MEASUREMENT AND TECHNICAL REPORT
EXHIBIT 2

HM ELECTRONICS
6675 Mesa Ridge Road
San Diego, CA 92121-2937

DATE: 02 October 1998

This Report Concerns:	Original Grant: X	Class II Change:

Equipment Type:	Base Station, Model SYS 400

Deferred grant requested per 47 CFR 0.457(d)(1)(ii)?	Yes: **Defer until:**	No: X

Company Name **agrees to notify the Commission by:**	N/A

of the intended date of announcement of the product so that the grant can be issued on that date.

Transition Rules Request per 15.37?	Yes:	*No:

(*) FCC Part 2, Paragraphs 2.985, 2.989, , 2.991 and 2.993; and Part 90, Paragraph 90.217(b)

Report Prepared by:

TÜV PRODUCT SERVICE
10040 Mesa Rim Road
San Diego, CA 92121-2912
Phone: 619 546 3999
Fax: 619 546 0364

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1 GENERAL INFORMATION

1.1 Product Description

Base Station, Model SYS 400

TÜV PRODUCT SERVICE

Electromagnetic Compatibility (EMC) Test Plan

Date: 15 Sept 98 Re: Quote #S298Φ82ΦRSΦ1- revised

Company: HM Electronics, Inc Contact: Seth Schlam
Address: 6675 Mesa Ridge Rd, Phone: 619-535-6000 x6063
City: San Diego, FAX: 619-535-6019
Zip: 92121 E-mail: sschlam@hme.com

**EUT Name: Base Station
**Model: Sys 400 S/N:

Test Objective:
- ☐ EMC Directive 89/336/EEC (EMC Requirements)
- ☐ Machinery Directive 89/362/EEC (EMC Requirements)
- ☐ Medical Device Directive 93/42/EEC (EMC Requirements)
- ☒ FCC Part 15 (list) Class A, FCC Part 2, FCC Part 90: Business Radio Service
- ☐ Other UL, CSA, CANADA RSS210 (please specify)
  ↳ Add to listing for Audio Equipment 6T14 (File: E153430(s))

Test will be,
- ☒ Attended by the customer.
- ☐ Unattended by the customer.

If a failure occurs, TÜV Product Service should,
- ☒ Call contact list above, if not available then stop testing.
- ☐ Continue testing to complete test series.
- ☐ Continue testing to define corrective action.
- ☐ Stop testing.

Customer authorization to perform tests according to this test plan.
x Seth Schlam Date: 15 Sept 98

Test plan prepared by:
x Seth Schlam (Please Print) Date: 15 Sept 98

Test plan reviewed by:
x Tom Riches Date: 9/15/98

(**) PLEASE NOTE: Information in this box will be the information in your test reports.

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Electromagnetic Compatibility (EMC) Test Plan

1.0 EUT Documentation

This section provides the necessary documentation for detailing the Equipment Under Test (EUT). Descriptions of the equipment including software and documentation on installation and operations should be provided.

Additional documentation necessary for test plan completion should be attached to the back of the test plan. For additional instruction on how to complete your test plan contact your TÜV Product Service representative.

1.1 EUT Description: The SYS 400 Base is a wireless intercom base station intended primarily for use by Quick Service Resaurants for drive through ordering.

1.1.1 Components of EUT

(List each one separately. Add attachment if necessary. NOT TO INCLUDE PERIPHERALS.)

Description	Model Number	Serial Number	FCC ID Number
Base Station	Sys 400 Base		BYMB400

1.2 Operating modes: (list and describe)

One - Normal Operation

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Electromagnetic Compatibility (EMC) Test Plan

1.3 EUT I/O Ports and Cables:

1.3.1 I/O Cables (Add attachment if necessary.)

CONNECTION:	16 VAC
SHIELD:	Yes
CONNECTORS:	Solder Lug
TERMINATION TYPE:	Terminal Block
LENGTH:	10 Feet
REMOVABLE:	Yes

CONNECTION:	Microphone IN
SHIELD:	Yes
CONNECTORS:	None
TERMINATION TYPE:	Terminal Block
LENGTH:	150 Feet
REMOVABLE:	Yes

