SUPERVISOR'S DECLARATION

"I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of the degree of Bachelor of Computer Science (Software engineering)."

Signature:

Name of Supervisor: Madam Syarifah Fazin Binti Seyed Fadzir

Date:

STUDENT'S DECLARATION

"I hereby declare that this project entitled "RFID Marathon Timing System" is the result of my own research except as cited in references. The project has not been accepted for any degree and is not concurrently submitted in candidature of any degree."

Signature:

Name:

ID Number:

Date:

DEDICTION

This thesis is dedicated to my father and mother, who taught me that the best kind of knowledge to have is that which is learned for its own sake. It is also dedicated to my brother and sister, who taught me that even the largest task can be accomplished if it is done one step at a time.

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ABSTRACT

The purpose of this study is to develop an application named RFID Marathon Timing System by using radio frequency identification device (RFID). RFID is a wireless non-contact technology that using radio frequency electromagnetic fields to transfers data from a tag attached to an object, for the purposes of automatic identification and tracking. In marathon competition, it is impossible to get accurate stopwatch readings for every entrant and display the result immediately. In this thesis, RFID Marathon Timing System is used to tracking the timing for each participant of marathon competition and display the result of each participant immediately. This system is developed by using Rapid Application Development methodology. First is compare and analyzes the RFID Marathon Timing System and the conventional timing system by compare the functions and operation. Next is design the structure and flow of RFID Marathon Timing System. RFID Marathon Timing System is analyzing in detail by its features and operations. Next is the development phase, RFID Marathon Timing System is developed and tested. Results of this RFID Marathon Timing System are it able to capture the timing of each participant and able to display result of each participant when they crossing the finish line. Furthermore, the result also showed that this RFID Marathon Timing System could be used as an alternative timing system for bicycle racing, triathlon and so on.

ABSTRAK

Kajian in dilakukan bertujuan membina satu sistem bernama RFID Marathon Timing System dengan bergunakkan alat identifikasi frekuensi radio. RFID adalah sebuah teknologi wayarles tanpa kontak langsung dengan menggunakan gelombang radio untuk hantar isyarat dari tag kepada object dengan bertujuan untuk identifikasi dan menjejaki. Dalam pertandingan maraton, sangat susah untuk mendapatkan bacaan masa untuk setip peserta dan serta-merta memaparkan keputusan untuk setiap peserta. Dalam tesis ini, RFID Marathon Timing System digunakkan untuk mendapatkan bacaan masa untuk setiap peserta dalam pertandingan maraton dan memaparkan keputusan untuk setiap peserta serta-merta. Sistem ini dibinakkan dengan mengunakkan metodologi Rapid Application Development. Langkah pertama adalah untuk membandingkan dan menganalisis RFID Marathon Timing System dengan konvensional Timing System dari segi fungsi dan operasi. Langkah seterusnya adalah reka struktur dan aliran sistem RFID Marathon Timing System. RFID Marathon Timing System dianalisis secara teliti daripada ciri-ciri nya dan operasional. Dalam fasa seterusnya, RFID Marathon Timing System dibinaan dan diujikan. Keputusan daripada RFID Marathon Timing System ialah sistem ini dapat menangkap masa untuk setiap peserta dan dapat memaparkan keputusan untuk setiao peserta serta-merta apabila mereka melalui barisan tamat. Keputusan ini juga menujunkkan sistem RFID Marathon Timing System boleh digunakkan dalam pertandingan basikal, triathlon dan lain-lain.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The purpose of chapter 1 is to introduce to the readers about the project that will be developed later. This chapter contains Introduction, Problem Statement, Objective, Scope and Thesis Organization.

1.2 BACKGROUND

Traditionally, the early timing system operating by using manual, for example: stopwatch. By using manual method to records time for marathon event, not only large of data need to records and also a lot of manpower needed to operate the system. For example: in marathon event, need a lot of manpower to register each participants, records timing for first 50 participants, updates score and update ranking by manually. This kind of manually system easy to made mistakes due to human factor. For example: speed of human being when pressing a stopwatch and time factor when deal with large of data. In order to solve this problem, RFID Marathon Timing System based on the radio frequency identification device (RFID) is developed. By using RFID Marathon Timing System, time used to register each participants can be reduce and rush error are avoided since everyone can finish in anytime without being in a batch mode. This is because RFID Marathon Timing System cans records the finish time of each participant and updates their score and ranking. In RFID Marathon Timing System have two main devices, RFID tags and RFID readers. An RFID tag is attached to the participants. An RFID tag is emits a unique code different with each other. Then an RFID tag is detected by RFID readers located at the finish line. When the RFID tag is detected by RFID readers, the RFID Marathon Timing System will immediately records the current timing of the participant and show the current timing and ranking of each participant. RFID Marathon Timing System is suitable for running marathon event.

1.3 PROBLEM STATEMENT

Capturing data is always a challenge because it deal with lot of manpower to manage and manipulate the data and human limitation while records timing for each participant. Capturing data in a race environment can be even more difficult. As events draw very large numbers of participants, so it is very difficult to measure the timing for every entrant and also very hard to get the accurate timing for every entrant due to human error. For example: speed of human when pressing stopwatch, errors in problem detection and problem may occur during races when two participants reach the finish line in almost same time. RFID Marathon Timing System can also act as checkpoint station because some participants may reach the finish line early without registered.

1.4 OBJECTIVE

Objective of the RFID Marathon Timing System is:

- To get timing reading for each participants.
- Able to manage data of participants and display the result instantly.
- To replace operators pressing a stopwatch.

1.5 SCOPE

Participants

- RFID Marathon Timing System only for marathon.
- The participant should wear the RFID tag.

Environment

- Open area without interfere of radio frequency.
- The finish line must inside the detection range.

1.6 THESIS ORGANIZATION

This thesis consists of five chapters. Chapter 1 will discuss on introduction to system. In Chapter 1 contains Introduction, Problem Statement, Objective, Scope, and Thesis Organization.

Chapter 2 is Literature Review. In this chapter will review and analyzing the work of literature in relation to the system.

Chapter 3 is Methodology. This chapter will discuss the approach and framework for the project. Method, technique or approach that will be used while designing and implementing the project will be included in the content.

Chapter 4 is Implementation. This chapter will explain about the designed project development on how the database and table that will be designed and use of equipment.

Chapter 5 will discuss on the results and data analysis. In Chapter 5 contains Result analysis, Project limitation and Suggestion and project enhancement.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter briefly discusses on literature review related with the proposed project. The first section will introduce about RFID technology and fundamental concepts of RFID. Second section will discuss about RFID components. The next section will explain the communication between tag and reader. The last section will discuss about the existing RFID application.

2.2 FUNDAMENTAL CONCEPTS OF RFID

Radio frequency identification (RFID) technology uses radio waves to automatically identify physical objects, either living beings or inanimate items. The range of objects identifiable using RFID includes virtually everything on this planet. Thus, RFID is an example of automatic identification (Auto-ID) technology by which a physical object can be identified automatically.

RFID is a technology that users radio waves to transfer data from an electronic tag. A wave is a disturbance that transports energy from one point to another.

Electromagnetic waves are created by electrons in motion an consist of oscillating electric an magnetic fields. This type of waves can pass through a number of different material types [1] [2].

The highest point of a wave is called a crest and the lowest point is called a through [1].

The distance between two consecutive crests or two consecutive troughs is called the wavelength [1].

One complete wavelength of oscillation of a wave is called a cycle [1].

The time take n by a wave to complete one cycle is called its period of oscillation [1].

The number of cycles in a second is called the frequency of the wave and the frequency of the wave is measured in hertz (Hz). If the frequency of a wave is 1 Hz, it means that the wave is oscillating at the rate of one cycle per second. It is common to express frequency in KHz, MHz, or GHz [1] [2].

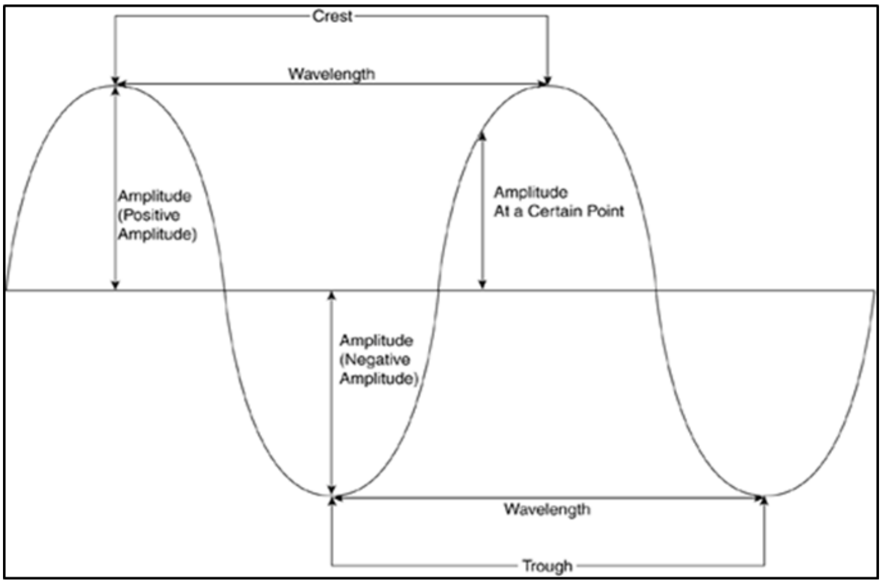

Figure 2.1:: Parts of Wave

Amplitude is the height of a crest or the depth of a trough from the undisturbed position [1][2]. The formers are also called the positive amplitude and the latter is called the negative amplitude. In general, the amplitude at a certain point of a wave is its height or depth from the undisturbed position, and is called positive and negative accordingly [1] [2].

Radio frequency waves are electromagnetic waves with wavelengths between 0.1 cm and 1,000 km or with frequencies lie between 30 Hz and 300 GHz. Example of electromagnetic wave types are infrared, visible light wave, ultraviolet, gamma ray, x ray, and cosmic ray. RFID uses radio waves that are generally between the frequencies of 30 KHz and 5.8 GHz. Modulation refers to the process of changing the characteristics of a radio wave to encode some information bearing signal. Modulation can also refer to the result of applying the modulation process to a radio wave [3].

Classes of RFID frequency types include the following:

- Low frequency (LF)
- High frequency (HF)
- Ultra high frequency (UHF)
- Microwave frequency

Low frequency is a frequency between 30 KHz and 300 KHz. RFID systems commonly use the 125 KHz to 134 KHz frequency range. RFID systems operating at low frequency (LF) generally use passive tags, have a low data transfer rates from the tag to the reader, and are especially food if the operating environment contains metals, liquids, dirt, snow, or mud. Active low frequency (LF) tags are also available from vendors. Because of the maturity of the type of tag, low frequency (LF) tag systems probably have the largest installed base. The low frequency (LF) range is accepted worldwide [3] [5].

High frequency (HF) is ranges from 3 MHz to 30 MHz with 13.56 MHz being the typical frequency used for high frequency (HF) RFID systems. A typical high frequency (HF) RFID system uses passive tags, has a slow data transfer rate from the tag to the reader and offers fair performance in the presence of metals and liquids. High Frequency (HF) systems are also widely used, especially in hospital because it does not interfere with the existing equipment [3] [5].

The rage of ultra-high frequency (UHF) is from 300 MHZ to 1 GHZ. A typical passive ultra-high frequency (UHF) RFID system operates at 315 MHz and 433 MHz.

An ultra-high frequency (UHF) system can therefore use both active and passive tags and has a fast data transfer rate between the tag and the reader, but performs poorly in the presence of metals and liquids. Ultra-high frequency (UHF) systems have been started being deployed widely because of the fast data transfer rates [4] [5].

Microwave frequency range upward from 1 GHz. A typical microwave RFID system operates either at 2.45 GHz or 5.8 GHz, although the former is more common, can use both semi-active and passive tags, has the fastest data transfers rate between the tag and the reader and performs very poorly in the presence of metals and liquids. Because antenna length is inversely proportional to the frequency, the antenna of a passive tag operating in the microwave range has the smallest length. The 2.4 GHz frequency range is called Industry, Scientific, and Medical band and is accepted worldwide [3] [5].

Table 2.1: RFID Frequency Ranges

Frequency Range	**Band**	**Read Range**	**Advantages**	**Disadvantages**	**Applications**
Low frequency	125 KHz-134 KHz	Below 0.5 meter	Operates well around water and metals; accepted worldwide	Short read range; slow read rates	Animal tracking Access control Vehicle immobilizers Product authorization
High frequency	13.56 MHz	Below 1 meter	Low cost of tags; accuracy; quick read	Require a higher power	Item tracking Airline baggage

			rates		Smart Cards Libraries
Ultrahigh frequency	860 MHz- 930 MHz	3 meters	Frequency selected by EPCglobal	Does not operate well near water or metals	Supply chain and logistics Automated toll collections Parking lot access
Microwave frequency	2.4 GHz	1 meter	Fastest read range	Does not operate well near water or metals	Supply chain and logistics Airline baggage Electric toll collections

2.3 COMMON RFID COMPONENTS

An RFID system consists of the following components from an end to end perspective:

- Tag. This is a mandatory component of any RFID system.
- Reader. This is a mandatory component.
- Antenna. This is another mandatory component. Some of the current readers or scanners available today have built-in antennas.
- Controller. This is a mandatory component. Nowadays, most of the new generation readers or scanners have this component built in to them.

- Host and software. An RFID system can function independently without this component, but an RFID system is close to worthless without this component.
- Communication infrastructure. This is mandatory component is a collection of both wired and wireless network and serial connection infrastructure needed to connect the previously listed components together to effectively communicate with each other.

2.3.1 Tags

Tags are the devices attached to the items or material that the RFID system is intended to track. The tags may be attached or placed directly on individual items such as in the case of customer goods or on shipping containers or pallets that hold multiple items. The tags come in all sort all sizes and shapes.

There are three primary types of tags produced: passive, semi-passive, and active. Passive tags do not have an interior power supply, and therefore they must rely on the scanners or readers for power. Active tags possess batteries that supply power for communication. Because of this reason, active tags can significantly improve the range between the tag and the interrogator. A hybrid of the active and passive tags, the semi-passive tag possesses a low cost batter that is used to power the tag's onboard electronics. The battery does not allocate power for increasing the tag's communication range [9].

The function of the tag is to transmit data to the rest of the RFID system. Tags generally contain three basic parts: the electronic integrated circuit, a miniature antenna, and a substrate to hold the integrated circuit and the antenna together and to the inventory item [9]. Tags have various memory structures and data capacities. Therefore, there are numerous methods of retrieving and transmitting information with RFID tags. Tags will transmit and receive information according to the type of information it stores and the specific commands of an interrogator. In systems using first generation protocols, tags from one vendor did not talk to interrogators from another vendor. All types of tag memory can perform basic read and write tasks. The RFID tag costs are directly associated with the complexity or memory read and write functions [6].

Tag memory is designed in three ways: Read-Only (RO), Write Once Read Many (WORN), or Read-Write (RW) [9]. In terms of complexity and cost, each tag type has advantages and disadvantages according to its memory type. A Read-Write tag may cost more and provides a greater functionality, but a Read-Only tag provides more security and ease of use [9]. All type of memory can be used in passive, semi-passive and active tags.

A passive tag is so named because it cannot generate and reflect radio signals to a reader if it is not in the presence of an electromagnetic field. A passive tag must be inside the interrogation zone in order to receive enough power to generate a response. The initial interrogator signal powers a passive tag's circuitry, allowing the tag to function [6] [7].

Semi-passive tags are the least used in the RFID industry. Semi-passive tags make use of the initial electromagnetic wave produced by the interrogator to generate communication. In this way, the operating principle of the semi-passive and passive tags is the same: both only operate when they receive a signal from the interrogator, and can only transmit when they receive adequate power from a source. The tags use their own batteries to run circuitry [8].

