
REPORT ON

EMC Testing of a Programmable Relay Switching System

Report No B0603936/1

February 1998

TÜV Product Service Limited



CAA Approved, BABT Listed, ISO 9000 Registered

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PREPARED FOR Pickering Interfaces Limited
Stephenson Road
Clacton-On-Sea
Essex
CO15 4NL

APPROVED BY Jensen Adams
J J ADAMS
Manager, Civil EMC Test - Birmingham

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1 STATUS PAGE

OBJECTIVE	To undertake measurements to determine the Equipment Under Test's (EUT's) compliance with the specifications.
MANUFACTURING DESCRIPTION	Programmable Relay Switching System
MANUFACTURER	Pickering Interfaces Limited
MANUFACTURERS MODEL NUMBER	System 10/20
SERIAL NUMBER	BP981014
TEST SPECIFICATION NUMBER	EN 50081-1; 1992 EN 50082-1; 1992
REGISTRATION NUMBER	B0603936/1
QUANTITY OF ITEMS TESTED	One
SECURITY CLASSIFICATION OF EUT	Unclassified
INCOMING RELEASE SERIAL NUMBER DATE	Build State Declaration B0603936/1 28th January 1998
DISPOSAL REFERENCE NUMBER DATE	Services Receipt Note 0687 30th January 1998
ORDER NUMBER DATE	S981008 19th January 1998
START OF TEST FINISH OF TEST	26th January 1998 30th January 1998
TEST ENGINEERS	R A Bennett J J Laydon
RELATED DOCUMENTS	EN 55022; 1994 IEC 801-2; 1984 IEC 801-3; 1984 IEC 801-4; 1st Edition; 1988

2 BRIEF SUMMARY OF RESULTS

Table 2 below shows a brief summary of the results obtained.

Specification and Section Number	Test	EUT Modification State	Result
EN 50081-1; 1992; (Table 1)	Radiated Electric Field Emissions 30MHz - 1000MHz	3	Pass
EN 50081-1; 1992; (Table 1)	Conducted Emissions On Power Lines 0.15MHz - 30MHz AC Power Port	0	Pass
EN 50082-1; 1992; (Table 1; 1.1)	Immunity To Radiated Electric Fields 27MHz - 500MHz Enclosure Port	1 and 3	Pass
EN 50082-1; 1992; (Table 1; 1.2)	Immunity To Electrostatic Discharge Enclosure Port	3	Pass
EN 50082-1; 1992; (Table 4; 4.1)	Immunity To Electrical Fast Transient Bursts AC Power Port	1 2 and 3	Fail Pass

Table 2

3 EUT MODIFICATION CHRONOLOGY

Table 3 below details modifications necessary in order for the EUT to pass the relevant tests applied.

Modification State	Description of Modification still fitted to EUT	Modification Fitted By	Date Modification Fitted
0	As Supplied by Manufacturer	Not Applicable	Not Applicable
1	* A Fair-Rite type 443164251 ferrite was fitted to the serial cable close to the RJ45 connector	TÜV PS	26.01.98
2	The RS232 signal ground connection to the RS232 cable shield was removed, the RS232 cable shield was then grounded to the EUT front panel using a shielded RJ45 plug and connector on the RS232 port	Customer	27.01.98
3	The ferrite fitted at modification state 1 was removed	TÜV PS	27.01.98

Table 3

* This modification was found to significantly reduce the EUT emissions during the Radiated Emissions characterisation test. At this point in the testing, the RS232 connector used did not allow for grounding of the cable screen. Subsequent tests indicated that the use of shielded RS232 connectors was necessary and that the ferrite could then be removed. The test for Immunity to Radiated Electric Fields was then repeated at modification state 3.

4 SYSTEM CONFIGURATION DURING EMC TESTING

The System 10/20 Programmable Switching System was configured for all testing as described below:

4.1 Emissions Testing

The EUT together with all associated cabling, was set-up simulating a typical user installation on the Open Field Test Site, then tested in accordance with the specification.

The EUT was functioning correctly during all testing, and was configured with a number of relay modules cross connected using short SMA cables, the relay outputs were terminated with screened SMA loads. The EUT RS232 port was connected to a laptop PC in the adjacent drive room. The PC was running a test program which operated each relay in turn.

