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| | Test No: T0976 | | |



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REPORT ON ELECTROMAGNETIC COMPATIBILITY TESTS

**Performed at:
TWENTY PENCE TEST SITE**

**Twenty Pence Road,
Cottenham,
Cambridge
U.K.
CB4 8PS**

on


Williams Refrigeration

L5UC + Envirostart

dated

21st July 2003

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Equipment Under Test (EUT):

L5UC + Envirostart

Test Commissioned by:

Williams Refrigeration
North Lynn Industrial Estate
Bryggen Road
King's Lynn
Norfolk
PE30 2HZ

Representative:

Steve Inns

Test Started:

10th July 2003

Test Completed:

11th July 2003

Test Engineer:

Richard Martin

Date of Report:

21st July 2003

Report:

Written by: Richard Martin

Checked by: Derek Barlow

Signature: _____

Signature: _____

Date: 23rd July 2003


Date: 23rd July 2003

dB Technology can only report on the specific unit(s) tested at its site. The responsibility of extrapolating this data to a product line lies solely with the manufacturer.

Test Standards Applied

| | | |
|------------------|--|----------------|
| EN61000-6-3:2001 | <i>Electromagnetic compatibility - Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments</i> | FAIL #1 |
| EN61000-6-1:2001 | <i>Electromagnetic compatibility (EMC) Part 6-1: Generic standards - Immunity for residential, commercial and light-industrial environments</i> | See Results |

- #1 Original unit, no modifications, default mode.
Only within limits when 0.47uF cap added AND unit operated in level 4 set-up (reference photo 2).

| | | | |
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Emissions Test Results Summary

EN61000-6-3:2001

FAIL

| Test | Port | Method | Limit | PASS/FAIL | Notes |
|-----------------------------------|--------------------|-------------|-----------------------------|-----------|-------|
| Conducted Emissions | ac power | CISPR 22 | EN61000-6-3 = CISPR22(B) | FAIL | #1 |
| Conducted Emissions | signal dc power | CISPR 22 | EN61000-6-3 = CISPR22(B) | N/A | #2 |
| Discontinuous Conducted Emissions | ac power | CISPR 14 | EN61000-6-3 | PASS | |
| Harmonic Currents | ac power | EN61000-3-2 | EN61000-3-2 | PASS | |
| Flicker | ac power | EN61000-3-3 | EN61000-3-3 | PASS | |
| Radiated Emissions | | CISPR 22 | EN61000-6-3 = CISPR22(B) | PASS | |

- #1 Original unit, no modifications, default mode.
Only within limits when 0.47uF cap added AND unit operated in level 4 set-up (reference photo 2).
- #2 Test not applicable because EUT has no relevant signal or dc power ports.

| | | | |
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Immunity Test Results Summary

EN61000-6-1:2001


| Test | Port | Method | Severity | Perf. Criterion (Rec'd) Ach'd | | Notes |
|--------------------------------|---|----------------|---|----------------------------------|-----|-------|
| Radiated Field Immunity | | IEC 61000-4-3 | 3V/m 80-1000MHz 80%1kHz am mod | (A) | A | |
| Conducted RF Immunity | power signal/control functional earth | IEC 61000-4-6 | 3Vrms 0.15-80MHz 80%1kHz am mod | (A) | A | |
| Electrical Fast Transients | a.c. power | IEC 61000-4-4 | 1kV | (B) | A | |
| | d.c. power signal functional earth | IEC 61000-4-4 | 0.5kV | (B) | N/A | #1 |
| Electrostatic Discharge | | IEC 61000-4-2 | 8kV air | (B) | A | |
| | | IEC 61000-4-2 | 4kV contact | (B) | A | |
| Surge | ac power | IEC 61000-4-5 | 1.0kV Line - Line 2.0kV Line - Earth | (B) | D | |
| | dc power | IEC 61000-4-5 | 0.5kV Line - Line 0.5kV Line - Earth | (B) | N/A | #1 |
| Voltage Dips and Interruptions | ac power | IEC 61000-4-11 | 30% reduction 10msec | (B) | A | |
| | | IEC 61000-4-11 | 60% reduction 100msec | (C) | C | |
| | | IEC 61000-4-11 | > 95% reduction 5 seconds | (C) | C | |
| Power Frequency Magnetic Field | | IEC 61000-4-8 | 50Hz/60Hz 3A/m | (A) | N/A | #2 |

#1 Test not applicable because EUT did not have any dc ports, functional earth or signal ports.

#2 Test not applicable because EUT did not contain any devices likely to be susceptible to a magnetic field.

Performance Criterion (Rec'd) = Minimum performance criterion recommended by standards
Ach'd = Performance criterion achieved during actual test


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1 EUT Details

1.1 General

The EUT was an L5UC stainless steel freezer with electronic thermostat. The freezer was fitted with a Envirostart energy saving device.

Details of the EUT and associated peripherals used during the tests are listed below. Figure 1 shows the interconnections between the EUT and peripherals.

| Item | Manufacturer | Model | Description | Serial No: | Notes |
|------|------------------------|--------------|---------------------|----------------|-------|
| 1 | Williams Refrigeration | L5UC SS | Freezer | 306/353018 | |
| 2 | Williams Refrigeration | LAE WUBC | Thermostat | | |
| 3 | EMS European Ltd. | 240-SPMEC-10 | Energy Saving Unity | 2974-1-962-102 | |

1.2 Details of Interconnecting Cables

There were no external interconnecting cables except for the three cored mains cable.

1.3 Modifications to EUT and Peripherals

Details of any modifications that were required to achieve compliance are listed below. The modification numbers are referred to in the results sections as appropriate.

| Mod No: | Details | Implemented for |
|---------|---|---------------------|
| 1 | 470n X2 cap. added from Live Line to Neutral Line. Envirostart changed from Default setting to Level 4. (See Photograph 2) | Conducted Emissions |

1.4 EUT Operating Modes

The EUT was tested in the following operating mode or modes. Generally, operating modes are chosen that will exercise the functions of the EUT as fully as possible and in a manner likely to produce maximum emission levels or susceptibility. Individual test result sheets reference the operating mode of the EUT.

| Operating Mode | Details |
|----------------|---|
| 1 | Freezer operating on a cyclic mode, utilising the Envirostart when compressor is running. |

1.5 EUT Performance Criteria

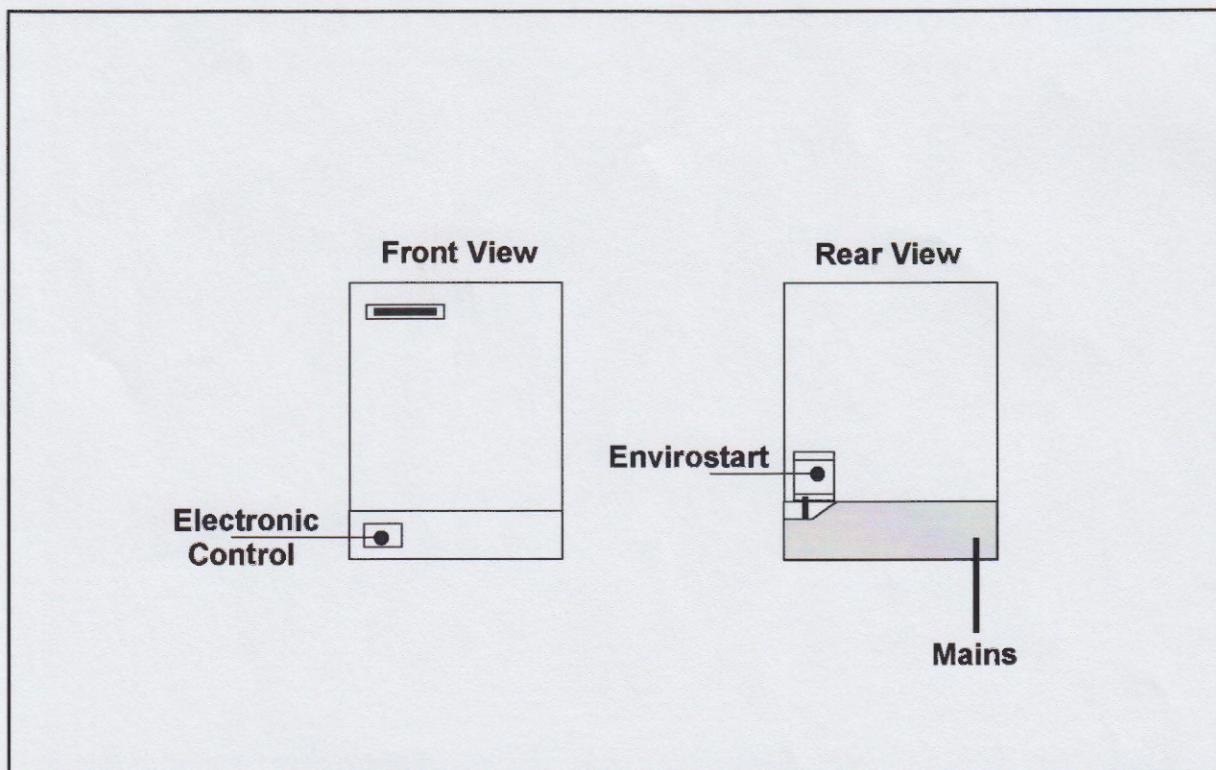
To assess the immunity performance of the EUT the performance criteria listed below were applied. The criteria specify the functions that were monitored during the tests and the levels of performance that were considered acceptable.


