

## Purpose

The purpose of this Laboratory Qualification Test is to evaluate the performance of the ModICE Connector System when subjected to the test sequence using the methods defined in Cinch Performance Specification PS-323.



## Revision

- January 2006 Original release
- A July 25, 2008 Added Solar Radiation / UV Exposure
- B March 10, 2009 Added Breather validation

# **Environmental Test Summary**

**Current vs. Temperature Derating Curves**

**Current Cycling**

**Temperature Life**

**Vibration**

**Mechanical Shock**

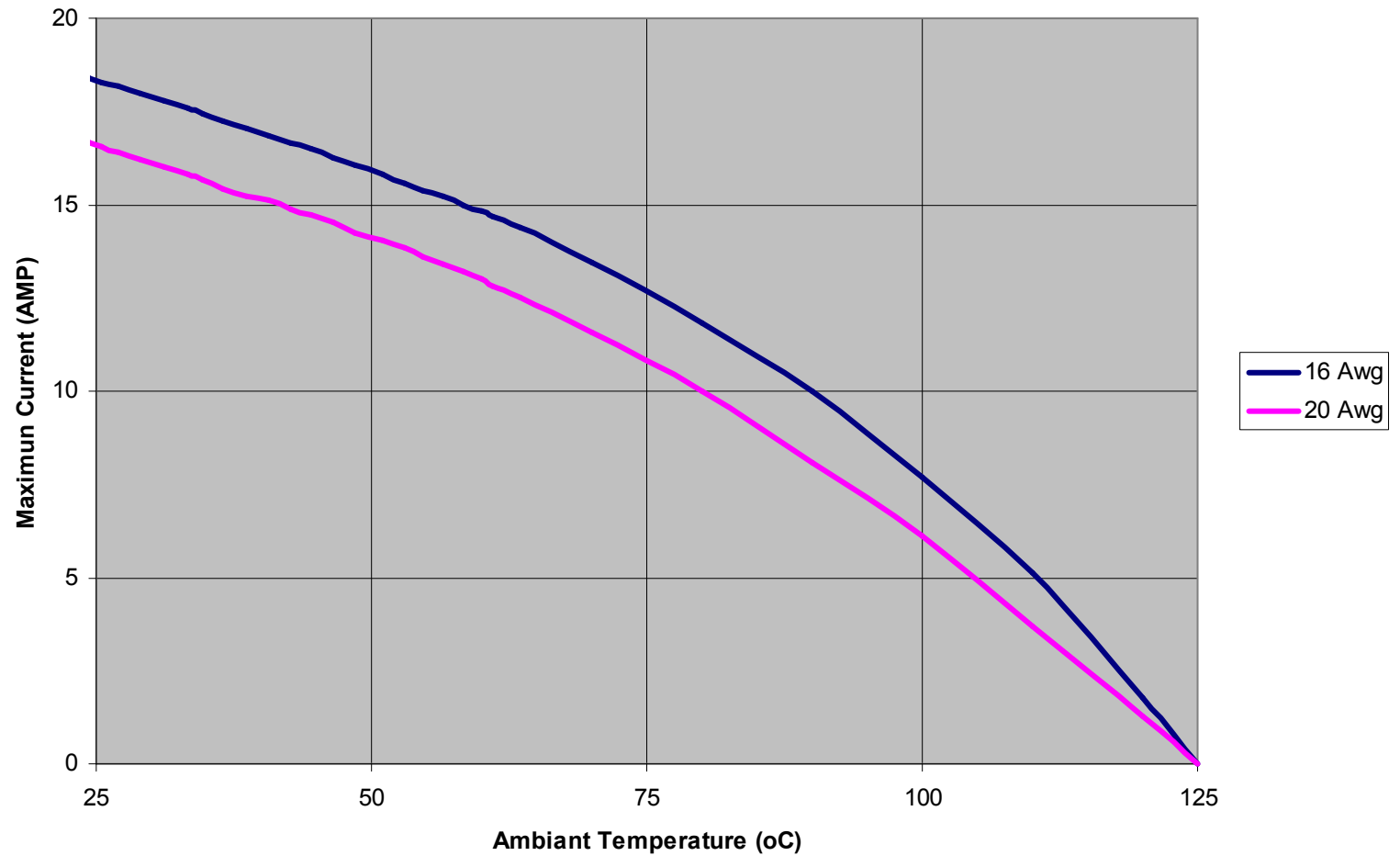
**Temperature Humidity Cycling**

**Salt Spray**

**Chemical Compatibility**

**Solar Radiation / UV Exposure**

## Current vs. Temperature Derating Curves



## Current Cycling Test

### Visual Inspection – Initial

All samples were found to be acceptable.

