

INTELLIGENT PRE-PAID DISPENSER

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ABSTRACT

INTELLIGENT PRE-PAID DISPENSER

(Keywords: Pre-paid vending machine, Remote Management, Soft form products)

An operating machine known as “Intelligent Pre-paid Dispenser” is developed. It is virtually a vending machine that is designed to sell and cater the need of multiple pre-paid products in the Malaysian market. Instead of a card, the product sold is simply the commercial distribution of PIN and Serial Number of the product. In other words, the machine uses embedded technology where the stock of PIN based products is kept in soft form. There are three modes of operation which are Sales Activity Mode, Diagnostic Mode and Remote Management Mode. The sales and purchase activities is done in Sales Activity Mode which involve connection of main controller to several peripherals such as a mini printer for receipt printing, display for user interface, and money validator for authentication purpose. The management and configuration of the sales product database is done via Hyper Terminal in Diagnostic Mode. This includes several menus such as product list, available stock, sold counter and system configuration. For Remote Management Mode, the machine is developed to include a facility where some of the Diagnostic Mode functions can be done over SMS messaging from a remote cellular GSM terminal.

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1. INTRODUCTION

Communication has been an important part of people's life in this world. It is essentially a part of our daily needs. The rapid growth of communication technologies has led to the introduction of mobile communication as a mean to serve communication between us. Mobile phone, which is one of mobile communication technologies, has been used by millions of people all over the world.

In general, there are two types of mobile phone subscription. One is post-paid subscription and the other is pre-paid subscription. Pre-paid subscription has been widely used with an estimated 17 million pre-paid users in Malaysia alone. It accounts for almost 75% of mobile phone users in Malaysia.

Two major problems encountered by most pre-paid users are the difficulty in finding 24 hours sales outlet and a convenient outlet location. Therefore, in order to overcome these problems, a self-operating pre-paid dispenser or pre-paid vending machine is seen as a possible solution. The advantage of this machine can be viewed in terms of low rental cost since it does not need a huge business space. Besides that, it also requires low operational and maintenance cost. The vending machine can be operated 24 hours a day, 365 days a year at many possible locations without requiring high workforce.

Therefore, the proposed project is intended to develop a self-operating pre-paid dispenser that is designed to sell and cater the need of multiple pre-paid products for Malaysian market. The selling product of the machine is not the pre-paid card itself but the commercial distribution of Personal Identification Number (PIN) and Serial numbers of the pre-paid product, which is a plus point against theft and vandalism issues. Apart from that, in contrast to other common vending machine, the machine is developed to include a facility where most of the operation and management functions can be done over Short-Message-Service (SMS) messaging from a remote cellular Global System Mobile (GSM) terminal.

2. PRE-PAID DISPENSER SYSTEM

2.1 Operational Modes

The proposed pre-paid dispenser is designed to be operated in three modes of vending operation, which are Sales Activity Mode, Diagnostic Mode and Remote Management Mode.

2.1.1 Sales Activity Mode

In this mode, the sales and purchase activities is done. Apart from the main controller board, the peripherals required for this mode include a mini serial printer for receipt printing, Liquid Crystal Display (LCD) for user interface, product buttons for user selection and a money validator for money authentication purpose.

2.1.2 Diagnostic Mode

The management and configuration of the database of the products being sold is done in this mode. This includes the product list, available stock and system configuration. The maintenance of the system is done over standard Window's Hyper Terminal.

2.1.3 Remote Management Mode

The machine is developed to include a facility where most of the diagnostic mode functions can be done over SMS messaging from a remote cellular GSM terminal.

2.2 System Structure

The overall structure for the proposed dispenser can be viewed as in Figure 2.1 below:

