emergency Telephone Number:

(800)424-9300

CHEMTREC 24-Hour Emergency Telephone Number (Outside of the U.S. and Canada):

(703)527-3887

2 Composition/Data on components**Chemical characterization***Description: Mixture of the substances listed below with nonhazardous additions.***Dangerous components:**

7440-31-5	tin	0-100%
7439-92-1	lead	0-100%
7440-36-0	antimony	0-100%
7440-50-8	copper	0-100%
7440-22-4	silver	0-100%
7440-69-9	bismuth	0-100%
7440-66-6	Zinc	0-100%
144413-22-9	Denatured Acid Hydrogenation Gum Resin	≤ 2.5%
65997-06-0	Modified Rosin	≤ 2.5%

Additional information:*Composition and weight percent of solder alloys varies widely and can be determined by product label.
Flux in core is typically 1-3% by weight.***3 Hazards identification****WHMIS Hazard Symbols****Information pertaining to particular dangers for man and environment:***The product has to be labelled due to the calculation procedure of international guidelines.**Harmful by inhalation and if swallowed.**Danger of cumulative effects.**May cause sensitisation by inhalation and skin contact.*

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Trade name: 275 CORE

(Contd. of page 1)

*Possible risk of impaired fertility.**Contains lead. Should not be used on surfaces liable to be chewed or sucked by children.***NFPA ratings (scale 0 - 4)**

Health = 2

Fire = 1

Reactivity = 0

HMIS-ratings (scale 0 - 4)

HEALTH	2
FIRE	1
REACTIVITY	0

Health = *2

Fire = 1

Reactivity = 0

4 First aid measures**After inhalation:** *Supply fresh air; consult doctor in case of complaints.***After skin contact:** *Immediately wash with water and soap and rinse thoroughly.***After eye contact:** *Rinse opened eye for several minutes under running water.***After swallowing:** *Seek immediate medical advice.***5 Fire fighting measures****Suitable extinguishing agents:***CO₂, extinguishing powder or water spray. Fight larger fires with water spray or alcohol resistant foam.***Special hazards caused by the material, its products of combustion or resulting gases:***In case of fire, the following can be released:**Carbon monoxide (CO)**Carbon dioxide (CO₂)**Aliphatic aldehydes**Melted solder above 1000°F will liberate toxic lead and/or antimony fumes.***Protective equipment:** *Wear self-contained respiratory protective device.***6 Accidental release measures****Person-related safety precautions:** *Ensure adequate ventilation***Measures for environmental protection:** *Do not allow product to reach sewage system or any water course.***Measures for cleaning/collecting:***Melted solder will solidify on cooling and can be scraped up. Use caution to avoid breathing fumes if a gas torch is used to cut up large pieces.***7 Handling and storage****Handling:****Information for safe handling:** *Ensure good ventilation/exhaustion at the workplace.*

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—USA

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Trade name: 275 CORE

(Contd. of page 2)

Information about protection against explosions and fires: Keep respiratory protective device available.

Storage:

Requirements to be met by storerooms and receptacles: No special requirements.

Information about storage in one common storage facility: Not required.

Further information about storage conditions:

Store in dry conditions.

Exposure to sulfur or to high humidity will tarnish solder surface.

8 Exposure controls and personal protection

Additional information about design of technical systems: No further data; see item 7.

Components with limit values that require monitoring at the workplace:

7440-31-5 tin

PEL	2 mg/m ³ Metal
REL	2 mg/m ³ Tin, Metal
TLV	2 mg/m ³

7439-92-1 lead

PEL	0.05* mg/m ³ as Pb
REL	<0.1* mg/m ³ as Pb; *Blood Pb <0.06 mg/100 g whole blood
TLV	0.05 mg/m ³ as Pb; BEI

