WOODWARD

Application Note 51530
(Revision A, 6/2024)
Original Instructions

Extended Atmospheric Environment Requirements

505, DVP (5K, 10K), EGCP-2, LINKnet HT™, MicroNet™, ProTech® GII/MSM/SX/TPS, RTCnet™

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Extended Atmospheric Environment Requirements:
505, DVP (5K, 10K), EGCP-2, LINKnet HT™, MicroNet™, ProTech® GII/MSM/SX/TPS, RTCnet™ *

Introduction

This application note contains information and guidelines pertinent to the installation of electronic equipment where it is exposed to atmospheric pollution in the form of particulates and corrosive gases. It covers corrosion mitigation techniques and provides information on conformal coatings that are employed on Woodward Inc. products for mitigation of corrosion and electrochemical migration. The benefits of the conformal coating types used are presented.

This information and installation environment recommendations are derived from the following environment classifications and applied test methods. See Tables 1 through 5.

Environment Classifications

- IEC 60664-1 Insulation coordination for equipment within low-voltage systems - part 1: principles, requirements and tests
- IEC 60721 / EN60721: Classification of environmental conditions –Part 3-3: Classification of groups of environmental parameters and their severities –Stationary use at weather protected locations
- ANSI/ISA-S71.04-1985. "Environmental Conditions for Process Measurement and Control Systems: Airborne Contaminants,"

Test Methods

- IEC 60068-2-60:1995 Part 2.60 Methods 1 and 4.
- IEC 364-65B Class IIIA

Conformal Coating Types

One of two types of conformal coating may be used on Woodward Inc. products. These two types are silicone and polyacrylate. Certain MicroNet Control System subassemblies and 505 products were transitioned from silicone to polyacrylate. The coating type you have may be determined by the product item number and revision. A list of products by family, item number and revision that use the polyacrylate coating can be found in Table 6 at the end of this document. The revision letter indicates the revision at which a change was made from silicone to the polyacrylate type.

Revision "NEW" or "-" indicates the initial product release was with polyacrylate coating. Once a product is produced with one conformal coating it cannot then be reverted to the other type of conformal coating. For example, a MicroNet 5466-1035 CPU produced at revision G with silicone conformal coating cannot be altered to utilize the polyacrylate conformal coating. If polyacrylate conformal coating is required for this module, a revision H or newer revision module must be purchased.

MicroNet modules and the 505 chassis are labeled with “Sulfur Resistant Conformal Coating” which means printed circuit board assemblies are coated with the polyacrylate type.

Both coating types protect from particulates and water such as condensate droplets. The polyacrylate material also protects coated areas from corrosive gases whereas silicone does not.

Pollution Types

Particulates

All conformal coated products protect against pollution in the form of particulates as defined by IEC 60664-1[1] Pollution Degree 2 (Normally only nonconductive pollution occurs. Temporary conductivity caused by condensation is to be expected). These particulates may become conductive with water condensation over insulating surfaces. Although both coating types do not allow condensate to penetrate, condensation should always be prevented in electronic systems. Heavy particulate contamination with high humidity can also be detrimental even without liquid water condensate. Where coating is not possible and bare metal is exposed, conductor spacing meets the requirements of Pollution Degree 2.

Corrosive Atmospheric Gases

Besides particulates, the atmospheric environment may also contain corrosive gases such as hydrogen sulfide, sulfur dioxide, nitrous oxide and chlorine. Certain product printed circuit assemblies are conformal coated with a specialized polyacrylate that provides protection from corrosive gaseous sulfur compounds and corrosion accelerants such as NOx and chlorine. By necessity, some areas can't be coated such as connectors, jumpers, test points, and field terminations. The larger conductor spacing, thicker metallization and corrosion resistant plating of these uncoated areas will mitigate the effects of corrosion for a time but not prevent eventual damage.

