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PERTRONIC
REMOTE VIBRATING ALARM SYSTEM
TECHNICAL MANUAL
NEW ZEALAND

Valid For Remote Vibrating Alarm System:

PCB Hardware:	**v2.05 and greater**
PCB Firmware:	**v2.50 and greater**

Issue 1.1

QUALITY ASSURED COMPANY

ISO 9001: 2000

International Standards Certifications
QAC/R61/0051

Acronyms:

RF	Radio Frequency	
ISM	Industrial Scientific and Medical	Refers to a Radio frequency band in which no licence fee is payable and is freely open for use by the public under the GURL.
GURL	General User Radio Licence	A Radio Frequency Licence which grants the Public free access to certain Radio Frequency channels on a co-operative basis. Any device that interferes with another may be requested to change channel or cease operation.
EOL	End of Line	End of Line termination. Nominally a 10kΩ Resistor. Used to monitor the presence and integrity of the detector circuit.
LED	Light Emitting Diode	
PCB		
EEPROM	Electrically Erasable and Programmable, Read Only Memory	A form of Non-Volatile computer memory, which can be reprogrammed many times.
CPU	Central Processing Unit	
LED	Light Emitting Diode	
SC	Short-circuit	
OC	Open-circuit	

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1. INTRODUCTION

1.1 Overview

The **Pertronic Remote Vibrating Alarm System** is designed to wake sleeping residents in the event of a fire, particularly those who may be hearing impaired or may not respond to normal auditory alerts.

This self-contained system monitors the Fire Alarm Panel BELL circuit for an 'Alarm' condition, and activates a vibrating bed-shaker unit placed under the pillow or mattress to alert residents for immediate evacuation. The system also provides the option for a strobe unit to be used to alert residents who may be in their room, but not asleep. Strobe(s) may be used in conjunction with, or instead of, the vibrating bed-shaker.

The system operates using a wireless link (transmitting at 433 MHz in the ISM frequency band) to drive up to eight individually addressed Slave units located in the bedrooms. The Master unit regularly communicates with each of the Slave units enabled on the system at a particular time, monitoring each unit's battery and Mains power supply state. System information is reported back and displayed on the Master unit using LEDs and a buzzer. The Master unit also displays any communication faults and sounds a warning if any of the enabled Slave units fails to communicate back. The Master unit is used to dynamically add or remove Slave units from service as required.

Slave units are powered from a hardwired 16Vac Mains Adapter, backed up with a rechargeable battery (12V Sealed Lead-Acid). Both Master and Slave units feature ON/OFF switches, defect indications and automatic battery monitoring and charging circuits. The operational state is indicated using LEDs on each Slave unit and the centralised Master unit.

In addition to the automatic system tests, the Slave unit features a manual 'Test' function to allow the user to test the effect of the vibration and provide peace-of-mind that the Slave unit is functioning correctly.

The Master unit is also powered from a hardwired 16Vac Mains Adapter, backed up with a rechargeable battery (12V Sealed Lead-Acid), featuring an automatic monitoring and charging circuit. The Master unit status is indicated using 3 LEDs located on the face of the unit.

Master Unit Slave Unit

Figure 1.1: Vibrating Alarm System Components

1.2 Specifications

Item	Value
RF Frequency Range (RC1240 module)	433.0775 – 434.7775MHz in 25 kHz steps.
RF Operating Frequency (RC1240 module)	69 user selectable RF channels. Default : 434.4025MHz (Channel 54). Changed in 'Programming Mode'.
RF Output Power:	5 user selectable RF power levels. Default: 8dBm (Level 5 ie. maximum) Changed in 'Programming Mode'.
Radio Coverage (RF Transmission Range):	>50 metres between Master and Slave Units outdoors. Coverage indoors may be affected by the physical construction materials of the building - refer to Section 6: NOTES ON RADIO FREQUENCY TRANSMISSIONS.

Table 1.1: Master and Slave Unit RF Specifications

Item	Value
Input Voltage	16Vac
Battery Backup	12Vdc, 0.7Ah - provides 17 Hours Standby @ Iq = 40mA
Master Unit: Quiescent Current Alarm Current	40mA 40mA
Input:	One BELL circuit input. Initiates Alarm state on polarity reversal. Provides for defect signalling to connected panel via internal fault relay and 3k3Ω resistor.
Poll Period:	500ms per Slave address
Slave Timeout Period: 1 Slave Unit 8 Slave Units	10s 80s
Mains Fault Timeout – Master Unit	30s
Battery Fault Timeout – Master Unit	20s (10..20s)
Battery Fault Level – Master Unit	12.0Vdc
Buzzer Disable:	Fit link **J2** on rear of PCB to disable.