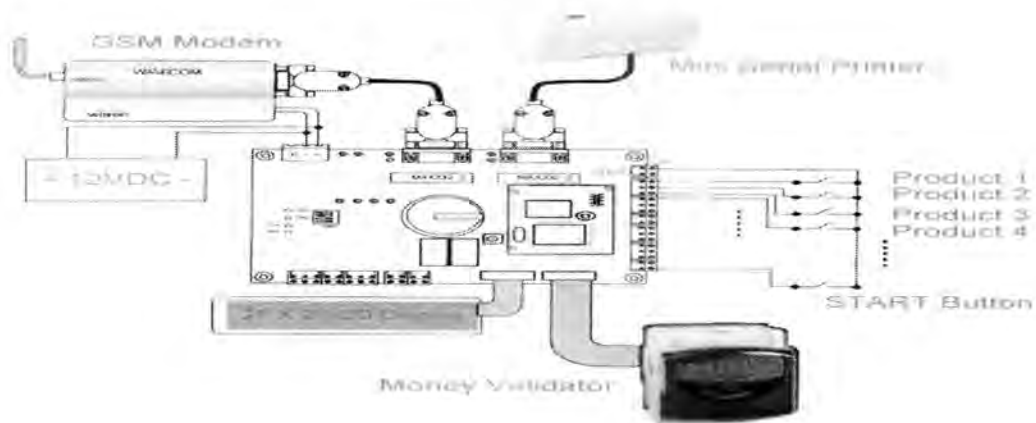


Figure 2.1: Structure of the proposed dispenser [1].

From Figure 2.1, it can be seen that the main controller board is connected to several peripherals. As described in section 2.1, the controller board is connected to money validator, LCD display and mini serial printer for sales activity mode while it is also connected to GSM modem for remote management mode.

The diagnostic of the main controller board is conducted by standard Hyper Terminal Windows software. Personal computer that runs the Hyper Terminal program is connected to the controller board communication port 1 on 9600-baud rate, no parity and one stop bit. The connection between the computer and the controller board is shown in Figure 2.2.

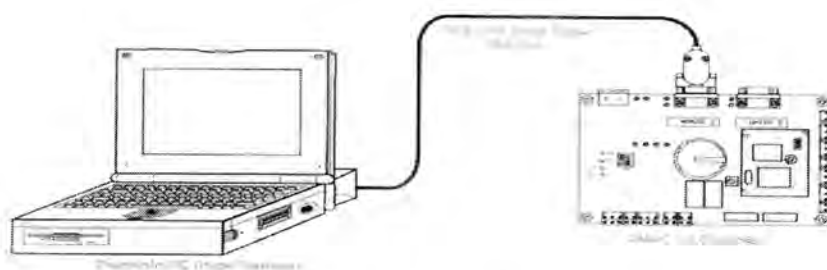


Figure 2.2: Diagnostic mode connection [1].

2.2.1 Main Controller Board

For this project, Vending Machine Controller (VMAC) version 1.0 is used as a main controller board. It is an embedded technology where the stock of PIN based products is kept in soft form. The product database holds by VMAC 1.0 consist of maximum 12 products with 16 cards carried by each product. The board layout of VMAC 1.0 is shown in Figure 2.3.

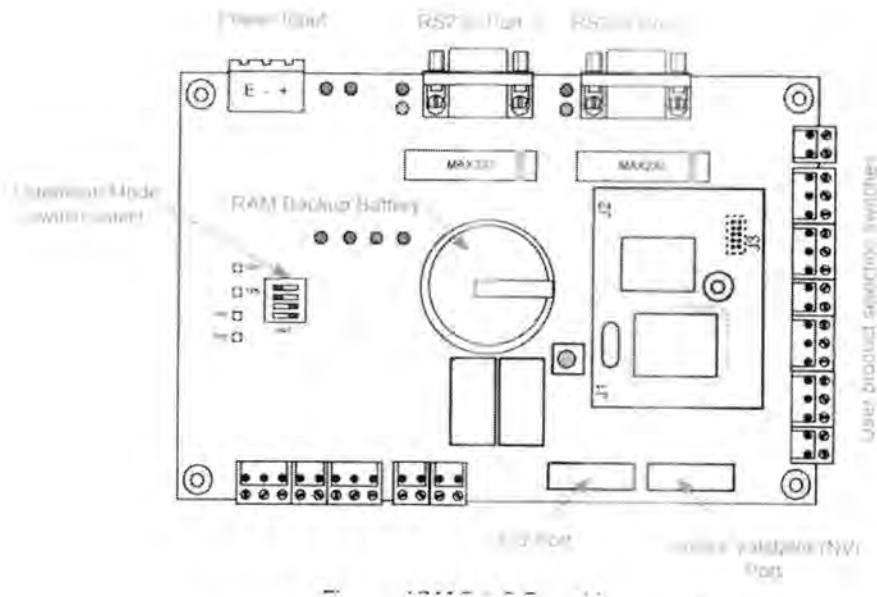


Figure 2.3: VMAC 1.0 board layout [1].