The sulfur resistant coating will provide protection for coated components in moderately severe atmospheric environments as described by ISA S71.04-1985[2] level “G2”, and IEC 721-3-3 1994 TABLE 4 Class 3C2 (Urban Industrial, Heavy Traffic) See Tables 2 and 3. Although testing shows the coating provides protection from environments more severe than G2, long term use in more severe environments is not recommended because some critical reactive metal connection surfaces can’t be coated and corrosion will occur at a rate determined by the corrosive gas concentrations and mixtures, materials, temperature, and humidity.

[1] IEC 60664-1, *"Insulation coordination for equipment within low-voltage systems - Part 1: Principles, requirements and tests"*

[2] ISA S71.04 -1985, *“Environmental Conditions for Process Measurement and Control Systems: Airborne Contaminants”*

Recommendations

To maximize reliability when operating in environments with G2 or more severe pollutants, the effects of contamination and corrosive gases should be further mitigated by one or more of the following means:

- Control humidity to <50% RH
- Clean particulates from existing installations
- Use ventilation air filters for reduction of particulates
- Cabinet air purging
- Use of sealed enclosures
- Use of replaceable sulfur getters in the form of commercially available papers or pastes

Table 1. IEC 60664-1 Pollution Degrees

Pollution Degree			
1	**2**	**3**	**4**
No pollution or only dry, nonconductive pollution occurs. The pollution has no effect.	Normally only nonconductive pollution occurs. Temporary conductivity caused by condensation is to be expected	Conductive pollution or dry non-conductive pollution that becomes conductive due to condensation occurs. To be found in industrial environment or construction sites (harsh environments).	The pollution generates persistent conductivity caused by conductive dust, rain, or snow.

Table 2. ANSI/ ISA S71.04-1985, Environment Classifications, Group A Gases

Severity Level	Class/ Cu Coupon Reactivity[3] (Å)	Description	Temp (°C)	RH (%)[4]	H_2S (ppb)	Cl_2 (ppb)	NO_x (ppb)	SO2, SO3 (ppb)
G1	**Mild/ < 300**	Sufficiently well-controlled such that corrosion is not a factor in determining equipment reliability.	Unknown	<50%	0<3<10	0<1<2	0<50<125	0<10<100
G2	**Moderate/ < 1000**	Effects of corrosion are measurable and may be a factor in determining equipment reliability.	Unknown	<50%	3<10<50	1<2<10	50<125<1250	10<100<300
G3	**Harsh/ < 2000**	High probability that corrosive attack will occur. These harsh levels should prompt further evaluation resulting in environmental controls or specially designed and packaged equipment.	Unknown	<50%	10<50≥50	2<10≥10	125<1250≥1250	10<100≥300
GX	**Severe/ ≥ 2000**	Only specially designed and packaged equipment would be expected to survive. Specifications for equipment in this class are a matter of negotiation between user and supplier.	Unknown	<50%	≥50	≥10	≥1250	≥300

[3] Gas concentrations are believed to approximate the stated copper reactivity levels after 30 days exposure.

[4] For a given gas concentration, the Severity Level (and Copper Reactivity Level) can be expected to be increased by one level for each 10% increase in relative humidity above 50%.

Table 3. IEC 721-3-3 1994 TABLE 4, Gas Concentrations by Atmospheric Environment Classification