4.2 Immunity Testing

The EUT was functioning correctly prior to each test, and was operating as described above. LEDs mounted adjacent to each relay module on the back panel indicated the state of the relays and an LED mounted on the RS232 port panel indicated activity on the port. The correct operation of the EUT was monitored throughout each test by viewing the LEDs continuously, using a closed circuit television camera and monitor where necessary, whilst also viewing the PC screen to monitor serial port activity and to check for errors in the relay operation.

MANDATORY REQUIREMENT

5 RADIATED ELECTRIC FIELD EMISSIONS 30MHz to 1000MHz

5.1 Enclosure Port - Test Procedure

A preliminary profile of the Radiated Electric Field Emissions was obtained by placing the Equipment Under Test (EUT) in a Characterisation Chamber; measurements were taken at a 3m distance. Measurements of emissions from the EUT were obtained with the Measurement Antenna in Horizontal and Vertical Polarisations. The characterisation produced a list of the highest emissions and their associated antenna polarisation.

The EUT was then transferred to the Open Field Site and placed on a remotely controlled turntable. Using the information from the preliminary profiling of the EUT, a search was made of the frequency spectrum from 30MHz to 1000MHz. The list of the highest emissions was then confirmed or updated under Open Site conditions. These emissions were then formally measured using a Quasi-Peak Detector which met the CISPR requirements. The readings were maximised by adjusting the antenna height, polarisation and turntable azimuth, in accordance with the specification. The details of these highest emissions were then recorded in the Job Log Book. Details of the highest emissions are presented in Table 5.2.

The emissions have been measured at 10m.

The Radiated Electric Field Emission measurements were made using a Rohde and Schwarz ESVP Test Receiver.

The climatic conditions recorded at the time of this test were:-

Temperature - 17.4°C Relative Humidity - 46.5%rh Atmospheric Pressure - 1006HPa

The test was performed in accordance with EN 55022; 1994.

MANDATORY REQUIREMENT

5.2 Enclosure Port - Test Results

Equipment Designation : Residential, Commercial and Light Industrial Equipment.

The EUT met the requirements of EN 50081-1; 1992; (Table 1 [Enclosure Port]) for Radiated Electric Field Emissions. Configured at modification state 3.

Open Field Results

The levels of the six highest emissions measured in accordance with the specification are presented in Table 5.2 below.

Frequency	Pol	Hgt	Azm	Uncorrected Level at 10m	Cable Loss	Antenna Factor	Field Strength at 10m	Specification Limit(10m)
MHz	H/V	cm	deg	dB μ V	dB	dB	dB μ V/m	dB μ V/m
74.001	V	170	100	12.8	1.0	6.6	19.8	30.0
111.456	V	100	125	2.7	1.3	12.0	16.0	30.0
120.000	V	100	355	-2.6	1.3	12.7	11.4	30.0
201.331	V	120	310	10.8	1.8	12.0	24.6	30.0
209.690	V	100	355	1.9	1.9	11.7	15.5	30.0
218.078	V	100	349	8.4	1.9	11.3	21.6	30.0

Table 5.2

The margin between the specification requirements and all other emissions was 19.2dB or more below the specification limit.

OBSERVATION

It was observed during testing that if the EUT's case and panel screws were not secured, excessive emissions could be detected.

Note: Abbreviations for table 5.2

H	Horizontal Polarisation	V	Vertical Polarisation
Pol	Polarisation	Hgt	Height
deg	degree	Azm	Azimuth

Procedure Test Performed in accordance with EN 55022; 1994.

Performed by J J Laydon, EMC Engineer.

MANDATORY REQUIREMENT

6 CONDUCTED EMISSIONS, MAINS DISTURBANCE 0.15MHz to 30MHz

6.1 AC Power Port - Test Procedure

All Conducted Emission Measurements were undertaken within the Characterisation Chamber. Conducted Emission measurements were undertaken on the Live and Neutral Lines.

