ABSTRACT

The invention pertains a system with modular hardware customized software for tracking and logging real time information of any moving object using Global Positioning System and a communication module. The system finds applications in fields like commercial transport, marine and the elated. The system I for automation of various processes including data collection and processing to generate reports, that will enable effective and error free management and also satisfy all concerned regulatory authorities. The complete system comprises of a device incorporating GPS module, communication module, on data storage (memory) and user interface. Unique software for report generation in prescribed formals also forms part of the System.

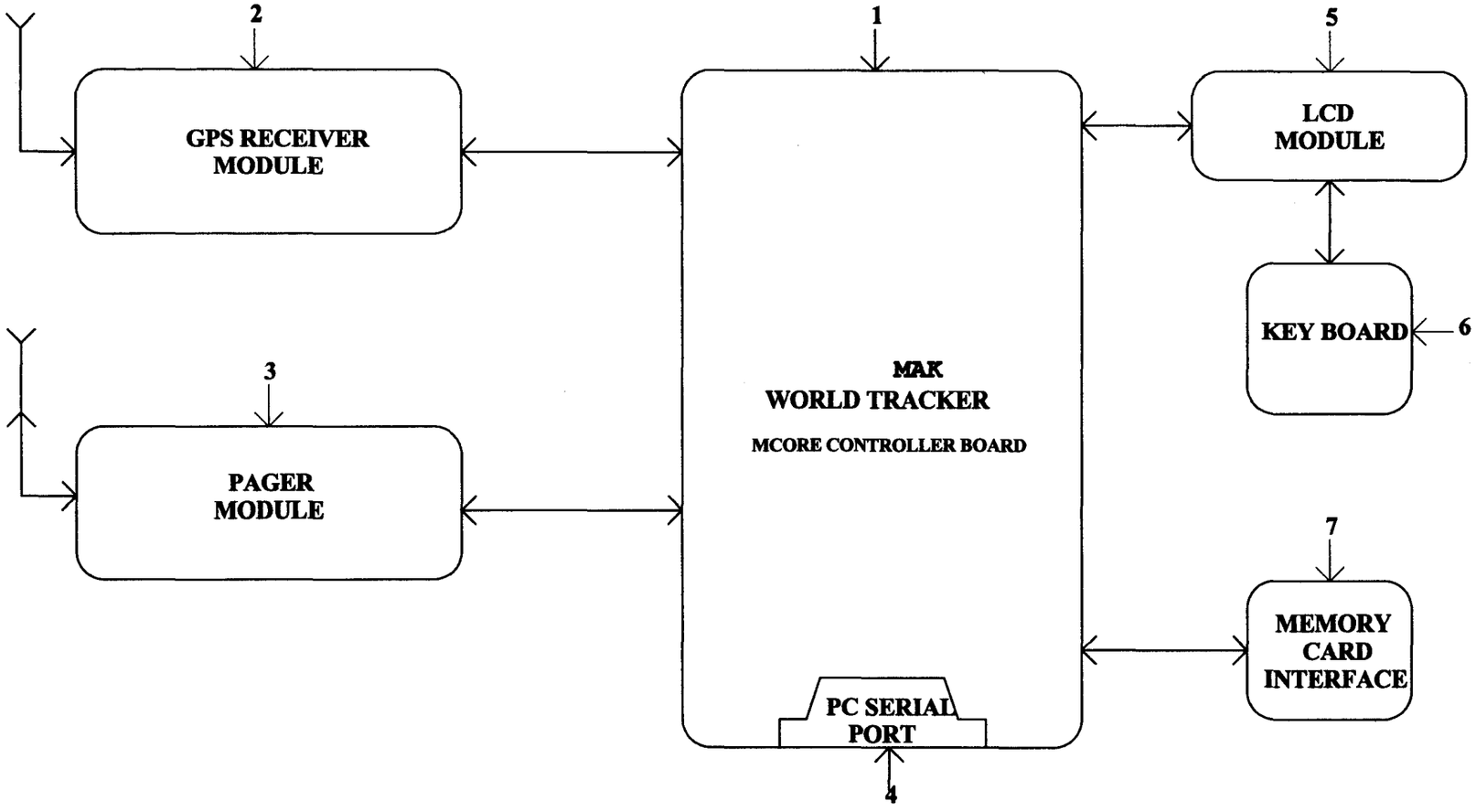
I Claim

1. A modular tracker system with customized software for tracking and logging real time information of any moving object using Global Positioning System and a communication module the said tracker system comprises as defined in the specification
   a. An unique preformatted memory card
   b. A base station equipped with a remote CPU for collecting and processing information from the said through a communication module
   c. A remote PC with a flash memory card reader located at various offices of the commercial transportation Company wherein the said TRACKER having a controller board for collecting position / time information from driver for amount of fuel added and driver break time information and storing the acquired data in on board memory for future retrieval and for transmitting the data over a two way pager module with an interval up to a minimum 1 minute, along with a keyboard / display unit as user interface and appropriate hardware for data transfer to the unique flash memory card, an unique preformatted flash memory card being held by the driver having storage capacity in the order of 128 kilobytes (which can be expanded) stores trip information of the vehicle with a programmable storage interval (e.g.1 minute minimum), a base station with remote CPU loaded with processing software collects information from the said TRACKER every minute through the Paging network enables the user to view the current position of the vehicle on a digital map on the PC screen, processes the information and capable of generating various reports and porting them on internet for authorized persons to view, a remote PC with flash memory card reader located at various offices of truck company reads the flash memory card handed over by the driver which contains the entire trip information on it and generates tip reports including Driver's hours of service, mileage report, fuel expenses, trip route map with exact current location and puts the information on internet for the authorized persons to view.

Dated this 19th day of June 2001.