### Contact Resistance - Initial

All readings met the 10.0m $\Omega$  Max. requirement.  
Group Average : 2.17 m $\Omega$   
Group Max : 2.37 m $\Omega$   
Group Min : 1.92 m $\Omega$   
Std Dev : 0.12 m $\Omega$

### Current Cycling

Connector enclosure SE and LE systems mated to harness were cycled for 500 hours (45 minutes "ON" and 15 minute "OFF") using 10 amps of current. All positions were loaded with a wire size of 16 GXL;20 positions were monitored continuously.

### Contact Resistance – After Current Cycling

All readings met the 10.0m $\Omega$  Max. requirement.  
Group Average : 2.63 m $\Omega$   
Group Max : 3.54 m $\Omega$   
Group Min : 2.20 m $\Omega$   
Std Dev : 0.39 m $\Omega$

### Visual Inspection – Post Current Cycle

All samples were found to be acceptable.

## Temperature Life

### Visual Inspection-Initial

All samples were found to be acceptable.

### Contact Resistance-Initial

All readings met the 10 mΩ Max. requirement.

#### SE Enclosure

Group Average : 1.66 mΩ

Group Max : 2.08 mΩ

Group Min : 1.47 mΩ

Std Dev : 0.15 mΩ

#### LE Enclosure

Group Average : 1.65mΩ

Group Max : 2.14 mΩ

Group Min : 1.47 mΩ

Std Dev : 0.12 mΩ

### Insulation Resistance - Initial

Per MIL-STD-1344 Test @ 500 VDC

All samples met requirement: IR > 5000 MΩ

### Temperature Life Test

Per SAE/USCAR-2 , para. 5.6.3.

Connector enclosure SE and LE systems mated to harness were exposed to 125°C for 1008 hours.

## Temperature Life

### Insulation Resistance – After Temperature Life

Per MIL-STD-1344 Test @ 500 VDC

All samples met requirement: IR > 1000 M $\Omega$

### Insulation Resistance of the heat sink – After Temperature Life

Per SAE/USCAR-2, para. 5.5.1.

Test @ 500 VDC, between adjacent Mosfets

All samples met requirement: IR > 20 M $\Omega$

### Contact Resistance - Final

All readings met the 10 m $\Omega$  Max. requirement.

#### SE Enclosure

Group Average : 2.03 m $\Omega$

Group Max : 3.34 m $\Omega$

Group Min : 1.62 m $\Omega$

Std Dev : 0.34 m $\Omega$

#### LE Enclosure

Group Average : 2.08m $\Omega$

Group Max : 3.48 m $\Omega$

Group Min : 1.67 m $\Omega$

Std Dev : 0.42 m $\Omega$

### Visual Inspection – Post Temperature Life

All samples were found to be acceptable without any damage.

## Vibration

### Visual Inspection-Initial

All samples were found to be acceptable.

### Contact Resistance-Initial

All readings met the 10 m $\Omega$  Max. requirement.

Daisy chain circuit wired in series measured through PCB.

Group Average : 3.29 m $\Omega$

Group Max : 4.40 m $\Omega$

Group Min : 2.57 m $\Omega$

Std Dev : 0.57 m $\Omega$

### Vibration

Per MIL-STD 1344, Method 2005, Condition III.

Sinusoidal vibration between frequencies of 10 to 2000 Hz with a peak g level of 15g's. The vibration was applied in each of the 3 perpendicular axis while continuity was being monitored.

Entire frequency range was traversed in 20 minutes and was repeated 24 times per axis for a total of 24 hours of sinusoidal vibration.

### Continuity Monitoring

There was no loss of continuity greater than one microsecond and no mechanical damage to the samples.

## Vibration

### **Contact Resistance - After Vibration**

All readings met the 10 mΩ Max. requirement.

Group Average : 3.44 mΩ

Group Max : 4.77 mΩ

Group Min : 2.62 mΩ

Std Dev : 0.59 mΩ

### **Visual Inspection – Final**

All samples were found to be acceptable.



## Mechanical Shock

### Visual Inspection-Initial

All samples were found to be acceptable.

### Mechanical Shock

Per SAE J2030, Para. 6.14.