The emissions were formally measured using a Quasi-Peak Detector which meets the CISPR requirements. The details of the highest emissions were then recorded in the Job Log Book. Details of the highest emissions for the Live and Neutral Lines are presented in Tables 6.2.1 and 6.2.2 respectively.

The Conducted Emission measurements were made using a Rohde & Schwarz ESH-3 Test Receiver and ESH3 - Z5 LISN.

The climatic conditions recorded at the time of this test were:-

Temperature - 17.7°C Relative Humidity - 41.5%rh Atmospheric Pressure - 1020HPa

The test was performed in accordance with EN 55022; 1994.

MANDATORY REQUIREMENT

6.2 AC Power Port - Test Results

6.2.1 Live Line

Equipment Designation : Residential, Commercial and Light Industrial Equipment. Live Line.

The EUT met the requirements of EN 50081-1; 1992; (Table 1 [AC Power Port]) for Conducted Emissions on the Live Line, configured at modification state 0.

As all emissions met both the Quasi-Peak and Average limits using the Quasi-Peak Detector no formal Average measurements were required.

Conducted Emissions Live Line

A search was made of the frequency spectrum from 150kHz to 30MHz. The levels of the six highest emissions were measured in accordance with the specification and are presented in Table 6.2.1 below.

Frequency	Uncorrected Quasi-Peak Level	Uncorrected Average Level	LISN Factor	Cable Loss	Quasi-Peak Level	Average Level	Quasi-Peak Specification Limit	Average Specification Limit
MHz	dB μ V	dB μ V	dB	dB	dB μ V	dB μ V	dB μ V	dB μ V
14.829	17.0	*	0.5	0.0	17.5	*	60.0	50.0
15.036	17.5	*	0.5	0.0	18.0	*	60.0	50.0
15.243	17.5	*	0.5	0.0	18.0	*	60.0	50.0
15.450	17.0	*	0.5	0.0	17.5	*	60.0	50.0
15.963	16.6	*	0.5	0.0	17.1	*	60.0	50.0
16.170	16.4	*	0.5	0.0	16.9	*	60.0	50.0

Table 6.2.1

Note: * Measurement not performed; see text above.

The margin between the specification requirements and all other emissions was 43.1dB or more below the specified Quasi-Peak limit and 33.1dB or more below the specified Average limit, when measured with a Quasi-Peak detector.

Procedure Test performed in accordance with EN 55022; 1994.

Performed by R A Bennett, EMC Engineer.

MANDATORY REQUIREMENT

6.2.2 Neutral Line

Equipment Designation : Residential, Commercial and Light Industrial Equipment. Neutral Line

The EUT met the requirements of EN 50081-1; 1992; (Table 1 [AC Power Port]) for Conducted Emissions on the Neutral Line, configured at modification state 0.

As all emissions met both the Quasi-Peak and Average limits using the Quasi-Peak Detector no formal Average measurements were required.

Conducted Emissions Neutral Line

A search was made of the frequency spectrum from 150kHz to 30MHz. The levels of the six highest emissions were measured in accordance with the specification and are presented in Table 6.2.2 below.

Frequency	Uncorrected Quasi-Peak Level	Uncorrected Average Level	LISN Factor	Cable Loss	Quasi-Peak Level	Average Level	Quasi-Peak Specification Limit	Average Specification Limit
MHz	dB μ V	dB μ V	dB	dB	dB μ V	dB μ V	dB μ V	dB μ V
15.441	17.0	*	0.5	0.0	17.5	*	60.0	50.0
15.954	16.8	*	0.5	0.0	17.3	*	60.0	50.0
16.161	17.2	*	0.5	0.0	17.7	*	60.0	50.0
16.368	17.1	*	0.5	0.0	17.6	*	60.0	50.0
16.575	16.8	*	0.5	0.0	17.3	*	60.0	50.0
16.782	17.5	*	0.5	0.0	18.0	*	60.0	50.0

Table 6.2.2

Note: * Measurement not performed; see text above.

The margin between the specification requirements and all other emissions was 43.1dB or more below the specified Quasi-Peak limit and 33.1dB or more below the specified Average limit, when measured with a Quasi-Peak detector.

Procedure Test performed in accordance with EN 55022; 1994.