As described in Section 2.1, the dispenser has three operational modes. The selection of each operational mode is set by 4-bit switch, SW3. The setting of SW3 and its corresponding operational mode is given in Table 2.1.

Table 2.1 Switches and Operational Settings

SW3 Setting	Operation
All switches ON	Sales Activity Mode – Enabled Diagnostic Mode – Disabled Remote Management Mode – Disabled
Switch 1 OFF, Other switches ON	Sales Activity Mode – Disabled Diagnostic Mode – Enabled Remote Management Mode - Disabled
Switches 1 and 2 OFF, Other switches ON	Sales Activity Mode – Enabled Diagnostic Mode – Enabled Remote Management Mode - Disabled
Switch 4 ON, Other switches OFF	Sales Activity Mode – Enabled Diagnostic Mode – Disabled Remote Management Mode - Enabled

2.2.2 GSM Terminal

For Remote Management Mode operation, Siemens TC35 GSM terminal has been chosen as the required GSM modem. The product is chosen since it has an industrial standard interfaces and an integrated SIM card reader that can be used rapidly, easily and universally as a dual band (900/1800 MHz) GSM terminal. Moreover, its performance bandwidth and a robust housing make it easier to quickly implement new applications. The product and its board layout is shown in Figure 2.4 and 2.5 respectively.



Figure 2.4: Siemens TC35 GSM terminal [2].

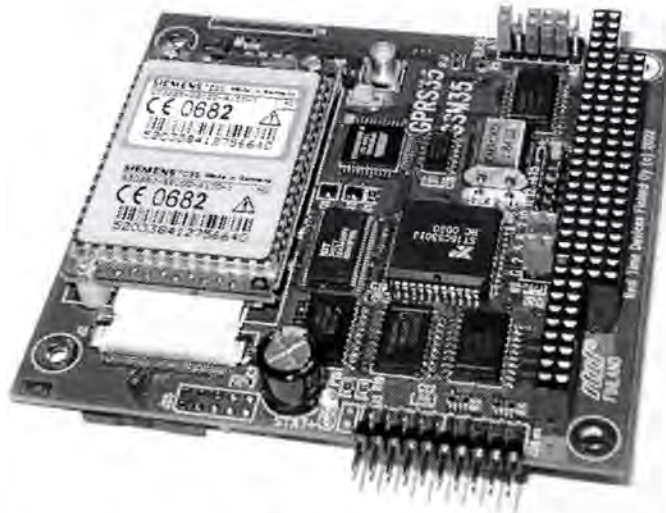


Figure 2.5: Board layout of Siemens TC35 GSM terminal [2].

The connection between the terminal and the VMAC 1.0 is done using RS 232 interface. The communication (data sent and data received) to the TC35 GSM terminal is performed through standard UART channel which is recognized and supported by all operating systems. Therefore no special communication drivers are needed to receive data from the TC35 GSM terminal. In other words, any communication software package or terminal program can be used to communicate with the terminal. In this project, this is done using Window's Hyper Terminal.

2.2.3 Hyper Terminal

Microsoft Hyper Terminal is a small program that comes with Microsoft Windows. It can be used to send AT commands to the GSM terminal in order to set communication link between the terminal and the remote mobile phone for Remote Management Mode. As stated in the Diagnostic Mode above, it is also used to do the maintenance and configuration of the database developed for the prepaid products sold by the dispenser.

The procedure to use the Hyper Terminal for communication link setup and maintenance in the Diagnostic Mode is briefly described below:

1. Run the Hyper Terminal by selecting *Start ->Programs ->Accessories ->Communications -> Hyper Terminal* on the computer.
2. In the *Connection Description* dialog box, enter a name and choose an icon for the connection. Then click the *OK* button.
3. Next, in the *Connect To* dialog box, choose the COM port that GSM modem or VMAC 1.0 is connecting to in the *Connect Using* box. For example, choose COM1 if the modem is connecting to the COM1 port. Then click the *OK* button.
4. The *Properties* dialog box comes out. Enter the correct port settings for the GSM modem or VMAC 1.0. To find the correct port settings, the easiest way is to consult the modem/controller manual. Then click the *OK* button.
5. If there is no problem, the GSM modem or VMAC 1.0 should now be working properly. AT commands to control the modem or main controller can be typed.