7440-36-0 antimony

PEL	0.5 mg/m ³
REL	0.5 mg/m ³ as Sb
TLV	0.5 mg/m ³

7440-50-8 copper

PEL	0.1*,1** mg/m ³ *fume **dusts & mists
REL	0.1*,1** mg/m ³ *Copper fume, as Cu **Copper dusts & mists, as Cu
TLV	0.2*, 1** mg/m ³ *fume; ** dusts&mists, as Cu

7440-22-4 silver

PEL	0.01 mg/m ³
REL	0.01 mg/m ³
TLV	0.1 mg/m ³

65997-06-0 Modified Rosin

TLV	Short-term value: 3 mg/m ³ , NE ppm Long-term value: NE mg/m ³ , NE ppm
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Additional information:*PEL = Permissible Exposure Limit (OSHA)**REL= Recommended Exposure Limit (NIOSH)**TLV= Threshold Limit Value (ACGIH)**OSHA= Occupational Safety and Health Administration**ACGIH= American Conference of Governmental Industrial Hygienists**NIOSH= National Institute for Occupational Safety and Health***Personal protective equipment:****General protective and hygienic measures:***Keep away from foodstuffs, beverages and feed.**Immediately remove all soiled and contaminated clothing.**Wash hands before breaks and at the end of work.**Store protective clothing separately.***Breathing equipment:***When ventilation is not sufficient to remove fumes from the breathing zone, a safety approved respirator or self-contained breathing apparatus should be worn.***Protection of hands:***Protective gloves**Material of gloves:**Cloth gloves**Nitrile rubber, NBR**Natural rubber, NR**Penetration time of glove material:**The exact break through time has to be found out by the manufacturer of the protective gloves and has to be observed.***Eye protection:***Tightly sealed goggles**Safety glasses***9 Physical and chemical properties****General Information**

Form:	<i>Solid</i>
Color:	<i>Silver grey</i>
Odor:	<i>Odorless</i>

Change in condition*Melting point/Melting range: > 100°C (> 212°F)**Boiling point/Boiling range: Undetermined.***Flash point:** > 93°C (> 199°F)

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Danger of explosion: *Product does not present an explosion hazard.***Density at 20°C (68°F):** *>7 g/cm³***Solubility in / Miscibility with Water:** *Insoluble.***10 Stability and reactivity****Thermal decomposition / conditions to be avoided:** *No decomposition if used according to specifications.***Materials to be avoided:** *Strong acids, strong oxidizers.***Dangerous reactions** *No dangerous reactions known.***Dangerous products of decomposition:***When heated to soldering temperatures, the solvents are evaporated and rosin may be thermally degraded to liberate aliphatic aldehydes and acids.**Carbon monoxide and carbon dioxide***11 Toxicological information****Acute toxicity:****LD/LC50 values that are relevant for classification:****65997-06-0 Modified Rosin**

Oral | LD50 | > 4.000 mg/kg (Rat)

7440-36-0 antimony

Oral | LD50 | 7000 mg/kg (rat)

7440-69-9 bismuth

Oral | LD50 | 5000 mg/kg (rat)

Primary irritant effect:*on the skin: Possible local irritation by contact with flux or fumes.**on the eye: Smoke during soldering can cause eye irritation.**through inhalation:**Flux fumes during soldering may cause irritation and damage of mucous membranes and respiratory system.**through ingestion: May be harmful if swallowed.***Sensitization:***Sensitization possible through inhalation.**Sensitization possible through skin contact.***Additional toxicological information:***The product shows the following dangers according to internally approved calculation methods for preparations:**Harmful**Irritant*

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(Contd. on page 6)

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Trade name: 275 CORE

(Contd. of page 5)