Connector enclosure SE and LE systems mated to harness were subjected to 5 half sine pulse of 50 G's and a duration of 11 millisecond. This was applied in each 2 perpendicular axes for a total of 20 pulses

### Continuity Monitoring

There was no lost of continuity greater than one microsecond and no mechanical damage to the samples.

### Visual Inspection – Final

All samples were found to be acceptable.

## Temperature Humidity Cycling

### Visual Inspection-Initial

All samples were found to be acceptable.

### Contact Resistance-Initial

All readings met the 10 mΩ Max. requirement.

#### SE Enclosure

Group Average : 1.77 mΩ

Group Max : 2.18 mΩ

Group Min : 1.57 mΩ

Std Dev : 0.15 mΩ

#### LE Enclosure

Group Average : 1.78 mΩ

Group Max : 2.11 mΩ

Group Min : 1.55 mΩ

Std Dev : 0.14 mΩ

### Insulation Resistance - Initial

Per MIL-STD-1344 Test @ 500 VDC

All samples met requirement: IR > 5000 MΩ

### Temperature Humidity Cycling Test

Per SAE/USCAR-2 , para. 5.6.2.

40 - 8 hrs cycles : -40°C, +85°C with 85% RH, +125°C

Connector enclosure SE and LE systems mated to harness were subjected to a total 320 hour test.

## Temperature Humidity Cycling

### Insulation Resistance – After Temperature Humidity Cycling

Per MIL-STD-1344 Test @ 500 VDC

All samples met requirement: IR > 1000 M $\Omega$

### Contact Resistance- Final

All readings met the 10 m $\Omega$  Max. requirement.

#### SE Enclosure

Group Average : 2.29 m $\Omega$

Group Max : 2.86 m $\Omega$

Group Min : 1.75 m $\Omega$

Std Dev : 0.21 m $\Omega$

#### LE Enclosure

Group Average : 2.28 m $\Omega$

Group Max : 3.20 m $\Omega$

Group Min : 1.79 m $\Omega$

Std Dev : 0.27 m $\Omega$

### Visual Inspection–Post Temperature Life

All samples were found to be acceptable without any damage.

## Salt Spray

### **Visual Inspection-Initial**

All samples were found to be acceptable.

### **Insulation Resistance - Initial**

Per MIL-STD-1344 Test @ 500 VDC

All samples met requirement: IR > 5000 MΩ

### **Salt Spray Test**

Per ASTM B-117-73

Connector enclosure SE and LE systems mated to harness were exposed to a salt spray environment (5% NaCl) for a period of 96 hours.

### **Insulation Resistance – After Salt Spray**

Per MIL-STD-1344 Test @ 500 VDC

All samples met requirement: IR > 1000 MΩ

### **Visual Inspection – Final**

All samples were found to be acceptable.

## Chemical Compatibility

### Visual Inspection – Initial

All samples were found to be acceptable.

### Insulation Resistance - Initial

Per MIL-STD-1344 Test @ 500 VDC

All samples met requirement: IR > 5000 MΩ

### Chemical Compatibility

Per SAE/USCAR-2, para. 5.6.4

Connector enclosure SE and LE systems mated to harness were immersed completely for 15 minutes into the test fluids listed below at the temperature specified. After immersion, connectors were air dried for a week and tested for insulation resistance.

SAE RM66-04 Brake Fluid @ 50°C

ASTM IRM-902 Oil @ 50°C

ASTM Fuel C Gasoline @25°C

ASTM Fluid 104 Engine Coolant @ 100°C

Citgo #33123 Auto Transmission Fluid @ 50°C

Windshield Washer Fluid @ 25°C

ASTM IRM-903 Power Steering Fluid @50°C

ASTM Diesel Fuel @ 25°C

ASTM E85 Ethanol Fuel @ 25°C

## Chemical Compatibility

### **Insulation Resistance – After Chemical Test**

Per MIL-STD-1344 Test @ 500 VDC

All samples met requirement: IR > 1000 MΩ

### **Visual Inspection – Post Chemical Compatibility**

All samples were found to be acceptable without any damage.

## Solar Radiation – UV Exposure

### Visual Inspection – Initial

All samples were found to be acceptable.

### Solar Radiation – UV Exposure

Per ISO 4892-2, part 2

Connector enclosure SE and LE systems mated to harness were exposed to 500 hrs of solar radiation

Wave length 340 A UV

Back panel temperature 65°C

250 – 2 hr cycles of 102 min light and 18 min water spray

### Visual Inspection–Post Solar Radiation

All samples were found to be acceptable with no external deterioration or gross color shift.