| Criterion | Details |
|-----------|---|
| A | Unit works as specification and temperature control is within 1deg. C. |
| B | Unit works as specification and temperature control is within 1deg. C |
| C | Unit stops working properly for duration of test but recovers automatically after interference source is removed. |
| D | EUT stops working due to electronic or mechanical failure caused by the test. |

Performance Criterion A is normally applied to tests where the phenomenon is likely to be continuous in nature - the EUT should continue to perform within the specified performance limits during the test. *Performance Criterion B* is normally applied to tests where the phenomenon is likely to be transient in nature - in this case temporary loss of performance is usually acceptable during the test as long as the EUT automatically returns to normal operation after the test.

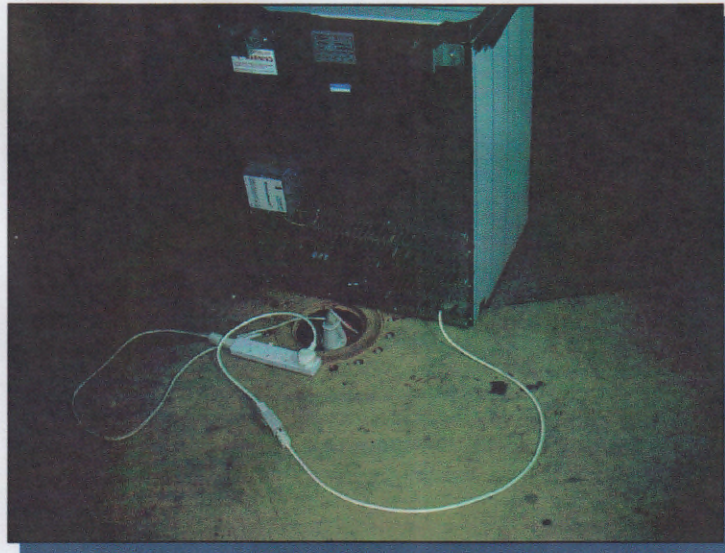
Performance Criterion C is normally associated with power supply failures - in this case loss of performance is usually acceptable as long as the EUT can recover with the aid of user intervention if necessary.

Figure 1 General Arrangement of EUT and Peripherals

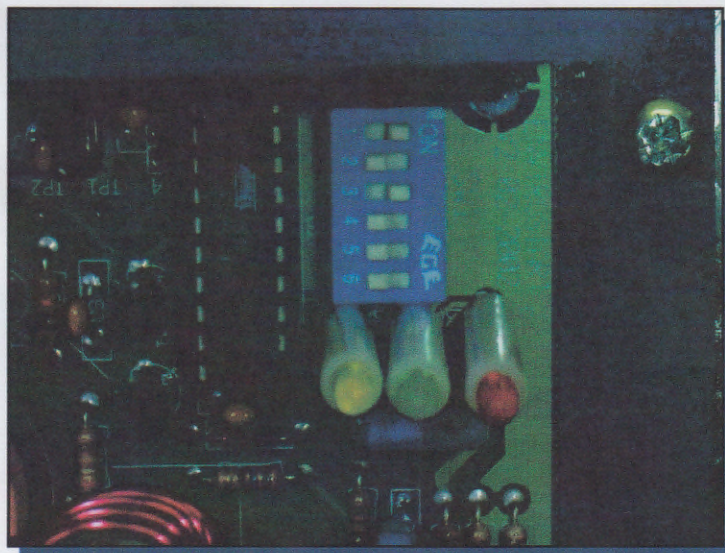


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Photograph 1 General Arrangement of EUT and Peripherals



Photograph 2 Switch Settings for Conducted and Harmonic Tests



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2 Test Equipment

The test equipment used during the tests was one or more of the items listed below. Individual test result sheets indicate which items were used.

| Ref No: | Manufacturer | Model | Description | Serial Number |
|------------------|---|----------------------------------|---|--|
| R1 | Chase | LHR7000 | RF Receiver (10kHz-30MHz) | 1056 |
| R5 R5A R5B | Hewlett Packard Hewlett Packard Hewlett Packard | HP 8595E HP11947A HP87405A | Spectrum Analyser Transient Limiter Pre-amp | 3412A00701 3107A01209 3207A00322 |
| L1 | EMCO | 3825/2 | LISN | 1358 |
| A5 | Chase | CBL111A | Bilog Antenna (30MHz-1GHz) | 1760 |
| SG1 | Marconi | 2022D | RF Signal Generator | 119216/050 |
| AMP1 | Kalmus | 737LC | Power Amplifier | 072694-4 |
| FP1A FP1B | Holaday Holaday | 4422 4416 | Field Strength Meter Repeater for FSM | 89360 84553 |
| WG4 | EM TEST | UCS 500-M | EFT, ESD, DIPS, Surge | 1299-36 |
| CDN1 | dB Technology | dB-CDN-M3 | 3w mains CDN | 001 |
| HA1 | Thurlby Thandar | HA16000 | Harmonics Analyser | 125509 |
| HA1a | Thurlby Thandar | AC1000 | Low Distortion Supply | 116745a |
| SG4 | Marconi | 2022D | RF Signal Generator | 119176/008 |
| SG5 | Blackstar | LD100 | Audio Signal Generator | 61300 |
| AMP2 | Kalmus | 737LC | Power Amplifier | 7355C1 |
| OS2 | Tektronix | TDS3052 | Oscilloscope | B013325 |

3 Test Methods

3.1 Conducted Emissions - ac power

This section describes the general method of performing this test. The specific method used and any deviations from this general method are listed in the appropriate results section.


Bench top EUTs and peripheral equipment are normally placed on a 0.8m high non-conducting bench, positioned 0.4m from one of the metallic walls of a screened room. Floor standing EUTs are normally placed 0.1m above the metallic floor of the screened room. Mains leads are bundled so as not to exceed 1m.

The EUT is powered using a 50ohm/50uH Line Impedance Stabilisation Network (LISN). Peripherals are powered using a second a 50ohm/50uH LISN. These LISNs are bonded to the screened room floor.

With the correct supply voltage applied to the EUT scans are performed on both the live and neutral line outputs of the LISN using quasi-peak detection over the specified frequency range. The results of these scans are shown in the plots section at the end of the report.

Significant emissions identified by the scans are measured and the results tabulated. The table of results is shown in the conducted emissions results section.

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3.2 Discontinuous Conducted Emissions - ac power

This section describes the general method of performing this test. The specific method used and any deviations from this general method are listed in the appropriate results section.

Bench top EUTs and peripheral equipment are normally placed on a 0.8m high non-conducting bench, positioned 0.4m from one of the metallic walls of a screened room. Floor standing EUTs are normally placed 0.1m above the metallic floor of the screened room. Mains leads are bundled so as not to exceed 1m.

The EUT is powered using a 50ohm/50uH Line Impedance Stabilisation Network (LISN). Peripherals are powered using a second a 50ohm/50uH LISN. These LISNs are bonded to the screened room floor.

With the correct supply voltage applied to the EUT measurements are made at the spot frequencies specified by the test standard. Measurements are made over a sufficient time period to allow the necessary number of transient emissions ('clicks') to be recorded.

The measurements are tabulated in the discontinuous conducted emissions results section.

3.3 Harmonic Current Emissions

This section describes the general method of performing this test. The specific method used and any deviations from this general method are listed in the appropriate results section.

The EUT was powered from a supply with low harmonic content (meeting the requirements of Annex A.2 of EN61000-3-2).