12 Ecological information**General notes:** *Do not allow product to reach ground water, water course or sewage system.***13 Disposal considerations****Product:****Recommendation:***Must not be disposed of together with household garbage. Do not allow product to reach sewage system.***Uncleaned packagings:****Recommendation:** *Disposal must be made according to official regulations.***14 Transport information****DOT regulations:***Hazard class: -
Not regulated.***Land transport ADR/RID (cross-border):***ADR/RID class: -
Not regulated.***Maritime transport IMDG:***IMDG Class: -
Not regulated.***Air transport ICAO-TI and IATA-DGR:***ICAO/IATA Class: -
Not regulated.***15 Regulations***USA The following information relates to product regulation specific to the USA.***SARA (Superfund Amendments and Reauthorization Act)***Section 355 (extremely hazardous substances):**None of the ingredient is listed.**Section 313 (Specific toxic chemical listings):**7439-92-1 lead**7440-36-0 antimony**7440-50-8 copper**7440-22-4 silver***TSCA (Toxic Substances Control Act):***All ingredients are listed.*

(Contd. on page 7)

Material Safety Data Sheet

acc. to ISO/DIS 11014

Printing date 06/03/2006

Reviewed on 06/03/2006

Trade name: 275 CORE

(Contd. of page 6)

California Proposition 65*Chemicals known to cause cancer:***WARNING:** *This product contains a chemical known to the State of California to cause cancer.**Chemicals known to cause reproductive toxicity:***WARNING:** *This product contains a chemical known to the State of California to cause birth defects and/or other reproductive harm.***Carcinogenicity categories**

<i>EPA (Environmental Protection Agency)</i>		
<i>7439-92-1</i>	<i>lead</i>	<i>B2</i>
<i>IARC (International Agency for Research on Cancer)</i>		
<i>7439-92-1</i>	<i>lead</i>	<i>2B</i>
<i>NTP (National Toxicology Program)</i>		
<i>None of the ingredients is listed.</i>		
<i>TLV (Threshold Limit Value established by ACGIH)</i>		
<i>None of the ingredients is listed.</i>		
<i>NIOSH-Ca (National Institute for Occupational Safety and Health)</i>		
<i>None of the ingredients is listed.</i>		
<i>OSHA-Ca (Occupational Safety & Health Administration)</i>		
<i>None of the ingredients is listed.</i>		

*CANADA: The following information relates to product regulation specific to Canada.***Workplace Hazardous Materials Identification (WHMIS):***This product has been classified in accordance with the hazard criteria of the Canadian Controlled Products Regulation (CPR) and the MSDS contains all of the information required by the CPR.***EUROPEAN UNION***The following information relates to product regulation specific to the directives of the European Union.***Risk phrases:***Harmful by inhalation and if swallowed.**Danger of cumulative effects.**May cause sensitisation by inhalation and skin contact.**Possible risk of impaired fertility.***Safety phrases:***Avoid exposure - obtain special instructions before use.**Keep locked up and out of the reach of children.**Do not breathe dust.**Avoid contact with skin.**Do not empty into drains, dispose of this material and its container at hazardous or special waste collection point.**Wear suitable gloves.**In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).**In case of accident by inhalation: remove casualty to fresh air and keep at rest.*

(Contd. on page 8)

-USA

Material Safety Data Sheet

acc. to ISO/DIS 11014

Printing date 06/03/2006

Reviewed on 06/03/2006

Trade name: 275 CORE

(Contd. of page 7)

Special labeling of certain preparations:*Contains lead. Should not be used on surfaces liable to be chewed or sucked by children.***16 Other information**

The information contained herein is based on data considered accurate and is offered solely for information, consideration and investigation. Kester extends no warranties, makes no representations and assumes no responsibility as to the accuracy, completeness or suitability of this data for any purchaser's use. The data on this Material Safety Data Sheet relates only to this product and does not relate to use with any other material or in any process. All chemical products should be used only by, or under the direction of, technically qualified personnel who are aware of the hazards involved and the necessity for reasonable care in handling. Hazard communication regulations require that employees must be trained on how to use a Material Safety Data Sheet as a source for hazard information.