CONNECTION:	Speaker Out
SHIELD:	Yes
CONNECTORS:	None
TERMINATION TYPE:	Terminal Block
LENGTH:	150 Feet
REMOVABLE:	Yes

CONNECTION:	Ceiling Speaker
SHIELD:	None
CONNECTORS:	none
TERMINATION TYPE:	Terminal Block
LENGTH:	50 feet
REMOVABLE:	Yes

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Electromagnetic Compatibility (EMC) Test Plan

1.3 EUT I/O Ports and Cables:

1.3.1 I/O Cables (Add attachment if necessary.)

CONNECTION:	RS 485
SHIELD:	Yes
CONNECTORS:	None
TERMINATION TYPE:	Terminal Block
LENGTH:	150 Feet
REMOVABLE:	Yes

CONNECTION:	
SHIELD:	
CONNECTORS:	
TERMINATION TYPE:	
LENGTH:	
REMOVABLE:	

CONNECTION:	
SHIELD:	
CONNECTORS:	
TERMINATION TYPE:	
LENGTH:	
REMOVABLE:	

CONNECTION:	
SHIELD:	
CONNECTORS:	
TERMINATION TYPE:	
LENGTH:	
REMOVABLE:	

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Electromagnetic Compatibility (EMC) Test Plan

1.3.2 Power Cords (Add attachment if necessary.)

UNIT:	N/A
MANUFACTURER:	N/A
SHIELDED:	N/A
LENGTH:	N/A

UNIT:	
MANUFACTURER:	
SHIELDED:	
LENGTH:	

UNIT:	
MANUFACTURER:	
SHIELDED:	
LENGTH:	

1.3.3 Power requirements:

***Note: European power is typically 230 VAC 50Hz or 400 VAC 50Hz, single and three phase, respectively. FCC requires testing to be performed at typical US power ratings at 60Hz.**

- ☐ 230 VAC 50Hz -- single phase _____ Amps
- ☐ 400 VAC 50Hz -- three phase _____ Amps per phase
- ☒ 120 VAC 60Hz -- single phase 1/2 Amps
- ☐ _____ VDC _____ Amps
- ☐ Battery: _____ VDC Expected life: _____ Hours
- ☐ Other: _____ (describe)

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Electromagnetic Compatibility (EMC) Test Plan

1.4 Oscillator Frequencies

Frequency	EUT Location	Description of use
3.686 MHz	XCVR Bd X4	clock for IC8, IC7
20.945 MHz	XCVR Bd X3	input to IC2, 2nd LO
12.8 MHz	XCVR Bd X2	input to IC1, PLL freq.
1.2 MHz	Audio Bd	Reference for U3

PARA 1.4 continued NXT page

1.5 Power Supply

Description	Manufacturer	Model #	Serial #	Switching frequency or (linear)
16 VAC class 2 xfmr	Electro-mech	N/A	N/A	

1.6 Power Line Filters

Manufacturer	Model #	Qty	LOCATION ON EUT
N/A			

1.7 Critical EMI Components (Capacitors, ferrites, etc.)

Description	Manufacturer	Part # or value	Qty	LOCATION ON EUT
N/A				

1.8 Description of Enclosure: (including Gasketing, Coatings, Bonding, etc.)

Painted Steel, No gaskets or coatings

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Electromagnetic Compatibility (EMC) Test Plan

1.4 Oscillator Fequencies (Continued)

Frequency	EUT Location	Description of use
4.0MHz, derived 1.0MHz	Audio Board	Reference for U14,U17, U18, U24 and U28
24.576HMz	Audio Board	Reference for U33
16.257MHz	Audio Board	Reference for U34
650kHz	Audio Board	Internal reference for switching regulator U6

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Electromagnetic Compatibility (EMC) Test Plan

1.9 Interfacing and/or Simulators Peripheral Equipment

(Please provide a complete description of all peripherals to be used during testing, please note that all I/O ports must be appropriately loaded)

DESCRIPTION:	Directional Electret Microphone
MANUFACTURER:	HME
MODEL NUMBER:	DM1
SERIAL NUMBER:	
FCC ID:	N/A