Environmental Parameter	Units[6]	Class[5]								
		Clean Room	Continuous environmental control	Rural/urban light industrial	Urban industrial, heavy traffic		Immediate proximity to industrial sources with chemical emission		Within industrial plants, high concentration emissions	
		3C1R Maximum Value	3C1L (Low) Maximum Value	3C1 Maximum Value	3C2		3C3[7]		3C4[7]	
					Mean Value	Maximum Value	Mean Value	Maximum Value	Mean Value	Maximum Value
Sea salts	None	None	None	None	Salt mist[8]		Salt mist		Salt mist	
Sulfur dioxide	mg/m^3	.01	.1	.1	.3	1	5	10	13	40
	cm^3/m^3	.0037	.037	.037	.11	.37	1.85	3.7	4.8	14.8
Hydrogen sulfide	mg/m^3	.0015	.01	.01	.1	.5	3	10	14	70
	cm^3/m^3	.001	.0071	.0071	.071	.36	2.1	7.1	9.9	49.7
Chlorine	mg/m^3	.001	.01	.1	.1	.3	.3	1	.6	3.0
	cm^3/m^3	.00034	.0034	.034	.034	.1	.1	.34	.2	1.0
Hydrogen chloride	mg/m^3	.001	.01	.1	.1	.5	1	5	1	5.0
	cm^3/m^3	.00066	.0066	.066	.066	.33	.66	3.3	.66	3.3
Hydrogen fluoride	mg/m^3	.001	.003	.003	.01	.03	.1	2.0	.1	2.0
	cm^3/m^3	.0012	.0036	.0036	.012	.036	.12	2.4	.12	2.4
Ammonia	mg/m^3	.03	.3	.3	1	3	10	35	35	175
	cm^3/m^3	.042	.42	.42	1.4	4.2	14	49	49	247
Ozone	mg/m^3	.004	.01	.01	.05	.1	.1	.3	.2	2.0
	cm^3/m^3	.002	.005	.005	.025	.05	.05	.15	.1	1.0
Nitrogen Oxides (as equivalent values of nitrogen dioxide)	mg/m^3	.01	.1	.1	.5	1	3	9	10	20
	cm^3/m^3	.005	.052	.052	.26	.52	1.56	4.68	5.2	10.4

[5] Means are for long term exposure. Maximums are limit or peak values occurring for not more than 30 minutes per day.

[6] Values given in cm3/m3 have been calculated from values given in mg/m3 and refer to a temperature of 20 ºC and a pressure of 101.3 kPa Values are rounded.

[7] Classes 3C3 and 3C4 need not be considered as requirements for combined effects of all environments, values of single relevant parameters may be selected from these classes. Class 3C2 severities are valid for all other parameters not especially named.

[8] Salt mist may be present in sheltered locations of coastal areas and in offshore sites.

Table 4. Mixed Flowing Gas TEST METHODS DEVELOPED BY EIA 364-65A 1998

Class	Temp (°C)	RH (%)	H_2S (ppb)	Cl_2 (ppb)	NO_2 (ppb)	SO_2 (ppb)
I	----	----	----	----	----	----
II	30±2	70±2	10±5	10±3	200±50	----
IIA	30±1	70±2	10±5	10±3	200±50	100±20
III	30±2	75±2	100±20	20±5	200±50	----
IIIA[9]	30±1	70±2	100±20	20±5	200±50	200±50
IV	40±2	75±2	200±20	30±5	200±50	----

Table 5. IEC 60068-2-60 TEST LEVELS

IEC 60068-2-60 TEST LEVELS	Temp (°C)	RH (%)	H_2S (ppb)	Cl_2 (ppb)	NO_2 (ppb)	SO_2 (ppb)
METHOD 1	25±1	75±3	100±20	N/A	N/A	500±100
IEC METHOD 4[10]	25±1	75±3	10±5	10±5	200±20	200±20
IEC Method 2 (for ref.)	30±1	70±3	10±5	10±5	200±50	----
IEC Method 3 (for ref.)	30±1	75±3	100±20	20±5	200±50	----

[9] All other test levels are shown for reference only. IIIA test levels were used.

[10] Method 4 was applied for an additional 28 days to the same samples already exposed at Method 1 levels for 14 days.