Department issuing MSDS: *Product Safety*

USA

CHEMTRONICS[®]

Technical Data Sheet

TDS # 132

Flux-Off[®] Aqueous

PRODUCT DESCRIPTION

Flux-Off[†] Aqueous is ideally formulated for flux removal in ultrasonic and in-line cleaning systems. It is an excellent cleaner for the removal of all rosin and no clean flux types from electronic subassemblies, printed circuit boards and all other electronic components. This concentrated formula can be diluted 1:10 with deionized water for many cleaning applications. Flux-Off[†] Aqueous will effectively remove other contaminants such as dirt, grease, handling soils and molding compounds.

" For use with ultrasonic and in-line cleaning systems

" Quickly removes all rosin and no clean flux types

" Removes encrusted, hard, baked fluxes

" Powerful cleaner leaves no residue

" Contains no CFCs or HCFCs

" Nonabrasive

" Nonflammable

" Noncorrosive

TYPICAL APPLICATIONS

Flux-Off[†] Aqueous removes flux residues and cleans:

" Chip Carriers

" Heat Sinks


" Metal Housings and Chassis

" Motors and Generators

" Printed Circuit Boards

" Surface Mount Device Pads

TYPICAL PRODUCT DATA AND PHYSICAL PROPERTIES

Boiling Point	212°F (Initial)
Solubility in Water @ 77°F/1 atm	100%
Specific Gravity (water = 1 @ 77°F)	1.03
Flash Point (TCC)	None
Evaporation Rate (butyl acetate=1)	>1
Appearance	Clear, Amber Liquid
Surface Tension (dynes/cm @ 73°F)	28.0
pH	12.5
Shelflife	2 years after opening
RoHS/WEEE Status	
VOC content	164 g/L as purchased* 1:10 dilution- 16 g/L as used

* SCAQMD compliant when diluted 1:7

COMPATIBILITY

Flux-Off[†] Aqueous is generally compatible with most materials used in printed circuit board fabrication. With any cleaning agent compatibility must be determined on a non-critical area prior to use.

<u>Material</u>	<u>Compatibility</u>
ABS Resin	Excellent
Buna-N	Fair
Butyl	Excellent
EPDM	Excellent
Graphite	Excellent
HDPE	Excellent
Kynar ^œ	Excellent
LDPE	Excellent
Lexan ^œ	Excellent
Neoprene	Good
Noryl [†]	Good
Nylon 101	Good
Cross-Linked PE	Good
Polyacrylate	Fair
Polypropylene	Good
Polystyrene	Good
PVC	Fair
Silicone Rubber	Good
Teflon ^œ	Excellent
Viton ^œ	Good

AVAILABILITY

ES132 1 Gallon Liquid

TECHNICAL & APPLICATION ASSISTANCE

Chemtronics[†] provides a technical hotline to answer your technical and application related questions. The toll free number is: 1-800-TECH-401.

NOTE:

This information is believed to be accurate. It is intended for professional end users having the skills to evaluate and use the data properly.

CHEMTRONICS[†] does not guarantee the accuracy of the data and assumes no liability in connection with damages incurred while using it.

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MANUFACTURED BY:

ITW CHEMTRONICS

8125 COBB CENTER DRIVE

KENNESAW, GA 30152

1-770-424-4888

REV. E (06/06)

USAGE INSTRUCTIONS:

For industrial use only.

Read MSDS carefully prior to use.

Dilute 1:10 with deionized water for general cleaning. Can be used in hot or cold immersion, ultrasonic or aqueous cleaning systems. For immersion systems, soak as necessary. For ultrasonic cleaning, add Flux-Off[†] Aqueous to the ultrasonic cleaning tank, allow about two minutes for the mixture to degas, and immerse the part to be cleaned in the ultrasonic cleaner. After cleaning, rinse parts in de-ionized water and dry where required.