Table 1.2: Master Unit Specifications

Item	Value
Input Voltage	16Vac
Battery Backup	12Vdc, 0.7Ah - provides 17 Hours Standby @ Iq = 25mA and half an hour in alarm after standby period.
Number of Outputs:	Two – Strobe only mode selectable by inserting link **J1** on base of PCB.
Vibrator Output:	Provides a 12 volt current limited drive current for Vibrating Disc. Monitors connected circuit for Open-Circuit (O/C) conditions only.
Strobe Output:	Provides a 12V current-limited drive current for a SpectraAlert strobe or PS1 sounder. Monitors connected circuit for Short-Circuit (S/C), Open-Circuit (O/C) and the prescence of a 10kΩ EOL resistor.
Slave Unit: Quiescent Current Alarm Current: 1 x Vibrator Only	25mA 250mA – Strobe(s) and/or PS1(s) extra.
Maximum Alarm Current:	250mA per output. - limited by 250mA polyfuse on each output.
Mains Fault Timeout – Slave Unit	30s
Battery Fault Timeout – Slave Unit	20s (10..20s)
Battery Fault level – Slave Unit	12.0Vdc
Master Unit Missing Fault Timeout	10s
Slave Unit - Strobe Missing Fault Timeout	10s
Slave Unit - Strobe EOL Range	Nominal 10kΩ Normal : $8k\Omega < R_{EOL} < 12k\Omega$ Fault : $7k\Omega < R_{EOL} < 13k\Omega$

Table 1.3: Slave Unit Specifications

2. MASTER UNIT

2.1 Overview

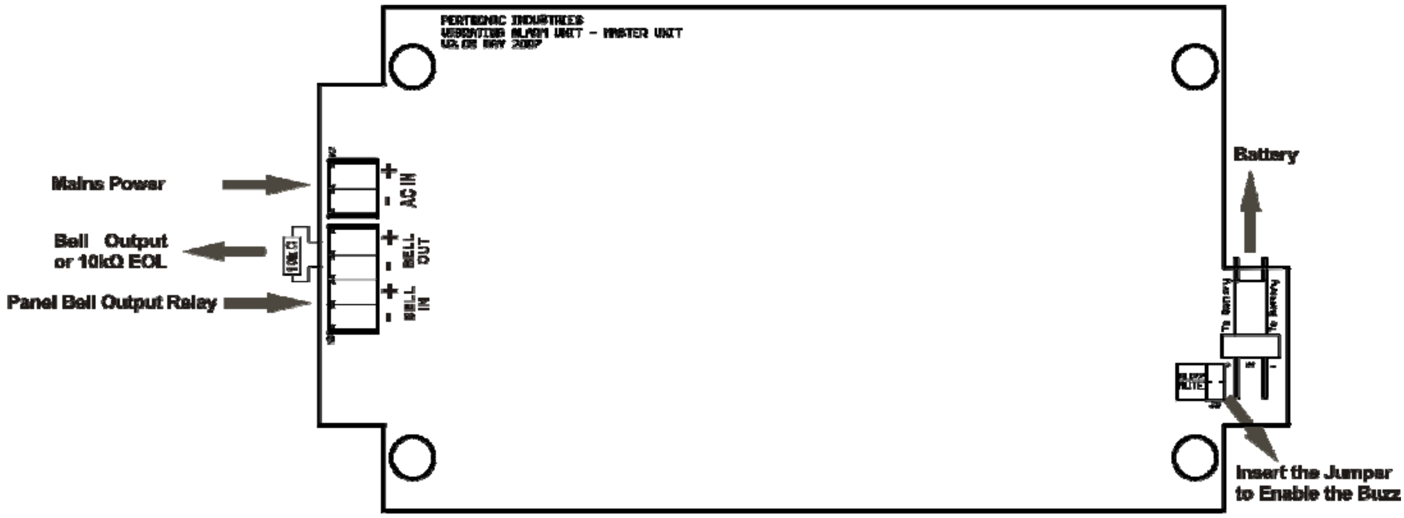


Figure 2.1: PCB Layout of Master Unit (Rear)