# **Pressure Wash / Sealing Test**

## **High Pressure Wash**

**IP 65**

**IP 66**

**IP69K**

## **Water Immersion**

**IP 67**

## **Modified SAE J2030**



## High Pressure Wash

### Visual Inspection-Initial

All samples were found to be acceptable.

### Insulation Resistance - Initial

Per MIL-STD-1344 Test @ 500 VDC

All samples met requirement: IR > 5000 MΩ

### Contact Resistance - Initial

All readings met the 10 mΩ Max. requirement.

Group Average : 3.03 mΩ

Group Max : 3.81 mΩ

Group Min : 2.14 mΩ

Std Dev : 0.45 mΩ

### High Pressure Wash

Per SAE J1455, section 4.5.3.

Connector enclosure SE and LE systems mated to harness were subjected to water from distance of 20-30 cm at a rate of 150 gal/hr ( 568 l/hr), with a source pressure of 1400 KPa (203 psi - 14 bar).

Water temperature 93oC.

Samples subjected to 375 cycles. One cycle consisted of the pressure washer being on for 3 sec and off for 3 sec.

## High Pressure Wash

### Contact Resistance- After Pressure Wash

All readings met the 10 mΩ Max. requirement.

Group Average : 3.35 mΩ

Group Max : 3.94 mΩ

Group Min : 2.20 mΩ

Std Dev : 0.65 mΩ

### Insulation Resistance – After High Pressure wash

Per MIL-STD-1344 Test @ 500 VDC

All samples met requirement: IR > 1000 MΩ

### Final Inspection

There was no water intrusion after the exposure to high pressure wash.

## Pressure Wash IP65

### Visual Inspection-Initial

All samples were found to be acceptable.

### Pressure Wash IP65

Per DIN40050 part 9.

Connector enclosure SE and LE systems mated to harness were subjected to water from distance of 2.5-3 m (approx. 9 ft) at a rate of 12.5 liters per minute (approx. 3.3 gal/min), with a source pressure of 30 KPa (4.35 psi - 0.3 bar).

The duration of the exposure was 3 minutes.

### Final Inspection

There was no water intrusion after the exposure to pressure wash IP65.

## Pressure Wash IP66

### Visual Inspection–Initial

All samples were found to be acceptable.

### Pressure Wash IP66

Per DIN40050 part 9.

Connector enclosure SE and LE systems mated to harness were subjected to water from distance of 2.5-3 m (approx. 9 ft) at a rate of 100 liters per minute (approx. 26 gal/min), with a source pressure of 100 KPa (14.5 psi - 1 bar).

The duration of the exposure was 3 minutes.

### Final Inspection

There was no water intrusion after the exposure to pressure wash IP66.

## High Pressure Wash IP69K Enclosure with and without breather

### Visual Inspection-Initial

All samples were found to be acceptable.

### High Pressure Wash IP69

Per DIN40050 part 9.

Connector enclosure SE and LE systems mated to harness were subjected to water from distance of 10-15 cm at a rate of 14-16 liters per minute (approx. 4 gal/min), with a source pressure of 9000 KPa (1305 psi - 90 bar).

Water temperature was 80°C.

The duration of the exposure was 30 seconds on four sides (0°, 30°, 60°, 90°)

### Final Inspection

There was no water intrusion after the exposure to high pressure wash IP69.

## Immersion IP67

### Enclosure with and without breather

#### **Visual Inspection-Initial**

All samples were found to be acceptable.

#### **Immersion IP67**

Per DIN40050 part 9.

Connector enclosure SE and LE systems mated to harness were immersed under 1 meter of water for 30 minutes.

#### **Final Inspection**

There was no water intrusion after immersion IP67.

## Immersion – Modified SAE J2030

### Visual Inspection–Initial

All samples were found to be acceptable.

### Water Immersion After Temperature Exposure

Per SAE J2030 - modified

Connector enclosure SE and LE systems were placed in an air circulating oven at 85oC for 1 hour temperature conditioning then immediately submerged under 3 feet (1 meter) of water for a duration of 30 minutes).

### Insulation Resistance – After High Pressure wash

Per MIL-STD-1344 Test @ 500 VDC

All samples met requirement: IR > 1000 MΩ

### Final Inspection

No water intrusion

## Immersion – Modified SAE J2030

### ModICE with Gortex Breather

#### **Visual Inspection–Initial**

All samples were found to be acceptable prior to testing.