Table 6. Polyacrylate Coated Products by Product Family, Item Number and Revision

Product Family		
Description	**Item Numbers with Polyacrylate Coating**	**Change Revision**
DVP		
DVP 5KW	8200-538	NEW
DVP 5KW	8200-541	NEW
DVP 5KW	8200-560	NEW
DVP 5KW	8200-560-250	-
DVP 5KW	8200-560DE	-
DVP 5KW	8200-560ES	NEW
DVP 5KW	8200-560HE	NEW
DVP 5KW	8200-560KR	NEW
DVP 5KW	8200-560RU	NEW
DVP 5KW	8200-560-TEP	NEW
DVP 5KW	8200-560ZH	NEW
DVP 5KW	8200-560ZH-250	-
DVP 5KW	8200-564	NEW
DVP 5KW	8200-565	NEW
DVP 5KW	8200-566	NEW
DVP 5KW	8200-570	NEW
DVP 5KW	8200-570FR	NEW
DVP 5KW	8200-570RU	NEW
DVP 5KW	8200-570ZH	-
DVP 5KW	8200-571	NEW
DVP 5KW	8200-585	-
DVP 5KW	8200-587	-
DVP 10KW	8200-545	NEW
DVP 10KW	8200-545ZH	-
DVP 10KW	8200-562	NEW
DVP 10KW	8200-562-250	-
DVP 10KW	8200-562KR	NEW
DVP 10KW	8200-562PL	-
DVP 10KW	8200-562PT	-
DVP 10KW	8200-562ZH	NEW
DVP 10KW	8200-562ZH-250	-

DVP 10KW	8200-567	NEW
DVP 10KW	8200-569	NEW
DVP 10KW	8200-586	-
DVP 12KW	8200-556	-
DVP 12KW	8200-558	-
DVP 12KW	8200-558-ID	-
DVP 12KW	8200-573	-
DVP 12KW	8200-573-250	-
DVP 12KW	8200-573ZH	-
DVP 12KW	8200-575	-
DVP 12KW	8200-575-250	-
DVP 12KW	8200-575TH	-
DVP 12KW	8200-575TH	-

505 / Flex500 / Vertex[11]		
Flex 505	All	NEW

[11] Legacy 505 is distinguished from Flex 500/505 by the Item Number series. This section accounts for 8200-XXXX series.

GS Series		
GS40/GS50 Valves	All	-

LINKnet-HT		
LINKNET-HT RTD (8 CH)	8200-1200	NEW
LINKNET-HT T/C (8 CH, FAIL HIGH)	8200-1201	NEW
LINKNET-HT AIO (8AI 4-20MA, 2AO)	8200-1202	NEW
LINKNET-HT AIO LOOP PWR (8AI 4-20MA, 2AO)	8200-1203	NEW
LINKNET-HT DIN (16 CH)	8200-1204	NEW
LINKNET-HT DOUT (16 CH)	8200-1205	NEW

MicroNet Communication Modules		
MICRONET REAL TIME NETWORK XCVR (REMOTE)	5466-1036	H
MICRONET PLUS RTN (CYBER-SECURITY)	5466-1046	NEW
MICRONET PLUS RTN (CYBER-SECURITY) LICENSED ENHANCED PERFORMANCE FOOTPRINT	5466-1146	NEW
MICRONET PLUS RTN ENHANCED PERFORMANCE FOOTPRINT	5466-1246	NEW
SIO MODULE, W/SCREW POSTS, SMART-PLUS	5466-5006	-
SIO MODULE, W/SLIDE LOCK, SMART-PLUS	5466-5007	-

MicroNet CPU Modules		
MICRONET CPU, POWERPC-5200, 400MHZ, 64MB FLASH, 128MB RAM (DUAL CAN)	5466-1035	H
MICRONET TMR CPU5200, 400MHZ, 64MB FLASH, 128MB RAM (NO CAN)	5466-1047	B
MICRONET TMR CPU5200, SHARED RTN	5466-1247	NEW
MICRONET TMR CPU5200, WITH CANOPEN	5466-1347	-
MICRONET PLUS CPU5200SA (SECURED APPLICATION)	5466-1141	NEW
MICRONET PLUS CPU5200 (CYBER-SECURITY) LICENSED ENHANCED PERFORMANCE FOOTPRINT	5466-1145	NEW
MICRONET PLUS CPU5200 ENHANCED PERFORMANCE FOOTPRINT	5466-1245	NEW
MICRONET PLUS P1020 CPU	5466-1510	NEW
MICRONET PLUS P1020 CPU	5466-1511	-
MICRONET PLUS P1020 CPU (SECURED APPLICATION)	5466-1520	NEW
MICRONET PLUS P1020 CPU (SECURED APPLICATION)	5466-1521	-