DESCRIPTION:	Horn Speaker
MANUFACTURER:	HME
MODEL NUMBER:	SP2000A
SERIAL NUMBER:	
FCC ID:	N/A

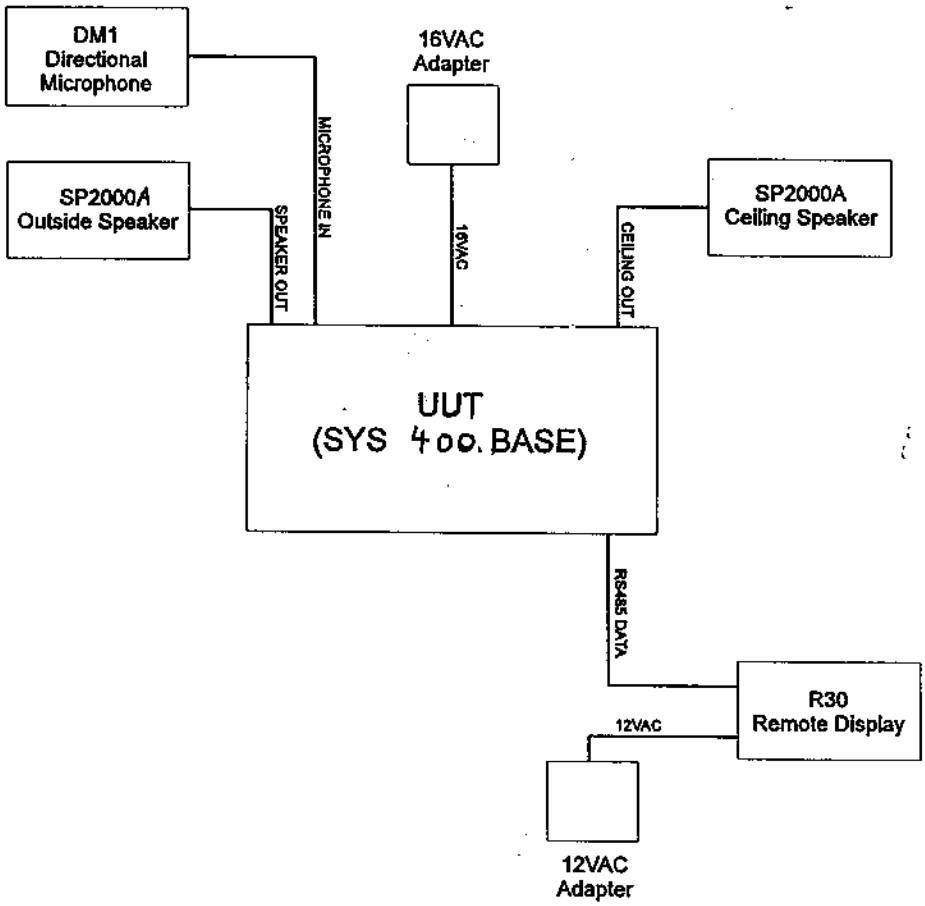
DESCRIPTION:	Remote Display
MANUFACTURER:	HME
MODEL NUMBER:	R30
SERIAL NUMBER:	
FCC ID:	N/A PART 15A

DESCRIPTION:	
MANUFACTURER:	
MODEL NUMBER:	
SERIAL NUMBER:	
FCC ID:	

DESCRIPTION:	
MANUFACTURER:	
MODEL NUMBER:	
SERIAL NUMBER:	
FCC ID:	

Electromagnetic Compatibility (EMC) Test Plan

1.10 System Configuration Block Diagram



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1 GENERAL INFORMATION (continued)

1.2 Related Submittal/Grant

None

1.3 Tested System Details

The FCC IDs for all equipment, plus descriptions of all cables used in the tested system are:

None

1.4 Test Methodology

Purpose of Test: To demonstrate compliance with the ANSI C63.4 setup.