#### **Water Immersion After Temperature Exposure**

Per SAE J2030 - modified

Connector enclosure SE and LE systems were placed in an air circulating oven at 85oC for 1 hour temperature conditioning. The samples were removed from the oven and immediately submerged under 1 meter of water for a duration of 30 minutes. The samples were checked for moisture intrusion into the enclosures.

#### **Final Inspection**

No water intrusion into enclosure was observed.



# Heat Sink

## Heat Dissipation

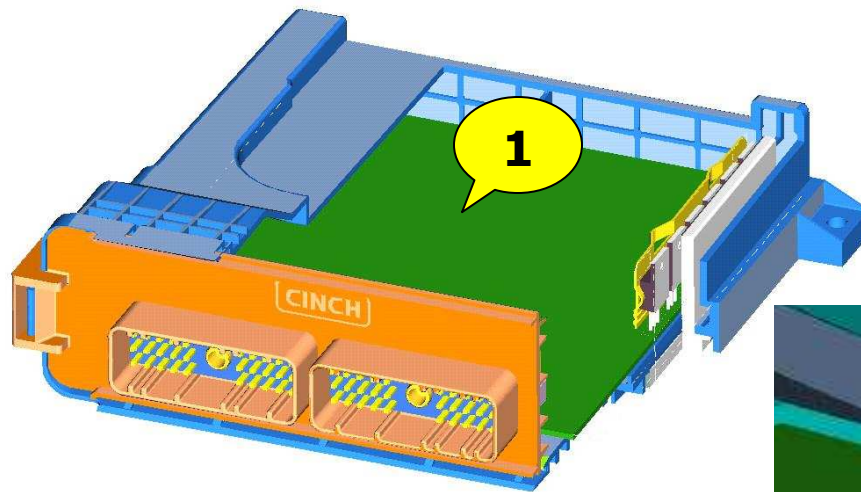