(SARAVANAN MANICKAM)
Signature

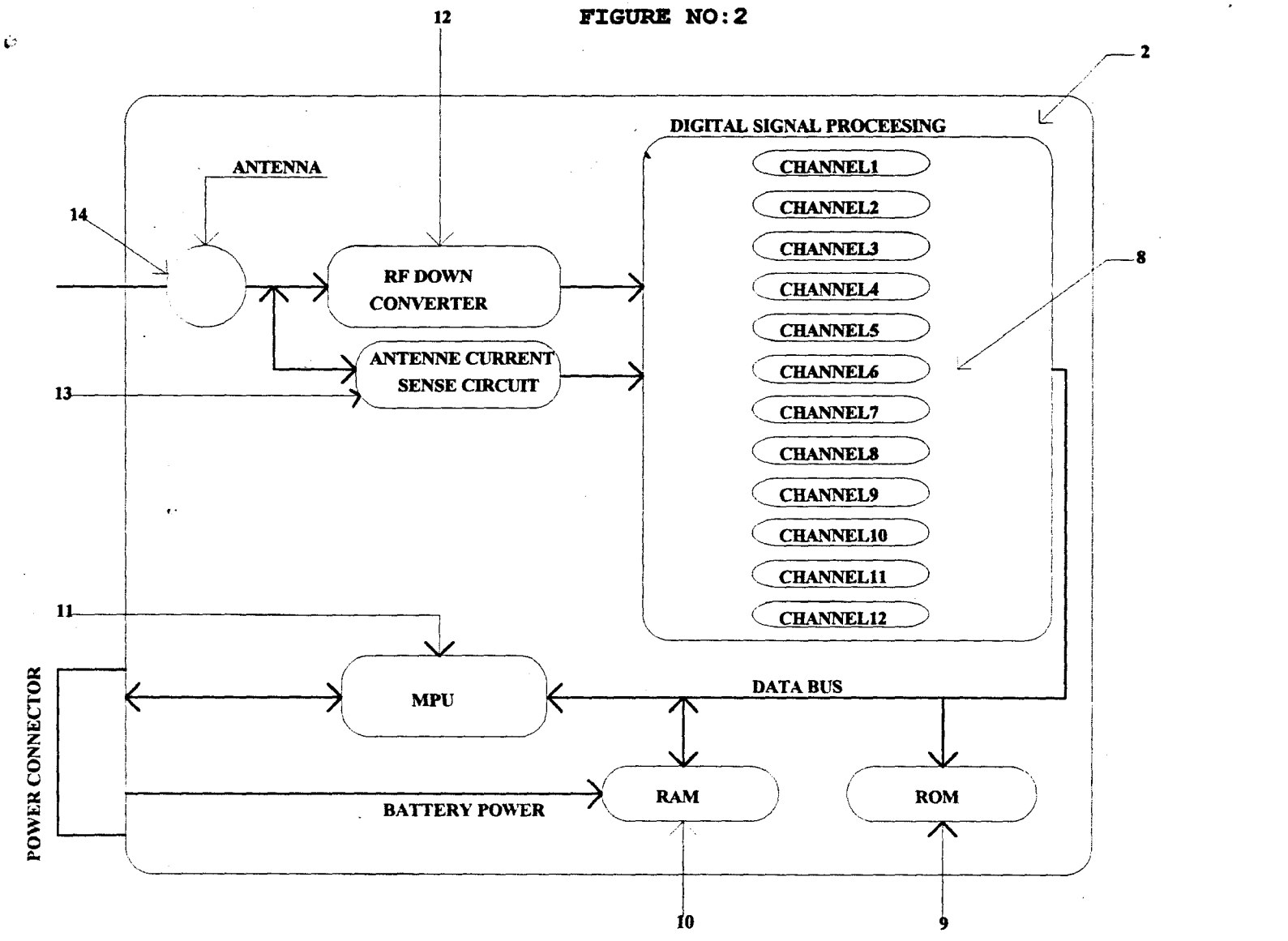
FIGURE NO: 1



SIGNATURE OF THE APPLICANT

SARAVANAN MANICKAM

FIGURE NO: 2