Performed by R A Bennett, EMC Engineer.

7 EMISSION TESTING INSTRUMENTATION

Instrument	Manufacturer	Type No	EMC No
Computer	Opus	PCV	CV5
Test Receiver	Rohde and Schwarz	ESH3	1805
Test Receiver	Rohde and Schwarz	ESVP	1806
Test Receiver	Rohde and Schwarz	ESVP	1807
Spectrum Monitor	Rohde and Schwarz	EZM	1811
Biconical Antenna	Emco	3104	1846
Biconical Antenna	Emco	3110	1847
Log Periodic Antenna	Emco	3146	1849
Log Periodic Antenna	Emco	3146	1850
LISN	Rohde and Schwarz	ESH 3-Z5	1814
LISN	Rohde and Schwarz	ESH 2-Z5	1814
Pulse Limiter	Rohde and Schwarz	ESH 3-Z2	1502
Turntable & Controller	British Turntables	RH253	1858
Automatic Antenna Mast & Controller	Emco	1050	1844/5
Antenna Mast	Electrometrics	AMU74A	1853
Plotter	Hewlett Packard	7550A	-
Printer	Epson	LQ400	-
Anechoic Screened Enclosure	Ray Proof	6277	1804
Open Area Test Site	Assessment Services	OATS 2	2280
Thermohydrograph	Rotronic	A1 Hygromer	3162
HPA Monitor	Diplex	-	1932

MANDATORY REQUIREMENT

8 IMMUNITY TO RADIATED ELECTRIC FIELDS 27MHz to 500MHz

8.1 Enclosure Port - Test Procedure

All testing was conducted within a Shielded Enclosure.

The EUT was subjected to a field strength of 3V/m over the frequency range 27MHz to 500MHz in both Horizontal and Vertical Polarisations. The carrier frequency was not modulated.

The climatic conditions recorded at the time of this test were:-

Temperature - 17.7°C Relative Humidity - 41.5%rh Atmospheric Pressure - 1020HPa

Correct functioning of the EUT throughout this test was checked by using the procedure described on page 5.

8.2 Enclosure Port - Test Results

The EUT met the requirements of EN 50082-1; 1992; (Table 1; 1.1 [Enclosure Port]) for Immunity to Radiated Electric Fields configured at modification states 1 and 3, for the test applied.

The EUT's performance, defined in accordance with the specification, was not impaired during testing.

Procedure Test performed in accordance with IEC 801-3; 1984.

Performed by R A Bennett, EMC Engineer.

MANDATORY REQUIREMENT

9 IMMUNITY TO ELECTROSTATIC DISCHARGE

9.1 Enclosure Port - Test Procedure

The EUT was set-up on insulators 100 millimetres above the Ground Plane and tested in accordance with IEC 801-2; 1984.

A potential of 8kV (positive only) was applied to each applicable test point. Where discharges occurred the potential was then applied a total of 10 times to each test point

The climatic conditions recorded at the time of this test were:-

Temperature - 18.3°C Relative Humidity - 41.2%rh Atmospheric Pressure - 1010HPa

Correct functioning of the EUT throughout this test was checked by using the procedures described on page 5.

9.2 Enclosure Port - Test Results

The EUT met the requirements of EN 50082-1; 1992; (Table 1; 1.2 [Enclosure Port]) for Immunity to Electrostatic Discharge configured at modification state 3, for the test applied.

The EUT's operation, defined in accordance with the specification, was not impaired during testing.

MANDATORY REQUIREMENT

9.2 Enclosure Port - Test Results (Continued)

Details of the points tested are shown below in Table 9.2

Test Points	8kV
	Positive
Ground plane	✓
RS232 module front panel	✓
RS232 connector	✓
Front panel LEDs	✓
Rear panel LEDs	✓
Relay modules/SMA connectors	✓
IEC mains connector	✓
Case left hand side	✓
Case right hand side	✓
Case front panel	✓
Case back panels	✓
Case top	✓

Table 9.2

- ✓ The EUT's performance was not impaired at this test point when the ESD pulse was applied

Procedure Test performed in accordance with IEC 801-2; 1984.

Performed by R A Bennett, EMC Engineer.