2.2.4 Notes Validator

In this project, the Smiley Bank Note validator has been chosen as the validator required for the purpose of Sales Activity Mode. It is a compact currency tester that is suitable for most money machines. Four different denominations of notes, inserted in any orientation can be accepted and it also can cope with different design of banknote that have the same value. The unit can be programmed using the built in teaching facility, without requiring any additional equipment, to cope with new issues of notes or different currencies.

2.2.4.1 Principle of Operation [3].

When a note is presented to the validator, the front optical sensor activates the motor and electronics. As the note is drawn through the validator, it is measured and examined with a variety of wavelengths of light along its length. The validator enabled by the lens assembly to examine the whole of the width of the note, while at the same time making the validation process insensitive to marks commonly found on many banknotes in circulation. The characteristics of the note are then analyzed to see if they fall within the

characteristics of any of the notes that been taught to the validator. If so, the note is accepted and the vend signal sent to the appropriate channel.

Several techniques are implemented to detect forged notes and prevent the retrieval of notes already accepted. If any irregularities are encountered, the note is immediately returned. After a successful validation process, the note is passed through the validator and into the host machine. There is an anti strimming device in the note path called a whale tail to prevent the return of a note once the validator has accepted it. If the validator is used with a stacker unit, then the whale tail is not needed and can be removed.

2.2.4.2 Teaching Procedure [3].

1. Slide the Teach/Run switch to the Teach position.
2. Repeatedly press the red Select Channel button until the channel 4 LED is ON.
3. Insert the teach note into the validator, one after another. Wait until one note has left the unit before trying to insert the next note. Insert the notes reasonably straight and central.

Precaution: Do not insert notes that go up the sides of the note path or are badly twisted. Make sure that none of the teach notes have corners or edges folded over as it may unnecessarily distort the note definition and reduce the effectiveness of the validator.

4. Reinsert the teach note in this same orientation at least twice. Then press the Select button. The channel LED will blink once to confirm that the note data has been stored.

Note: If other faces of this note need to be recognized, change the orientation of the teach note and insert the note in the manner just described. Remember to press the Select button at the end of each face taught.

5. Slide the Teach/Run switch to Run position. The channel lights will indicate the security setting for the channel that have been taught.
6. After 5 seconds, the LED will flash 4 times indicating the teaching is completed.

- c) Test Printer: Execute printing of a sample receipt in order to determine that the printer is in good order
- d) Real Time Clock (RTC): Setting and viewing of VMAC RTC.
- e) Station Name and Header: Assign station name where the machine is located. Header is used as a welcome display and printed on the bottom of the receipt.

3.1.1 Product Management

Product Management menu is programmed to have nine menu list as tabulated in Table 3.1 and as in Figure 3.2.

Table 3.1: Product Management Menu List

Menu Number	Menu List and Description
1	Refresh Menu: Redisplay the menu list
2	List Card Item: List of all 16 cards for each product
3	Stock In: Insert new stock card in a selected product slot
4	Stock Out: Remove available stock card in a selected product slot
5	Configure Product: Changing the name and price of a product slot
6	Clear Slot: Remove all available cards in the product slot
7	Sold Counter: Count of card being sold since last update
8	Stock List: List of stock in a selected slot that is still available for sale
9	Product Attribute: List of all 12 product name and price