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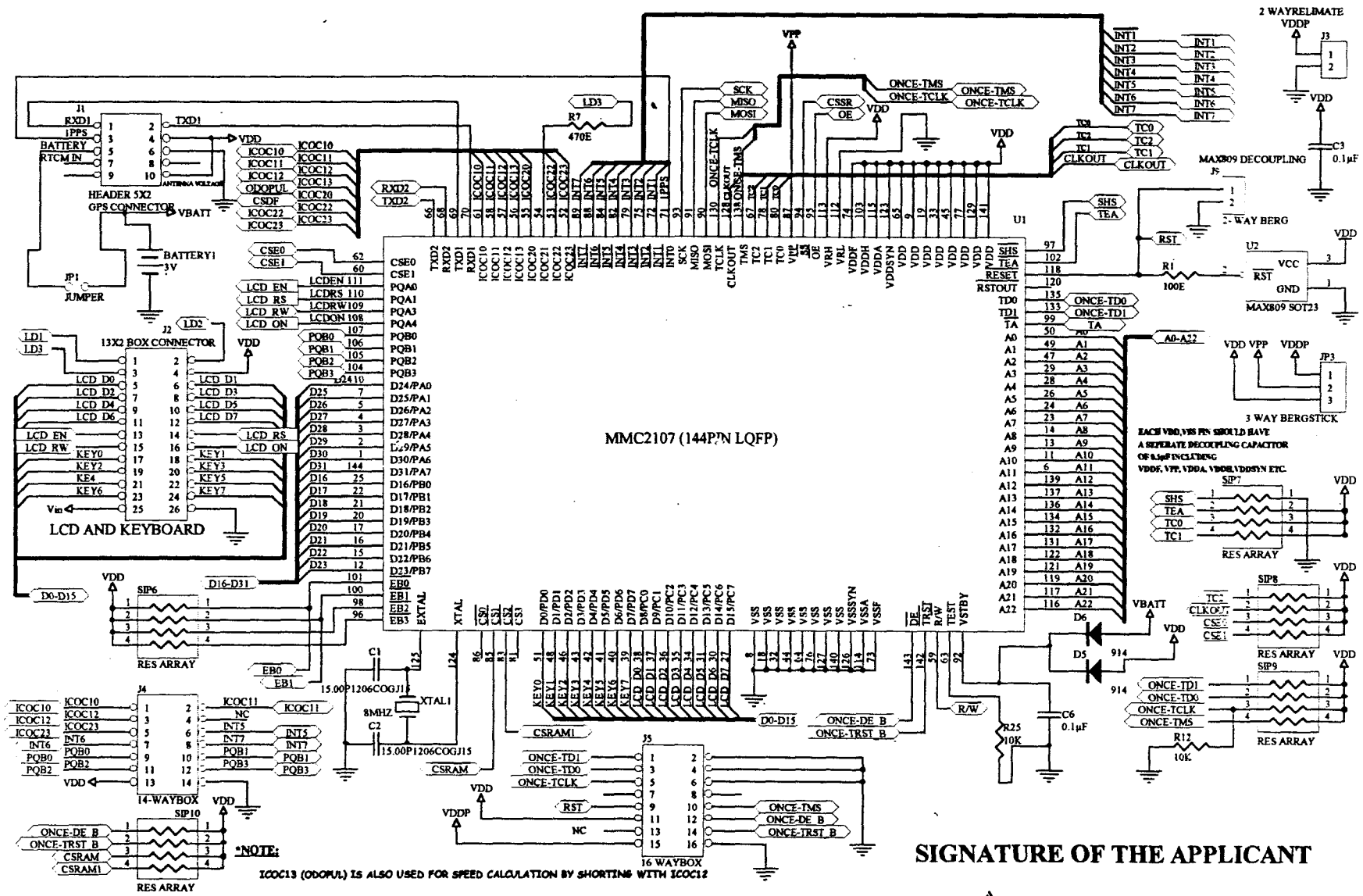
SARAVANAN MANICKAM

FIGURE NO: 3 (SHEET NO.1 OF 4)