Semi-passive tag additional battery power allows them to resist interference or circumvent a lack of power from the original interrogator signal. The transmission signal sent back to the interrogator is stronger than that of passive tags, which allows tags to transmit across longer distances and sustain operation for the proper amount of time during information transaction. Like passive tags, the size of semi-passive tags can vary depending on their range and functionality. Because of their batteries, semi-passive tags are large than passive tags. Battery powers in semi-passive tags also increase memory capacity, which allows room to implement large components. These tags can remain in operation for extended lifetimes, but their batteries need to be monitored and eventually replaced [8] [9].

Active tags contain their own battery source, broadcast their own signal to a reader, and therefore do not rely on the reader for power. Because of this internal power, active tags achieve the greatest read ranges and some active RFID tags can send a signal one kilometer. In some cases, an active tag can be integrated with a Global Positioning System (GPS) to pinpoint the exact location of an item. A tag operating all of the time will act as a type of beacon, broadcasting its location at specified intervals [9].

Active tags are the largest compare to passive and semi-passive tags because of their batteries. Typical active tags have a thickness of approximately one-half inch and a surface area of 1.5 $\times$ 3 inches. Greater tag size also allows for more memory capacity and functionality. The information contained in an active tag can be more complex than that in a passive or semi-passive tag. Active tags can store an object's standard serial number as well as the full list of contest in the container, the container destination, and the origin of the container. With all of this information available, active tags offer up to date supply chain information. As with semi-passive tags, active tag's batteries have finite lifetimes and will need to be maintained or replaced accordingly [9].

Table 2.2: RFID Technologies Comparison

Type of tag	Power source	Range	Size	Data storage	Cost
Passive	External electromagnetic antenna field	Measured in feet	Smaller	Less	Less
Semi-Passive	On-board battery for internal circuitry. External electromagnetic field for transmission	Measured in feet	Larger	More	More
Active	On-board battery	Up to thousands of feet	larger	More	More

2.3.2 Readers

An RFID reader is also called an interrogator, is a device that can read from and write data to compatible RFID tags. Thus, a reader also doubles up as a writer. The act of writing the tag data by a reader is called creating a tag. The process of creating a tag uniquely associating it with objects is called commissioning the tag. Similarly, decommission a tag means to disassociate the tag from a tagged object and optionally destroy it. The time during which a reader can emit RF energy to read tags is called the duty cycle of the reader.

The reader is the central nervous system of the entire RFID hardware system, establishing communication with and control of this component is the most important task of any entity which seeks integration with this hardware entity.

A reader has following main components:

- Transmitter

  The reader's transmitter is used to transmit AC power and the clock cycle via its antennas to the tags in its read zone. This is one part of the transceiver unit, this component responsible for sending the reader's signal to the surrounding environment and receiving tag responses back via the reader's antenna. The antenna ports of a reader are connected to its transceiver component, one reader antenna can be attached to each such antenna port [11] [12].
- Receiver

  Receiver is also one part of the transceiver module. It receives analog signals from the tag via the reader antenna. It then sends these signals to the reader's microprocessor, where it is converted to its equivalent digital form that is, the digital representation of the data the tag has transmitted to the reader antenna [10] [9].
- Memory

  Memory is used for storing data such as the reader configuration parameters and a list of tag reads. Therefore, if the connection between the reader and the controlled of software system goes down, not all the read tag data will be lost. Depending on the memory size, however a limit applies as to how many such tag reads can be stored at any one time. If the connection remains down for an extended period with the reader reading tags during this downtime, this limit might be exceeded and part of the stored data lost. That is overwritten by the other tags are read later [9].
- Microprocessor

  Microprocessor is responsible for implementing the reader protocol to communicate with compatible tags, it is performs decoding and error checking of the analog signal from the receiver. In additional, the microprocessor might contain custom logic for doing low-level filtering and processing of read tag data [11] [12].

- Communication interface

  Communication interface provides the communication instructions to a reader that allow it to interact with the eternal entities, via a controller to transfer its stored data and to accept commands and send back the corresponding responses. you can assume that this interface component is either part of the controller of is the medium that lies between a controller and the external entities. This entity has important characteristics that make it necessary to treat this as an independent component. A reader could have a serial as well as a network interface for communication. A serial interface is probably the most widespread type of reader interface available, but the next generation readers are being developed with network interfaces as a standard feature. Sophisticated readers offer features such as automatic discovery by an application, embedded Web servers that allow the reader to accept commands and display the result using a standard Web browser, and so forth [11] [12].

2.3.3 Antennas

RFID antenna is used to transmit the radio frequency signal from reader to the tags. RFID antenna is also used to receive the radio frequency signal from the tag for subsequent processing by the RFID reader [9].

Normally, where the orientation of the tag with the respect to the reader will not change, it is possible to have a single antenna. This can work in manufacturing applications where a product is undergoing a process. However, in more complex situations where the orientation of the tag is not guaranteed, it is normal for RFID systems to utilize more than one antenna. For a given sized interrogation zone for an antenna, the greater the number of antennas, the greater the probability of a successful read by the system [9] [11].

RFID antennas are commonly contained within an outer rectangular shaped plastic housing. The housing protects the antenna and associated electronic components from damage. The housing also protects the antenna from minor environment hazards such as dust. Thus, many RFID antennas have little resemblance to the type of antenna that may be used to seeing. The plastic housing also provides a means of attaching the antenna in position.

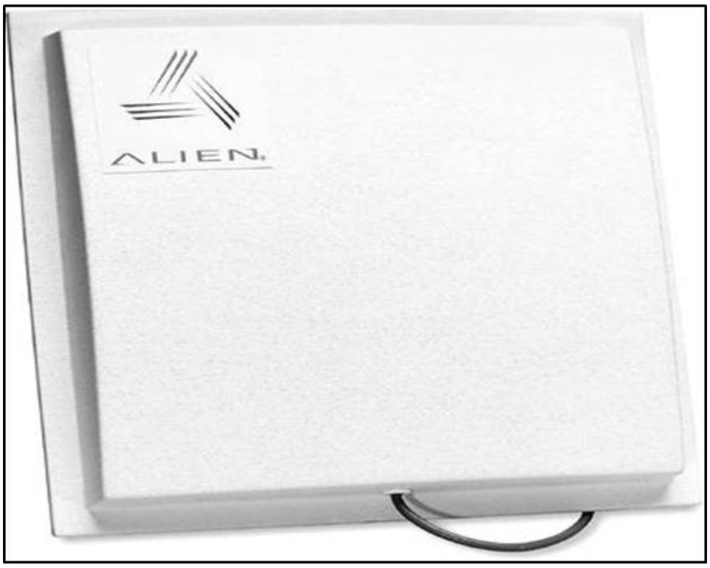

Figure 2.2: RFID Antenna with Rectangular Shaped [24]

Positioning of the RFID antenna is also an important issue. Both the packaging material and the item to be tracked can affect the ability of the RFID system to conduct a successful read. In a forklift type application, the antennas may be positioned above the driver’s safety cage. In a shrink wrap application, the antennas would be positioned in locations around the turntable, which would still allow access to the table.

Another antenna placement issue is the height of the antenna. In some applications, the material will not necessarily be passing through a specific portal. In many cases, the range of the antenna and the size of the interrogation zone can be increased by raising the antenna above ground level. Some experimentation will be necessary in order to determine the optimal sized zone [9].

Another possible antenna issue is a situation where the antenna cannot be allowed to interfere with the surface movement of the material. In situations like this, it is possible to mount the antenna suspended from the ceiling with the field oriented downwards. This method works particularly well when the tags can be placed on the topmost horizontal surface. In this case, the system has an unobstructed view of the tags and the successful read rate is likely to be very high.

2.3.4 Controller

A controller is an intermediary agent that allows an external entity to communicate with and control a reader's behavior together with the annunciators and actuators associated with this reader. Controller is the only component of an RFID system or reader through which reader communications are possible, no other medium or entity provides this ability. A controller for a reader can be embedded inside the reader or can be separate component by itself. To retrieve tag data stored on a reader, a computer must use a controller. Computer cannot communicate to the reader in any other way. A controller also provides a communication interface for the external entities to interact with it [9].

2.3.5 Host and Software

Host and software system is an all-encompassing term for the hardware and software component that is separate from the RFID hardware. The system is composed of the following two main components:

- Edge interface

  Edge interface is the software that runs on the host computer that interfaces with the reader. With standalone interrogator systems that do not require a host computer to operate, edge interface runs on the interrogator. It allows configuration of the interrogator's functions, including the read rate, power level, frequency of operation, and method to poll tags. Edge interface may organize some information by consolidating multiple reads from one tag or eliminating responses from item level tags when only case tag information is desired [13].
- Middleware

Middleware is for the data collection, management, and flow among the tags, interrogators, and inventory applications. It plays an important role in the business justification for RFID applications. Middleware communicates the data collected by the interrogators to the application layer software, such as inventory management software used to make business decisions. Without this middleware, the data collected by RFID installations cannot be easily integrated into the decision making process. Middleware is often written by a different vendor than the interrogator and the application software vendor, but can be customized to each customer's requirements [9] [13].

2.3.6 Communication Infrastructure

This component provides connectivity and enables security and systems management functionalities for different components of an RFID system, and is therefore an integral part of the system. It includes the wired and wireless network, and serial connection between readers and computers. Common types of protocols include RS-232 and Ethernet-based systems.

RS-232 is the simple protocols to be available with an RFID system. This serial protocol is commonly utilized in industry to communicate directly between a host computer and one or more devices via individual dedicated cables. This port has either nine or twenty-five pins. RS-232 suffers from slow data transfer rates of 20K and limited transmission cable lengths of fifty feet. While some transmission distance issues may be overcome, other issues may make another protocol more attractive. For example, RS-232 cable is more expensive than other alternatives such as Ethernet. Despite many industry announcements of the death of RS-232, the protocol continues to be utilized in the industry environment [14].

Figure 2.3: RS-232 Port

Another for communication between the RFID reader and the host computer is Ethernet. The attraction of an Ethernet based system is that mist facilities probably already have an Ethernet network in place. Ethernet also has a much higher data transfer rate than RS-232. Newer Ethernet systems have the capability to transfer data at 100M. Ethernet cable can be more inexpensively obtained and installed than RS-232 cable [14].

Figure 2.4: Ethernet Port

2.4 COMMUNCATION BETWEEN TAG AND READER

An RFID system consists of an interrogator or reader, tags, tag and interrogator antennas, and a host computer as shown in Figure 5.

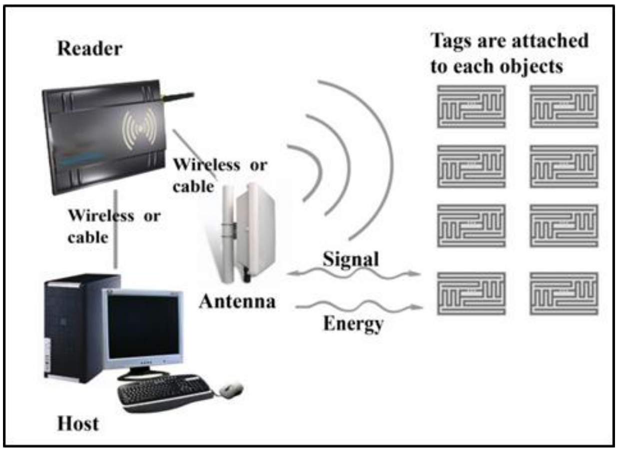

Figure 2.5: RFID System

When an interrogator or reader first sends a radio frequency signal to an antenna, radio frequency modulation occurs. In radio frequency modulation, the initial signal is encoded and prepared for transmission. If the antenna has been connected to the interrogator with the correct length of cable, the signal will be transmitted without distortion. Output power is also established at this step in the process. Because of this, the configuration of the interrogator and antenna determine the output power of a system.

When the interrogator or reader antenna transmits the radio frequency modulated signal, the signal travels the farthest distance it can. The interrogation zone is defined during the antenna’s transmission. Before operation, the initial setup and testing of the system will have established the range and integrity of the propagated signal. If the components have been set up perfectly and the system has been properly analyzed, tags in the interrogation zone will read 100 percent of the time [15].

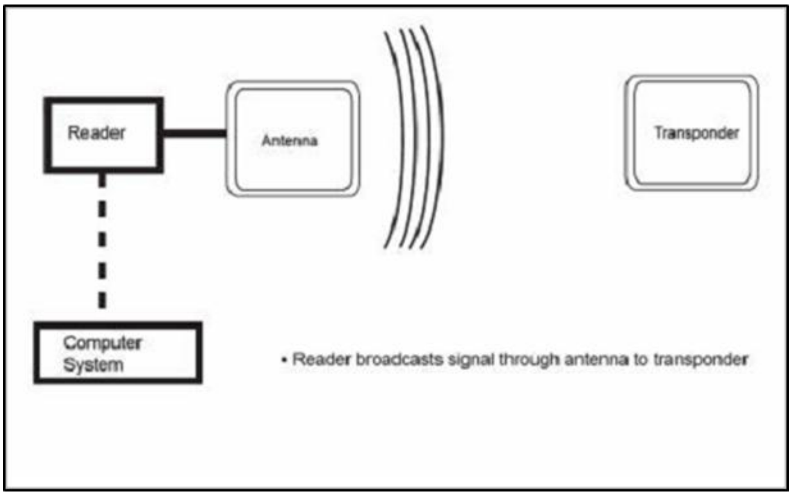

Figure 2.6: Reader to Tag Communication

When a tag receives power from the initial carrier signal, it is activated or "wakes up" and starts operation. By this time, inductive coupling or backscatter will have occurred. The tag continues using the interrogator's signal to gain power until it can generate a return signal. Tags will determine how much a system will be able to accomplish because they retain all of the pertinent data a system is working to transport. Once the return signal is generated, the tag transmits it to the antenna, which receives the tag's information and communicates it to the interrogator [15].

After receiving tag data from the antenna, the interrogator communicates this information to the appropriate middleware. From the middleware, the flow of data is organized so that a host computer can manipulate the information for myriad uses [9] [15].

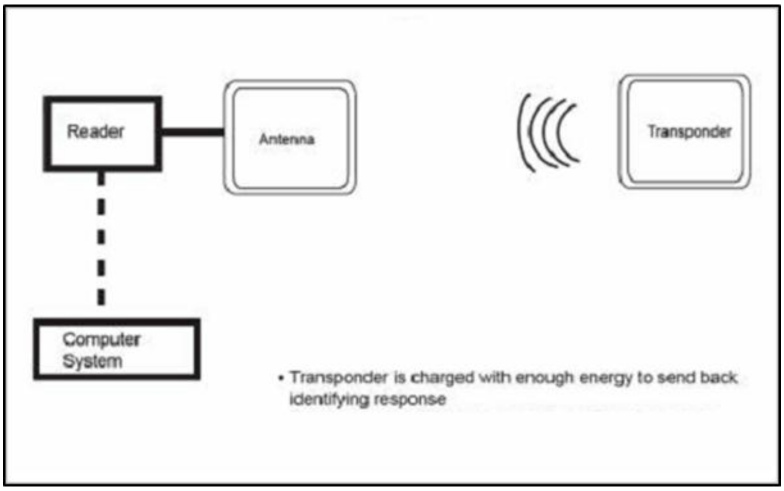

Figure 2.7: Tag to Reader Communication

2.5 RFID SPORTS APPLICATION

RFID technology has actually been used in some individual competitive sports such as early as 1994. In that year, the passive RFID tag was utilized in the Berlin marathon. Since then, RFID chips have been used in cycling, skating, and even triathlon competitions [16] [17].

The use of RFID technology in these types of events is particularly advantageous because competition race committees need to process large volumes of competitors in relatively short periods of time. For example, in marathon race, there may be hundreds or even thousands of runners' start of the race. Though the numbers of competitors passing though the checkpoints at the same time will diminish over the course, each individual competitor still needs an accurate time record [16].