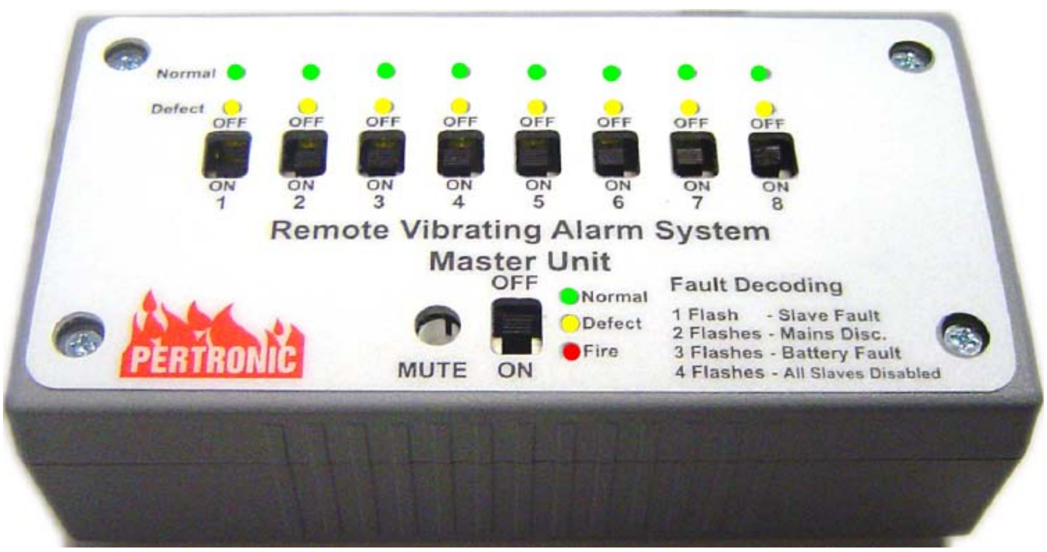


Figure 2.2: Front Panel Layout of Master Unit

2.2 Operation

The centralised Master unit provides three functions:

a) Operates as an interface to the Fire Alarm panel.
b) Acts as a communications hub.
c) Acts as an interface for the user.

The Master unit features 3 status LEDs, which indicate the state of the Master unit and the state of the complete system. The Master unit allows the user to add or remove Slave units from the system and determine the state of each Slave unit from the LEDs designated for each unit:

LED Colour	System State When Lit
Green	System Normal – flashes briefly when a Slave unit is being polled.
Yellow	System Defect: the nature of the fault is determined by coded flashes on the LED - refer to Section 2.3: System Fault LED Decoding.
Red	System in Fire: the connected panel Bell relay has activated.

Table 2.1: Master Unit System LED States.

2.3 System Fault LED Decoding

When a fault is detected, the green 'Normal' LED turns OFF and the yellow 'Fault' LED flashes a coded sequence to identify the cause of the fault condition. The LED always flashes 4 times, corresponding to the number of possible fault sources. The duration of each flash indicates whether that particular fault condition is present; a long flash (1s duration) indicates the current fault. A short flash (100ms) indicates the status of that fault input is normal. The 'Fault' codes are:

Flash Number	Description
1	There is a fault on at least 1 of the remote Slave Units.
2	Mains Supply lost.
3	Low Battery or Battery Missing.
4	All Slave Units are disabled.

Table 2.2: Master Unit Fault Decoding

2.4 Slave Unit Selection

Up to eight Slave units may be connected to a single Master unit. At set up, each Slave unit is identified by a unique address from one to eight inclusive – refer to Section 4: Configuration.

Switches labelled 1-8 are provided on the Master unit to activate each particular Slave unit.

- Switch OFF: the corresponding Slave unit is de-activated; the unit is neither polled nor monitored.
- Switch ON: the corresponding Slave unit is activate, the unit is polled and the status is monitored.
- Switches All OFF: the Master unit generates an "All Slaves Disabled" defect on the Master Fault Decode LED (4th Flash long).

Each Slave unit has a 'Normal' (Green) and 'Defect' (Yellow) status LED. The Master unit indicates all faults reported by the Slave unit, identifying the state of each Slave unit on these LEDs adjacent to the switch.

Slave Status LED State	Slave Unit State	Description
Yellow and Green not Illuminated	Unit Disabled	Slave Unit switch on Master Unit is OFF
Green	Enabled	Briefly flashes whenever a reply is received from a Slave Unit.
Yellow (Rapid flash)	Communications Fault (Unit timeout)	Master Unit did not receive the response from the Slave Unit within the timeout period.
Yellow (Slow flash)	Most Recent Slave Unit Fault	A fault with a Slave Unit - check the status of the particular Slave Unit LEDs for more information. The LED flashes slowly to indicate new faults; i.e. those that have not been acknowledged.
Yellow (ON)	Acknowledged Slave Unit Fault	A fault with a Slave Unit that has been acknowledged by pressing the Buzzer MUTE button.

Table 2.3: Slave Unit LED States

2.5 Fault Buzzer

The Master unit provides an audible alert of any system fault using an inbuilt buzzer. The buzzer sounds in the event of any system fault and is silenced by pressing the Buzzer 'MUTE' button. The buzzer remains muted until another fault is detected, when it will sound again overriding the mute setting.

The buzzer can be disabled by removing jumper: **J2**.

2.6 Alarm Acknowledgement

Slave unit faults are indicated on the Defect LEDs located above the individual Slave select switches.