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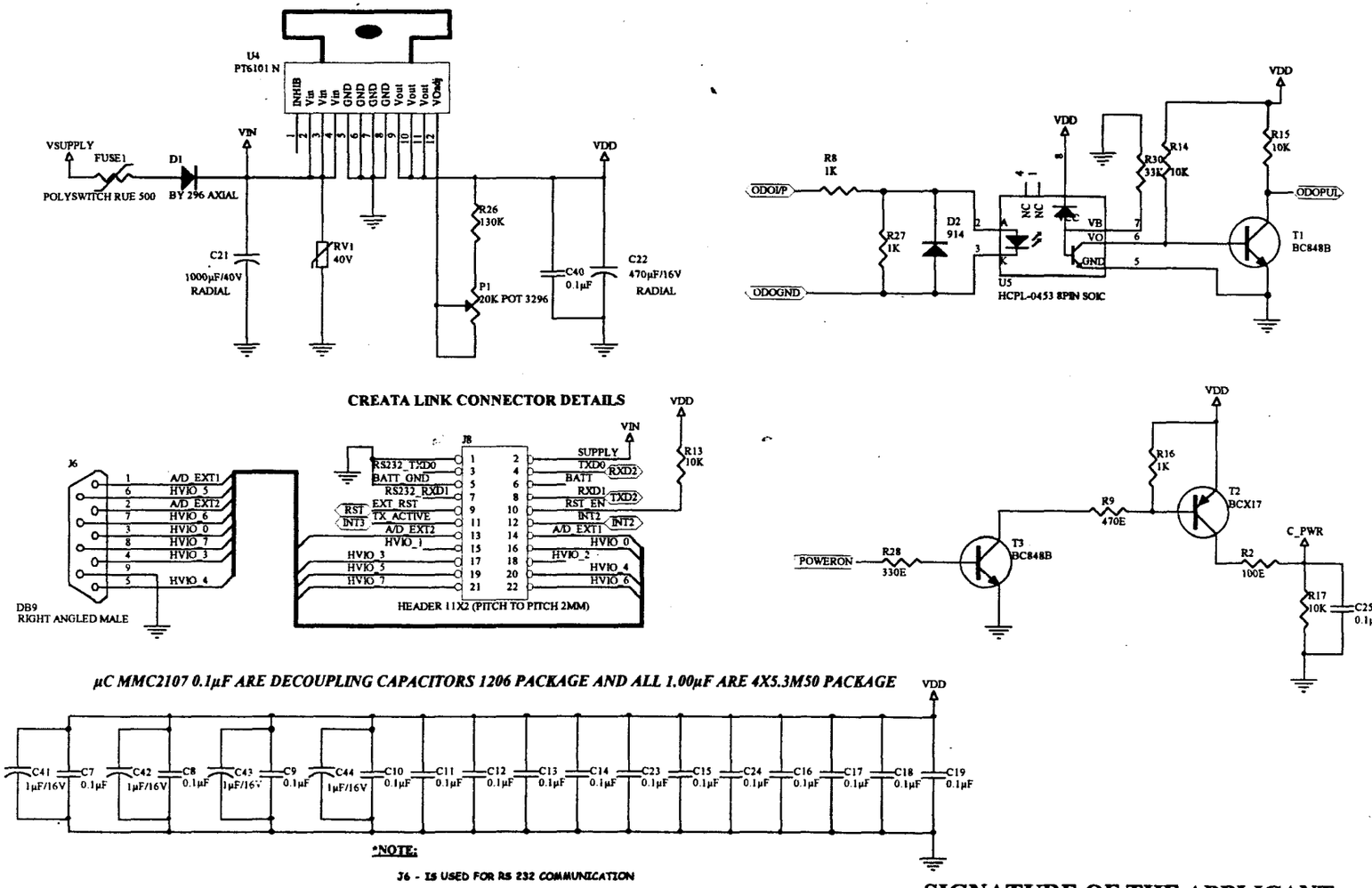
SARAVANAN MANICKAM

FIGURE NO: 3 (SHEET NO.2 OF 4)



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SARAVANAN MANICKAM

FIGURE NO: 3 (SHEET NO.3 OF 4)