MicroNet I/O Modules[12]		
MICRONET SIMPLEX 48/24 HDDIO SMART-PLUS	5466-1050	NEW
MICRONET TMR 48/24 HDDIO SMART-PLUS	5466-1051	NEW
MICRONET SPEED/ANALOG I/O COMBO - 4X SPEED, 12X I/V SELECTABLE INPUTS, 4X 4-20 MA OUTPUTS	5466-1105	NEW
MICRONET HIGH DENSITY COMBO I/O - 4 SPEED INPUTS (SELECTABLE MPU/PROX/EDDY), 12 ANALOG INPUTS (SELECTABLE 4-20 MA OR 0-5 V), 4 ANALOG OUTPUTS (4-20 MA 600 OHM)	5466-1115	NEW
MICRONET TMR 48/24 HDDIO-2 SMART-PLUS (BACKWARD COMPAT)	5466-1156	NEW
MICRONET SIMPLEX 48/24 HDDIO-2 SMART-PLUS (BACKWARD COMPAT)	5466-1158	NEW
ANALOG COMBO (TMR)	5466-253	L
ANALOG COMBO	5466-316	J
2CH ACTUATOR CONTROLLER (10MA) W/ FFL & WEIGHTED AVE	5501-1428	NEW
2CH ACTUATOR CONTROLLER (25MA) W/ FFL & WEIGHTED AVE	5501-1429	NEW
2CH ACTUATOR CONTROLLER (50MA) W/ FFL & WEIGHTED AVE	5501-1430	NEW
2CH ACTUATOR CONTROLLER (100MA) W/ FFL & WEIGHTED AVE	5501-1431	NEW
2CH ACTUATOR CONTROLLER (200MA) W/ FFL & WEIGHTED AVE	5501-1432	NEW
2CH ACTUATOR CONTROLLER (10MA)	5501-428	J
2CH ACTUATOR CONTROLLER (25MA)	5501-429	J
2CH ACTUATOR CONTROLLER (50MA)	5501-430	H
2CH ACTUATOR CONTROLLER (100MA)	5501-431	H
2CH ACTUATOR CONTROLLER (200MA)	5501-432	K
MICRONET SPEED SENSOR, 4 CHANNEL, MPU SMART-PLUS	5466-5000	NEW
MICRONET SPEED SENSOR, 4 CHANNEL, EDDY PROBE CH1/MPU SMART-PLUS	5466-5001	NEW
MICRONET SPEED SENSOR, 4 CHANNEL, 2 MPU/2 PROX SMART-PLUS	5466-5002	NEW
MICRONET SPEED SENSOR, 4 CHANNEL, 3 MPU/1 PROX SMART-PLUS	5466-5003	NEW
MICRONET HIGH DENSITY ANALOG I/O - 24 INPUTS (SELECTABLE 4-20 MA OR 0-5 V), 8 OUTPUTS (4-20 MA 600 OHMS) ISOLATED I/O	5466-5025	NEW
MICRONET SIMPLEX HIGH DENSITY ANALOG I/O - 24X 4-20 MA INPUTS, 8X 4-20 MA OUTPUTS	5466-5026	NEW
MICRONET SIMPLEX HIGH DENSITY ANALOG I/O - DATAFORTH 24X 0-5 V INPUTS, 8X 4-20 MA OUTPUTS	5466-5027	NEW

[12] All MicroNet FTMs are coated with silicone, if coated.