DISTRIBUTED BY:

SECTION 1: CHEMICAL PRODUCT AND COMPANY INFORMATION**Company Address:**8125 Cobb Center Drive
Kennesaw, GA 30152Product Information: 800-TECH-401
Customer Service: 800-645-5244Emergency: (Chemtrec) 800-424-9300
Revision Date: February 12, 2004**Product Identification****FLUX-OFF® AQUEOUS (Liquid)****Product Code: ES132****SECTION 2: COMPOSITION/INFORMATION ON INGREDIENTS**

Chemical Name	CAS#	Wt. % Range
Deionized water	7732-18-5	50.0-75.0
Dipropylene glycol methyl ether	34590-94-8	10.0-20.0
Propylene glycol butyl ether	5131-66-8/15821-83-7	5.0-10.0
Sodium xylene sulfonate	1300-72-7	5.0-10.0
Sodium metasilicate	6834-92-0	1.0-5.0
Benzyl alcohol	100-51-6	0.5-2.0

SECTION 3: HAZARDS IDENTIFICATION

Emergency Overview: Clear, colorless liquid with mild solvent odor. Liquid will irritate eyes and skin under repeated or prolonged exposure. Breathing high concentrations of product vapor may produce central nervous system depression. This product is not flammable.

Potential Health Effects:

Eyes: DO NOT get in eyes. This product is irritating and can cause pain, tearing, reddening and swelling accompanied by a stinging sensation.

Skin: Contact may cause skin irritation.

Ingestion: DO NOT take internally. Harmful if swallowed. Irritating to mouth, throat and stomach. May cause vomiting.

Inhalation: Excessive inhalation of vapors can cause nasal and respiratory irritation and central nervous system effects including dizziness, weakness, fatigue, nausea, headache and unconsciousness.

Pre-Existing Medical Conditions Aggravated by Exposure: Lung, skin, eye and central nervous system.

SECTION 4: FIRST AID MEASURES

Eyes: Immediately flush with plenty of water. After initial flushing, remove any contact lenses and continue flushing for at least 15 minutes. Have eyes examined and tested by medical personnel if irritation develops or persists.

Skin: Wash skin with soap and water immediately. Remove contaminated clothing. Get medical attention if irritation develops or persists. Wash clothing separately before reuse.

Ingestion: Swallowing less than an ounce will not cause significant harm. For larger amounts, do not induce vomiting, but give one or two glasses of water to drink and get immediate medical attention.

Inhalation: Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

SECTION 5: FIRE FIGHTING MEASURES

Flash Point: >200°F

LEL/UEL: Not established (% by volume in air)

Extinguishing Media: Use water fog, carbon dioxide, or dry chemical when fighting fires involving this material.

Fire Fighting Instructions: As in any fire, wear self-contained breathing apparatus (pressure-demand, MSHA/NIOSH approved or equivalent) and full protective gear.

SECTION 6: ACCIDENTAL RELEASE MEASURES

Large Spills: Shut off leak if possible and safe to do so. Wear self-contained breathing apparatus and appropriate personal protective equipment. Absorb spill with inert material (e.g. dry sand or earth), then place in a chemical waste container for proper disposal. Do not flush to sewer. Avoid runoff into storm sewers and ditches which lead to waterways.

Small Spills: Absorb spill with inert material (e.g. dry sand or earth), then place in a chemical waste container for proper disposal.

SECTION 7: HANDLING AND STORAGE

Avoid prolonged or repeated contact with eyes, skin, and clothing. Wash hands thoroughly after handling or contact. Use with adequate ventilation. Avoid breathing product vapor or mist. Do not reuse this container. Store in a cool dry place away from heat, sparks and flame. Keep container closed when not in use. Do not store in direct sunlight.

KEEP OUT OF REACH OF CHILDREN.**SECTION 8: EXPOSURE CONTROLS, PERSONAL PROTECTION****Exposure Guidelines:**

CHEMICAL NAME	ACGIH TLV	OSHA PEL	ACGIH STEL
Dipropylene glycol methyl ether	100 ppm	100 ppm	150 ppm
Propylene glycol butyl ether	NA	NA	NA
Benzyl alcohol	NA	NA	NA

Work/Hygienic Practices: Good general ventilation should be sufficient to control airborne levels. If vapor concentration exceeds TLV, use NIOSH approved organic vapor cartridge respirator. Wear safety glasses with side shields (or goggles) and rubber or other chemically resistant gloves when handling this material.