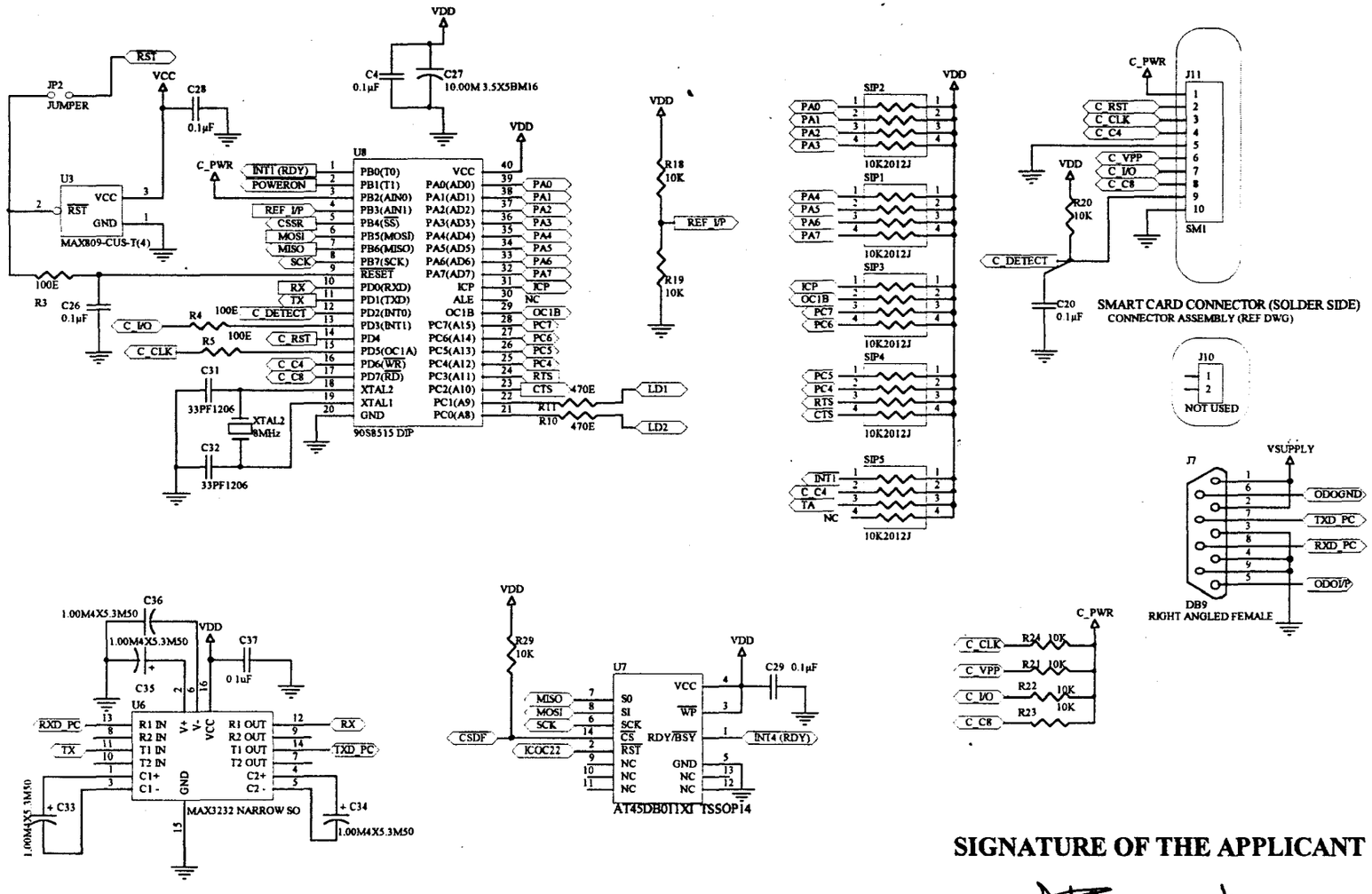

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FIGURE NO: 3 (SHEET NO.4 OF 4)