Harmonic currents imposed on the mains supply by the EUT were measured using a Harmonics Measurement Set. Where necessary the operating mode of the EUT was changed to find the condition that produced highest levels of harmonics.

A table of results is shown in the results section.

3.4 Voltage Flicker


This section describes the general method of performing this test. The specific method used and any deviations from this general method are listed in the appropriate results section.

The EUT is powered via a voltage flicker meter which analyses changes in mains voltage across the EUT caused by voltage drops across a reference impedance due to changes in EUT load current.

The flicker meter is used to assess short term and long term flicker in accordance with EN 61000-3-3.

Maximum relative voltage change is assessed using an oscilloscope connected to the current monitor output of the flicker meter. The voltage drop that would occur across the EN61000-3-3 reference impedance is calculated from the current measurements.

The measurements obtained are shown in the results section.

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3.5 Radiated Emissions

This section describes the general method of performing this test. The specific method used and any deviations from this general method are listed in the appropriate results section.

Initial scans are performed in a semi-anechoic screened room at a distance of 3m. Scans are performed over the frequency range specified in the test standard with the antenna both horizontally and vertically polarised. During these scans the EUT and peripherals are rotated through 360°. Bench top EUTs are placed on a non-conducting bench at a height of 0.8m above the ground plane. Floor standing EUTs are placed 0.1m above the ground plane. The results of the scans are shown in the plots included at the end of the report.

Significant emissions identified by the scans are measured on an open area test site at the appropriate test distance using a CISPR16 quasi-peak receiver. Maximised readings are obtained by rotating the EUT through 360° and adjusting the height of the antenna from 1m to 4m. Measurements are made with the antenna both horizontally and vertically polarised and the results tabulated.

3.6 RF Fields Immunity

This section describes the general method of performing this test. The specific method used and any deviations from this general method are listed in the appropriate results section.

Bench top EUT is placed on a non-conducting wooden bench at a height of 0.8m above the floor of an anechoic screened room. Floor standing EUT is placed 0.1m from the floor of the screened room. The transmitting aerial is placed at the relevant calibration distance from the EUT and driven by means of a power amplifier and signal generator. An isotropic field strength meter is placed on the bench adjacent to the EUT to monitor the local field strength.

The signal generator frequency is swept over the appropriate frequency range whilst the amplitude of the signal is controlled either:

using the real-time field strength meter reading;

using a profile previously determined in a calibration run without the EUT in place.

3.7 Conducted RF Immunity


This section describes the general method of performing this test. The specific method used and any deviations from this general method are listed in the appropriate results section.

The EUT and peripheral equipment are placed at a height of 0.1m above a ground plane.

AC input ports and other suitable ports are connected to CDNs (coupling decoupling networks).

An interference signal is derived from a signal generator and fed through a power amplifier and attenuator. The signal is applied in turn to each port tested via the CDN, an EM clamp or directly onto cable screens via 150R - the results table indicates the method of application.

The signal is swept through the appropriate frequency range and the output level adjusted to a level determined by the characteristics of the coupling device and the test level specified in the standard. The level of the applied signal was monitored using the forward power meter on the RF amplifier.

| | | | |
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3.8 Electrical Fast Transient Immunity

This section describes the general method of performing this test. The specific method used and any deviations from this general method are listed in the appropriate results section.

Bench top EUT is placed on a non-conducting wooden bench at a height of 0.8m above a ground plane. Floor standing EUT is placed 0.1m above the ground plane. The EFT generator is bonded to the ground plane.

Electrical Fast Transients are applied to the power leads of the EUT via a coupling network. Electrical Fast Transients are also applied to signal and control leads exceeding 3m in length using a capacitive coupling clamp. Where required, the leads are extended to facilitate this.

3.9 Electrostatic Discharge Immunity

This section describes the general method of performing this test. The specific method used and any deviations from this general method are listed in the appropriate results section.

Bench top EUT is placed on thin insulating sheets positioned on a horizontal metal coupling plane. The coupling plane is 0.8m above a metallic ground plane and connected to it by discharge resistors with a total value of 1Mohm. Floor standing EUT is placed on, but insulated from, the ground plane / screened room floor. The ESD generator and the return cable of the discharge gun are both bonded to the ground plane.

For conductive areas of the EUT, contact discharge is made to the relevant accessible points. Where areas of the EUT are insulated and contact discharge cannot be performed, air discharge is performed. Contact discharge is also made to the horizontal coupling plane and to a vertical coupling plane at the side of the EUT.

For each location selected, ten discharges are performed at the appropriate levels and polarities.

3.10 Surge Immunity

This section describes the general method of performing this test. The specific method used and any deviations from this general method are listed in the appropriate results section.

Surges are generated using a CWG (combination wave generator) and applied via an appropriate coupling network to the mains lead of the EUT. Surges are applied at the specified levels, polarities and mains phase angle.

For some equipment surges are also applied via an appropriate coupling network to certain signal leads.


3.11 Voltage Dips and Interruptions

This section describes the general method of performing this test. The specific method used and any deviations from this general method are listed in the appropriate results section.

The mains lead of the EUT was connected to a variable power source. The output of the power source is varied to simulate the specified voltage dips and interruptions.

4 Test Results

The following sections contain tabulated test results. Plots of various scans are included at the back of this section.


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4.1 Conducted Emission Results

| | | | | | |
|-----------------|---------------|--------|----------|-------|------------|
| Test Equipment: | Factor Set 1: | EMLISN | 10DB_PAD | RG214 | 10 m cable |
|-----------------|---------------|--------|----------|-------|------------|

Conducted Emissions

| Company: Williams Refrigeration | | | | | | | | | | Product: L5UC + Envirostart | | | | |
|---------------------------------|---------|--|------------|----------|-----------|-----------|--------------------------|------------------|------------------|---|----------------------|-------|--------|-------|
| Date: 11th July 2003 | | | | | | | | | | Test Eng: Richard Martin | | | | |
| Ports: ac power | | | | | | | | | | | | | | |
| Test: CISPR 22 | | | | | | | | | | using limits of EN61000-6-3 =CISPR22(B) | | | | |
| Ports: | | | | | | | | | | | | | | |
| Test: | | | | | | | | | | | | | | |
| Test | Op Mode | Mod State | Line (L/N) | Fact Set | Freq. MHz | Det qp/av | Rec. Level dBuV | Corr'n Factor dB | Total Level dBuV | Limit CISPR22(B) dBuV | Margin CISPR22(B) dB | Limit | Margin | Notes |
| | | | | | | | | | | | | | | |
| Results | | | | | | | Minimum Margin PASS/FAIL | | | FAIL | | | | |
| Notes | | Comments and Observations | | | | | | | | | | | | |
| | | <p>Results of scans shown in plots 1 to 4.</p> <p>The worst emissions point of the EUT was found to be when it first switched on the compressor after the EUT's temperature was allowed to rise during switch-off.</p> | | | | | | | | | | | | |


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4.2 Discontinuous Conducted Emission Results

| | | | | | | | | | |
|--|--|--|--|--|---|--|--|--|--|
| Company: Williams Refrigeration | | | | | Product: L5UC + Envirostart | | | | |
| Date: 10th July 2003 | | | | | Test Eng: Richard Martin | | | | |
| Ports: ac power | | | | | | | | | |
| Test: CISPR 14 | | | | | using limits of EN61000-6-3 | | | | |
| Limit relaxation = 44 dB | | | | | Based on a click rate of : 0.083 per minute | | | | |
| Test Equipment: L1,R1 | | | | | | | | | |

| Test | Oper. Mode | Mod State | Freq. (MHz) | Line | Click Levels (dBuv) | Click Limit | No: above | RESULT |
|------|------------|-----------|-------------|------|---------------------|-------------|-----------|--------|
| | 1 | 1 | | | | | | #1 |
| | | | | | | | | |

| Notes | Comments and Observations |
|-------|--|
| #1 | No readings were taken as Observed Clicks were less than 10 ms in duration and typically the length was 0.5 to 5 ms. There is no specification for Clicks under 10 ms in length. |

| | | | |
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4.3 Harmonic Currents Results