Test Performed:
- x 1. Conducted Emissions, FCC Part 2, Paragraphs 2.985, 2,989, 2.991, and Part 90, Para 90.217(b),
- 2. Radiated Emissions, EN55022: 1992 Class B limit, 30 - 1,000 MHz, 10 meters
- x 3. Radiated Emission per FCC Part 2, Paragraph 2.993
- 4. Engineering evaluations

1.5 Test Facility

The open area test site and conducted measurement data were tested by:

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10040 Mesa Rim Road
San Diego, CA 92121-2912
Phone: 619 546 3999
Fax: 619 546 0364

The Test Site Data and performance comply with ANSI 63.4 and are registered with the FCC, 7435 Oakland Mills Rd, Columbia Maryland 21046. All Measurement Data is acquired according to the content of FCC Measurement Procedure and ANSI C63.4, unless supplemented with additional requirements as noted in the test report.

1.6 Part 2 Requirements

Emission Code 25K6F3E
DC Voltage 243.6 mV
Current 24.4 mA

Production Quantity - 500 per year up to 2,000 in the third year.
RF Output Power
Frequency Tolerance
Function of Each Semiconductor or Active Device
Description of circuitry used for Suppression of Spurious Radiation
DC Voltage
Current
Schematics - Appendix A
User Manual - Appendix B
Photograph, Internal (board) - Appendix C
BOM - Appendix E
Tune Up Procedure Appendix F
Equipment Specifications Appendix G
Block Diagram Appendix H
Product Labeling Appendix I

Frequencies Used by Base Station/ System 400

Transmit:	457.5125	Ch U45
	457.5375	Ch U1
	457.5625	Ch U43
	457.5875	Ch U2
	457.6125	Ch U44
Receive:	468.4875	Ch U7
	468.7625	Ch U8
	468.8375	Ch U9
	469.1375	Ch U10
	469.4625	Ch U11
	469.6375	Ch U12
	469.6625	Ch U13
	469.8875	Ch U14

Rated RF Output Power in Watts

100 mW Nominal	(0.1 Watt)
80 mW Minimum	(0.08 Watt)
120 mW Maximum	(0.12 Watt)

Frequency Tolerance 5 ppm

Micro Controllers

XCVR Bd IC8 PIC16C57-XT/SS

BASE AUDIO BD U3 MC68HC705K1CDW

U34 ADSP2186 (DSP)

U24 MC68HC705C8ACFN

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Function of Each Semiconductor or Active Device.

Functional description of the circuitry on the Audio Board has already been provided. The following functional description of RF transceiver board includes description of the individual active devices on that board.

Receive (Rx) Function: The Rx antenna is connected to jack J1. The signal is coupled through transformer T1, then goes through Band Pass Filter (BPF) FL1, which is a Surface Acoustic Wave (SAW) filter. The signal then goes through RF amplifier Q1 into pin 23 (the mixer input) of IC1 which is a frequency synthesizer IC. The synthesizer obtains its reference frequency from crystal X2 which is 12.8 MHZ. Variable capacitor CV2 is used to fine tune /adjust the reference frequency. The IC1 synthesizer creates the appropriate frequency to mix with the incoming signal to obtain the 1st Intermediate Frequency (IF) of 21.4 MHZ. The 1st IF is output from pin 12 of IC1 and goes through filter FL2. FL2 is a crystal filter that serves as the 1st IF BPF filter. The signal then goes to the 2nd mixer input, which is pin 16 of IC2. IC2 is the Rx demodulator. Crystal X3 (20.945 MHZ) provides the other input to the 2nd mixer. The mixer output, a 455 Khz 2nd IF, is output through IC2 pin 3 through FL4. FL4 is the 2nd IF BPF. The signal then goes back to IC2 pin 5 (IF in). The signal is demodulated and exits IC2 through pin 9 , Audio Frequency Out (AF Out).