MicroNet Power Supplies		
MICRONET-PLUS, 24 VDC INPUT, 2 SLOT POWER SUPPLY	5466-1000	D
MICRONET-PLUS, 110 VAC/125 VDC INPUT, 2 SLOT POWER SUPPLY	5466-1001	C
MICRONET-PLUS, 220 VAC/250 VAC INPUT, 2 SLOT POWER SUPPLY	5466-1002	C
MICRONET TMR PLUS KERNEL PS	5466-1049	A
5009/MICRONET TMR POWER SUPPLY (24V DC)	5501-370	E
5009/MICRONET TMR POWER SUPPLY (120V AC/DC)	5501-380	F
5009/MICRONET TMR POWER SUPPLY (220V AC)	5501-381	F

MicroNet Chassis		
MICRONET PLUS 8 SLOT, REDUND WITH SMART FANS	5453-829	B
MICRONET-PLUS 14 SLOT, REDUND WITH SMART FANS	5453-759	B

PEAK200		
Peak 200	All	-

ProTech GII/MSM/SX/TPS		
ProTech GII/MSM/SX/TPS	8237-XXXX	NEW

RTCnet		
RTCNET T/C HA (8 CH, FAIL HIGH)	8200-1151	NEW
RTCNET RTD (8 CH)	8200-1100	NEW
RTCNET T/C (8 CH, FAIL HIGH)	8200-1101	NEW
RTCNET AIO (8AI 4-20MA, 2AO 4-20MA)	8200-1102	NEW
RTCNET AIO LOOP PWR (8AI 4-20MA, 2AO)	8200-1103	NEW
RTCNET DIN (16 CH)	8200-1104	NEW
RTCNET DOUT (16 CH)	8200-1105	NEW

SPC		
Servo Position Controller w/ Marine	8200-226	D
Servo Position Controller w/ CANOpen	8200-227	-

Frequently Asked Questions

- Why isn't everything conformal coated?
  Woodward cannot apply conformal coating on third party products nor can coating be applied to connectors, mating contacts, or anywhere good electrical connection must be made or where it would interfere with mechanical assembly or operation.

- What level of protection does silicone conformal coating provide?
  Silicone conformal coating is permeable to corrosive gases generated by some industrial and natural processes. It does not protect from these gases. It does, however, provide good electrical insulation and protection from particulate pollutants as well as water condensation and salt. Polyacrylate coating provides significant protection from corrosive gases in addition to the benefits of silicone coating.

- How do I verify the coating type on my Woodward manufactured equipment?
  See Table 6. Any Woodward manufactured product family that is not listed uses silicone coating with the exception of some MicroNet FTMs which have no conformal coating.

- Why are some Field Terminal Modules (FTMs) and chassis backplanes not coated?
  Coating is not necessary where the risk of corrosion is negligible such as where bare metal is not exposed, components are of the through-hole type and have relatively robust terminations and packaging, or where corrosion resistant plating materials are used. There are no historical instances of corrosion occurring on uncoated FTMs or backplanes.

- If my equipment has the polyacrylate coating, does that mean corrosion is not a concern?
  No, corrosion is always a concern where salt spray, corrosive particulates or corrosive gases come in contact with the equipment. The coating only mitigates the effects of pollutants on coated areas and increases the time required for pollutants to cause a problem.

- Were the coatings tested for resistance to corrosive gases?
  Yes, the coatings were tested specifically for their ability to protect the reactive metals commonly found in electronics. The testing was performed by an accredited test laboratory. See Tables 4 and 5.

- Can I send my equipment back to Woodward for conversion from silicone to polyacrylate?
  No, it is not possible to coat board assemblies once final assembly has been completed. If it is determined that equipment coated with silicone is installed in a corrosive environment the best plan is to apply other mitigation methods stated in the Recommendations section to prevent the pollutants from contacting the equipment. Otherwise, contact your Woodward representative for polyacrylate coated equipment options.

- Will the Woodward product or service warranty cover the cost of replacement due to corrosion occurring during the warranty period?
  No, the Woodward product and service warranty does not cover damage from environmental conditions or improper installation. The warranty will cover defects in materials and workmanship determined to be the cause of a failure for the warranty period.

Released

We appreciate your comments about the content of our publications.

Send comments to: industrial.support@woodward.com

Please reference publication 51530.

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