Harmonic currents

Harmonic currents

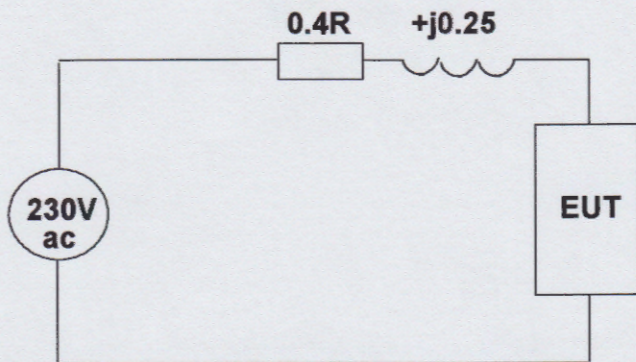
| | | | | | | |
|-----------------|--|-------------------------------|-------------------------------|-----------------------------|------------|------------|
| Company: | Williams Refrigeration | | Product: | L5UC + Envirostart | | |
| Date: | 10th July 2003 | | Test Eng: | Richard Martin | | |
| Ports: | ac power | | | | | |
| Test: | EN61000-3-2 | using limits of | EN61000-3-2 | | | |
| Ports: | | | | | | |
| Test: | | | | | | |
| Load Power: | 402.6 to 571.2 W | 640.5 VA | Power Factor: | 0.823 | | |
| Load Current: | 2.190 to 2.855 Arms | 4.950 Apk | Crest Factor: | 1.561 | | |
| | Duration under Class D mask: 61.3% | | THD: | 11.2% | | |
| Limits: | Load declared Class A. Standard Limits. | | | | | |
| Harmonic Number | Limit Current mA | Min value Unfiltered mA | Max value unfiltered mA | Max value filtered mA | % Limit | Assessment |
| Fundamental: | | 2162.7 | 2887.1 | 2826.6 | | |
| 2: | 1080.0 | 143.6 | 268.1 | 235.3 | 19.4 | Pass |
| 3: | 2300.0 | 66.5 | 181.0 | 150.5 | 5.5 | Pass |
| 4: | 430.0 | 0.3 | 42.2 | 42.2 | 5.0 | Pass |
| 5: | 1140.0 | 9.7 | 186.1 | 186.1 | 2.5 | Pass |
| 6: | 300.0 | 0.0 | 18.8 | 7.7 | 2.0 | Pass |
| 7: | 770.0 | 9.5 | 130.7 | 130.7 | 2.4 | Pass |
| 8: | 230.0 | 3.5 | 25.5 | 25.5 | 4.5 | Pass |
| 9: | 400.0 | 0.1 | 20.5 | 20.5 | 1.7 | Pass |
| 10: | 184.0 | 0.0 | 13.1 | 9.8 | 3.6 | Pass |
| 11: | 330.0 | 0.0 | 27.8 | 27.8 | 1.2 | Pass |
| 12: | 153.3 | 0.0 | 14.2 | 14.2 | 2.7 | Pass |
| 13: | 210.0 | 0.0 | 27.3 | 27.3 | 1.1 | Pass |
| 14: | 131.4 | 0.1 | 7.1 | 6.1 | 2.3 | Pass |
| 15: | 150.0 | 0.0 | 8.6 | 8.6 | 1.4 | Pass |
| 16: | 115.0 | 0.0 | 8.9 | 8.9 | 2.2 | Pass |
| 17: | 132.3 | 0.0 | 8.8 | 8.6 | 1.2 | Pass |
| 18: | 102.2 | 0.0 | 6.1 | 6.1 | 1.4 | Pass |
| 19: | 118.4 | 0.0 | 6.2 | 5.0 | 1.1 | Pass |
| 20: | 92.0 | 0.0 | 6.1 | 6.1 | 1.3 | Pass |
| 21: | 107.1 | 0.0 | 5.3 | 5.3 | 1.0 | Pass |
| 22: | 83.6 | 0.0 | 5.5 | 5.5 | 1.6 | Pass |
| 23: | 97.8 | 0.0 | 4.6 | 4.6 | 1.2 | Pass |
| 24: | 76.7 | 0.0 | 5.7 | 5.7 | 2.1 | Pass |
| 25: | 90.0 | 0.0 | 4.8 | 4.8 | 1.3 | Pass |
| 26: | 70.8 | 0.0 | 4.6 | 4.6 | 2.0 | Pass |
| 27: | 83.3 | 0.0 | 4.1 | 4.1 | 1.6 | Pass |
| 28: | 65.7 | 0.0 | 4.6 | 4.6 | 2.0 | Pass |
| 29: | 77.6 | 0.0 | 4.4 | 4.4 | 1.1 | Pass |
| 30: | 61.3 | 0.0 | 3.9 | 3.9 | 2.6 | Pass |
| 31: | 72.6 | 0.0 | 3.7 | 3.7 | 1.2 | Pass |
| 32: | 57.5 | 0.0 | 3.7 | 3.7 | 1.2 | Pass |
| 33: | 68.2 | 0.0 | 2.8 | 2.8 | 1.0 | Pass |
| 34: | 54.1 | 0.0 | 3.5 | 3.5 | 1.3 | Pass |
| 35: | 64.3 | 0.0 | 3.9 | 3.9 | 1.0 | Pass |
| 36: | 51.1 | 0.0 | 3.2 | 3.2 | 1.1 | Pass |
| 37: | 60.8 | 0.0 | 2.6 | 2.6 | 0.9 | Pass |
| 38: | 48.4 | 0.0 | 3.2 | 3.2 | 1.0 | Pass |
| 39: | 57.7 | 0.0 | 3.0 | 3.0 | 0.9 | Pass |
| 40: | 46.0 | 0.0 | 2.8 | 2.8 | 1.0 | Pass |


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| | Test No: T0976 | | |

4.4 Voltage Flicker Results

Voltage Flicker

| | | | |
|---|---|-----------------------------|--|
| Company: Williams Refrigeration | | Product: L5UC + Envirostart | |
| Date: 10th July 2003 | | Test Eng: Dave Smith | |
| Ports: ac power | | | |
| Test: EN61000-3-3 | | using limits of EN61000-3-3 | |
| Ports: | | | |
| Test: | | | |
| <div></div> | | | |
| Notes | Comments and Observations | | |
| | <p>The absolute maximum number of switch-ons of the compressor per hour is 10. From the above diagram of information given by the compressor manufacture :- $Z_{in} = 0.471R$. Voltage dropped across impedance is 6.13V. The switch on surge across the compressor is 13A and therefore the transient flicker result obtained is 2.67% which is within specification.</p> | | |


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| | Test No: T0976 | | |

4.5 Radiated Emissions Results

| | | | | |
|-----------------|---------------|----------|-------|------------|
| Test Equipment: | Factor Set 1: | HFBIOLOG | RG214 | 25 m cable |
|-----------------|---------------|----------|-------|------------|

Radiated Emissions

| Company: Williams Refrigeration | | | | | Product: L5UC + Envirostart | | | | | | | | | |
|---------------------------------|---------|--|--------|----------|---|---------|-----------------|--------------------|--------------------|--------------------------|----------------------|-------|--------|-------|
| Date: 10th July 2003 | | | | | Test Eng: Richard Martin | | | | | | | | | |
| Ports: CISPR 22 | | | | | using limits of EN61000-6-3 =CISPR22(B) | | | | | | | | | |
| Ports: | | | | | | | | | | | | | | |
| Test: | | | | | | | | | | | | | | |
| Test | Op Mode | Mod State | Dist m | Fact Set | Freq. MHz | Ant Pol | Rec. Level dBuV | Corr'n Factor dB/m | Total Level dBuV/m | Limit CISPR22(B) dBuV/m | Margin CISPR22(B) dB | Limit | Margin | Notes |
| | 1 | 0 | | | | | | | | | | | | #1 |
| Results | | | | | | | | | | Minimum Margin PASS/FAIL | | PASS | | |
| Notes | | Comments and Observations | | | | | | | | | | | | |
| | | <p>Results of screened room scans shown in plots 5 and 6.</p> <p>All emissions were sufficiently below the limit line that it was not considered necessary to maximise on the open area test site.</p> | | | | | | | | | | | | |