A new alarm on a Slave unit is indicated with the Buzzer sounding and the Defect LED flashing slowly.

Alarms are acknowledged by pressing the Buzzer 'MUTE' button. This silences the Buzzer and changes the Defect LED associated with that particular Slave from a slow flash to steady ON.

2.7 Fire Panel Interface

The Master unit connects to the Fire Alarm panel BELL Out relay.

The Fire Panel BELL output is self-monitoring using a 10kΩ EOL resistor. The Master unit provides feedback to the panel in the event of a Slave unit fault.

The Master unit circuit contains a 3k3Ω resistor, which is switched by a relay. In 'Normal' condition, the relay is energised and disconnects the internal resistor from the BELL circuit, which must be terminated by a 10kΩ EOL resistor.

For any fault condition on the system, or in the event of a complete power failure, the relay de-energises and the 3k3Ω resistor connects across the panel's BELL circuit, causing a BELL monitoring fault on the Fire Alarm panel. If the Mains power is lost, relay de-activation is delayed by 45 minutes – this applies to either the Master or Slave unit.

3. SLAVE UNIT

3.1 Overview

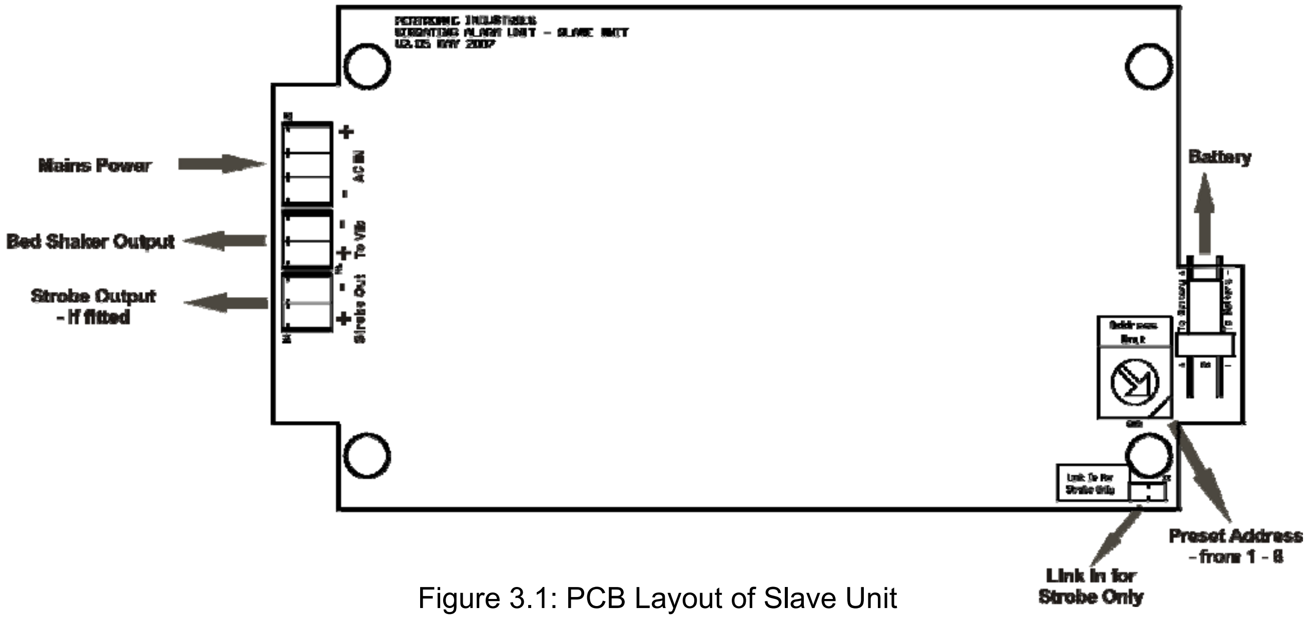


Figure 3.1: PCB Layout of Slave Unit

Figure 3.2: Front Panel Layout of Slave Unit

3.2 Operation

Slave units are placed in bedrooms to provide physical warning in the event of an ‘Alarm’. The Slave unit is typically placed under or beside the bed, with the vibrating Bed-Shaker placed under the pillow or mattress.

Strobes may optionally be used, either in conjunction with or instead of (fit ‘Strobe Only’ link: J1) a vibrating Bed-Shaker. If a strobe is not fitted, the output must be terminated with a 10kΩ EOL resistor.

The Mains plug pack can be plugged into any domestic Mains socket and the 16Vac supply from the plug pack is hardwired to the Slave Unit during installation. Ensure the unit is located so that it does not act as an obstruction and it cannot be accidentally disconnected from the Mains supply.

Each Slave unit must be addressed by switching the rotary switch from positions ‘1’ through ‘8’.