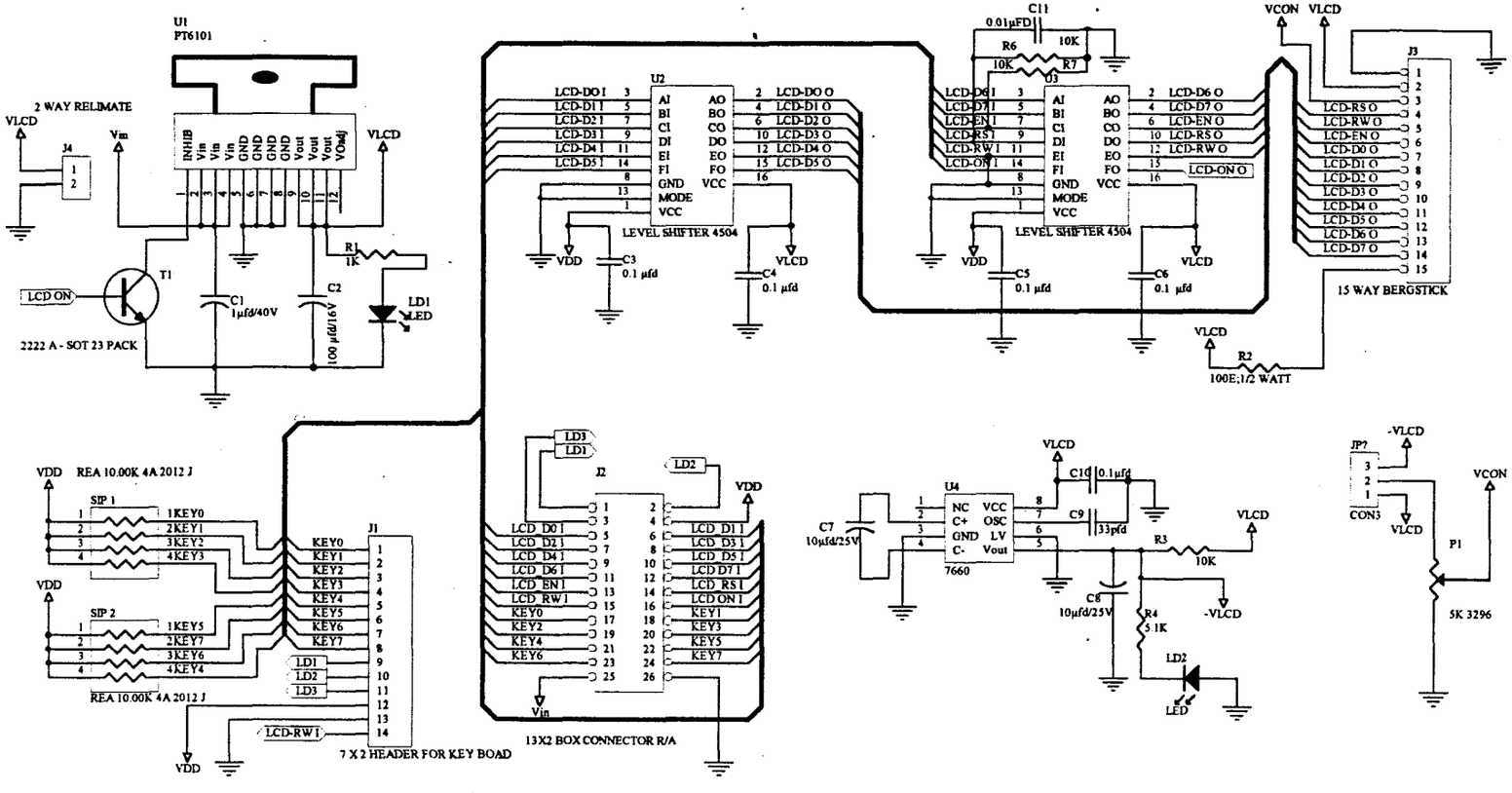

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FIGURE NO. 4
TOP VIEW OF MAK WORLD TRACKER