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| | Test No: T0976 | | |

4.6 RF Field Immunity Results

RF Immunity


| Company: Williams Refrigeration | | | | | Product: L5UC + Envirostart | | | | | | |
|---|-----------|-----------------|---------|----------|-----------------------------|-------------|------------|---------------|--------------------|-----------------------|---------------|
| Date: 10th July 2003 | | | | | Test Eng: Richard Martin | | | | | | |
| Test Equipment: SG1,AMP1,FP1 | | | | | | | | | | RESULT | |
| Ports: IEC 61000-4-3 3V/m 80-1000MHz 80%1kHz am mod | | | | | | | | | | Recm'd Crit (A) | Ach'd Crit. A |
| Ports: | | | | | | | | | | Recm'd Crit | Ach'd Crit. |
| Test: | | | | | | | | | | | |
| Ports: | | | | | | | | | | Recm'd Crit | Ach'd Crit. |
| Test: | | | | | | | | | | | |
| Oper. Mode | Mod State | EUT orientation | Profile | Ant-enna | Frequency Range MHz | Step Size % | Dwell msec | Polaris ation | Field Strength V/m | Modulation %AM / freq | Notes |
| 1 | 1 | Front | 3vlf | A5 | 80-200 | 0.15 | 450 | V | 3 | 80%, 1kHz | #1 |
| 1 | 1 | Front | 3hlf | A5 | 80-200 | 0.15 | 450 | H | 3 | 80%, 1kHz | #1 |
| 1 | 1 | Front | 6vhf | A5 | 200-1000 | 0.15 | 450 | V | 3 | 80%, 1kHz | #1 |
| 1 | 1 | Front | 6hhf | A5 | 200-1000 | 0.15 | 450 | H | 3 | 80%, 1kHz | #1 |
| 1 | 1 | Front | 6vhf | A5 | 900 | N/A | N/A | V | 3 | 200Hz, pulse | #2 |
| 1 | 1 | Front | 6hhf | A5 | 900 | N/A | N/A | H | 3 | 200Hz, pulse | #2 |
| 1 | 1 | Side | 3vlf | A5 | 80-200 | 0.15 | 450 | V | 3 | 80%, 1kHz | #1 |
| 1 | 1 | Side | 3hlf | A5 | 80-200 | 0.15 | 450 | H | 3 | 80%, 1kHz | #1 |
| 1 | 1 | Side | 6vhf | A5 | 200-1000 | 0.15 | 450 | V | 3 | 80%, 1kHz | #1 |
| 1 | 1 | Side | 6hhf | A5 | 200-1000 | 0.15 | 450 | H | 3 | 80%, 1kHz | #1 |
| 1 | 1 | Side | 6vhf | A5 | 900 | N/A | N/A | V | 3 | 200Hz, pulse | #2 |
| 1 | 1 | Side | 6hhf | A5 | 900 | N/A | N/A | H | 3 | 200Hz, pulse | #2 |

V = Vertical, H = Horizontal polarisation

#1, 2, 3.... see Observations Table below

| Notes | Comments and Observations |
|-------|---|
| #1 | No effect observed. |
| #2 | For information only. No effect observed. |
| | Stored profile method used. |

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| | Test No: T0976 | | |

4.7 Conducted RF Immunity Results

Conducted RF

Conducted by:


| | | | |
|----------|------------------------|-----------|--------------------|
| Company: | Williams Refrigeration | Product: | L5UC + Envirostart |
| Date: | 11th July 2003 | Test Eng: | Richard Martin |

| | | | | | | |
|-----------------|---------------|------------------|------------------|-------------|-------------|--|
| Test Equipment: | | | | SG1, AMP1 | RESULT | |
| Ports: | power | signal/control | functional earth | Recm'd Crit | Ach'd Crit. | |
| Test | IEC 61000-4-6 | 3Vrms 0.15-80MHz | 80%1kHz am mod | (A) | A | |
| Ports: | | | | Recm'd Crit | Ach'd Crit. | |
| Test: | | | | | | |
| Ports: | | | | Recm'd Crit | Ach'd Crit. | |
| Test: | | | | | | |

| Test | Oper. Mode | Mod State | Cable | Coupler | Frequency Range MHz | Step Size % | Modulation %AM / freq | Level Vrms | Notes |
|------|------------|-----------|-------|------------|---------------------|-------------|-----------------------|------------|-------|
| 1 | 1 | 1 | Mains | 3 wire CDN | 0.15 - 80 | 0.15 | 80% 1kHz | 3 | #1 |
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| Notes | Comments and Observations |
|-------|---------------------------|
| #1 | No effects. |

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| | Test No: T0976 | | |

4.8 Electrical Fast Transient Immunity Results

EFT

Company: Williams Refrigeration

Date: 11th July 2003

Product: L5UC + Envirostart

Test Eng: Richard Martin


| | | | | |
|-----------------|---------------|--------|------------------|-------------|
| Test Equipment: | | WG4 | RESULT | |
| Ports: | a.c. power | | Recm'd Crit | Ach'd Crit. |
| Test | IEC 61000-4-4 | 1kV | (B) | A |
| Ports: | d.c. power | signal | functional earth | Recm'd Crit |
| Test: | IEC 61000-4-4 | 0.5kV | (B) | Ach'd Crit. |
| | | | Recm'd Crit | Ach'd Crit. |
| Test: | | | | |

| Test | Oper. Mode | Mod State | Transients Applied to: | Level kV | Polarity | Duration s | Notes |
|------|------------|-----------|------------------------|----------|----------|------------|-------|
| 1 | 1 | 1 | Mains L | 1 | + | 60 | #1 |
| 2 | 1 | 1 | " N | 1 | + | 60 | #1 |
| 3 | 1 | 1 | " E | 1 | + | 60 | #1 |
| 4 | 1 | 1 | " L+N | 1 | + | 60 | #1 |
| 5 | 1 | 1 | " L+E | 1 | + | 60 | #1 |
| 6 | 1 | 1 | " N+E | 1 | + | 60 | #1 |
| 7 | 1 | 1 | " L+N+E | 1 | + | 60 | #1 |
| 8 | 1 | 1 | Mains L | 1 | - | 60 | #1 |
| 9 | 1 | 1 | " N | 1 | - | 60 | #1 |
| 10 | 1 | 1 | " E | 1 | - | 60 | #1 |
| 11 | 1 | 1 | " L+N | 1 | - | 60 | #1 |
| 12 | 1 | 1 | " L+E | 1 | - | 60 | #1 |
| 13 | 1 | 1 | " N+E | 1 | - | 60 | #1 |
| 14 | 1 | 1 | " L+N+E | 1 | - | 60 | #1 |

L = Live, N = Neutral, E = Earth #1, 2, 3.... see Observations Table below

| Notes | Comments and Observations |
|-------|---------------------------|
| #1 | No effect. |

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4.9 Electrostatic Discharge Immunity Results


ESD

| Company: Williams Refrigeration | | | | Product: L5UC + Envirostart | | | | | | | |
|---------------------------------|------------|-----------|------------------------|-----------------------------|------------|-----------|-----------|---------------|-----------|-----------|-----------|
| Date: 11th July 2003 | | | | Test Eng: Richard Martin | | | | | | | |
| Test Equipment: WG4 | | | | RESULT | | | | | | | |
| Ports: | | | | Recm'd Crit (B) | | | | Ach'd Crit. A | | | |
| Test: IEC 61000-4-2 8kV air | | | | | | | | | | | |
| Ports: | | | | Recm'd Crit (B) | | | | Ach'd Crit. A | | | |
| Test: IEC 61000-4-2 4kV contact | | | | | | | | | | | |
| Test: | | | | Recm'd Crit | | | | Ach'd Crit. | | | |
| Test | Oper. Mode | Mod State | Discharges Applied to: | + 4kV cont | - 4kV cont | + 2kV air | - 2kV air | + 4kV air | - 4kV air | + 8kV air | - 8kV air |
| 1 | 1 | 1 | L5UC Freezer | | | #1 | #1 | #1 | #1 | #1 | #1 |
| 2 | 1 | 1 | Led Display | | | | | | | | |
| 3 | 1 | 1 | Outer panels and Edges | | | | | | | | |
| 4 | 1 | 1 | Outer Screws | #1 | #1 | | | | | | |
| 5 | 1 | 1 | Inner Panels | #1 | #1 | | | | | | |
| | | | Inner Screws | #1 | #1 | | | | | | |
| 6 | 1 | 1 | Envirostart unit | | | | | | | | |
| | | | Case | #1 | #1 | | | | | | |
| 7 | 1 | 1 | Screws | #1 | #1 | | | | | | |

#1, 2, 3.... see Observations Table below

| Notes | Comments and Observations |
|-------|---------------------------|
| #1 | No effect observed. |