The use of RFID tags in individual sports competition is dependent on the organizing committee. Some organizing committees may accept compatible competitor owned RFID chips, other committees may require competitors to use race specific chips [17] [18] [19].

The use of compatible competitor owned RFID chips reduces the logistical costs to the organizing committees. A common problem is that before the race, competitors using their own chips must ensure that their tag's identification number is properly associated with their entry. If the competitor fails to do so, there is no way that the committee can properly record his start, splits, and finishes [16].

In the races, the race committee can require competitors to utilize the organizations RFID chips. This has the advantage of insuring that each competitor's tag identification number is properly recorded. However, the purchase of the anticipated number of RFID tags plus a reserve for a particular competition can significantly add to the operating costs of the event [16].

The cost of the event also depends on how the organizing committee intends to set up the RFID technology. RFID tags can be used to record any combination of individual starts, splits and checkpoints, and finishes [16].

The exact choice of RFID tag reading may also be a function of the funding available to the race committee. The most expensive system will be one that uses RFID tags to record the start, a number of splits or checkpoints, and the finish. There must be reader antenna systems positioned at each of these locations. In addition, if the data are to be carefully recorded, additional networking hardware will be required. This type of system will actually produce the most accurate type of performance data. The net time resulting from the difference between the finish and the start can be precisely calculated for each competitor. Competitors can also utilize the split time for race analysis and future training. Similarly, race organizers can utilize the checkpoint times to insure that competitors have negotiated the entire course in realistic times. This approach virtually eliminates the possibility of competitors cheating, as has happened with many competitions in the past [16].

2.6 EXISTING RFID TIMING APPLICATION

This section will compare three existing system of RFID Race Timing Systems which are:

- RFID Race Timing Systems
- Winning Time
- Innovative Timing Systems

2.6.1 RFID Race Timing System

The RFID Race Timing System is company developed a transponder timing system for their local triathlon club. By 2004, the RFID Race Timing System was being used to time major triathlons around the country including Australian Triathlon Championships and North and South America.

RFID Race Timing System use low frequency (134 KHz) tags and readers which generally are the standard used for sports timing. Low frequency offer good read range read focus of antennas and can penetrate most mediums other than metal. The tag is half duplex meaning that only one tag can be read at any given time over a reader. However, if tags are slightly staggered as they cross over the reader, they will both be read in the correct sequence. This is actually an advantage since it means that the correct order to tags crossing the reader is recorded.

Figure 2.8: Tag

There are two types of readers used by RFID Race Timing System. The mats type reader and side type readers. Mats are manufactured from anti fatigue rubber, are light and easy to deploy onto the race track. Each mat is 1 meter long and timing points is up to 9 cm. slide type readers are useful in timing events for swimming where mats are not practical.

Figure 2.9: Mats Type Reader and Slide Type Reader

2.6.2 Winning Time

Winning Time is the world leader chip timing since 1005 and offers the highest level of passive chip timing technology. Winning Time suitable for event likes Running, Triathlon, Cycling and Skiing.

The Winning Time tag is an extremely light passive radio transmitter without a battery. The tag consists of a micro antenna and an integrated circuit which can transmit a unique 20 digit code, and is encased in a hard plastic cover. It is worn by athletes on an adjustable easy on and easy off ankle strap. The tag can also be mounted on a bicycle's front fork with a special lightweight support case. The Winning Time tag is extremely durable and will last for up to 10 years.

Figure 2.10: Tag

The Winning Time mats are composed of antenna wires covered in durable, light weight rubber. The mat is 7 feet wide by 5 feet deep and weight less than 20 pounds. They can be used for any required configuration for start lines, finish lines, transition areas, and intermediate check point. The mat is specially constructed with anti-slip material making them ideal for any weather condition and ensuring the safety of every racer crossing the mat.

Figure 2.11: Mats

The Winning Time System operates in the following way:

- The antenna in the mats is driven by the controller to generate an electromagnetic field that send an energizing signal to the tag.
- Within 60 milliseconds the tag is fully powered and ready to send its unique identification code back to the antennas.
- The tag ID code is then passed through the antenna to the controller and the data is then read through the controller via computer into the scoring software.

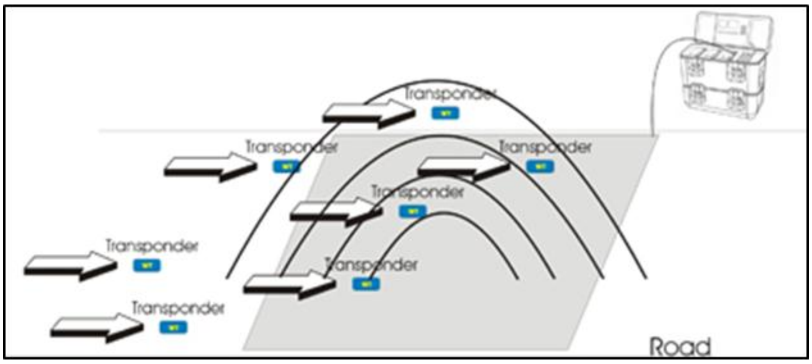

Figure 2.12: Operation of Winning Time

2.6.3 Innovative Timing System

The Innovative Timing Systems is designed to handle running events (5Ks, 10Ks, trail runs, and marathons) as well as cycling races, time trials, decathlons, triathlons, and motocross racing. The system can handle races with as few as 50 athletes and as large as 500,000 competitors.

The Innovative Timing Systems is a comprehensive platform that includes all the software and hardware needed for race timing. It includes the cabinet, circular antennas, and waterproof RFID tags for each racer. Inside the cabinets are RFID readers, backup power, network interfaces, a dedicated computer, fan, and support tools. Race directors place the cabinets at the start, transition, and finish to collect split and final times for athletes.

Each racer is equipped with a bib or identifier with a specially designed waterproof timing chip. These tags can be detected by readers. With reliable UHF readers and antennas, Innovative Timing Systems has an extremely high accuracy rate because the tags can be read accurately from as far as 30 feet, and its antenna can be places overhead or beside the course, making Innovative Timing Systems ideal for races on open roads or trail runs.

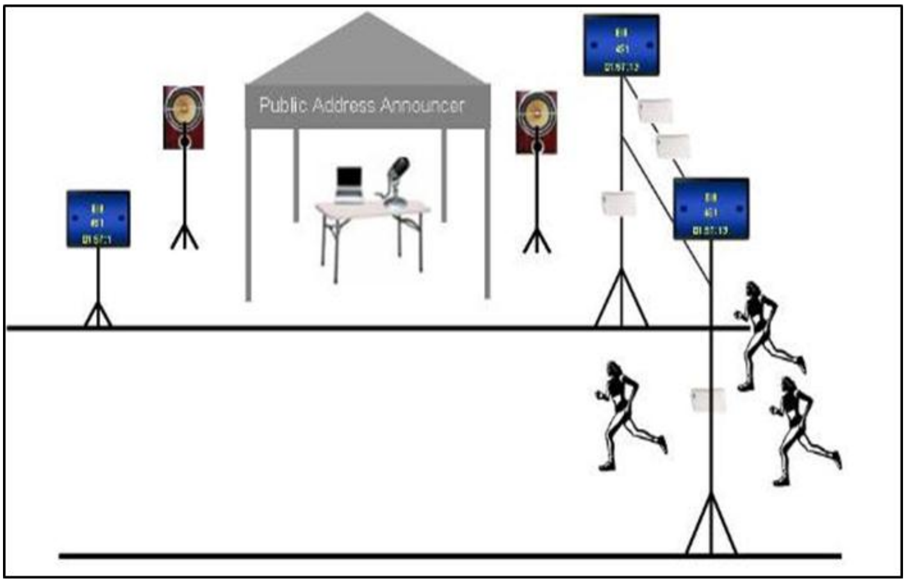

Figure 2.13: Innovative Timing System

Table 2.3: Comparison between Existing Systems [20] [21] [22]

System	Tag	Reader	Benefit
RFID Race Timing Systems	Passive, Low Frequency.	Mat and Side Reader	• Good read range. • Half duplex.
Winning Time Systems	Passive	Mat	• Last for up to 10 years. • Mat can be used for any weather condition.
Innovative Timing Systems	Passive, UHF Frequency.	Reader	• Tags are waterproof, sweat proof. • The tags can place in anywhere.

2.7 SOFTWARE DEVELOPMENT METHODOLOGY

Software development methodology is a framework that used to structure, plan and control the process of developing an information system. There are many types of software development methodology: waterfall, prototyping, spiral, rapid application development and others. The section will explain about the Rapid Application Development [21].

2.7.1 Rapid Application Development

Rapid Application Development is a software development methodology that uses minimal planning in favor or rapid prototyping. There are four phase of Rapid Application Development: requirements planning phase, user design phase, construction phase and cutover phase [21].

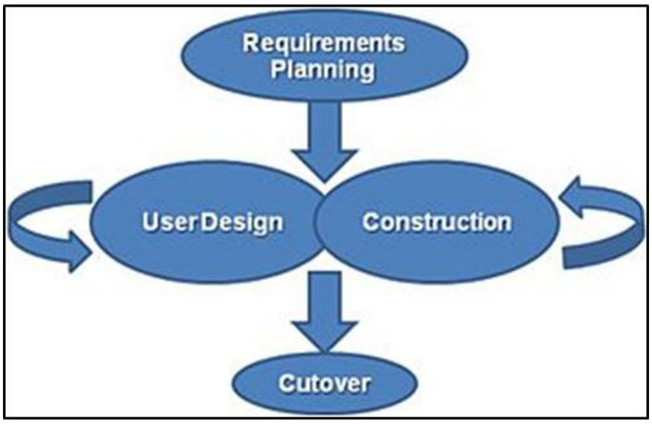

Figure 2.14: Rapid Application Development [21]

Table 2.4: Advantages and Disadvantages

Advantages	Disadvantages
Time to deliver is less.	Management complexity is more.
Changing requirements can be accommodated.	Resource requirements may be more.
Progress can be measured.	Suitable for systems that component based and scalable.
Productivity with fewer people in short time.	Requires user involvement through tout the life cycle.
Use of tools and frameworks.	Suitable for project requiring shorter development times.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

In this chapter will discuss about the methodology that will be using in the development of RFID Marathon Timing Systems. For develop RFID Marathon Timing Systems, the Rapid Application Development (RAD) method was choosing because RAD have several characteristic that is suitable for the development of RFID Marathon Timing Systems. There have three section consists in this chapter. The first section explains about the introduction of the RAD development method and the reason to choosing the RAD approach. The next section discuss about the implementation of RAD method in RFID Marathon Timing System development. The last section will elaborate the hardware and software that was used in the development of RFID Marathon Timing System.

3.2 RAPID APPLICATION DEVELOPMENT (RAD)

A software development methodology or system development methodology in software engineering is a framework that is used to structure, plan, and control the process of developing a system [22]. Rapid application development (RAD) refers to a type of software development methodology that uses minimal planning in favor of rapid prototyping and higher quality results than those achieved with the traditional lifecycle. Rapid means fast, so the Rapid application development method has a task list and a work breakdown structure that is designed for speed. This is achieved by using a series of proven application development techniques, within a well-defined methodology [23]:

- Focus to gather requirements.
- Prototyping. An approach based on creating a demonstrable result as early as possible and refining that result. The refinement is based in the testing or feedback from the users.
- Iteration is a commitment to incremental development based on refinement. Prototyping and iteration go hand in hand.

3.3 THE JUSTIFICATION OF THE CHOSEN METHOD

Rapid Application development used in RFID Marathon Timing System is because it allows software to be written much faster, and makes it easier to change requirements. In RFID Marathon Timing System, development time is critical and Rapid application development is a focused process in which the conceptual requirements of the project are fed into construction iterations. The construction iterations occur within a fixed time box, emphasize reducing development time and generating efficient executable code.

3.4 DETAILS AND STEPS OF RAPID APPLICATION DEVELOPMENT METHODS

There have four main life cycle phases in the RAD life cycle as refer to Figure 3.1, which is:

a. Requirements Planning
b. User Design
c. Construction
d. Cutover

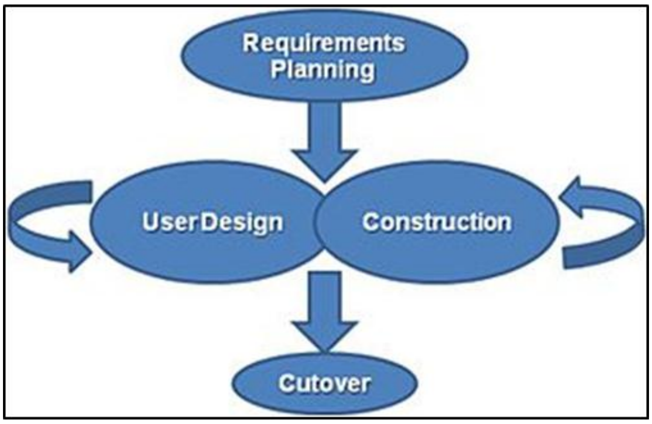

Figure 3.1: Rapid Application Development [21]

3.4.1 Requirements Planning

This type of research is to identifying problem area prior an RFID institutive. Consider the three parts of a research is equipment, environmental and human factor:

- **Equipment:** The first of the research is to analysis the equipment, which would include estimating needs and training that will be required when using RFID equipment.
- **Environmental**: environment evaluation allows for identification and creation of physical and logical read zones such as portals that will not hinder operation.
- **Human factor**: Often the human element of the process and operations is overlooked when performing an assessment. It is important because it is needed to consider not only what is being done but also who is using it.

In the Rapid Application development, requirement is a statement of the function and behavior of the system required by the users and operators. In this phase will be listing of specific, measurable behavioral system constraints that satisfy system requirements.

Table 1 shows about the number of quantity of hardware specification and purposes include quantity in developing this RFID Marathon Timing System.

Table 3.1: Hardware Facilities and Purpose

Hardware	**Specification**	**Purpose**	**Quantity**
Laptop	• Acer Aspire 4736Z Intel(R)Pentium(R) 2.0 GHZ, Hard Disk 160GB 3GB DDR3 Memory	Used to develop the system Prepare document and proposal	1
Printer	Canon PIXMA MP145	Print document and proposal	1
USB storage device	Kingston 4GB PenDrive 4GB	Backup data and files	4 1
External Hard Disk	Samsung 500GB	Backup data and files	1
RFID Reader	Reader Module	Used to read the RFID tag	2

The software specifications for the development have listed in below Table:

Table 3.2: Software Facilities and Purpose

Software	**Purpose**
Microsoft Visual Studio 2010	Designing interface and generate coding.
Microsoft Office • Microsoft Word 2007 • Microsoft Project 2010 • Microsoft Visio 2007	• Prepare documentation and proposal. • Prepare the Gantt Chart • Design the draw chart and diagram.
Microsoft Operating System Window 7	A platform for a software to run and used to develop the TMS
Rational rose 2007	Modeling and design UML
Web Browser Software • Mozilla Firefox • Microsoft Internet Explorer 8 • Google Chrome	Access internet and search the related information on internet.

3.4.2 User Design

In this phase, flow chart are used to represents all system processes, input and output.