Address ‘0’ is only used during programming of RF channel and output power.

Address ‘9’ is not used.

Operating a Slave unit with the switch set to addresses ‘0’ or ‘9’ during normal operation causes a Slave communication error to be reported by the Master unit.

When a ‘Global Alarm’ sounds, all Slave units receive a ‘Global Alarm ON’ message from the Master unit and begin to vibrate – simultaneously all strobes will flash, if fitted. When the Fire Alarm panel returns to ‘Normal’, a ‘Global Alarm OFF’ message is sent to the Slave units.

To conserve battery power, the Bed-Shaker/Strobe operation varies with time:

- for the first 10 minutes: continuous
- after 10 continual minutes: cycles 2 seconds ON, 2 seconds OFF
- after 30 continual minutes: cycles 2 seconds ON, 6 seconds OFF

During ‘Normal’ operation, the Master unit regularly polls each of the activated Slave units, which responds providing its status for system health check purposes. The Slave unit monitors the 16Vac power supply status, measures the internal battery voltage and performs a continuity test to ensure the bed-shaker will operate correctly during an ‘Alarm’.

The Slave unit may be tested manually to demonstrate correct Bed-Shaker/Strobe function by inserting a small diameter pen or screwdriver (or similar) into the ‘Vibrator Test’ hole and briefly pressing the switch. This triggers the Slave unit to operate continuously for at least 2 seconds. This may also be used to test whether the user will feel the vibration from the position it is placed.

The Slave unit has 3 LEDs mounted on the top to indicate the status of the unit:

LED Colour	System State When Lit
Green	Indicates the Slave unit is being polled by the Master unit: Normal: usually ON, but turns OFF briefly (40ms) when a poll is received. Off-Normal: usually OFF, but turns ON briefly (40ms) when a poll is received.
Yellow	Fault: the nature of the fault is determined by coded flashes on the LED. - refer to Section 3.3 below.
Red	Fire: the Slave Unit has activated the Bed-Shaker/Strobe.

Table 3.1: Slave Unit System LED States

When an ‘Alarm’ command is received from the Master unit, the vibrating discs on all the Slave units turn ON and the strobe is activated, if connected. Slave units remain in alarm until the command is received from the Master unit to return to ‘Normal’.

3.3 Fault LED Decoding

When a fault is detected, the green 'Normal' LED turns OFF and the yellow 'Fault' LED flashes a coded sequence to indicate the cause of the fault condition.

The LED always flashes 5 times, corresponding to the number of possible fault conditions. The duration of each flash indicates which particular fault condition(s) is present:

Source of Defect	Position Code
Bed-Shaker not connected.	Flash 1 long
Strobe Fault.	Flash 2 long
Mains Supply Absent.	Flash 3 long
Low Battery or Battery Missing.	Flash 4 long
No communications received from Master unit.	Flash 5 long

Table 3.2: Slave Unit Fault Decoding

A long flash (1s) indicates the presence of a fault.

A short flash (100ms) signifies no fault for that position.

Multiple defects are indicated by more than one position code.

4. CONFIGURATION

To allow the system to co-exist with other wireless devices on the same or adjacent sites, different RF frequencies and power levels may be set on the Master and Slave units.

Sixty nine individual RF channels are selectable at frequencies between 433.0775 and 434.7775MHz (in 25 kHz steps) and at power levels from -14dBm to +8dBm. The settings available are:

Setting	Result
RF Channel	f_{RF} = 433.0775 + (N-1)*0.025 MHz - where N is the channel number (1..69). Default channel is 54 (434.4025MHz)
Output Power	1: -14 dBm 2: -6 dBm 3: 0 dBm 4: +5 dBm 5: +8 dBm (default)

Table 4.1: RC1240 RF Module Settings

NOTE: Although it is possible to set values outside the ranges specified, operation using such values is <u>undefined</u> and may not work as intended.

If two Remote Vibrating alarm systems are to be installed in close proximity, it is suggested a separation of at least two RF channels is used.

4.1 Master Unit Configuration

To put the Master unit into configuration mode, turn all Slave select switches (1-8) OFF, and then turn the power ON while pressing the Mute button. The buzzer gives a short burst of rapid pulses to indicate the unit is in configuration mode. Release the Mute button.

Once in Configuration mode, the red Fire LED blinks a number of times to indicate the stage in the configuration sequence. The 3 stages are:

Number	Name	Description
1	LED Test	The Slave Unit LEDs are illuminated in a "rotating" pattern and the global Normal and Fault LEDs are lit alternately so that all LEDs can be visually tested (the Fire LED should periodically blink once to show the stage number).
2	RF Channel	The current RF channel can be viewed and edited.
3	RF Power	The current RF power level can be viewed and edited.