## Heat Dissipation Test Set Up

### Test Procedure

13.2 Volts

Apply current by increment of 0.5 Amps

Record temperature after 30 minutes at rated current



### Temperature Probing Location

1 : Middle of PCB – Inside Enclosure

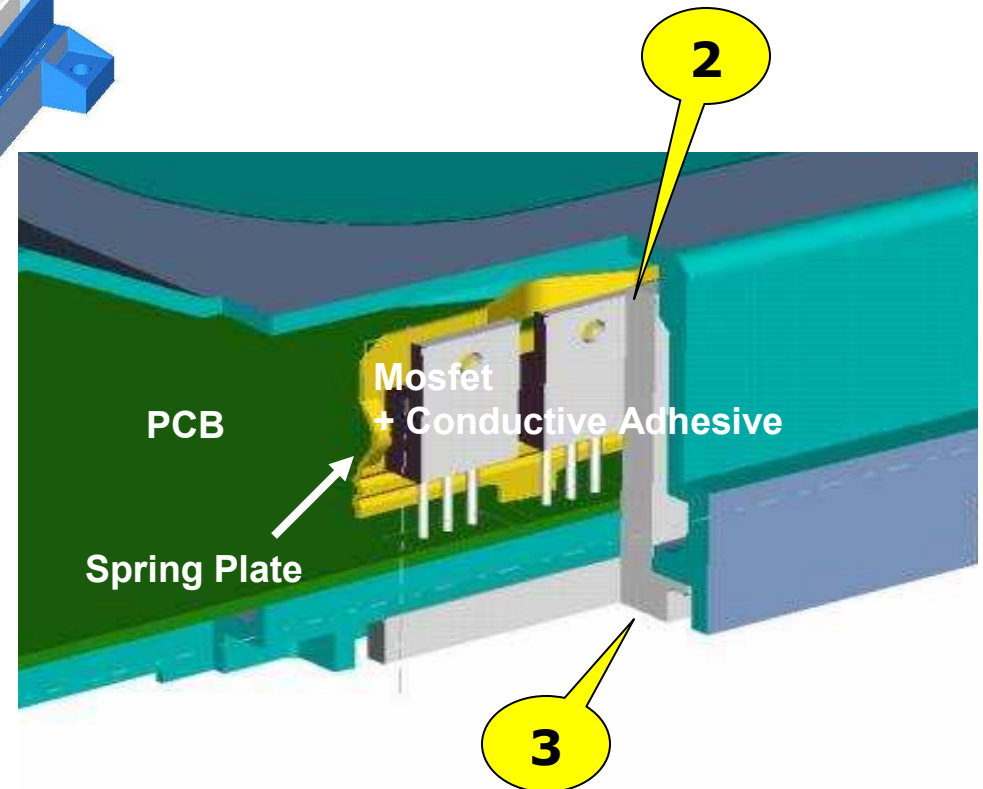
2 : On Heat Sink - Inside Enclosure

3 Thermocouples per heat sink

3 : On Mounting Plate - Outside Enclosure

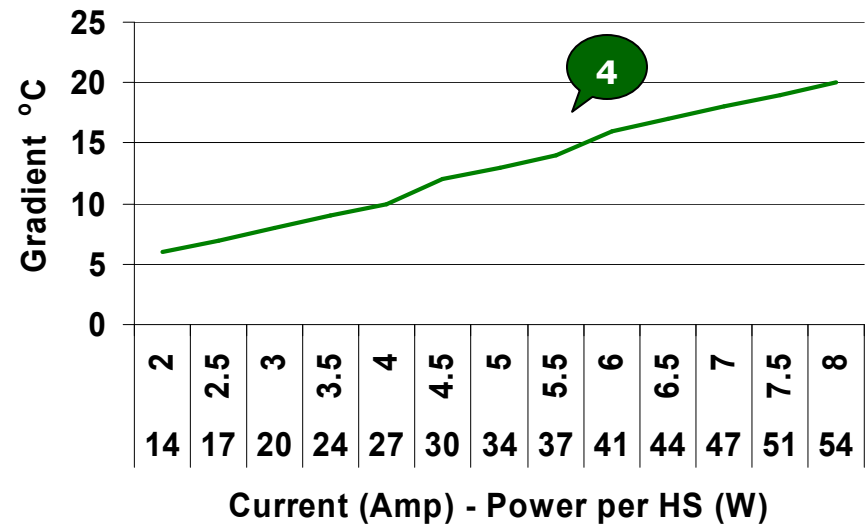
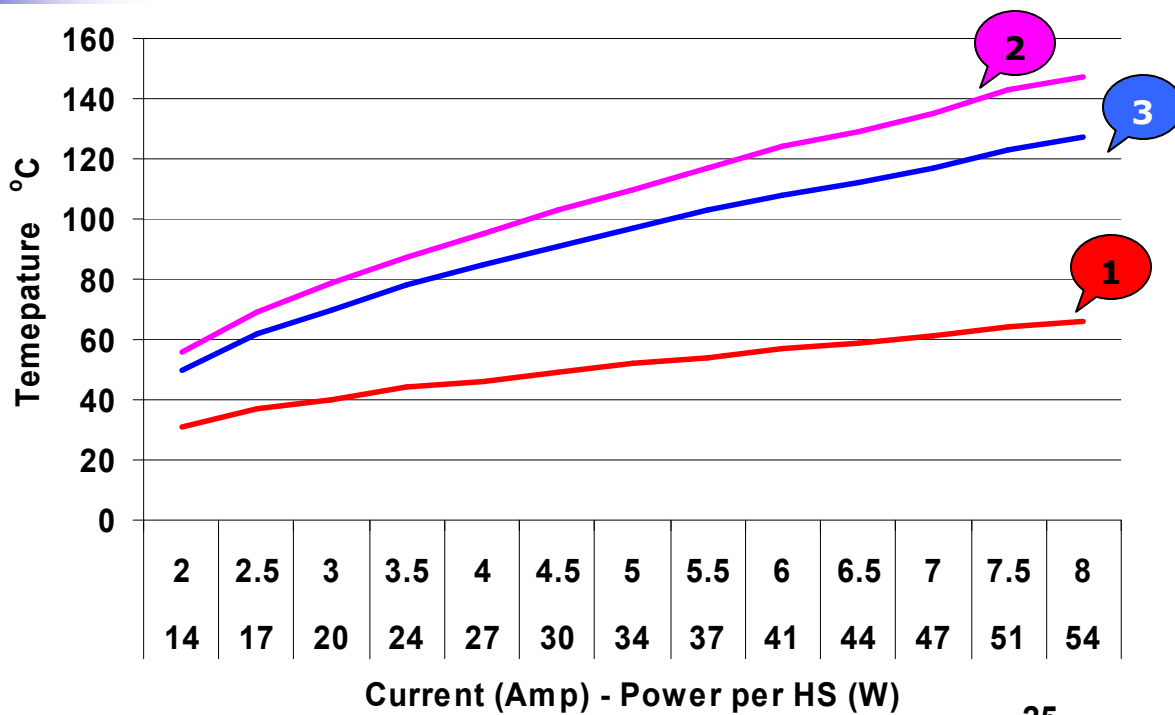
Under middle of heat sink