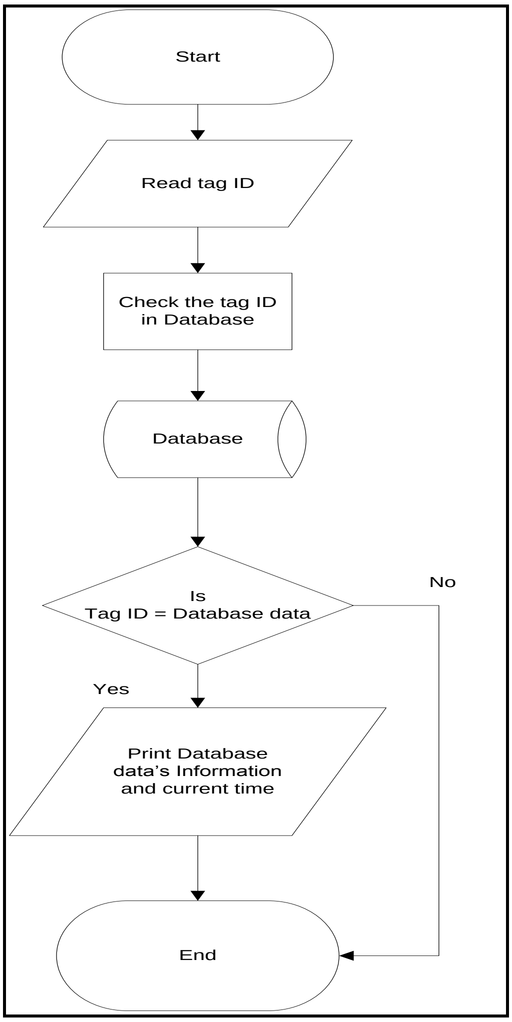

Figure 3.2: Flowchart of RFID Marathon Timing System

Figure 3.3 is Data Flow Diagram for RFID Marathon Timing System. Data Flow Diagram is representation of the flow of data through a RFID Marathon Timing System. It shows what kinds of data will be input to the RFID Marathon Timing System, where the data will come from and go to, and where the data will be stored.

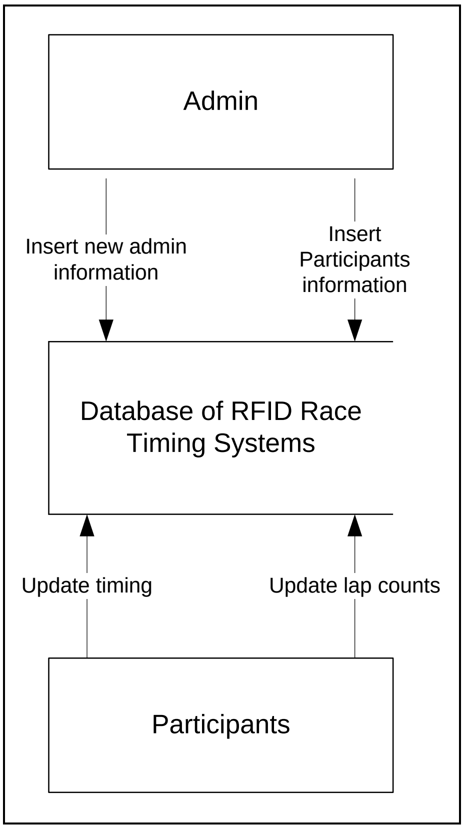

Figure 3.3: Data Flow Diagram Level 0

Figure 3.4 show the use case diagram for administration. In RFID Marathon Timing System, administer can add new admin, update information of the admin, delete admin, add participants, update participants information and delete participants.

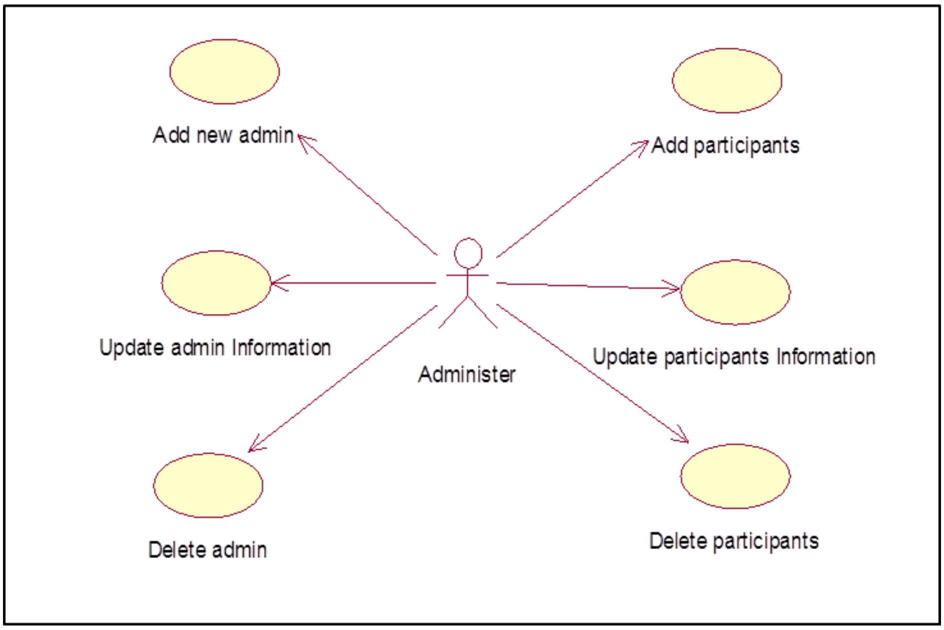

Figure 3.4: Use case for Administer

3.4.3 Construction

In this phase is focuses on program and application development task. Its tasks are programming and application development, coding, unit integration and system testing. RFID Marathon Timing Systems will develop by using Microsoft Visual Studio 2010 and programming language is VB.Net. The RFID Marathon Timing Systems also will be tested by using Microsoft Visual Studio Test Professional to find the defects in the coding.

3.4.4 Cutover

In this phase, the new system is built, delivered, and placed in operation much sooner. Its tasks are data conversion, full scale testing, and develop user manual.

CHAPTER 4

IMPLEMENTATION

4.1 INTRODUCTION

The main purpose of this chapter is to document all the process that involved in developing the system. Generally, this system chapter explained project development that has been designed for RFID Marathon Timing System.

This section depicts the whole processes in this RFID Marathon Timing System. This chapter includes detailed on architecture of the system development such as database system and the tables' design which used SQL Command to insert data in database and tools for RFID Marathon Timing System using Radio Frequency Identification Device.

4.2 MAIN MENU

The Figure 4.1 shows the interface of RFID Marathon Timing System named Main Menu. Main Menu is main interface of the RFID Marathon Timing System which provides basic operation that let user to enter choose the function of the RFID Marathon Timing System.

Figure 4.1: Main Menu

The coding of the Main Menu is shows in Figure 4.2.

```
Public Class frmMainMenu
    Private Sub btnAdmin_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles btnAdmin.Click
        'Show Admin Interface'
        Me.Hide()
        frmAdmin.Show()
    End Sub

    Private Sub Button2_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles btnParticipant.Click
        'Show Admin Interface'
        Me.Hide()
        frmParticipant.Show()
    End Sub

    Private Sub Button3_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles btnRaceTimingSystem.Click
        'Show Admin Interface'
        Me.Hide()
        frmRaceTimingSystem.Show()
    End Sub

    Private Sub Button4_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles btnExit.Click
        'Terminate RFID Race Timing System'
        Application.Exit()
    End Sub
End Class
```

Figure 4.2: Coding of Main Menu

4.3 ADMIN

Figure 4.3 is the interface for administrator for RFID Marathon Timing System. The main function of this interface is to register the information of admin. This interface can perform Save, Update, and Delete operation. The Main Menu button is to let user return to the Main Menu of the RFID Marathon Timing System.

Figure 4.3: Admin Interface

The database consists of name, password, tel, position, and id. In this table, the primary key is the id and it's unique. The table of Admin interface is shows below:

Column Name	Data Type	Length	Allow Nulls	Unique	Primary Key
name	nvarchar	100	No	No	No
password	nvarchar	16	No	No	No
tel	nvarchar	100	No	No	No
position	nvarchar	100	No	No	No
id	nvarchar	10	No	Yes	Yes

Figure 4.4: Table of Admin

The SQL commands of each button are shows in below:

Table 4.1: SQL Command for Form Admin

Button Name	SQL Command
Save	“INSERT admin_information (id,name,password,tel,position) VALUES (@ID,@Name,@Password,@Tel,@Position)”
	“UPDATE admin_information SET name=@Name, password=@Password, tel=@Tel, position=@Position WHERE id=@ID”
Update	“SELECT * FROM admin_information WHERE id=@ID”
Delete	“SELECT password FROM admin_information WHERE id=@ID”
	“DELETE FROM admin_information WHERE id=@ID”

4.4 PARTICIPANT

The next interface is named Participant. Form Participant is used to register information of each participant. In this form, user needs to scan the tag ID to register. The command of the RFID is shows at Appendix 1. Below is the interface of Participant.

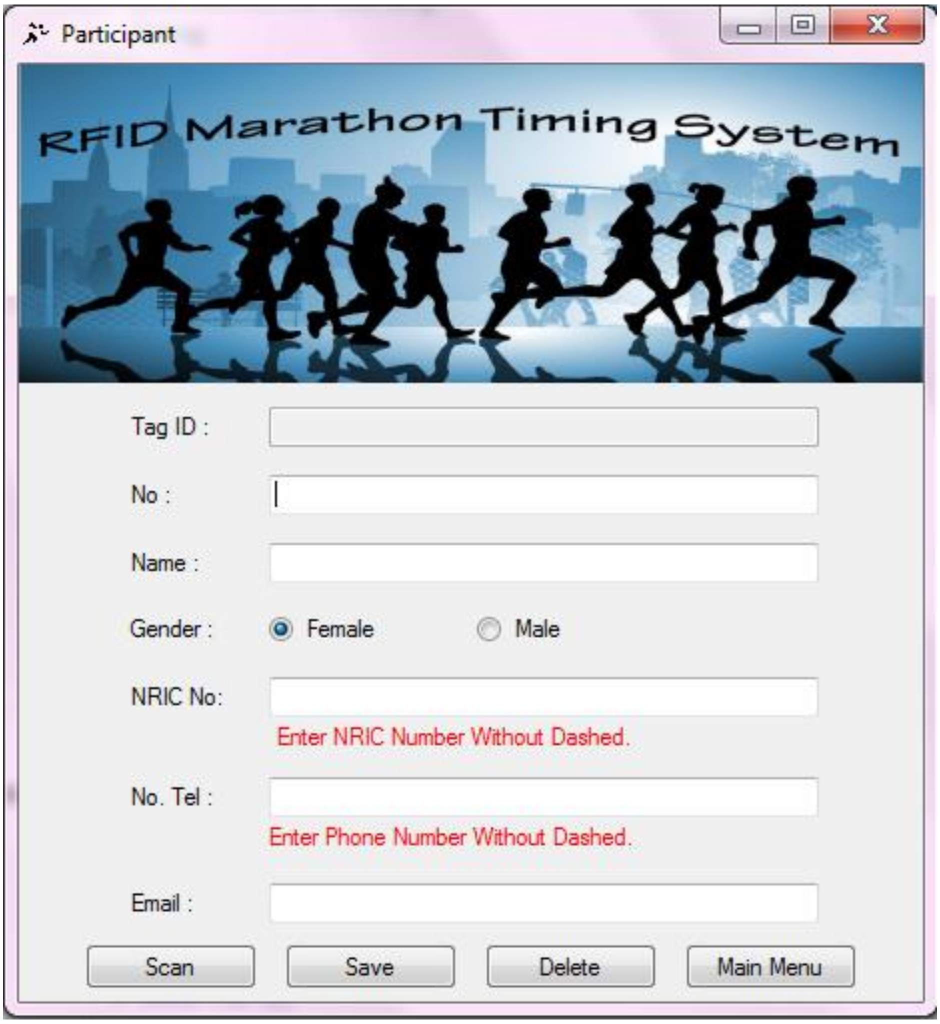

Figure 4.5: Participant

The database table of form Participant is show in Figure 4.6. The primary key of this table is no. The data named no, tag_id, and nric are unique.

Column Name	Data Type	Length	Allow Nulls	Unique	Primary Key
no	int	4	No	Yes	Yes
name	nvarchar	100	No	No	No
gender	nvarchar	6	No	No	No
mobile_no	nvarchar	10	No	No	No
email	nvarchar	100	No	No	No
tag_id	nvarchar	50	No	Yes	No
nric	nvarchar	12	No	Yes	No

Figure 4.6: Table of Participant

The SQL command of button Save and Delete are shows at below:

Table 4.2: SQL Command for Form Participant

Button Name	SQL Command
Save	"INSERT participant (no, name, gender, mobile_no, email, tag_id, nric) VALUES (@No, @Name, @Gender, @MobileNo, @Email, @TagID, @NRIC)"
Delete	"DELETE FROM participant WHERE nric=@NRIC"

4.5 RACE MARATHON TIMING SYSTEM

This is the interface used to shows result of each participant. It contains timer on the right hand side on the interface. When a participant crossing the finish line. The result will show at the grid view which contains information such as rank, no, name time, and gender. The interface is show at below:

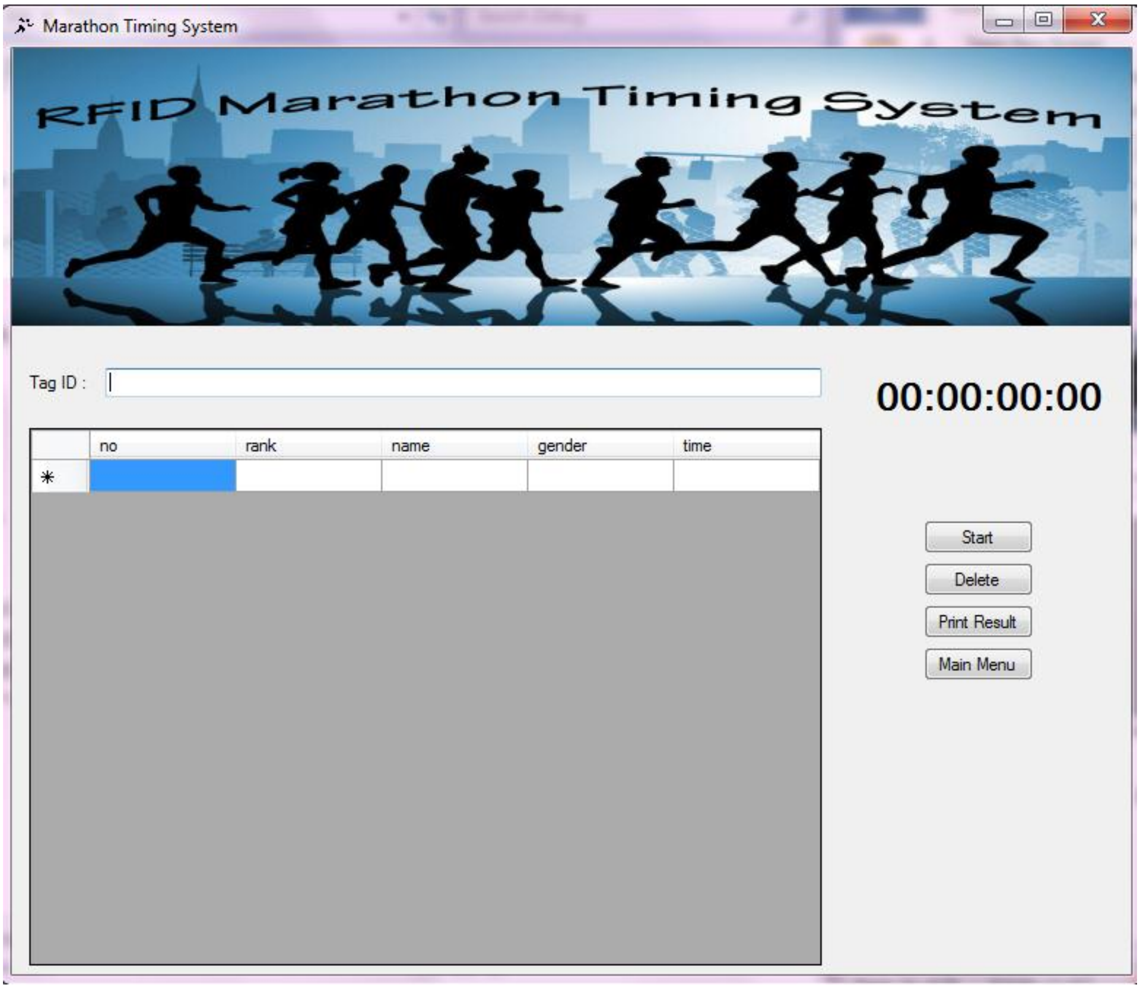

Figure 4.7: Race Marathon System

The primary key for this table is no. the unique data are no and rank. The database table design for this Marathon Timing System interface is shows as below:

Column Name	Data Type	Length	Allow Nulls	Unique	Primary Key
no	int	4	No	Yes	Yes
rank	int	4	No	Yes	No
name	nvarchar	100	No	No	No
time	nvarchar	100	No	No	No
gender	nvarchar	6	No	No	No

Figure 4.8: Table of Race Marathon System

The SQL commands for this interface are:

Table 4.3: SQL Command for Form RFID Marathon System

Name	SQL Command
Time Tick event	"SELECT no, name, gender FROM participant WHERE tag_id=@ID"
	"INSERT result (no,name,time,gender) VALUES (@No, @Name, @Time, @Gender)"
Delete button	"SELECT password FROM admin_information WHERE id=@ID"
	"DROP TABLE result"
	"CREATE TABLE result (no int NOT NULL UNIQUE, rank int NOT NULL UNIQUE IDENTITY, name NVARCHAR (100) NOT NULL, time NVARCHAR (100) NOT NULL, gender NVARCHAR (6) NOT NULL, PRIMARY KEY (no), FOREIGN KEY (no) REFERENCES participant (no))"

4.6 REPORT

The form named Report is to display the result and analyze the result. The interface of this form and the design of the report are shows as below:

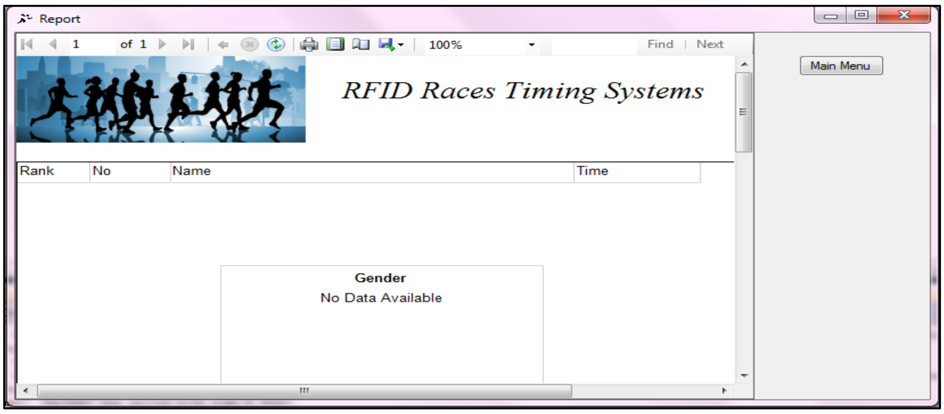

Figure 4.9: Report

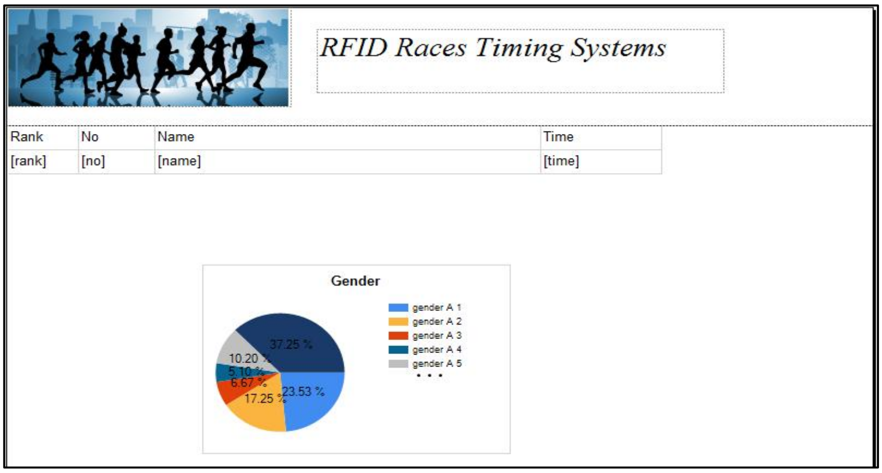

Figure 4.10: Report Design

CHAPTER 5

RESULT AND DISCUSSION

5.1 INTRODUCTION

This chapter is discuss about the outcome, output or result that have obtained and analysis of the data. In addition, this chapter also contains the result analysis, constraint of the project and conclusion.

5.2 RESULT ANALYSIS AND DISCUSSION

The result of the RFID Marathon Timing System are the system able to capture the timing of each participant when they crossing the finish line or at the detection range of the antenna. The number of participant must less than 20 people at the same time. Extra antenna is needed to increase the number of detection of the participant. This is because of the limitation of the device. The device is currently able to capture data less than 20.

Table 5.1: Result and Implementation

Objective	Result and Implementation
To get timing reading for each participants.	The antenna is placed at the finish line so the when the participant crossing the finish line, the antenna will get the tag ID from the participant.
Able to manage data of participants and display the result instantly.	In this system, it will analyze the timing for each participant who crossing the finish line. After this, the system will display the ranking and the elapsed time of the participant at the system immediately.
To replace operators pressing a stopwatch.	This system is act like the stopwatch. Where the admin pressing start button, the timing will start running. If the participant crossing the finish line, the antenna will detect the tag ID and record the timing to the database.

5.3 CONSTRAINT OF THE PROJECT

Project constraint is the constraint in this project development. It restricts an entity, project, or system from achieving its potential. In this project consists of three components, which are development constraint, system constraint, and hardware constraint.

Development constraint is discuss about the problem arises during the developing this system. For example: time, programming skills and insufficient knowledge at RFID fields.

During developing this system, time is very important. The RFID device is only allowed to borrow for 3 days. It is not enough time for us to develop and do the testing.

Hence time for development becomes shorter because the laboratory is open during office hours and we also have other commitment. For example: go to lecture, do other subject project, assignment, and homework. So for the solution, the laboratory must be open during weekend too because normally students are free at weekend.

During developing the system, knowledge in programming is essential as a developer. For example: syntax, algorithms, and interoperability of the programming languages.

This system is developing using VB.Net. So the constraint in VB.Net are how to create a coding of how to connect RFID device to the system, how to connect database to the system, and how the system send command to the reader and how the reader response to the system.

Next is the system constraint. The system constraint on this system is the system only can read 20 tags per second.

In this system, the hardware constraint is RFID device. The reader has difficulties to read the signal of the tag received by RFID antenna. Sometime it take a long times to read.

5.4 CONCLUSION

In conclusion, RFID Marathon Timing System is still can improve by using the better RFID device. With the better RFID device, RFID Marathon Timing System maybe can be used in any kind of competitions with require speed which is lower than speed of radio frequency. For example: car racing, motor racing and so on.

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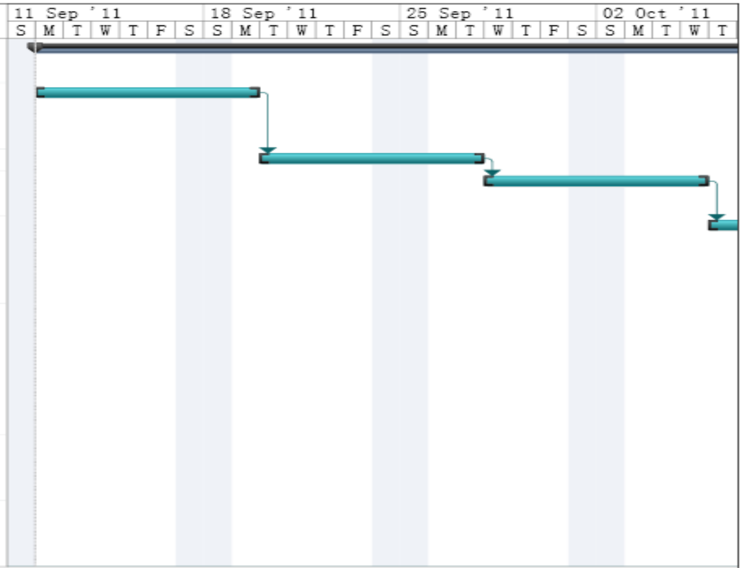
APPENDICES

Appendix A

Gannt Chart

ID		Task Mode	Task Name	Duration	Start	Finish
1			**Requirements Planing**	**92 days**	**Mon 12-09-11**	**Tue 17-01-12**
2			Discuss Chapter 1 and Progress to Supervisor	6 days	Mon 12-09-11	Mon 19-09-11
3			Sumbit Chapter 1	6 days	Tue 20-09-11	Tue 27-09-11
4			Discuss About Literature Review	6 days	Wed 28-09-11	Wed 05-10-11
5			Show material of Literature Review and Progress of Literature Review	6 days	Thu 06-10-11	Thu 13-10-11
6			Show the Comparison of Current Existing System and Discuss About Literature Review	6 days	Fri 14-10-11	Fri 21-10-11
7			Show the Progress of Literature Review	6 days	Mon 24-10-11	Mon 31-10-11
8			Finding Information About Methodology	6 days	Tue 01-11-11	Tue 08-11-11



Project: Full Gantt Chat.mpp
Date: Fri 08-06-12

Task	External Milestone	Manual Summary Rollup	
Split	Inactive Task	Manual Summary	
Milestone	Inactive Milestone	Start-only	
Summary	Inactive Summary	Finish-only	
Project Summary	Manual Task	Deadline	
External Tasks	Duration-only	Progress	

ID	Task Mode	Task Name	Duration	Start	Finish
9		Submit Literature Review and Discuss About Methodology with Supervisor	6 days	Wed 09-11-11	Wed 16-11-11
10		Research Information About Methodology	11 days	Thu 17-11-11	Thu 01-12-11
11		Discuss Methodology ;	6 days	Fri 02-12-11	Fri 09-12-11
12		Submit Methodology and Discussion	6 days	Mon 12-12-11	Mon 19-12-11
13		Show Project Overview and Chapter 4	11 days	Tue 20-12-11	Tue 03-01-12
14		Submit Project Overview and PSM Draft	10 days	Wed 04-01-12	Tue 17-01-12
15		**User Design & Construction**	**36 days**	**Mon 13-02-12**	**Sat 31-03-12**
16		Submit Chapter 1 ,Chapter 2 and Chapter 3	25 days	Mon 13-02-12	Fri 16-03-12
17		System Development	35 days	Mon 13-02-12	Fri 30-03-12
18		System Testing	35 days	Mon 13-02-1	Fri 30-03-12

11 Sep '11 | 18 Sep '11 | 25 Sep '11 | 02 Oct '11
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Project: Full Gantt Chat.mpp
Date: Fri 08-06-12

Task	External Milestone	Manual Summary Rollup
Split	Inactive Task	Manual Summary
Milestone	Inactive Milestone	Start-only
Summary	Inactive Summary	Finish-only
Project Summary	Manual Task	Deadline
External Tasks	Duration-only	Progress

ID	Task Mode	Task Name	Duration	Start	Finish
19		**Cutover**	**41 days**	**Mon 02-04-1**	**Mon 28-05-12**
20		Discuss Chapter 4, Chapter 5, and Progress to Supervisor	11 days	Mon 02-04-12	Mon 16-04-12
21		Submit Chapter 4 and 5 to Supervisor	15 days	Mon 16-04-12	Fri 04-05-12
22		Submit Thesis Draft	5 days	Mon 07-05-12	Fri 11-05-12
23		Submit Executive Summary	4 days	Mon 14-05-12	Thu 17-05-12
24		PSM Carnival	3 days	Fri 18-05-12	Tue 22-05-12
25		Submit Full Thesis	4 days	Wed 23-05-12	Mon 28-05-12

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Project: Full Gantt Chat.mpp
Date: Fri 08-06-12

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Summary	Inactive Summary	Finish-only
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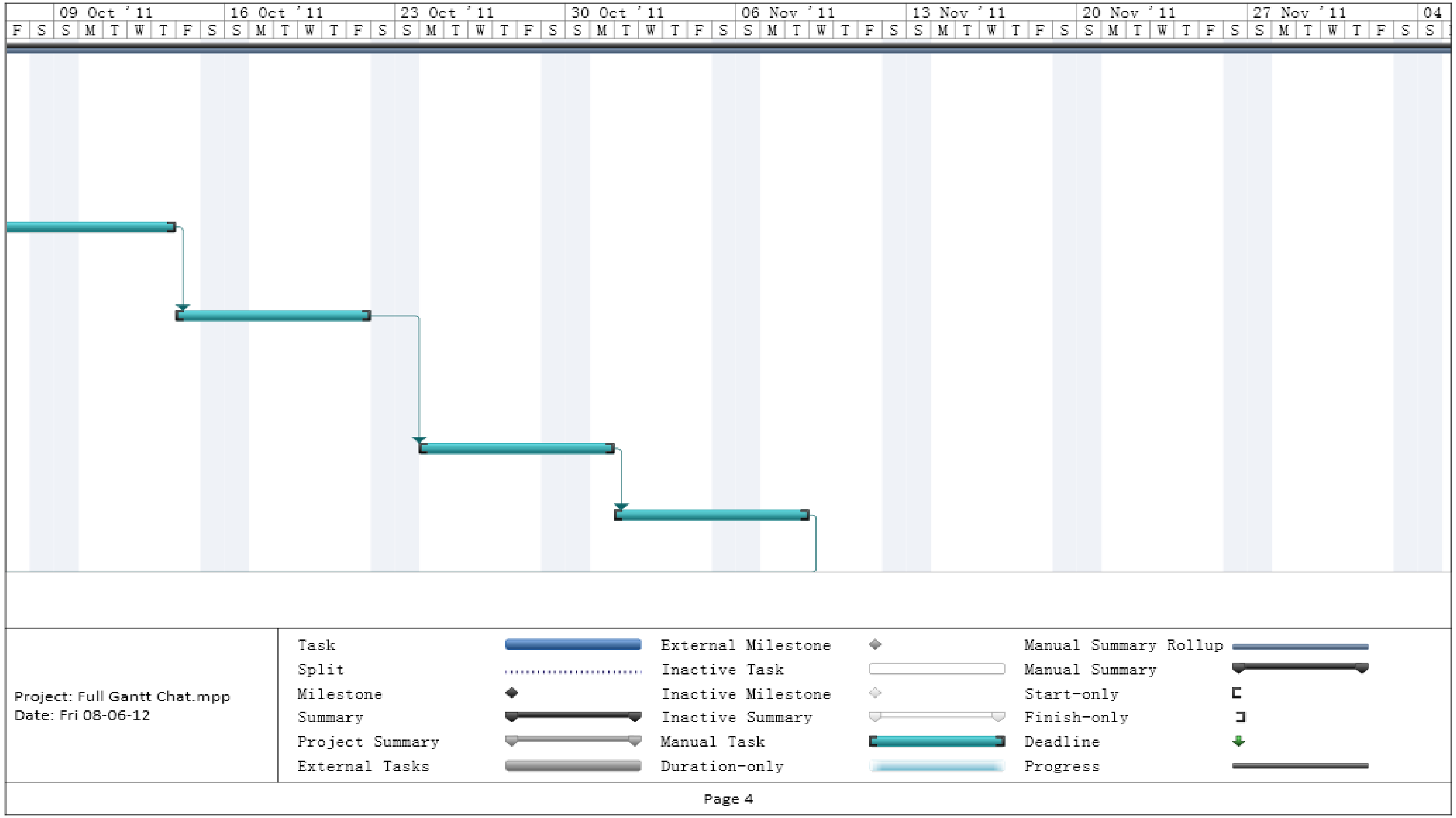
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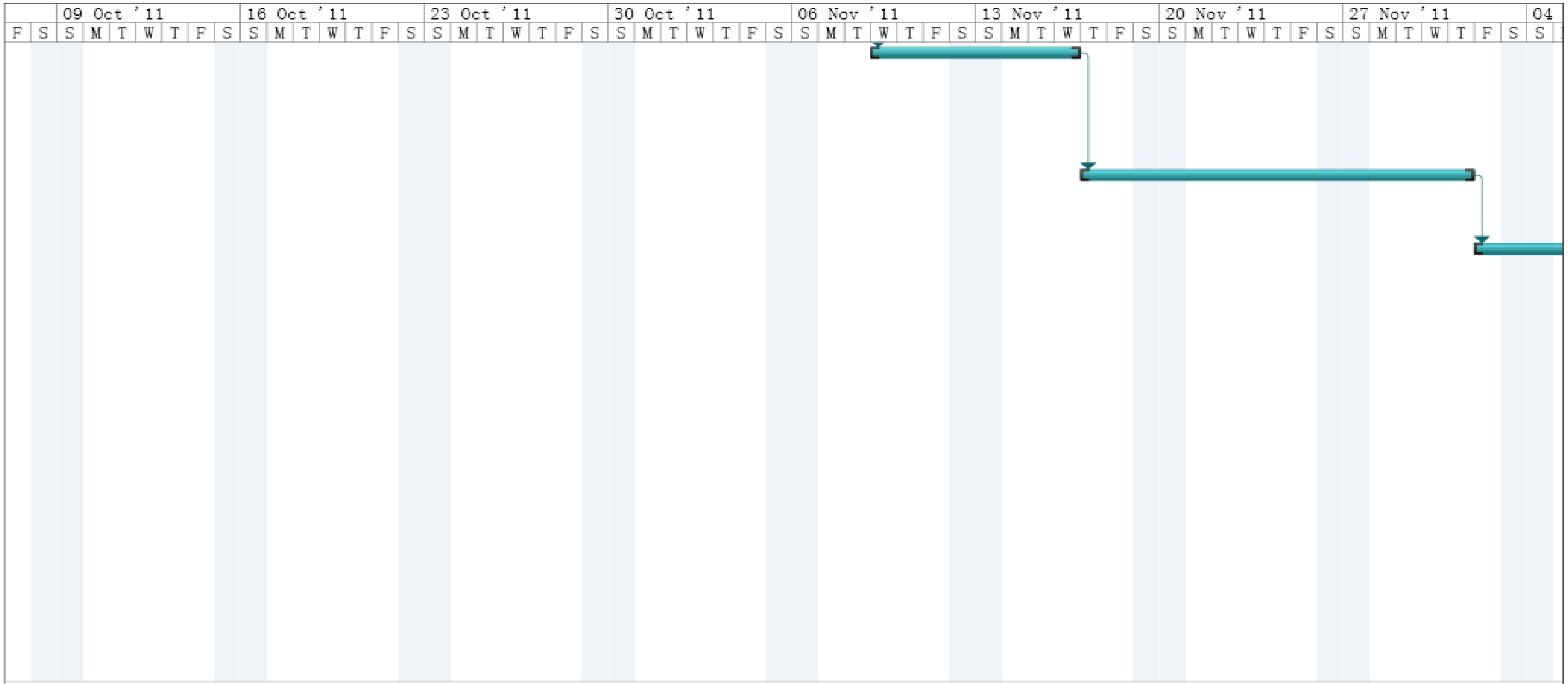