NFPA and HMIS Codes:

	NFPA	HMIS
Health	1	1
Flammability	0	0
Reactivity	0	0
Personal Protection	-	B

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

Physical State: Clear, pale yellow liquid
Odor: Mild solvent
pH: 12 - 14
Vapor Pressure: 14 mm Hg @ 25C
Vapor Density: Not available
Boiling Point: 212 F

Solubility in Water: Completely
Specific Gravity: (Water =1) 1.03
Evaporation Rate: <1 (Butyl acetate=1)
Melting Point: NA
Percent Volatile: 93%

SECTION 10: STABILITY AND REACTIVITY

Stability - This product is stable. Conditions to Avoid: Do not spray near open flames, red hot surfaces or other sources of ignition.
Incompatibility: Do not mix with aluminum, galvanized iron and zinc, powdered alkali and alkaline earth metals or strong oxidizing agents.
Products of Decomposition: Thermal decomposition may release carbon monoxide, carbon dioxide and incompletely burned hydrocarbons.
Hazardous Polymerization: Will not occur
Conditions to Avoid: NA

SECTION 11: TOXICOLOGICAL INFORMATION

Ingestion:

Sodium metasilicate	LD50/rats	1153 mg/kg	<u>Inhalation:</u> Not considered a hazard.
Dipropylene glycol methyl ether	LD50/rat	5135 mg/kg	
Propylene glycol butyl ether	LD50/rat	3300 mg/kg	

Skin:

Dipropylene glycol methyl ether	LD50/rats	9,500 mg/kg	<u>Eye:</u>
Sodium metasilicate	Human	250 mg/24H SEV	Dipropylene glycol methyl ether human 8 mg MLD
Propylene glycol butyl ether	LD50/Rabbit	3100 mg/kg	

Cancer Information: No ingredients listed as human carcinogens by NTP or IARC
Reproductive effects: none Teratogenic effects: none Mutagenic effects: none

SECTION 12: ECOLOGICAL INFORMATION

Environmental Impact Information
 Avoid runoff into storm sewers and ditches which lead to waterways. Water runoff can cause environmental damage.

REPORTING

US regulations require reporting spills of this material that could reach any surface waters. The toll free number for the US Coast Guard National Response Center is:1-800-424-8802

SECTION 13: DISPOSAL CONSIDERATIONS

Dispose of in accordance with all federal, state and local regulations. Water runoff can cause environmental damage.

SECTION 14: TRANSPORTATION INFORMATION

Proper Shipping Name: Cleaning Compound
Air and Ground: Not Regulated

SECTION 15: REGULATORY INFORMATION

SECTION 313 SUPPLIER NOTIFICATION

This product contains no toxic chemicals subject to the reporting requirements of Section 313 of the Emergency Planning and Community Right-To-Know Act of 1986 (40 CFR 372).

This information should be included on all MSDSs copied and distributed for this material.

TOXIC SUBSTANCES CONTROL ACT (TSCA)

All ingredients of this product are listed on the TSCA Inventory.

WHMIS: Class D2B

This product has been classified according to the hazard criteria of the CPR and the MSDS contains all of the information required by the CPR.

SECTION 16: OTHER INFORMATION **Note: This MSDS is applicable to date codes of 1215 and later.**

Normal ventilation for standard manufacturing practices is usually adequate. Local exhaust should be used when large amounts are released.

To the best of our knowledge, the information contained herein is accurate. However, all materials may present unknown hazards and should be used with caution. In particular, improper use of our products and their inappropriate combination with other products and substances may produce harmful results which cannot be anticipated. Final determination of the suitability of any material is the sole responsibility of the user. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that may exist.