Table 4.2: Master Unit Configuration Stages

To view or set the RF channel and power setting, the green Slave LEDs show the current setting stored in the unit's EEPROM. The yellow Slave LEDs show the value of the setting to be stored - this is selected by turning the corresponding Slave select switch ON.

The LED and switch positions are binary as follows:

Switch or LED Number	Value
1	1
2	2
3	4
4	8
5	16
6	32
7	64
8	128

Table 4.3: Master Unit Binary Channel Number Calculation

To calculate the value of the setting, add the values associated with the LEDs: for example, the default channel number is represented by LEDs 2, 3, 5 and 6, corresponding to 2+4+16+32=54.

The Mute button performs two tasks:

- briefly press the Mute button to switch between the three configuration stages.
- press and hold the Mute button for one second to store new settings - the buzzer gives 2 short pulses to confirm the new settings. Release the Mute button to store the value and change stages.

The store operation can be aborted by holding the button down for a further 3 seconds - the buzzer gives a single long beep to confirm.

While in LED Test, if the Mute button is not pressed within 20 seconds the unit automatically reverts to normal operation unless the Configuration mode entry sequence is satisfied as the CPU resets.

4.2 Slave Unit Configuration

To put the Slave unit into configuration mode, set the rotary address switch to zero (0), and then turn the power ON while pressing the Vibrator Test button. The Normal and Fault LEDs light alternately to indicate configuration mode has been entered. Release the Test button.

Once in Configuration mode, the red Fire LED blinks a number of times to indicate the stage in the configuration sequence. There are 4 stages:

Number	Name	Description
1	LED Test	The Normal and Fault LEDs are lit alternately so that all LEDs can be visually tested (the Fire LED should periodically blink once to show the stage number).
2	RF Channel – 10's	The current RF channel's "tens" digit can be viewed and edited.
3	RF Channel – 1's	The current RF channel's "ones" digit can be viewed and edited.
4	RF Power	The current RF power level can be viewed and edited.

Table 4.4: Slave Unit Configuration Stages

For viewing the RF channel and power, the green Normal LED blinks from 0 to 9 times to show the current setting stored in the unit's EEPROM. The rotary Slave address switch sets the digit value to be stored into EEPROM.

The Mute button performs two tasks:

- briefly press the Mute button to switch between the four configuration stages.
- press and hold the Mute button for one second to store new settings – the yellow Fault LED lights to confirm the new settings. Release the Mute button to store the value and change stages.

The store operation can be aborted by holding the button down for a further 3 seconds - the Fault LED turns OFF to confirm.

While in LED Test, if the Mute button is not pressed within 20 seconds the unit automatically reverts to normal operation unless the Configuration mode entry sequence is satisfied as the CPU resets.

4.3 Restoring Default RF Settings

Occasionally a unit's configuration data may become corrupted due to power supply fluctuations occurring on power-up. If this occurs, the unit fails to operate correctly – the unit's default settings may be restored and the unit reconfigured from a defined starting position.

Master unit: - ensure that at least one Slave address (1-8) is selected.
- hold down the Mute button and switch the Master unit ON.

Slave unit: - ensure the Address switch is NOT in the zero position, used for entering configuration mode
- hold down the Vibrator Test button and power the Slave unit ON,

Note: restoring the default settings on either unit does NOT reset the RF Frequency or RF Power Out level.

5. SYSTEM INSTALLATION

The Remote Vibrating Alarm is a stand-alone system, controlled from the Fire Alarm Panel. Connection is made between the Fire Alarm Panel BELL output to the Master Unit BELL INPUT connector using standard bell-wiring cable When the Fire Alarm Panel activates into 'Alarm', the BELL output reverses polarity, triggering the Master unit. As long as the BELL polarity remains reversed, the Master unit repeatedly generates 'Alarm' messages to initiate vibrator operation on the Slave units.