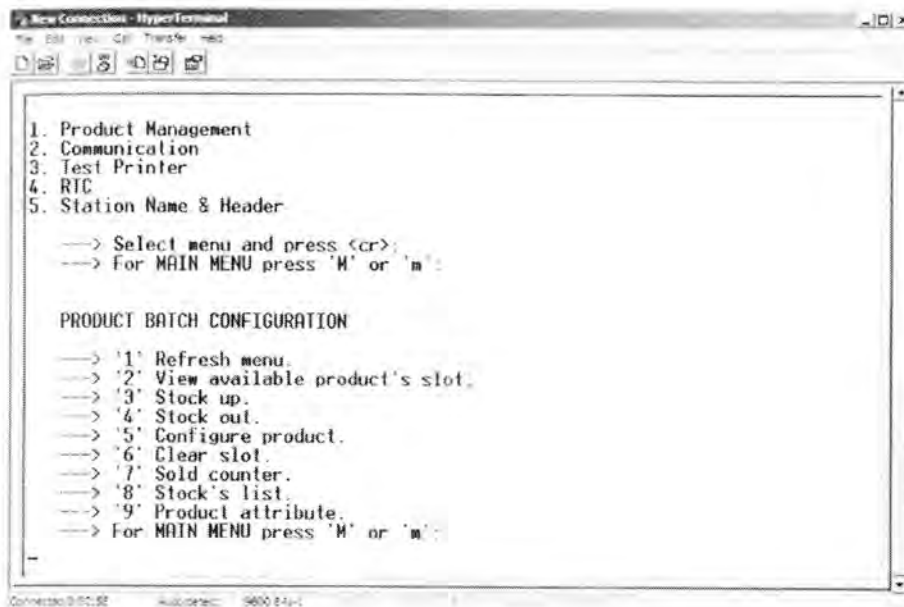


Figure 3.2: Product Management menu list [1].

3.1.1.1 Refresh Menu

This menu is used to enable the user to redisplay the available menu under Product Management menu list.

3.1.1.2 List Card Item

In this menu, the user is allowed to view product's item that is occupying the whole 16 slots of the product item. The product is set to consist of the following information.

Table 3.2: Product Information

Item	Description
Product Name	Attribute name of the selling product
Product Price	Price of the product

Meanwhile, the information for each slot in the product item is programmed as in Table 3.3.

Table 3.3: Slot Information

Item	Description
Availability Flag	SOLD or IN STOCK
Serial Number	Product Serial Number
PIN Number	PIN Code for commercial assessment
Stock in Date	Date the card being slot in
Stock out Date	Date the card being sold (all '0' if the flag is IN STOCK
Expiry Date	Date the card will be expired

An example of this process is shown in Figure 3.3.

```

List card's item.
--> Choose product [1 - 12]: 1
Product: Hotlink012, Price: RM30
lCard01, SN: 000202281781, PIN: 20939767608412, 11/2006 | Stocked: 26/1/2005, 20:53:3
9
lCard02, SN: 0002343009834, PIN: 03403748902233, 12/2007 | Stocked: 26/1/2005, 20:57:
7
lCard03, SN: , PIN: , 0/1900 | Sold: 0/0/1900, 0:0:0
lCard04, SN: , PIN: , 0/1900 | Sold: 0/0/1900, 0:0:0
lCard05, SN: , PIN: , 0/1900 | Sold: 0/0/1900, 0:0:0
lCard06, SN: , PIN: , 0/1900 | Sold: 0/0/1900, 0:0:0
lCard07, SN: , PIN: , 0/1900 | Sold: 0/0/1900, 0:0:0
lCard08, SN: , PIN: , 0/1900 | Sold: 0/0/1900, 0:0:0
lCard09, SN: , PIN: , 0/1900 | Sold: 0/0/1900, 0:0:0
lCard10, SN: , PIN: , 0/1900 | Sold: 0/0/1900, 0:0:0
lCard11, SN: , PIN: , 0/1900 | Sold: 0/0/1900, 0:0:0
lCard12, SN: , PIN: , 0/1900 | Sold: 0/0/1900, 0:0:0
lCard13, SN: , PIN: , 0/1900 | Sold: 0/0/1900, 0:0:0
lCard14, SN: , PIN: , 0/1900 | Sold: 0/0/1900, 0:0:0
lCard15, SN: , PIN: , 0/1900 | Sold: 0/0/1900, 0:0:0
lCard16, SN: , PIN: , 0/1900 | Sold: 0/0/1900, 0:0:0
  
```

Figure 3.3: Example of List Card Item [1].

In Figure 3.3, it can be seen that Product No.1 is set as Hotlink 012 with the price of RM 30.00 and it has 2 IN STOCK items. As in Table 3.3, the first item is set to have the following information:

Serial Number: 000202281781

PIN Number: 20939767608412

Stock in Date: 26/01/05 at 8.53pm

Stock out Date: Not Applicable since the product is IN STOCK

Expiry Date: November 2006

Similarly, for the second item:

Serial Number: 0002343009834

PIN Number: 03403748902233

Stock in Date: 26/01/05 at 8.57pm

Stock out Date: Not applicable since the product is IN STOCK

Expiry Date: December 2007

The rest of the slots are yet to be configured, therefore no serial and PIN numbers are displayed.