APPENDIX C RGA SCAN

C.1 CALIBRATION SCAN

C.2 BACKGROUND SCAN

C.3 AFTER BAKE SCAN

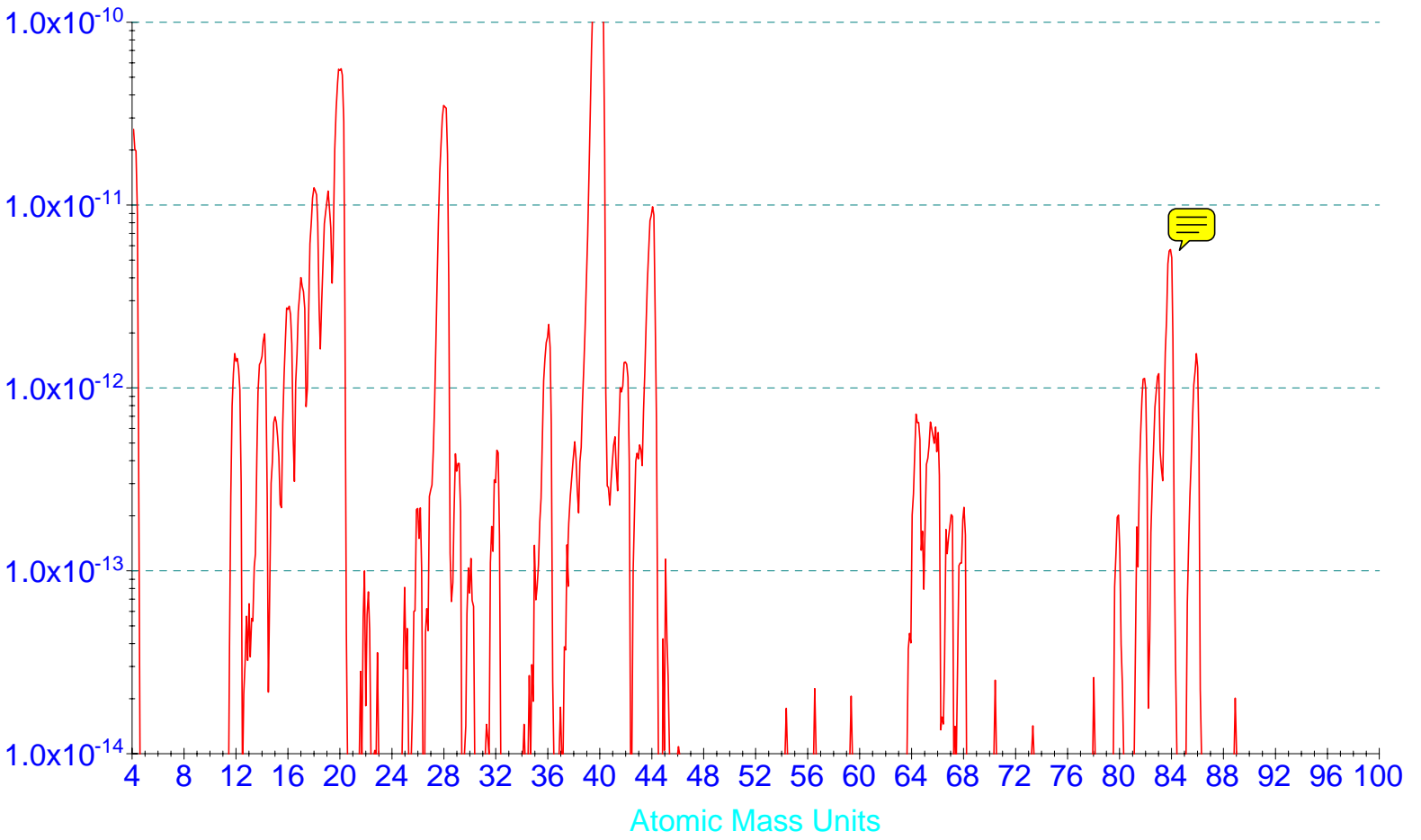
C.4 BACKGROUND SCAN WITH ELEVATED TEMPERATURE