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| | Test No: T0976 | | |

4.10 Surge Immunity Results

SURGE

Company: Williams Refrigeration

Date: 11th July 2003

Product: L5UC + Envirostart

Test Eng: Richard Martin


| Test Equipment: WG4 | | | | RESULT | |
|---------------------|---------------|-------------------|--------------------|-------------|-------------|
| Ports: | ac power | | | Recm'd Crit | Ach'd Crit. |
| Test: | IEC 61000-4-5 | 1.0kV Line - Line | 2.0kV Line - Earth | (B) | D |
| Ports: | dc power | | | Recm'd Crit | Ach'd Crit. |
| Test: | IEC 61000-4-5 | 0.5kV Line - Line | 0.5kV Line - Earth | (B) | N/A |
| Ports: | | | | Recm'd Crit | Ach'd Crit. |
| Test: | | | | | |

| Test | Oper. | Mod | Surges Applied to: | Level kV | Polarity | Phase ° | Interval secs | Notes |
|------|-------|-----|--------------------|-------------|----------|------------|------------------|-------|
| 1 | 1 | 1 | Mains L - N | 0.5 | + | 0, 90, 270 | 20 | #1 |
| 2 | 1 | 1 | Mains L - E | 0.5 | + | 0, 90, 270 | 20 | #1 |
| 3 | 1 | 1 | Mains N - E | 0.5 | + | 0, 90, 270 | 20 | #1 |
| 4 | 1 | 1 | Mains L - N | 0.5 | - | 0, 90, 270 | 20 | #1 |
| 5 | 1 | 1 | Mains L - E | 0.5 | - | 0, 90, 270 | 20 | #1 |
| 6 | 1 | 1 | Mains N - E | 0.5 | - | 0, 90, 270 | 20 | #1 |
| 7 | 1 | 1 | Mains L - N | 1 | + | 0, 90, 270 | 20 | #1 |
| 8 | 1 | 1 | Mains L - E | 1 | + | 0, 90, 270 | 20 | #1 |
| 9 | 1 | 1 | Mains N - E | 1 | + | 0, 90, 270 | 20 | #1 |
| 10 | 1 | 1 | Mains L - N | 1 | - | 0, 90, 270 | 20 | #1 |
| 11 | 1 | 1 | Mains L - E | 1 | - | 0, 90, 270 | 20 | #1 |
| 12 | 1 | 1 | Mains N - E | 1 | - | 0, 90, 270 | 20 | #1 |
| 13 | 1 | 1 | Mains L - E | 2 | + | 0, 90, 270 | 30 | #2 |
| 14 | 1 | 1 | Mains N - E | 2 | + | 0, 90, 270 | 30 | #2 |
| 15 | 1 | 1 | Mains L - E | 2 | - | 0, 90, 270 | 30 | #2 |
| 16 | 1 | 1 | Mains N - E | 2 | - | 0, 90, 270 | 30 | #2 |

L = Live, N = Neutral, E = Earth

#1, 2, 3.... see Observations Table below

| Notes | Comments and Observations |
|-------|--|
| #1 | No effect. |
| #2 | Envirostart unit was seen to arc at every test before failing. |

| | | | |
|---|------------------|-------------|----------------|
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| | Test No: T0976 | | |


4.11 Voltage Dips Immunity Results

Dips

| | | | |
|---------------------------------|--|-----------------------------|-------------|
| Company: Williams Refrigeration | | Product: L5UC + Envirostart | |
| Date: 10th July 2003 | | Test Eng: Richard Martin | |
| Test Equipment: WG4 | | RESULT | |
| Ports: | ac power | Recm'd Crit | Ach'd Crit. |
| Test | IEC 61000-4-11 30% reduction 10msec | (B) | A |
| Ports: | | Recm'd Crit | Ach'd Crit. |
| Test | IEC 61000-4-11 60% reduction 100msec | (C) | C |
| Ports: | | Recm'd Crit | Ach'd Crit. |
| Test | IEC 61000-4-11 > 95% reduction 5 seconds | (C) | C |
| Ports: | | Recm'd Crit | Ach'd Crit. |
| Test: | | | |

| Test | Oper. Mode | Mod State | Voltage Reduction | Period | Number Applied | Notes |
|------|------------|-----------|-------------------|-----------|----------------|-------|
| 1 | 1 | 1 | 30% reduction | 10msec | 5 | #1 |
| 2 | 1 | 1 | 60% reduction | 100msec | 5 | #1 |
| 3 | 1 | 1 | > 95% reduction | 5 seconds | 5 | #2 |

| Notes | Comments and Observations |
|-------|--|
| #1 | No effect on either 0 or 180 deg. |
| #2 | Unit stopped but automatically restarted when power is restored to normal. |

| | | | |
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| | Test No: T0976 | | |

Chase EMS 6.21

Notes

Analyse 030710 C1L Williams Refrig. L5UC + Enviro - 230V

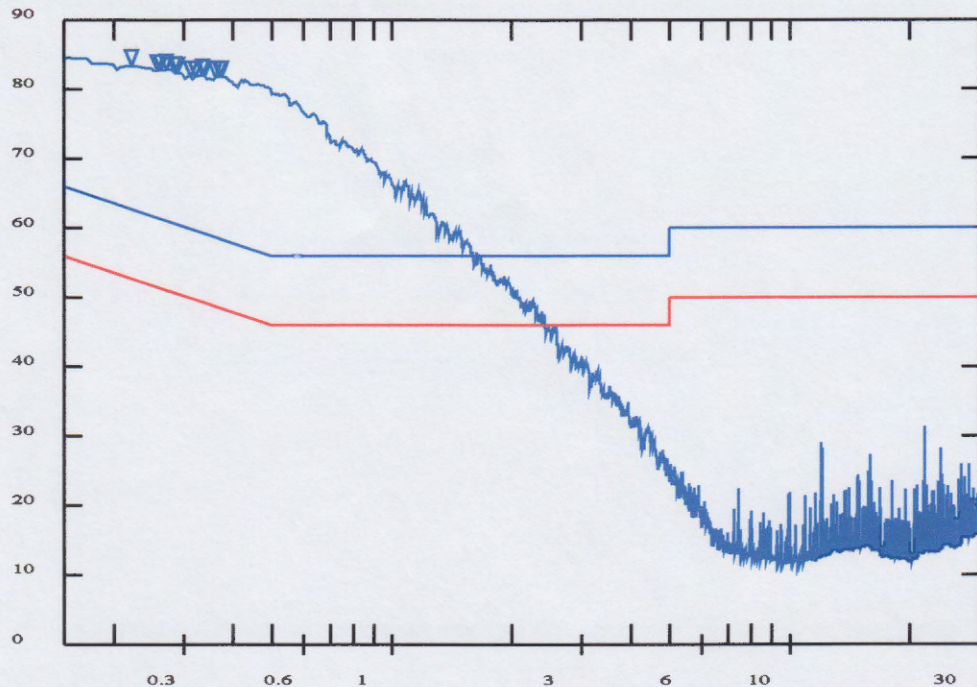
Test: EN55022(B),EN55011(B),EN55014&13 Main Cond(QP Det)

RF level

dBuV

030710 C1L W

Quasi-peak



Log Freq. (0.15 - 30)MHz

Limit EN 55022 B Conducted Aver


PLOT 1 Conducted Emissions : Default Setup - 230V Live (no mods)

| | | | | | |
|-------------------------------|------------------------|-------------|----------------|--------------------|---|
| Company: | Williams Refrigeration | | Product: | L5UC + EnviroStart | |
| Date: | 10 Jul 03 | | Test Engineer: | Richard Martin | |
| Test: | EN55022 | | Limit: | EN (B) QP + AV | |
| Notes: | | | | | |
| EnviroStart in Default Setup. | | | | | |
| 230V | | | | | |
| Line: | Live | Attenuator: | 10dB PAD | Operating Mode: | 1 |
| Detector: | QuasiPeak | | | Mod. State: | 0 |
| LISN: | EMCO | Filename: | C3710600.plt | | |

Frequency List (MHz)

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|---|-------------------------|--|
|  | Report No: R1737 | <div style="border: 1px solid black; width: 100px; height: 20px;"></div> |
| | Issue No: 2 | |
| Test No: T0976 | Test Report | Page: 25 of 29 |