Out of the Rx demodulator the signal has two paths. The first path goes through IC3, an audio amplifier, to pin P2-7, which connects to the audio board. The signal on this pin consists of compressed audio plus the Continuous Tone Controlled Squelch System (CTCSS) tone. The second signal path goes to pin 23 (Rx in) of IC7, which is the CTCSS encoder/ decoder chip. Tone information is provided to IC7 from the microprocessor (IC8) through pin 12(serial data). The channel and tone information is stored in Erasable Programmable Read Only Memory (EPROM) IC11 in a lookup table. The received audio signal is stripped of the CTCSS tone and exits IC7 through pin 6 (SP out). The compressed audio then goes to Compander IC6 (pins 2 and 3), where it is expanded to the correct frequency range, and output through pin 6. The audio then goes through audio amplifier IC9 to pin P3-6 where it exits the PC board.

Squelch circuitry: The Rx demodulator, IC2, provides an output proportional to signal strength through pin 12, the Received Signal Strength Indicator (RSSI). This signal goes through comparator IC3, where it is compared to a reference level from P3-4. The resulting signal goes through Q5 and Q6 which adjust polarity and outputs a "Squelch Status" to the audio board through P3-5.

Transmit Function: Audio is input through P1-4, and goes through audio amplifier IC9, to pin 11 (Comp in) of IC6, which is the compandor IC. The audio is compressed and exits IC6 through pin 10 (Comp Out). The compressed audio then goes into the CTCSS encoder (IC7) through pins 1& 3 (Tx In) The encoder adds the appropriate CTCSS tone and outputs the compressed audio plus tone through IC7 pin 6 (SP out). The signal goes through VR1, which is a trimmer resistor provided to adjust the amount of maximum frequency deviation. The output of VR1 is applied to varactor diode D2. The varying capacitance of D2 controls / modulates the RF Oscillator circuit which is a Voltage Controlled Oscillator(VCO) made up of passive discrete

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components near D2 and circuitry within synthesizer IC1. The VCO maintains an accurate transmit frequency by means of feedback from a Phase Locked Loop (PLL) within the IC1 synthesizer. The modulated RF at the transmit frequency exits IC1 through pin 1 (Tx out) to the RF transmit strip. On the RF strip, Q9, Q3, and Q2 are all RF amp gain stages. FL3 is a 457 MHZ SAW filter. Trimmer capacitor CV1 allows final adjustment of output power and is set for 100mW output. The signal then goes to the Tx antenna through Jack J2.

Additional Components on RF board: IC4 is a 3.5 V regulator for DC power. IC5 is an IC to reset the microprocessor when required.

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Description of Circuitry used for Suppression of Spurios Radiation

The Audio Board contains two RF chokes (components L1 and L2) for suppression of RF spurs. The Ausio Board also contains two Ferrite beads (components FB1 and FB2) to suppress RF on the RS485 data line that drives a remote display unit.

Description of circuitry for limiting modulation.

Trimmer Resistor VR1 on the RF board enables adjustment of the amount of maximum frequency deviation.

Description of circuitry for limiting power.

The RF board contains a variable capacitor, component CV1, that allows adjustment of the output power level to 100 mW.

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2. SYSTEM TEST CONFIGURATION

2.1 Justification

The **Base Station, Model SYS 400** was initially tested for FCC emission in the following configuration:

See Block Diagram, Appendix H.

2.2 EUT Exercise Software

None

2.3 Special Accessories

None

2.4 Modification

None

2.5 Configuration of Tested System

See Block Diagram, Appendix H.

3.1 CONDUCTED EMISSIONS DATA, EQUIPMENT, ETC. Appendix J

3.2 RADIATED MEASUREMENT DATA, EQUIPMENT, ETC. Appendix J

3.3 MODULATION CHARACTERISTICS Appendix K
CARRIER FREQUENCY STABILITY Appendix K
AUDIO LOW PASS FILTER RESPONSE Appendix K
AUDIO FREQUENCY RESPONSE Appendix K

4. Cover Letters - Appendix L

5 SUMMARY:

All tests according to the regulations cited on page 1 were

■ - Performed

☐ - **Not** Performed

The Equipment Under Test

■ - **Fulfills** the general approval requirements cited on page 1.

☐ - **Does not** fulfill the general approval requirements cited on page 1.

_____

- TÜV PRODUCT SERVICE, INC. -

Responsible Engineer:

Mary Washington
(EMC Engineer)