Project: Full Gantt Chat.mpp
Date: Fri 08-06-12

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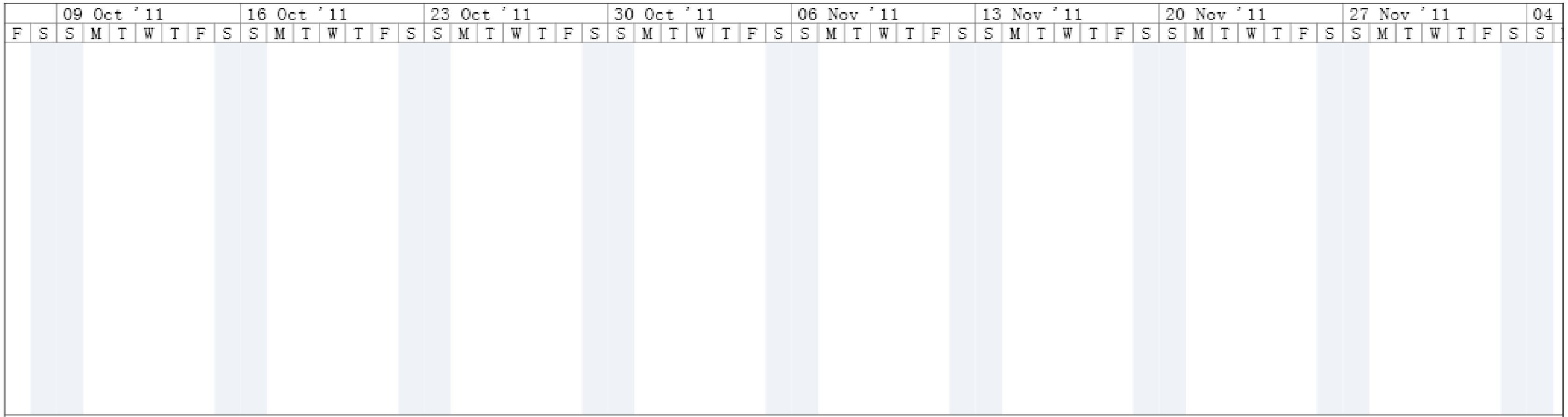

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Date: Fri 08-06-12

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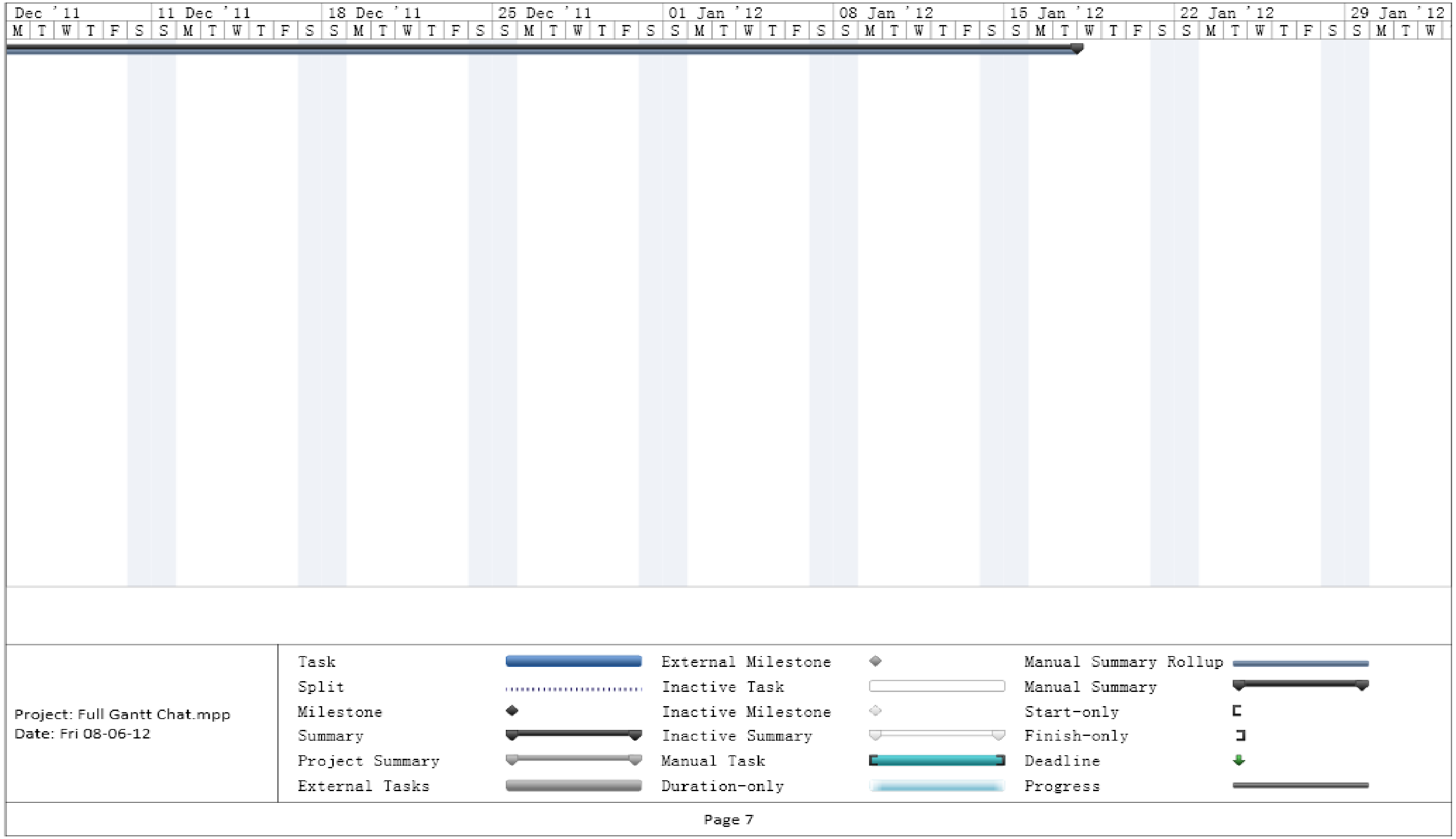
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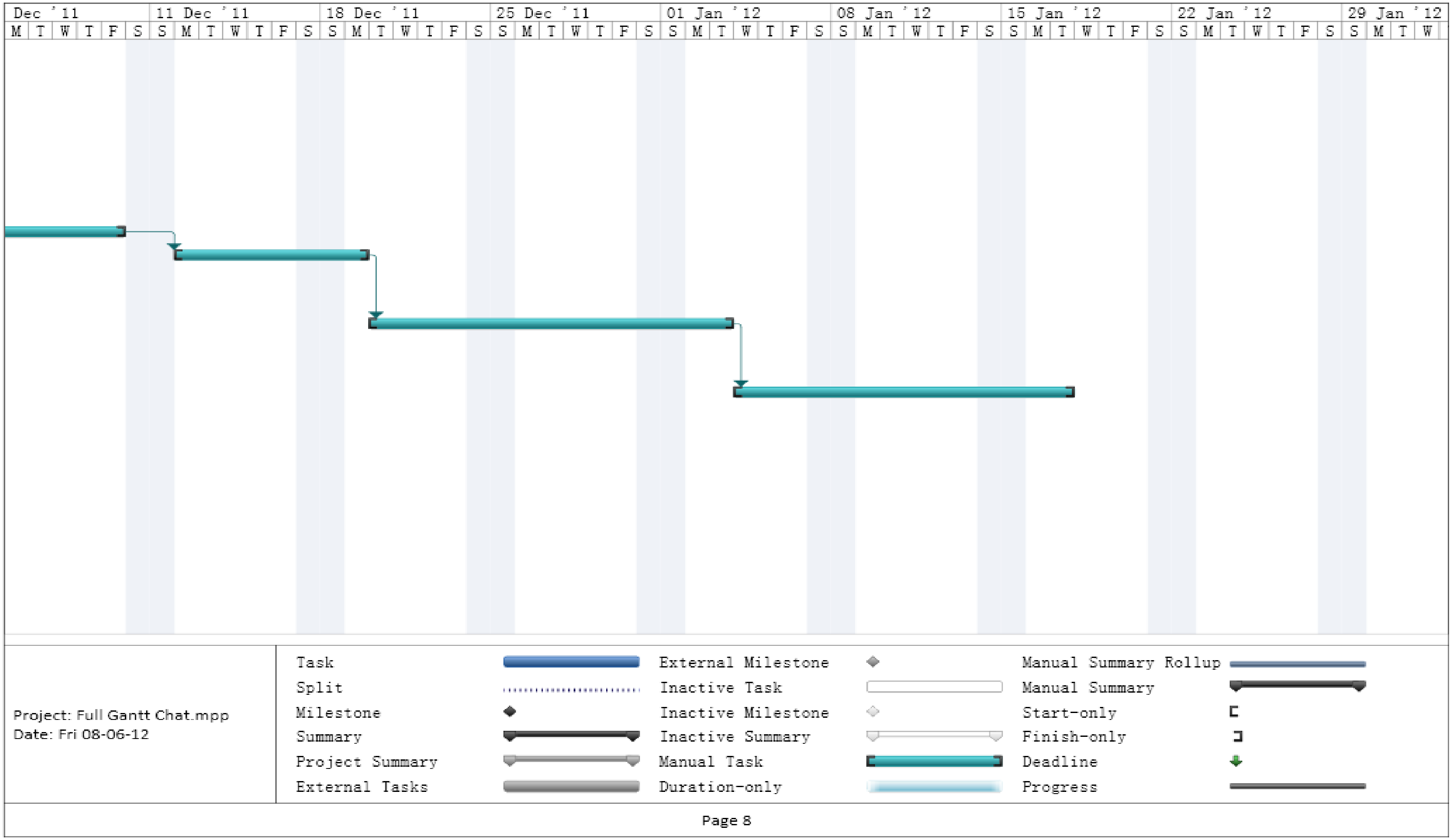
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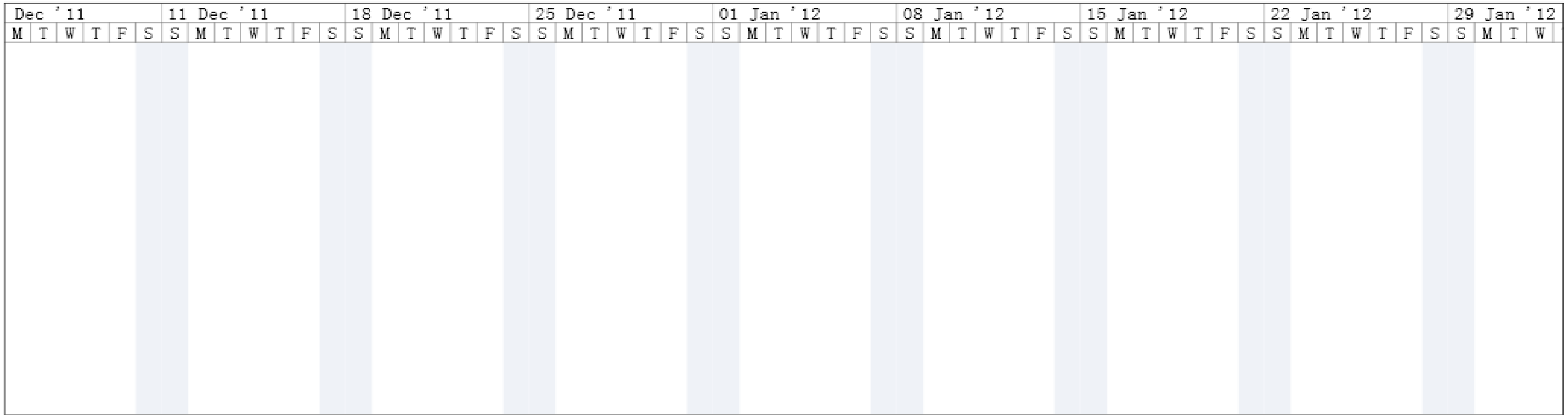