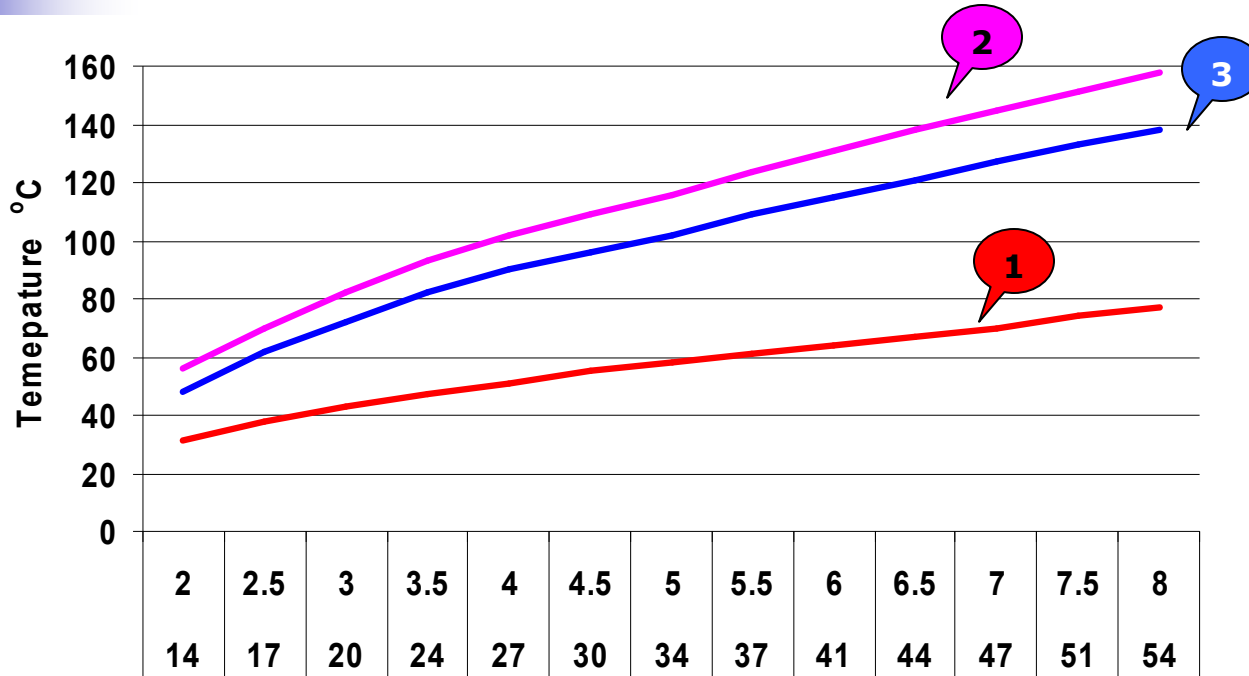
1 Thermocouple per heat sink



### Heat Sink – ModICE SE

- 1 : Middle of PCB**
- 2 : On Heat Sink**
- 3 : On Mounting Plate**
- 4 :Temp. Gradient 2-3**

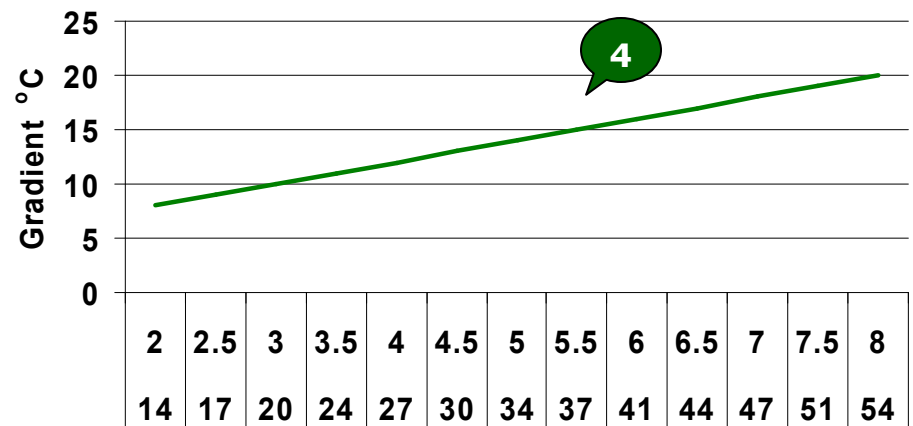




Current (Amp) - Power per HS (W)