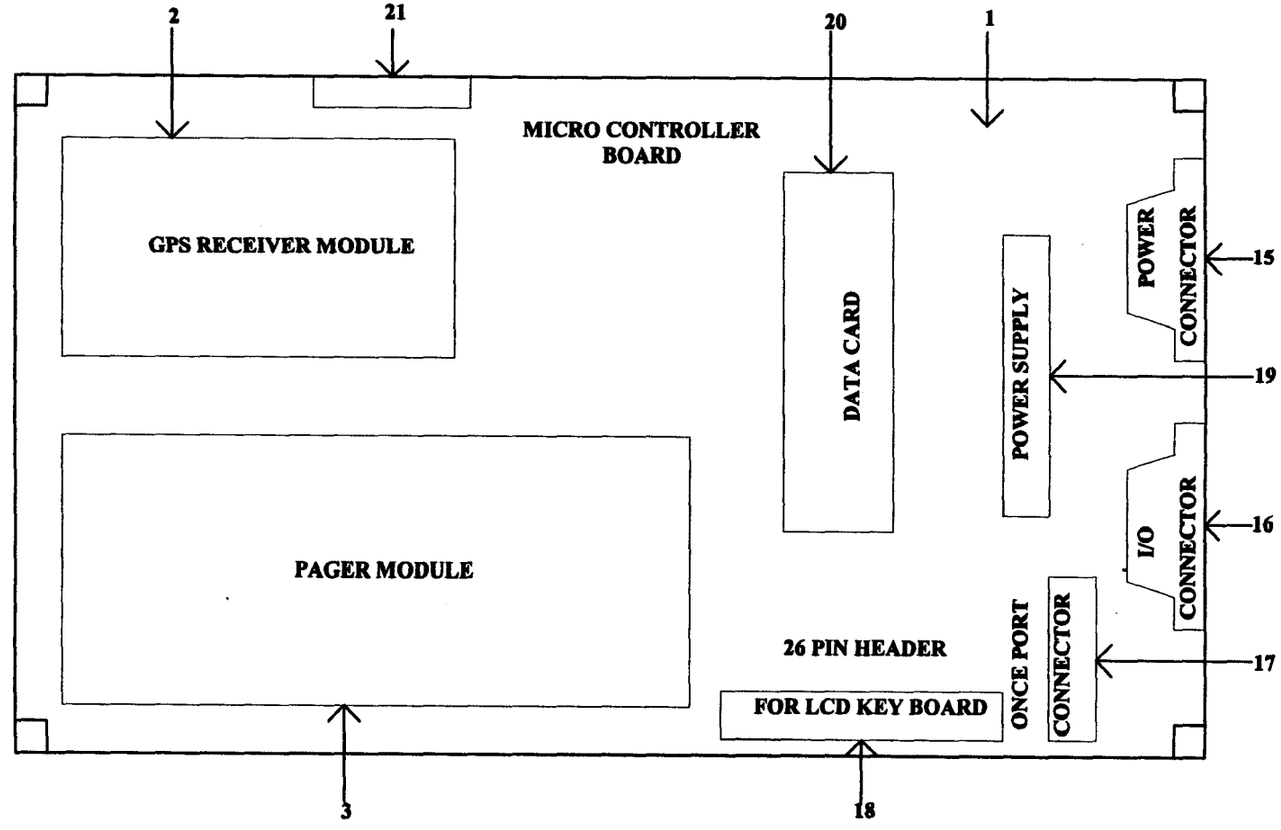

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FIGURE NO: 5

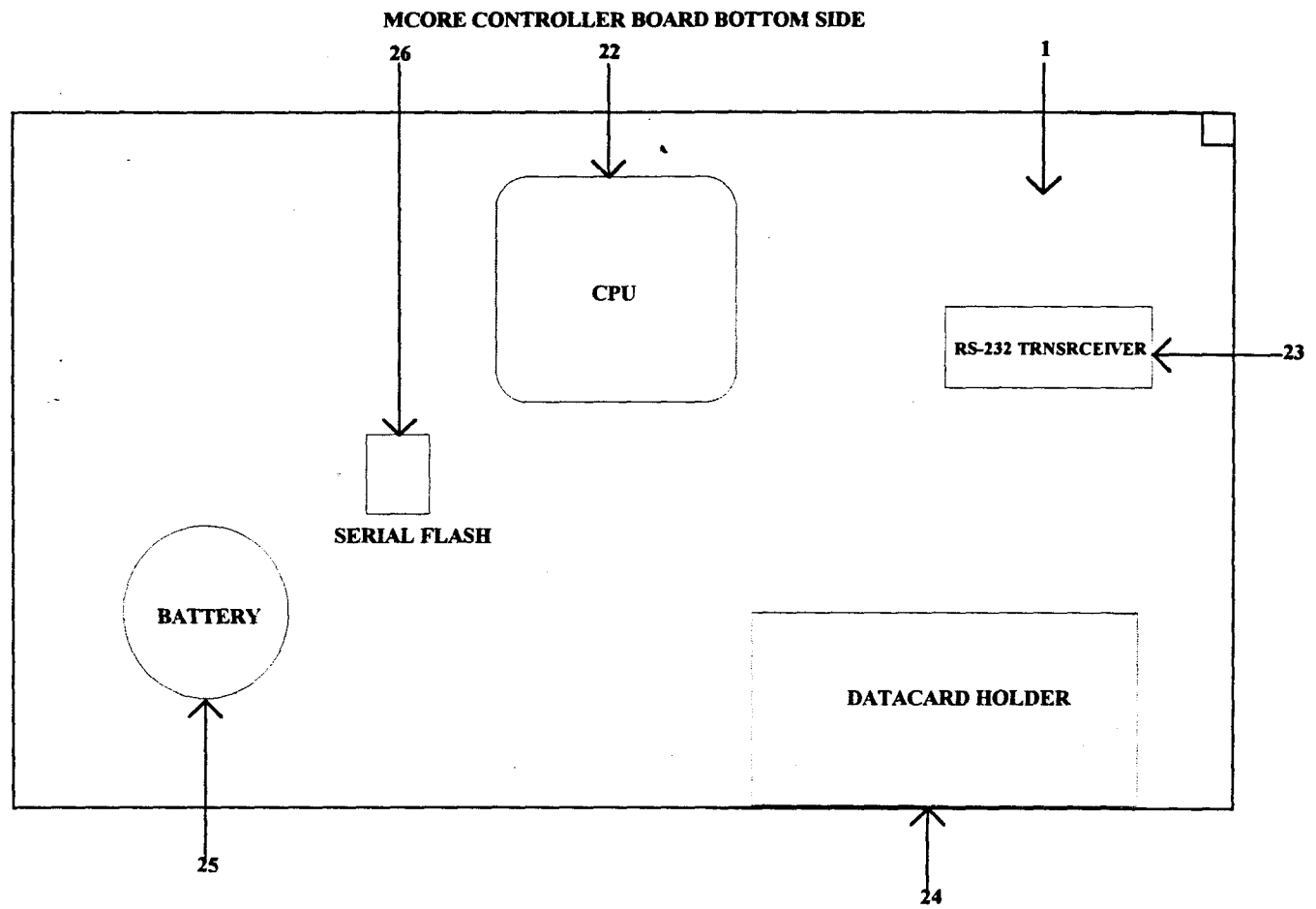

figure - sheet 5