3.1.1.3 Stock In

The maximum number of item per product is set to 16. Stock In activity for each product can be carried out as long as the available slot not exceeding 16 units. Figure 3.4 shows an example of Stock In activity.

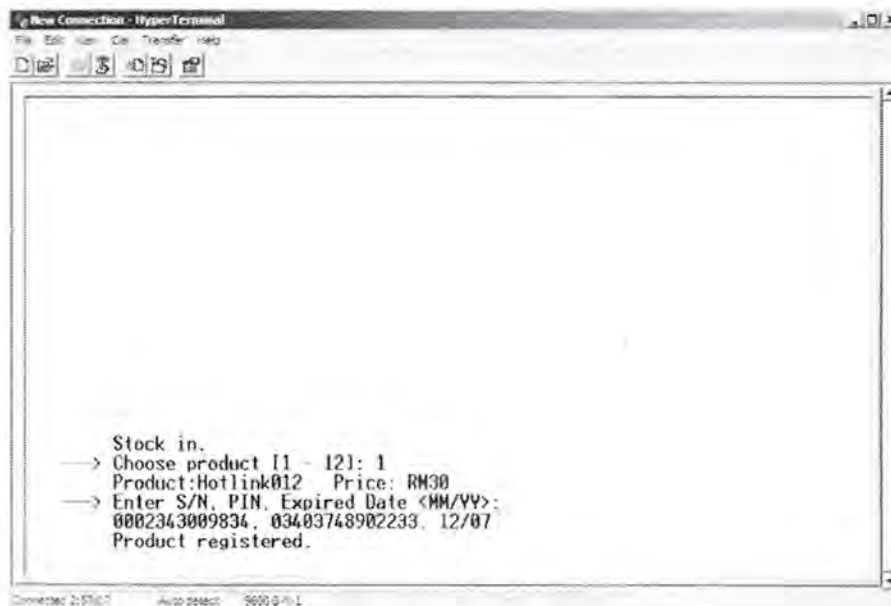


Figure 3.4: Example of Stock In [1].

If all items slot is occupied, the VMAC 1.0 would prompt the user accordingly.

<Display HYPT ... Top up reject menu>

Upon receiving the information, VMAC 1.0 would slot the item information to next empty item's slot. If the item's slot exceeds 16, the VMAC will slot the information at slot number 1 as long as the slot is empty or previously item occupied the slot has been sold.

3.1.1.4 Stock Out

This menu can only be validated if there is any product available. An example to illustrate the function of the menu is shown in Figure 3.5.



Figure 3.5: Example of Stock Out [1].

In Diagnostic Mode, user has to select one from list of maximum 12 product name to remove out the item. This operation is treated similarly as purchase activity in Sales Activity Mode, where after successfully done, the earliest Stock In item would be removed as printed receipt and changes of the slot information would take place as shown in Figure 3.6.


```

New Connection - HyperTerminal
File Edit View Call Transfer Help
[Icons]

List card's item.
--> Choose product 11 - 121: 1
Product: Hollink012, Price: RM30
ICard01, SN: 000202281781, PIN: 20939767608412, 11/2006 | Sold: 26/1/2005, 21:17:1
ICard02, SN: 0002343009834, PIN: 03403748902233, 12/2007 | Stocked: 26/1/2005, 20:57:
7
ICard03, SN: ., PIN: ., 0/1900 | Sold: 0/0/1900, 0:0:0
ICard04, SN: ., PIN: ., 0/1900 | Sold: 0/0/1900, 0:0:0
ICard05, SN: ., PIN: ., 0/1900 | Sold: 0/0/1900, 0:0:0
ICard06, SN: ., PIN: ., 0/1900 | Sold: 0/0/1900, 0:0:0
ICard07, SN: ., PIN: ., 0/1900 | Sold: 0/0/1900, 0:0:0
ICard08, SN: ., PIN: ., 0/1900 | Sold: 0/0/1900, 0:0:0
ICard09, SN: ., PIN: ., 0/1900 | Sold: 0/0/1900, 0:0:0
ICard10, SN: ., PIN: ., 0/1900 | Sold: 0/0/1900, 0:0:0
ICard11, SN: ., PIN: ., 0/1900 | Sold: 0/0/1900, 0:0:0
ICard12, SN: ., PIN: ., 0/1900 | Sold: 0/0/1900, 0:0:0
ICard13, SN: ., PIN: ., 0/1900 | Sold: 0/0/1900, 0:0:0
ICard14, SN: ., PIN: ., 0/1900 | Sold: 0/0/1900, 0:0:0
ICard15, SN: ., PIN: ., 0/1900 | Sold: 0/0/1900, 0:0:0
ICard16, SN: ., PIN: ., 0/1900 | Sold: 0/0/1900, 0:0:0

Connected 3.21 KB Auto detect: 9600 8-N-1

```

Figure 3.6: New List Card Item after Stock Out activity [1].