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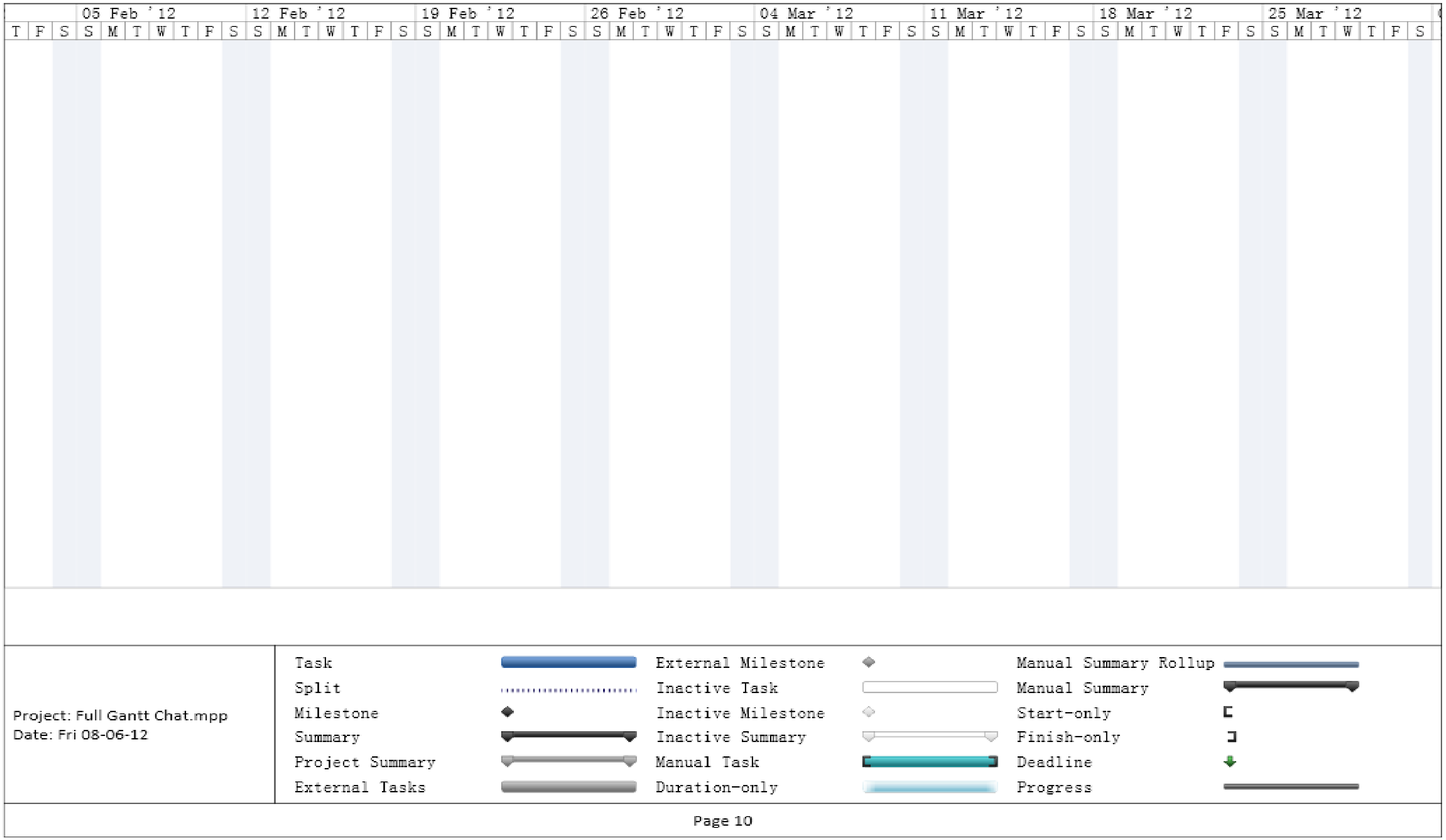
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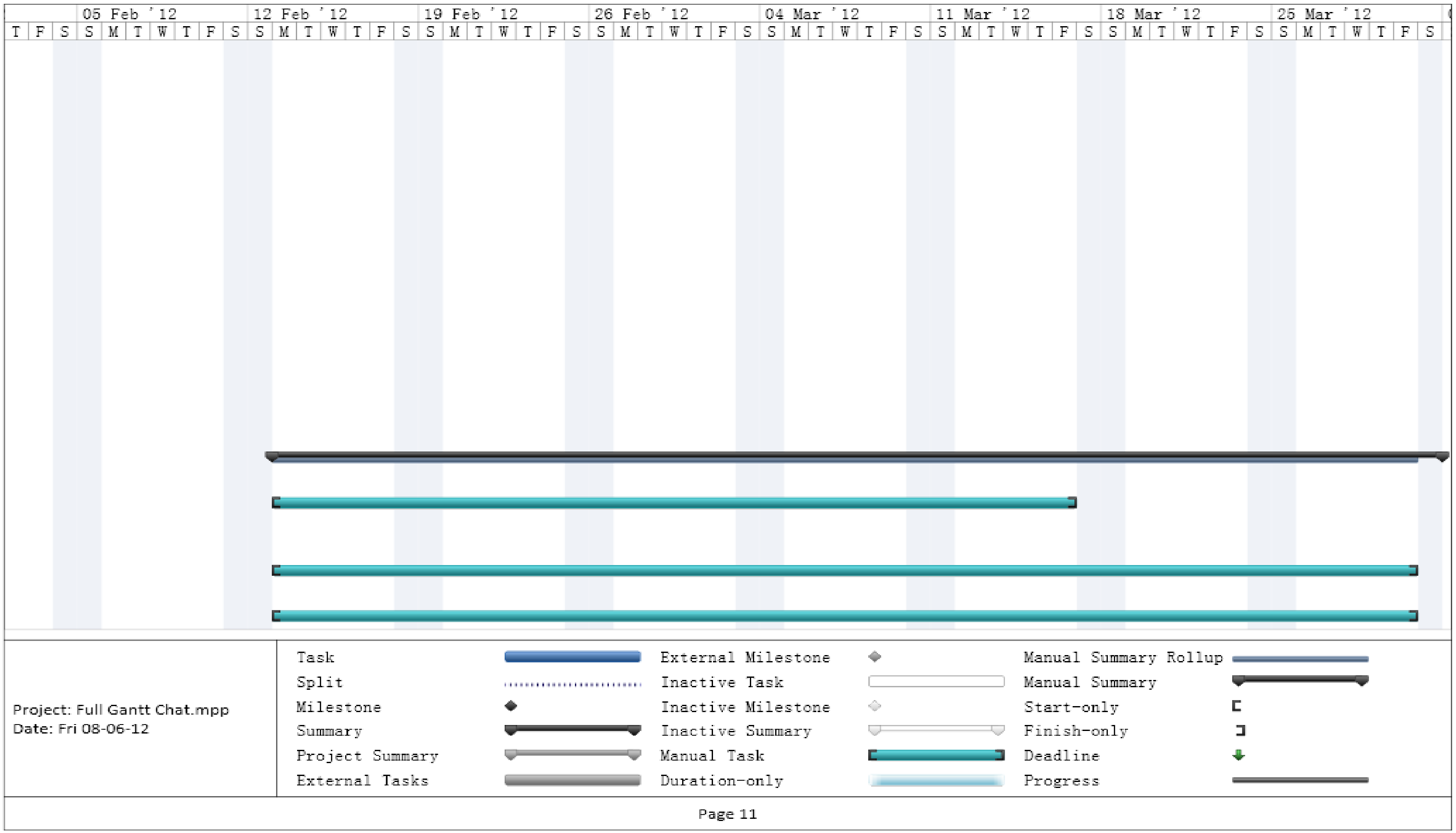
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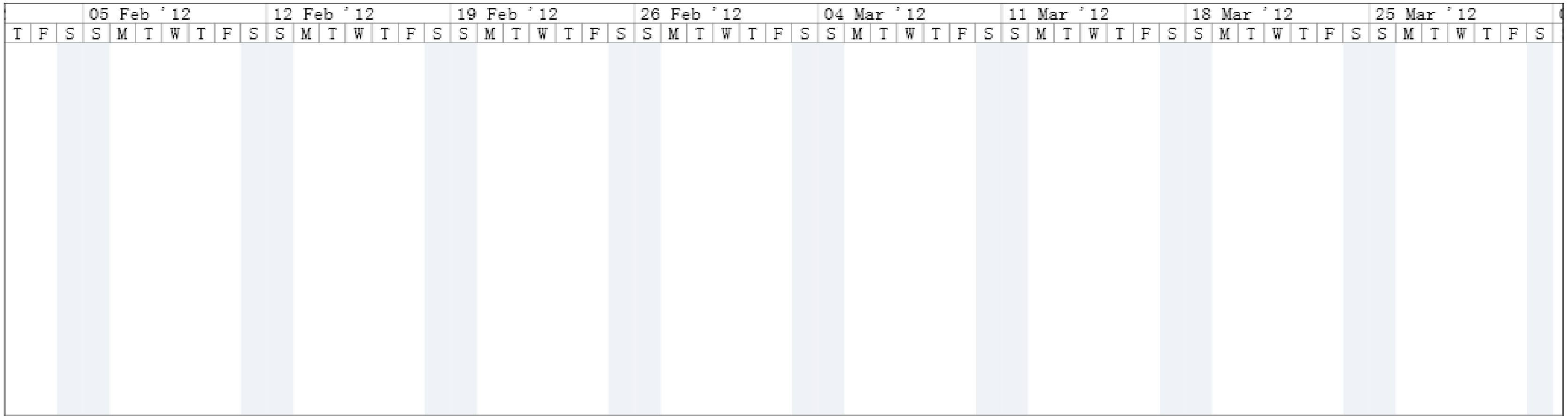

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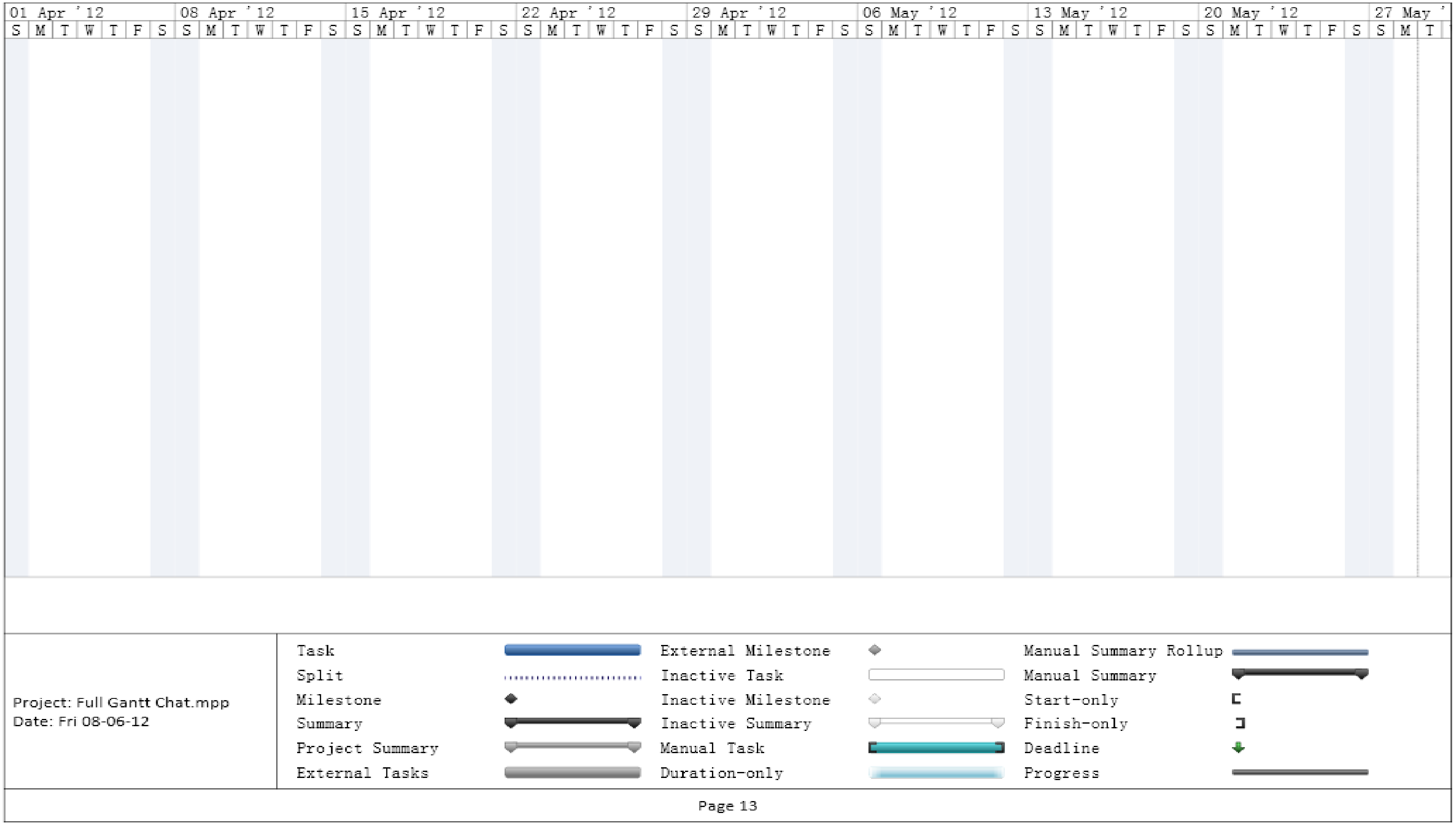
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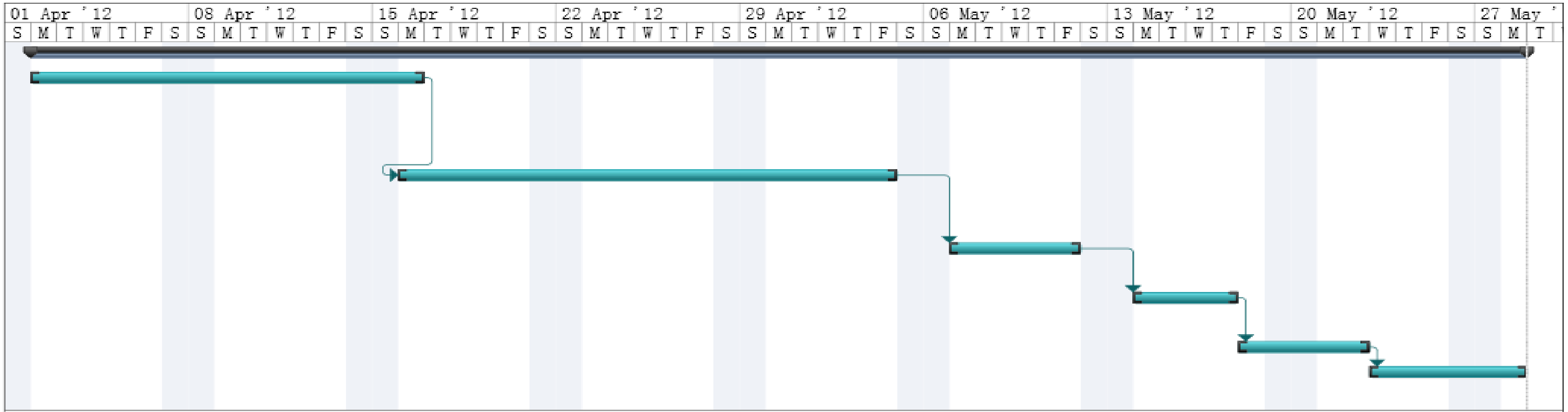

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Appedix B
User Manual

1. INTRODUCTION

This User Manual provides instructions for installing and operating the RFID Marathon Timing System. This document is designed for use by RFID Marathon Timing System.

1.1. Audience

For the purpose of this document, we assume the readers of the User Manual:

- Are competent PC users
- Have minimal previous knowledge of radio-frequency identification technology.