MANDATORY REQUIREMENT

10 IMMUNITY TO ELECTRICAL FAST TRANSIENT BURSTS

10.1 AC Power Port - Test Procedure

The EUT was set-up and functioned correctly. A series of Fast Transient Bursts meeting the specification were applied for a period of greater than 60 seconds. The Transient Bursts were applied for both Positive and Negative Burst Trains as follows :-

To each of the following AC supply lines in turn,

Line
Neutral
Earth

The test severity level applied was, 1kV on AC Supply Lines.

The climatic conditions recorded at the time of this test were:-

Temperature - 17.7°C Relative Humidity - 41.5%rh Atmospheric Pressure - 1020HPa

Correct functioning of the EUT throughout this test was checked by using the procedure described on page 5.

10.2 AC Power Port - Test Results

The EUT failed to meet the requirements of EN 50082-1; 1992; (Table 4; 4.1 [AC Power Ports]) for Immunity to Fast Transient Bursts configured at modification state 1, for the test applied. The EUT was modified and identified as modification state 2. The EUT was then re-tested and subsequently found to meet the requirements of the specification for the tests applied. The EUT was also found to meet the requirements of EN 50082-1; 1992; (Table 4; 4.1 [AC Power Ports]) for Immunity to Fast Transient Bursts configured at modification state 3.

The modified EUT's performance, defined in accordance with the specification, was not impaired during testing.

Procedure Test performed in accordance with IEC 801-4; 1st Edition; 1988.

Performed by R A Bennett, EMC Engineer

11 IMMUNITY TESTING INSTRUMENTATION

Instrument	Manufacturer	Type No	EMC No
Computer	Opus	PCV	CV5
Power Amplifier	Amplifier Research	100W1000	1930
Power Amplifier	Amplifier Research	150L	1772
Signal Generator	Rohde and Schwarz	SMPC	1808
Test Receiver	Rohde and Schwarz	ESVP	1806
Isotropic Monitoring System	Amplifier Research	FM/FP 2000	2062
Power Biconical Antenna	Emco	3108	1598
Log-Periodic Antenna	Emco	3146	1850
10dB Attenuator	Bird	8308-100	1837
Directional Coupler	Amplifier Research	DC2500	2064
Directional Coupler	Amplifier Research	DC6280	2063
Screened Enclosure	Ray Proof	6277	1804
TV Monitor	TOA	CC-2090	1857
TV Camera	Hitachi	HV240K	1854
Fast Transient Burst Generator	Emtest	EFT5	1927
ESD Generator	Keytek	MZ-15/EC	1929
Thermohydrograph	Rotronic	A1 Hygromer	3162
HPA Monitor	Diplex	-	1932

12 SYSTEM MEASUREMENT UNCERTAINTY

For a 95% confidence level, the measurement uncertainties for defined systems, in accordance with the recommendations of NIS 81 Edition 1, May 1994 are :-

For Radiated Emissions, Quasi-Peak Measurements using the ESVP Test Receiver and Biconical Antenna:-

Frequency	$\pm 5\text{ppm} + 500\text{Hz}$
Amplitude	$\pm 4.2\text{dB}$

For Radiated Emissions, Quasi-Peak Measurements using the ESVP Test Receiver and Log Periodic Antenna:-

Frequency	$\pm 5\text{ppm} + 500\text{Hz}$
Amplitude	$\pm 3.1\text{dB}$

For Conducted Emissions, <Quasi-Peak and >Average measurements using a Rohde & Schwarz ESH-3 Test Receiver :-

Frequency	$\pm 15\text{ppm} + 50\text{Hz}$
Amplitude	$\pm 2.7\text{dB}$

For Radiated E-Field Susceptibility Tests :-

Frequency	27MHz to 500MHz ± 2 parts in 10^6
Amplitude	+ 1.7dB -1.6dB

For Fast Transient Burst:-

Voltage	$\pm 2\%$
Pulse Duration	$\pm 0.2\%$

For Electrostatic Discharge :-

Discharge Current First Peak	$\pm 10\%$
ESD Voltage	$\pm 5\%$ of reading $\pm 0.2\text{kV}$