Comparing Figure 3.6 to Figure 3.3, changes of slot information immediately take place as the first card is sold on 26/01/05 at 9.17 pm.

3.1.1.5 Configure Product

This menu is set to allow user to configure the product information (Product Name and Product Price), provided there is no item left for sale. Otherwise user has to clear up all items in the product's slot. An example of this menu is shown in Figure 3.7.

```

New Connection - HyperTerminal
File Edit View Call Transfer Help
[Icons]

PRODUCT LIST:
01. Hollink012 Price: RM20
02. Price: RM0
03. Price: RM0
04. Price: RM0
05. Price: RM0
06. Price: RM0
07. Price: RM0
08. Price: RM0
09. Price: RM0
10. Price: RM0
11. Price: RM0
12. Price: RM0

Configure product.
--> Choose product 11 - 121: 2
Product: ., Price: RM0
--> Enter <product name, price>:
Xplore019, 30
New registered product: Xplore019
Price: 30

Connected 4.2 KB Auto detect: 9600 8-N-1

```

Figure 3.7: Example of Configure Product [1].

3.1.1.6 Clear Slot

In this menu, the user is allowed to remove and reset all parameter in all slots of the selected product. Upon successful Clear Slot operation, the parameters of the whole 16 product slots are reset as follow:

Availability Flag	:	SOLD
Serial Number	:	'0'
PIN Number	:	'0'
Stock In Date	:	'0'
Stock Out Date	:	'0'
Expiry Date	:	'0'

To select which product to be cleared, the user is required to enter the product number which is from '1' to '12'. The menu is protected by a password to prevent any possible vandalism on the product database. An example of this menu is given in Figure 3.8.