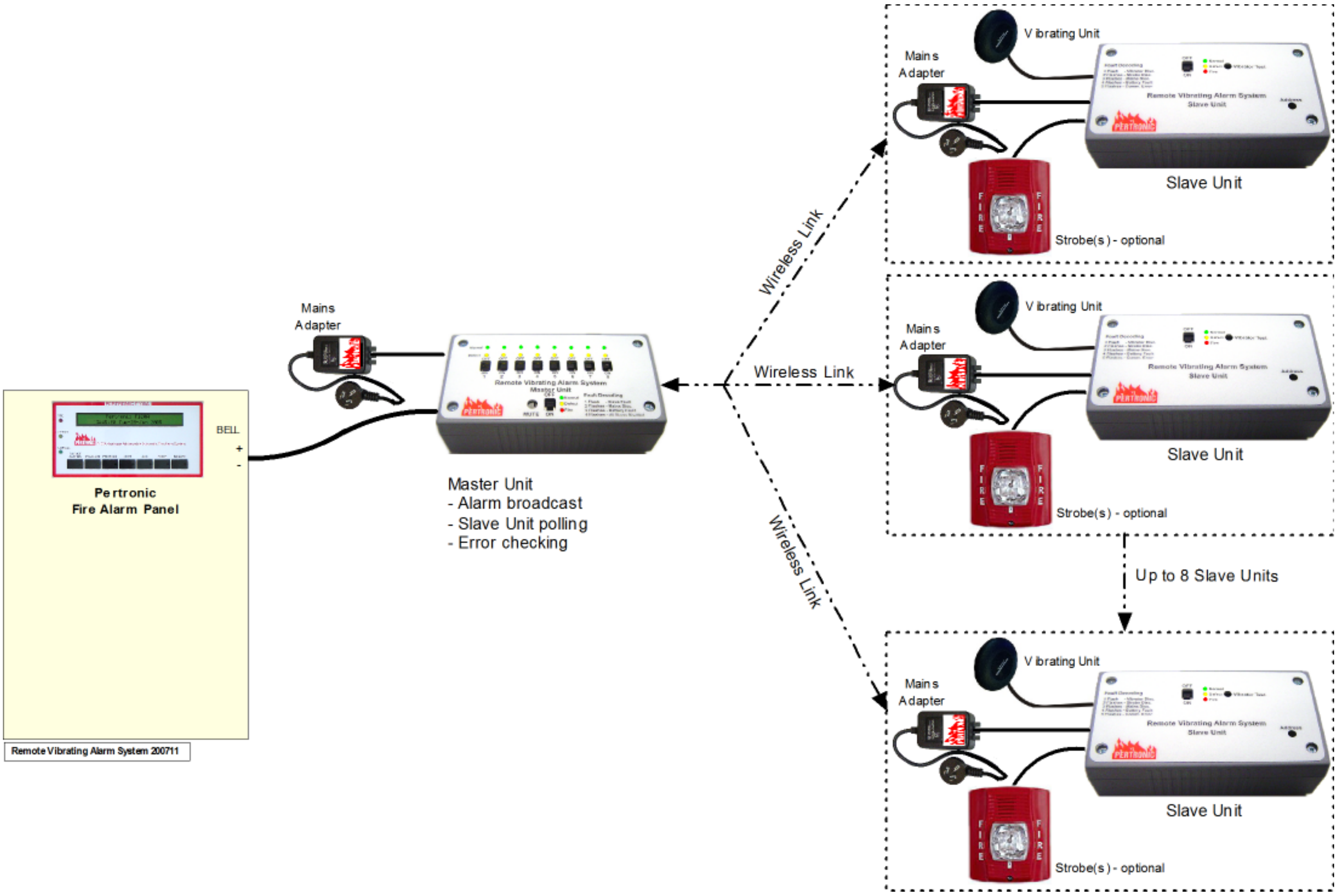


Figure 5.1: Typical Panel Connection

Initially each Slave unit must be set to a unique address - '1' through '8', using the rotary Address switch on each Slave unit. An incorrectly set address generates a communications error at the Master unit, indicated by the applicable Address LED.

If a Slave unit is placed out of range of the Master unit, it produces a communications fault. When setting the system up, configure the Slave units adjacent to the Master unit and ensure the system LEDs are all 'Normal'. Move each Slave unit to its intended location individually, checking whether a communication fault is generated – if it is, it is presumed the unit has been placed beyond the range of the Master unit - typically ~50m outdoors. The Slave unit should be moved closer to the Master unit where it can communicate successfully. Refer to Section 6: NOTES ON RADIO FREQUENCY TRANSMISSIONS for further discussion of the effect of various materials on RF coverage.