Chase EMS 6.21

Notes

Analyse 030710 C4L Williams Refrig. L5UC Enviro - 230V

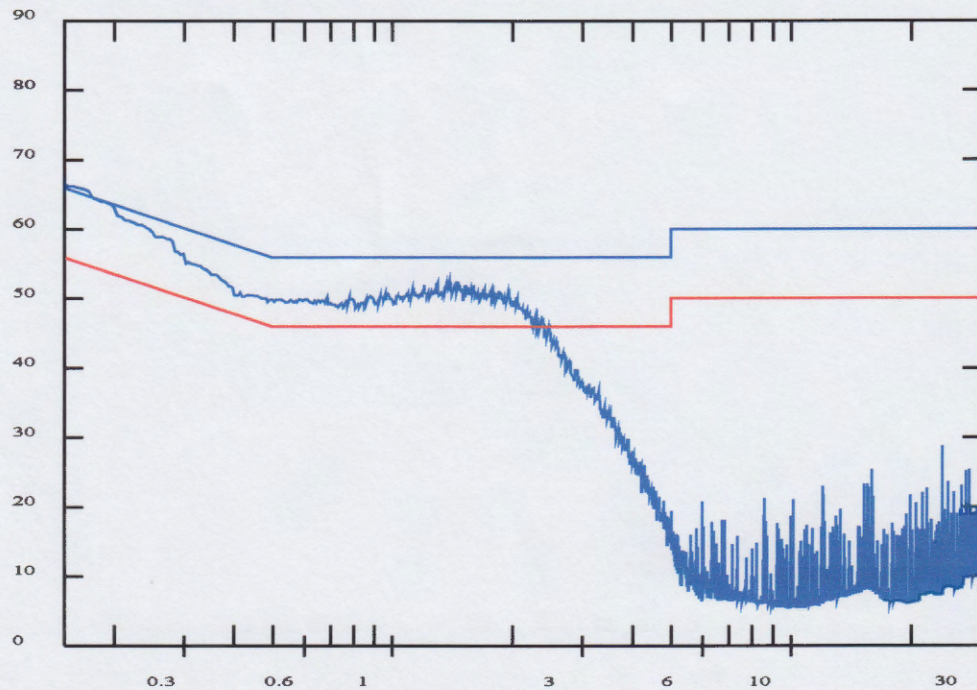
Test: EN55022(B),EN55011(B),EN55014&13 Main Cond(QP Det)

RF level

dBuV

030710 C4L W

Quasi-peak



Log Freq. (0.15 - 30)MHz

Limit EN 55022 B Conducted Aver

PLOT 2 Conducted Emissions : Default Setup - 230V Live (mods applied)

| | | | | | |
|-------------------------------|------------------------|-------------|----------------|--------------------|---|
| Company: | Williams Refrigeration | | Product: | L5UC + EnviroStart | |
| Date: | 10 Jul 03 | | Test Engineer: | Richard Martin | |
| Test: | EN55022 | | Limit: | EN (B) QP + AV | |
| Notes: | | | | | |
| EnviroStart in Default Setup. | | | | | |
| 470n X2 cap added. | | | | | |
| 230V | | | | | |
| Line: | Live | Attenuator: | 10dB PAD | Operating Mode: | 1 |
| Detector: | QuasiPeak | | | Mod. State: | 1 |
| LISN: | EMCO | Filename: | C37106CC.plt | | |

Frequency List (MHz)

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Chase EMS 6.21

Notes

Analyse 030710 C3L Williams Refrig. L5UC + Enviro - 230V

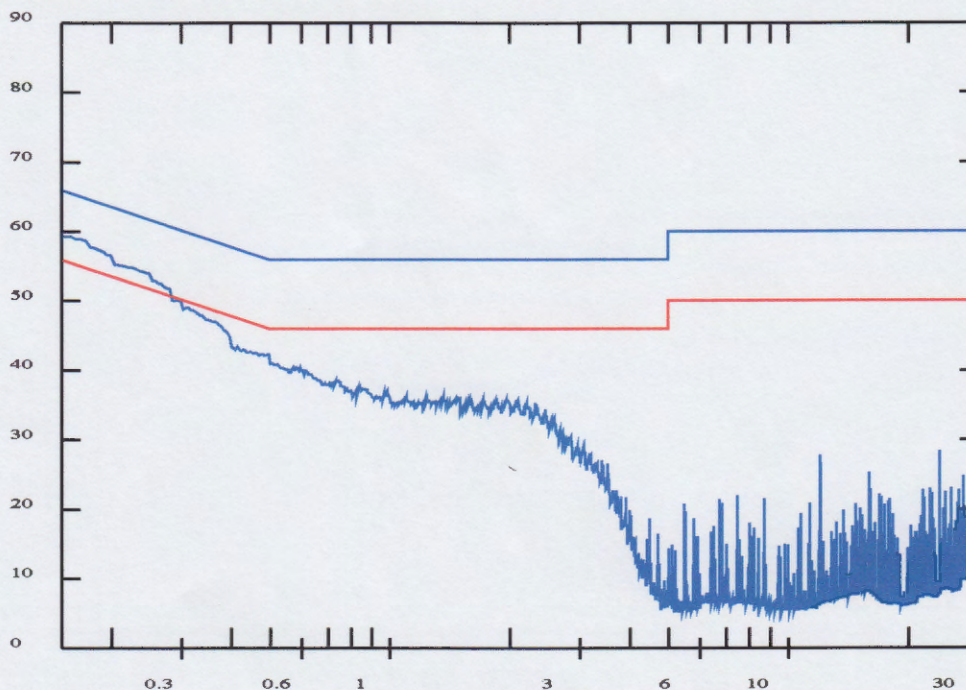
Test: EN55022(B),EN55011(B),EN55014&13 Main Cond(QP Det)

RF level

dBuV

030710 C3L W

Quasi-peak



Log Freq. (0.15 - 30)MHz


Limit EN 55022 B Conducted Aver

PLOT 3 Conducted Emissions : Level 4 Setup - 230V Live Line (mods applied)

| | | | |
|--|------------------------|-----------------|--------------------|
| Company: | Williams Refrigeration | Product: | L5UC + Envirostart |
| Date: | 10 Jul 03 | Test Engineer: | Richard Martin |
| Test: | EN55022 | Limit: | EN (B) QP + AV |
| Notes: | | | |
| Envirostart in Step 1 (Level 4) Setup. | | | |
| 470n X2 capacitor added. | | | |
| 230V | | | |
| Line: | Live | Attenuator: | 10dB PAD |
| Detector: | QuasiPeak | Operating Mode: | 1 |
| LISN: | EMCO | Mod. State: | 1 |
| | | Filename: | C37106A7.plt |

Frequency List (MHz)

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|  | Report No: R1737 | |
| | Issue No: 2 | |
| Test No: T0976 | Test Report | Page: 27 of 29 |

Chase EMS 6.21

Notes

Analyse 030710 C6N Williams Refrig. L5UC + Enviro - 230V

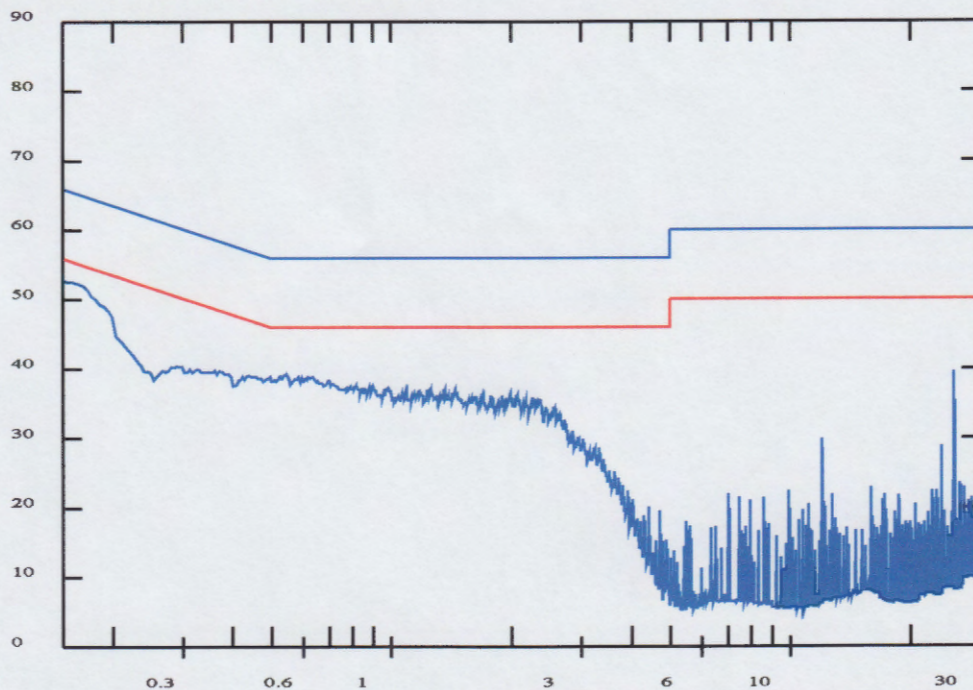
Test: EN55022(B),EN55011(B),EN55014&13 Main Cond(QP Det)