1.2. RFID Reader Overview

The RFID reader is designed to read and program EPC C1G2 tags and issue event reports to a RFID Marathon Timing System. The RFID Marathon Timing System can be locally connected to the reader via RS-232. The RFID Reader is develired with the following components and accessories:

- RFID Reader
- One RS-232 serial cable
- Power supply

1.3. Requirements

To interface with the RFID Marathon Timing System, you will need the following:

- A PC running Windows 7
- RS-232 serial port
- Standard 110~220V AC power

- RFID tags
- External antenna(s) and coaxial cable(s)
- Standard power cord (desired length) with grounded, 3 pronged plugs

1.4. Specifications

Specification for key components of the RFID Marathon Timing System are provided in the tables below:

1.4.1. RFID Reader

Name	Evo-UHF
Part Number	RFS2004A/B
Frequency	902.6 ~ 927.4 MHz
Hopping Channels	63
Channel Spacing	400 KHz
Channel Dwell Time	< 0.4 Seconds
RF Transmitter	20 ~ 30dBm at the end of 3m cable or 0.9W.
Modulation Method	ASK
Power Consumption	15 Watts
Communications Interface	RS-232
Inputs / Outputs	1 com port
Antenna Port	4 coax antennas
Dimensions	(L) 21cm (8.2 in) × (W) 20cm (7.9 in) × (D) 5cm (2 in)
Weight	Approximately 1.5 kg
Operating Temperature	0°C to + 50°C (+32°F to 122°F)

1.4.2. Mechanical

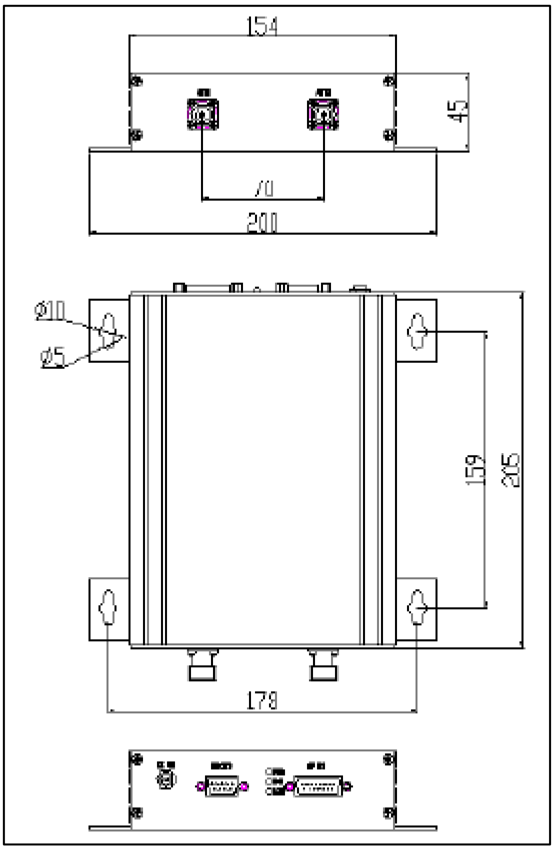


Figure 1.1: Oulline Drawing of the reader

2. READER HARDWARE INSTALLATIONS AND OPERATION

This chapter describes the RFID Reader and provides installation and operation information.

2.1. Reader I/O Panel

The I/O panel (shown below) houses the following:

- Power connector
- RS-232 serial port
- 3 Diagnostic LEDs (RS-232 communication, RF Power, Supply Power)
- 15-pin I/O connectior

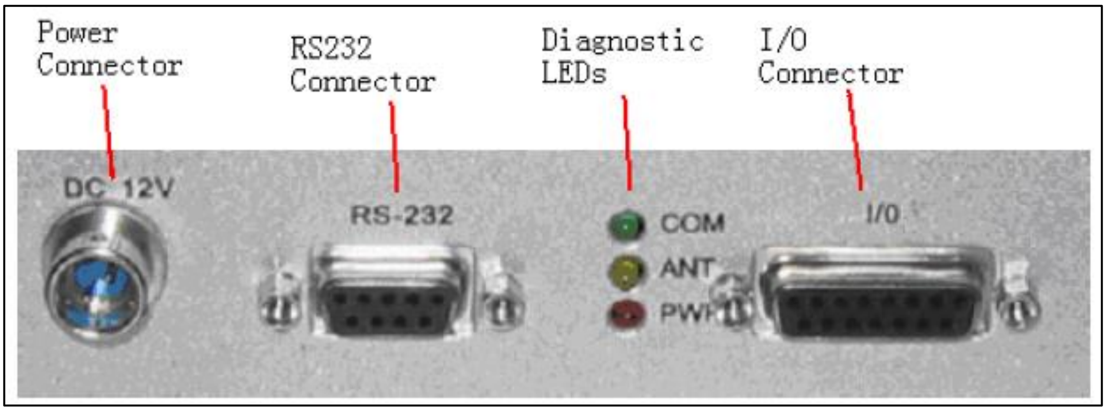


Figure 2.1: Reader Connections and LEDs

2.2. Diagnostic LEDs

The diagnostic LEDs provide external indication of various conditions:

- COM (green) – indicates that reader is communiting with a RFID Marathon Timing System.
- ANT (yellow) – indicates that RF is being emitted by the reader
- PWR (red) – indicates power is applied to the reader

2.3. Antenna Panel

The antenna panel (opposite the reader's I/O panel) contains either two coax antenna connector ports as shown below. These are N type connectors.

Figure 2.2: Antenna Connections

2.4. System Assembly

Assembling the RFID Marathon Timing System is easy. We recommend you set up the system and verify its operation in a bench test configuration (shown below) before installing it in a production setting.

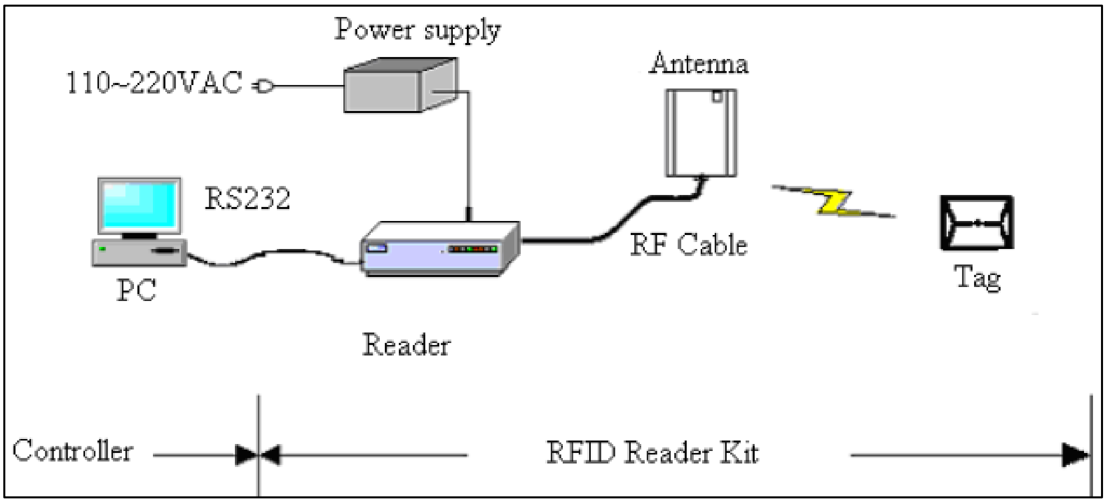


Figure 2.3: Typical connection of Test

2.5. Reader Configuration

1) Situate the Reader on a tabletop

Ensure the following conditions:

- Two standard 220V AC outlets are available nearby (one for the reader, one for the PC if needed). Sufficient space is available in the tabletop for the reader and antenna.

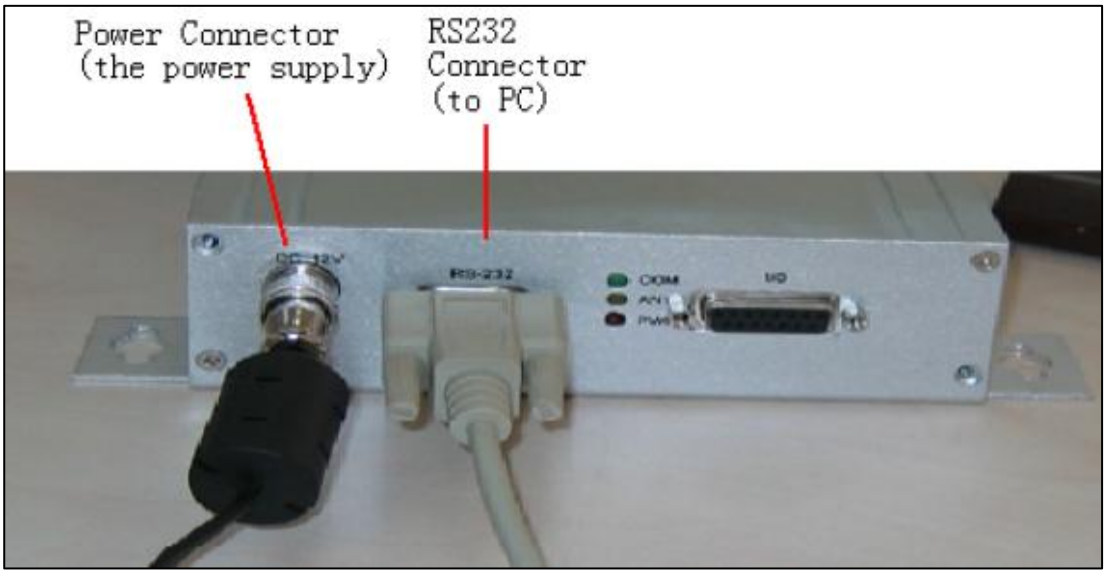


Figure 2.4: RS-232 and Power Connections

2) **Connect the RS-232 cable to the reader**

- Align the male cable connector so that its shape and pins match the shape and holes of the female DB-9 RS-232 port.
- Push the aligned connector into the port
- Finger tighten the screws to secure the cable/connector to the reader.

Figure 2.5: RS-232 Connector

3) **Connect the RS-232 cable to the serial port on the PC**

4) **Connect the power supply to the reader**

Using the thin cable attached to power supply, push the connector into the port until it is securely seated. Do not plug the power supply into the wall outlet yet.

5) Connect the coaxial cable(s) to the antenna port(s)

- Antenna port 1 is on the right if viewing reader with flange side down. The reader has 4 antenna ports.
- Align the coax cable's center pin and push into the port.
- Screw the fitting from the cable end onto the reader connector clockwise until finger-tight to secure the cable to the reader.
- Connect additional antennas to their respective ports and tighten fittings clockwise until finger- tight.

6) Plug power cord into power supply

Use the femali end of a standard 3-prologed power cord.

7) Plug the power supply cable into the wall outlet and verify power

The red LED will illuminate when power is on.

8) Plug in the PC and turn it on

9) Launch the RFID Marahon Timing System

3. Installation

This section provides guidance for configuring components in your RFID Marathon Timing System.

3.1. Requirements

Before onstalling your RFID Marathon Tiiming System, you will need the following:

- A PC running Window 7, a RFID Marathon Timing System and one available RS-232 serial port.
- Standard 110~220V AC power for the reader and PC.
- (optional) extra antennas (if desired for additional coverage)
- Additional RS-232 cables or antenna coax cable needed to accommodate routing requiremenets.
- Standard grounded, three-pronged power cord of desired length.

3.2. Hardware Installation Procedure

1) Select mounting position for antenna(s)

Caution:*Reader antennas should be positioned so that personnel in the area for prolonged periods may safely remain at least 23 cm in an uncontrolled environment from the antenna's surface.*

- Mount the antenna(s) at the periphery of the desired read window (either overhead or at the side), so that the powition of the most distant tag passing through the window is no farther from the antenna than the maximun range specified for RFID Marathon Timing System.
- Position the antenna(s) at the height approximately midway between the highest and lowest expected tag position.
- If you are using two antennas, mount the second antenna in a mirror-image of the first antennna's position, uness otherwise indicated in your system design specification.
- **NOTE:** To maintain compliance with local regulation, use only antennas supplied with the unit.

2) Select mounting position for reader

- Reader should be positioned close enough to the antenna to accommodate the cable length without putting strain on the connectors.
- Be sure power is available at the selected reader location.

3) Select location for host PC or controller

- Situate location for host PC or controller within 50ft of the reader in a safe location away from vehicular and foot traffic.

4) Install reader

- Secure the reader through the two mounting holes on either flange to irs mountiing location using appropriate hardware.
- If desired, position the reader so that the LEDs are easily observed.

5) Install antennas

- Secure each antenna throug the mounting holes on either flange to its mounting location using appropriate hardware.

6) Connect antennas to reader

- Route coax cabled from the antennas to the reader and secure them properly.
- Align the connector for each cable with the reader antenna port, push into the port, and finger-tighten the screw fitting.

7) Connect reader Power

- Push the power supply connector ontio the reader port.
- Plug the female end pf the power cord into the power supply.
- Plug the male end of the power cord into the 110~220V AC outlet.

8) Connect power to the PC or controller

- Aligin the RS-232 connector with the corresponding serial port on the readr and push the connector onto the pins. Tighten the screws to secure the cable to the reader.
- Aligin and connect the other end RS-232 with the serial port on the PC or controller.

Frequency	902~928MHZ
Carrier	Frequency Hopping Spread Spectrum
Max RF Power Output	32dBm
Power Control	27~32dBm~~1dBm per step
Protocol	ISO-18000-6
Antennas	4 ports
Power Supply	5VDC, 4A
Power Consumption	<12Watts
Communication Interface	RS232/RS485;1 Wiegand26/34
Indicators	Power, RF, Communication
Operating Temperature	-10°C +55°C
Storage Temperature	-20°C +80°C
Tag Read Rate	>20 tags per second
Read Range	>6m tag and antenna dependent

Figure 3.1: Reader Specification

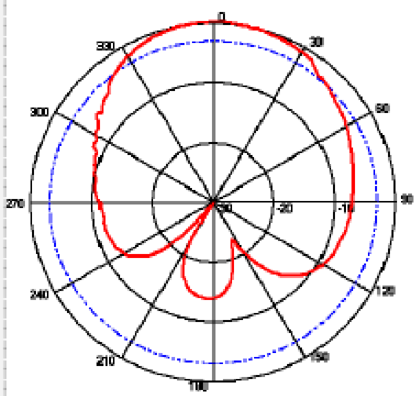
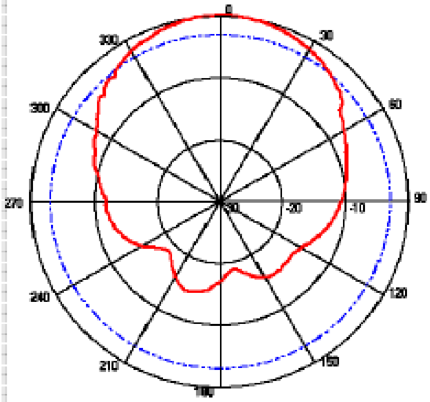
Electrical Specifications	(Frequency Range)	900MHz~928MHz
	(Polarization)	Circular
	(Horizontal 3dB Beamwidth)	65° ±5°
	(Vertical 3dB Beamwidth)	65° ± 5°
	(Gain)	9dBi
	(VSWR)	<1.3
	(Front-Back Ratio)	>25dB
	(IM.3rdOrder (2×43dBm))	<-150dBc
	(Impedance (Ω))	50
	(Maximum Input Power (w))	200
	(Connector)	N-F
	(Lightning Protection)	Direct Ground
	(Work temperature range)	-40℃~+55℃
Mechanical Specifications	(Dimensions (L×W×H) (mm))	300x270x80
	(Weight of Antenna)	<2.0kg
	(Casing Material)	UPVC
	(Rated Wind Velocity)	241km/h
Pattern	Horizontal 3dB Beamwidth: 65° ±5° 	Vertical 3dB Beamwidth: 65° ±5° 

Figure 3.2: Antenna Specification