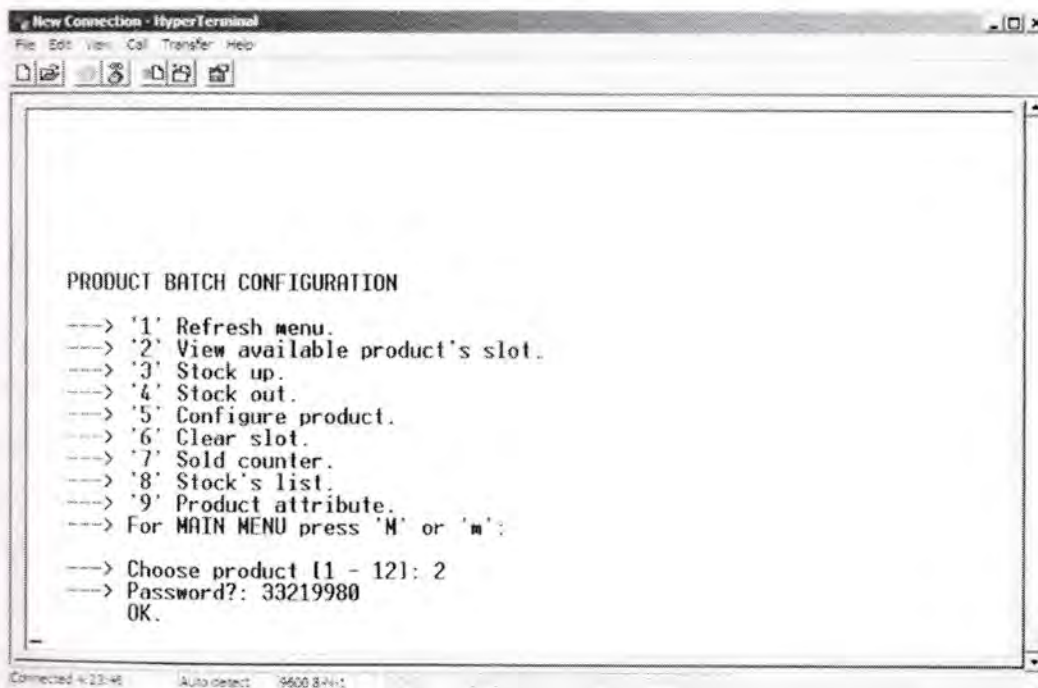
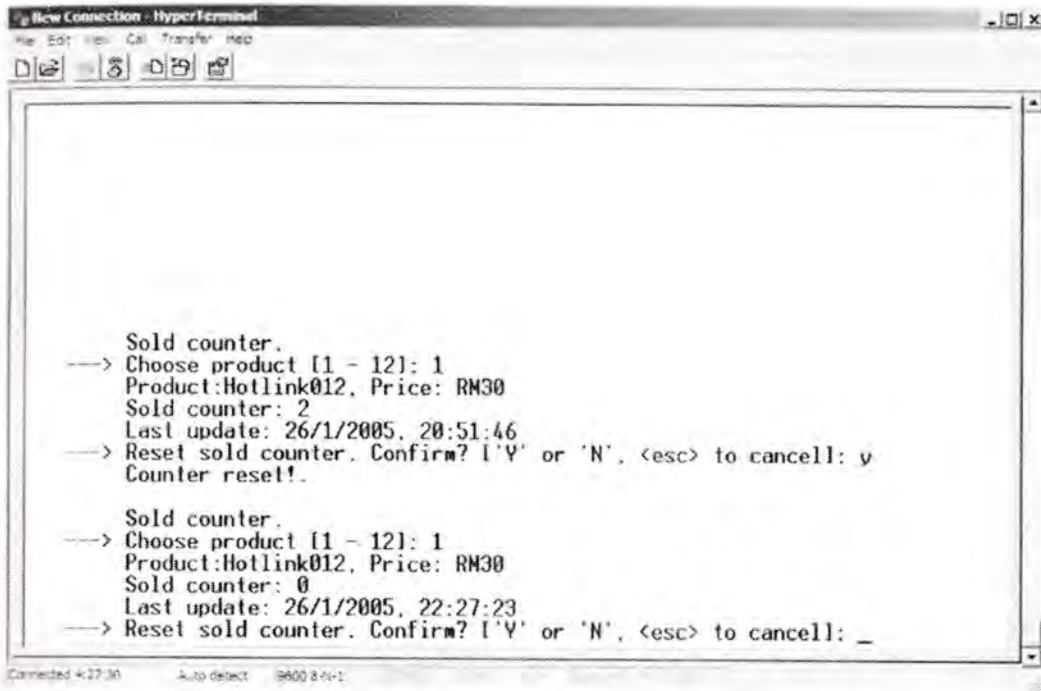


Figure 3.8: Example of Clear Slot [1].

3.1.1.7 Sold Counter

Each item which underwent Stock Out function in Diagnostic Mode as well as item that is purchased in Sales Activity Mode would have Sold Counter incremented. It will be continuously incremented until the user chose to reset the counter. An example of Sold Counter function is given in Figure 3.9.



```
New Connection - HyperTerminal
File Edit View Call Transfer Help
[Icons]
Sold counter.
--> Choose product [1 - 12]: 1
Product:Hotlink012, Price: RM30
Sold counter: 2
Last update: 26/1/2005, 20:51:46
--> Reset sold counter. Confirm? [ 'Y' or 'N', <esc> to cancel]: y
Counter reset!.

Sold counter.
--> Choose product [1 - 12]: 1
Product:Hotlink012, Price: RM30
Sold counter: 0
Last update: 26/1/2005, 22:27:23
--> Reset sold counter. Confirm? [ 'Y' or 'N', <esc> to cancel]: _

Connected 4:27:30 Auto detect 9600 8-N-1
```

Figure 3.9: Sold Counter operation [1].

Based on Figure 3.9, it can be seen that since 26/01/05 at 8.51 pm, 2 cards of Hotlink012 have been sold. When the user reset the Sold Counter, the Last Update date would be tagged as immediate time supply by the RTC after the reset activity has been successfully done. It is shown in Figure 3.9 that on 26/01/05 at 10.27 pm, the user has reset the counter.

Sold Counter menu is normally used for maintenance operation to check compatibility of the sold item's count since last update with the amount of cash collection and current List Card's Item.