RF level

dBuV

030710 C6N W

Quasi-peak



Log Freq. (0.15 - 30)MHz

Limit EN 55022 B Conducted Aver

PLOT 4 Conducted Emissions : Level 4 Setup - 230V Neutral Line (mods applied)

| | | | | | |
|---|------------------------|-------------|----------------|--------------------|---|
| Company: | Williams Refrigeration | | Product: | L5UC + Envirostart | |
| Date: | 10 Jul 03 | | Test Engineer: | Richard Martin | |
| Test: | EN55022 | | Limit: | EN (B) QP + AV | |
| Notes: | | | | | |
| Envirostart in Step 1 (Level 4) Setup.. | | | | | |
| 470n X2 capacitor added. | | | | | |
| Cycling. | | | | | |
| 230V | | | | | |
| Line: | Neutral | Attenuator: | 10dB PAD | Operating Mode: | 1 |
| Detector: | QuasiPeak | | | Mod. State: | 1 |
| LISN: | EMCO | Filename: | C3710746.plt | | |

Frequency List (MHz)

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|--|--|--|--|--|--|
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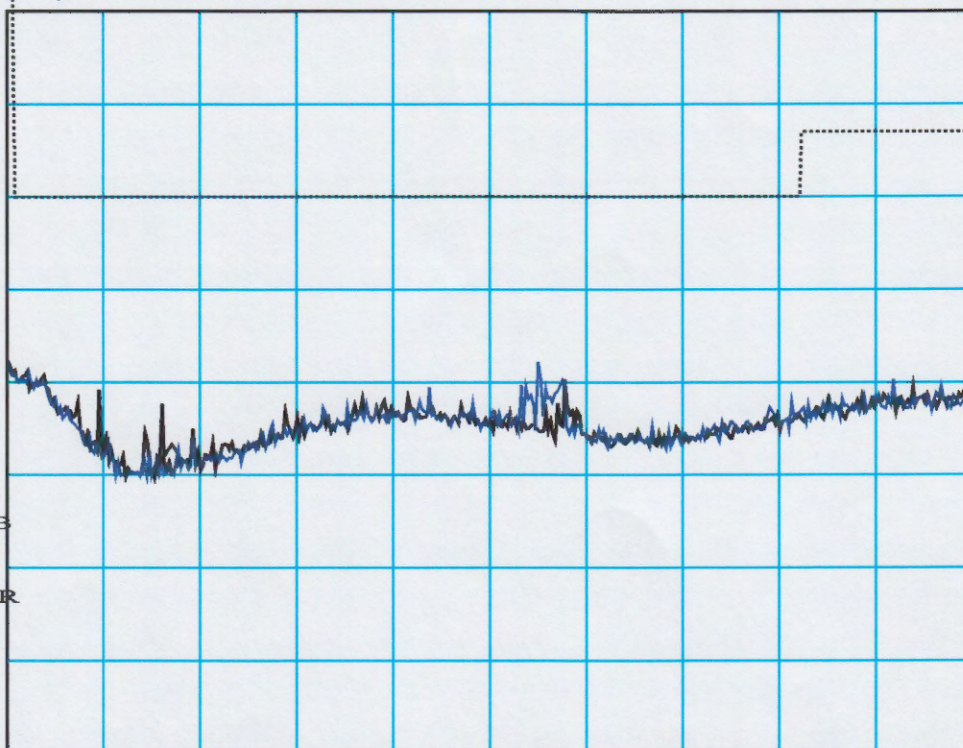
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hp

REF 60.0 dBV #AT 0 dB PG 14.0 dB MKR 67.5 MHz 10.12 dBV

PEAK
LOG
10
dB/

VA VB
SC FC
ACORR



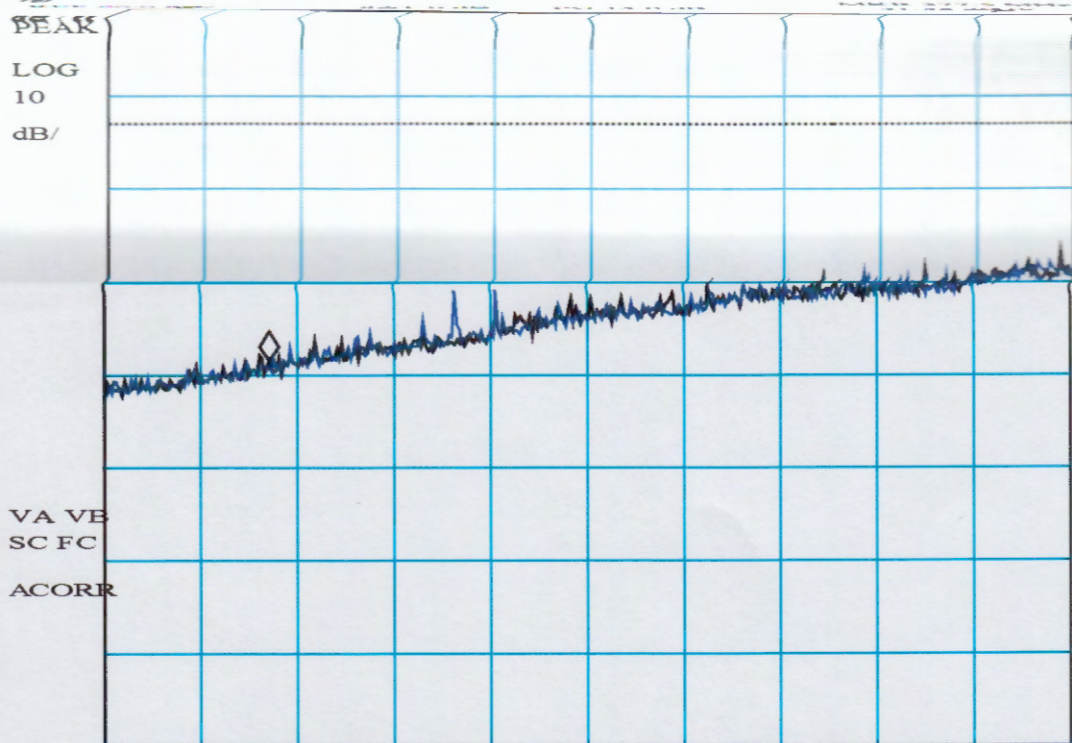
START 25.0 MHz STOP 275.0 MHz
#RES BW 120 kHz VBW 300 kHz SWP 52.1 msec

PLOT 5 Radiated Emissions : 25 MHz to 275 MHz

| | | | |
|---|------------------------|-----------------|--------------------|
| Company: | Williams Refrigeration | Product: | L5UC + Envirostart |
| Date: | 10 Jul 03 | Test Engineer: | Richard Martin |
| Test: | EN55022 | Limit: | EN (B) |
| Notes: | | | |
| Envirostart unit set to default settings. | | | |
| Black=Vert. Blue=Horiz. | | | |
| Polarisation: | V + H | Orientation: | 0 - 360° |
| Distance: | 3m | Antenna: | Bilog |
| Height: | 1m | Filename: | H37104C5.plt |
| | | Operating Mode: | 1 |
| | | Mod. State: | 0 |

Frequency List (MHz)

| | | | | | |
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START 250.0 MHz

STOP 1.0000 GHz

#RES BW 120 kHz

VBW 300 kHz

SWP 156 msec

PLOT 6 Radiated Emissions : 250 MHz to 1 GHz

| | | | |
|---|------------------------|-----------------|--------------------|
| Company: | Williams Refrigeration | Product: | L5UC + Envirostart |
| Date: | 10 Jul 03 | Test Engineer: | Richard Martin |
| Test: | EN55022 | Limit: | EN (B) |
| Notes: | | | |
| Envirostart unit set to default settings. | | | |
| Black=Vert. Blue=Horiz. | | | |
| Polarisation: | V + H | Orientation: | 0 - 360° |
| Distance: | 3m | Antenna: | Bilog |
| Height: | 1m | Filename: | H37104CF.plt |
| | | Operating Mode: | 1 |
| | | Mod. State: | 0 |

Frequency List (MHz)

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