### Heat Sink – ModICE LE

- 1 : Middle of PCB**
- 2 : On Heat Sink**
- 3 : On Mounting Plate**
- 4 : Temp. Gradient 2-3**



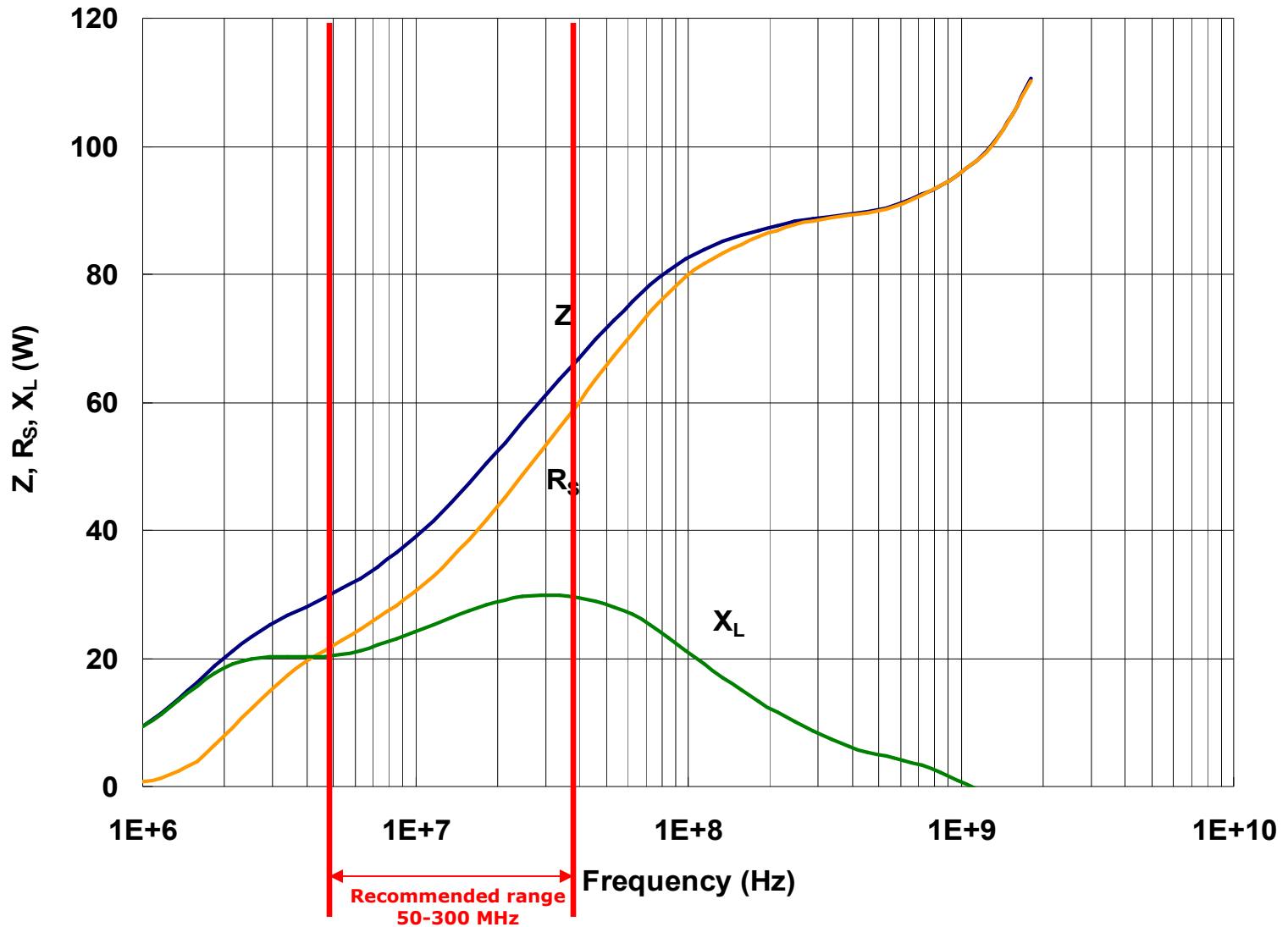
Current (Amp) - Power per HS (W)

# **Filtering Ferrite Insertion Loss Curves**

# Ferrite Insertion Loss

**Typical Attenuation  
3 to 7 dB**

## 18 I/O Header – One Ferrite Block



# Ferrite Insertion Loss

**Typical Attenuation  
3 to 7 dB**

**30 I/O Header – One Ferrite Block**