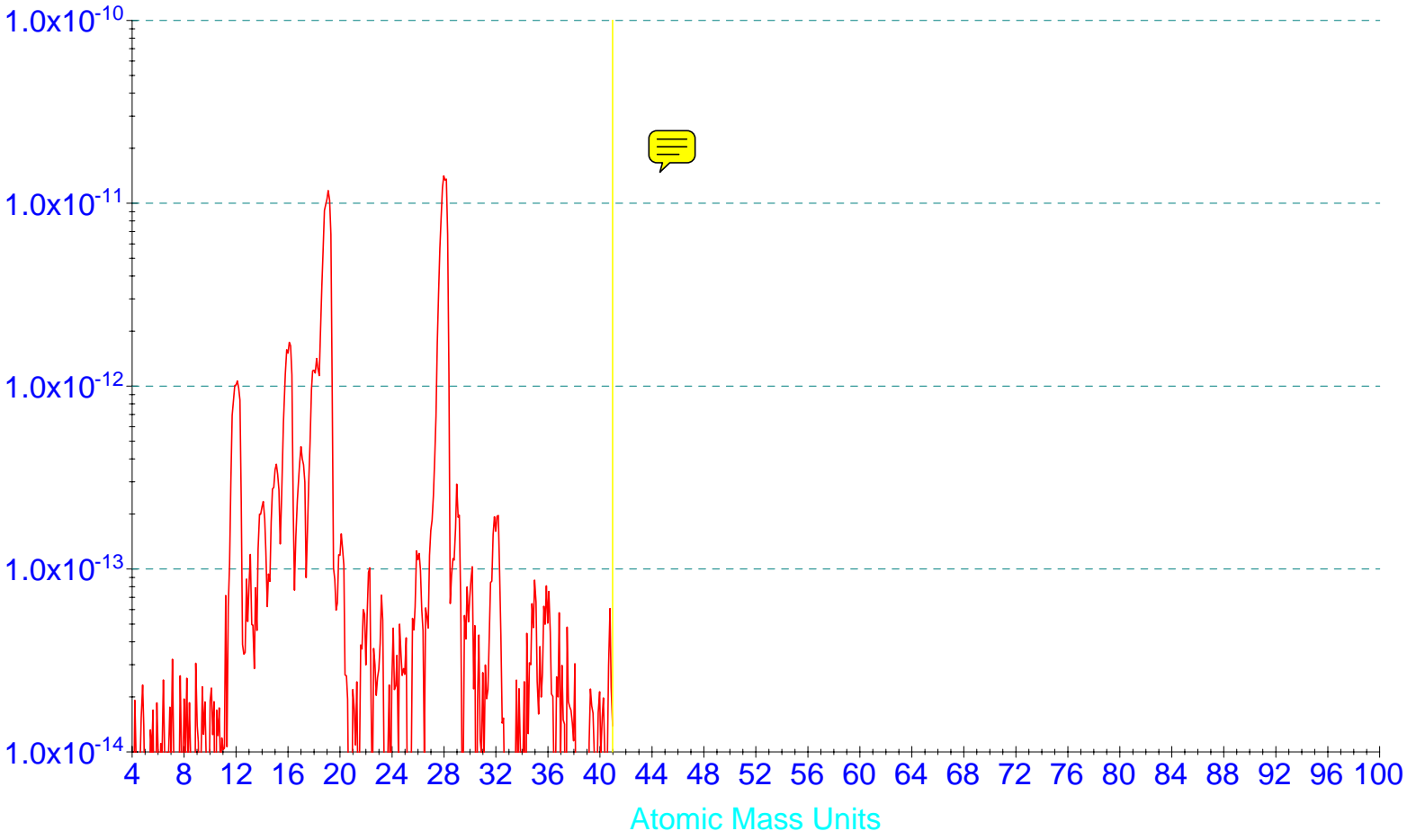
C.5 AFTER BAKE SCAN WITH ELEVATED TEMPERATURE

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