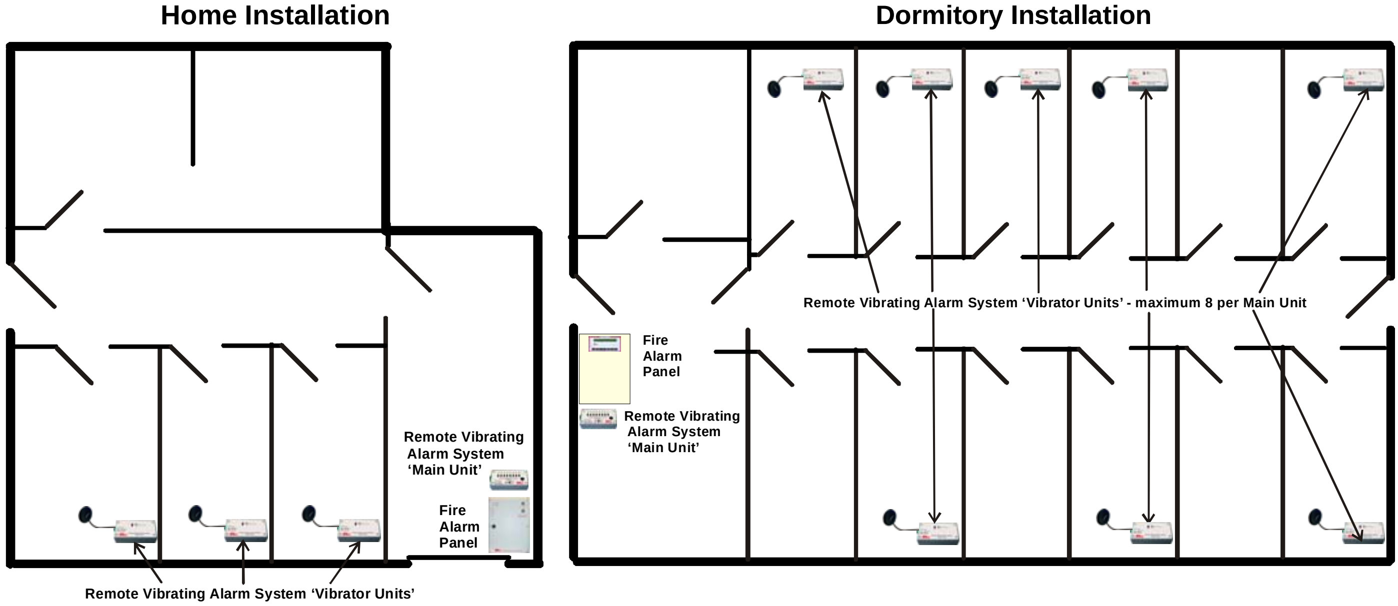


Figure 5.2: Sample Installation Layouts

Slave units may have an external strobe added to provide visual warning in the event of a 'Global Alarm'. A strobe from the System Sensor SpectrAlert® range can be driven by a Slave unit. The optional strobe is connected to the Slave unit using the STROBE OUT connection adjacent to the VIBRATOR OUT connector.

6. NOTES ON RADIO FREQUENCY TRANSMISSIONS

Radio signals, like light, form part of the electromagnetic energy spectrum. Like light, radio waves fundamentally travel in straight lines, and can be affected by objects in their path. They are capable of transmission through some materials, absorption by others and can be reflected, refracted and diffracted.

Metallic surfaces are excellent reflectors of radio frequency (RF) energy; water and wet areas are also good reflectors. Refraction occurs when electromagnetic waves pass across a boundary between materials of different refractive index and diffraction can occur when signals pass close to large, particularly sharp, objects. Attenuation in different materials (resulting from energy absorption and high frequency scattering) is caused by the material's molecular characteristics, structure and resonances at different wavelengths.

In an open space, the power reduction down a radio signal path is proportional to the square of the distance from the transmitter. In addition to this square law attenuation, signal strengths inside a building will also vary from place to place due to destructive and constructive interference caused by signals arriving with different phases, resulting from different path lengths. These factors contribute to the occurrence in a building of areas of varying signal strengths and reception characteristics.

Within any typical building environment, signals can come into contact with many objects in a range of materials such as ceilings, floors and walls at different angles, desks, filing cabinets and a variety of plant and machinery. There are numerous opportunities for reflection, refraction and absorption. A steel-reinforced concrete floor or wall, for example, can reduce a signal's strength by up to 90%. Some common building materials are listed in Table 6.1: Typical RF Energy Loss for Building Materials together with typical energy loss figures that can be expected.

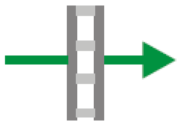
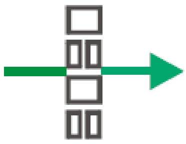
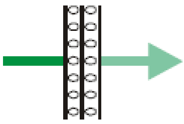
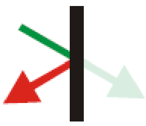
Material	Loss
 Wood / Plasterboard	0 – 10%
 Brick	5 – 35%
 Steel Reinforced Concrete	30 – 90%
 Metal Plates, Under-Floor Heating	90 – 100%

Table 6.1: Typical RF Energy Loss for Building Materials

7. PRODUCT CODES

Description	Product Code
Remote Vibrating Alarm Master Transmitter Unit	VIBATX
Remote Vibrating Alarm Slave Receiver Unit	VIBARX
Vibrating Pad	VIBPAD
SpectrAlert Advance 2-Wire Strobe 12/24V	SR
Power Pack: 230Vac to 16Vac @ 1.5A	ACPP16V1.5A

Table 7.1: Product Codes