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FIGURE NO: 6

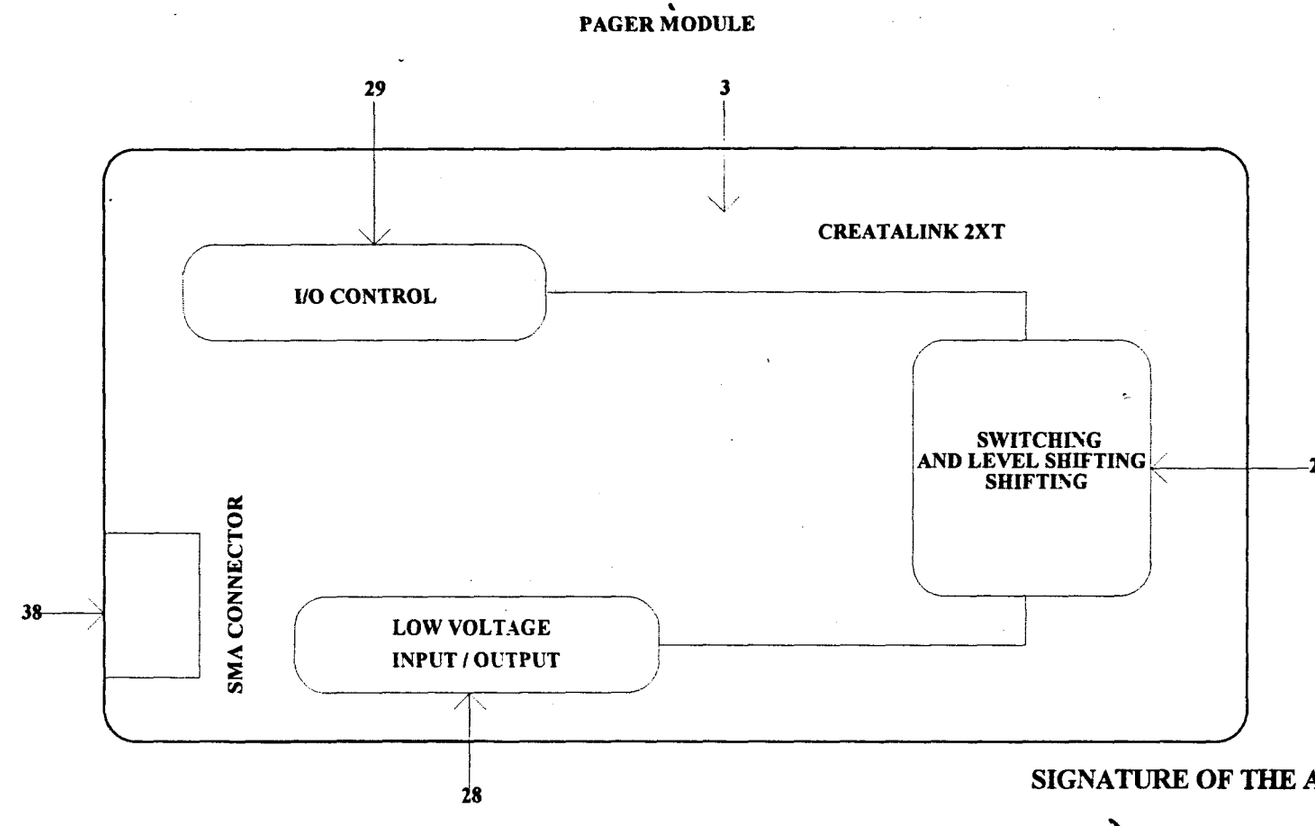

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FIGURE NO: 7

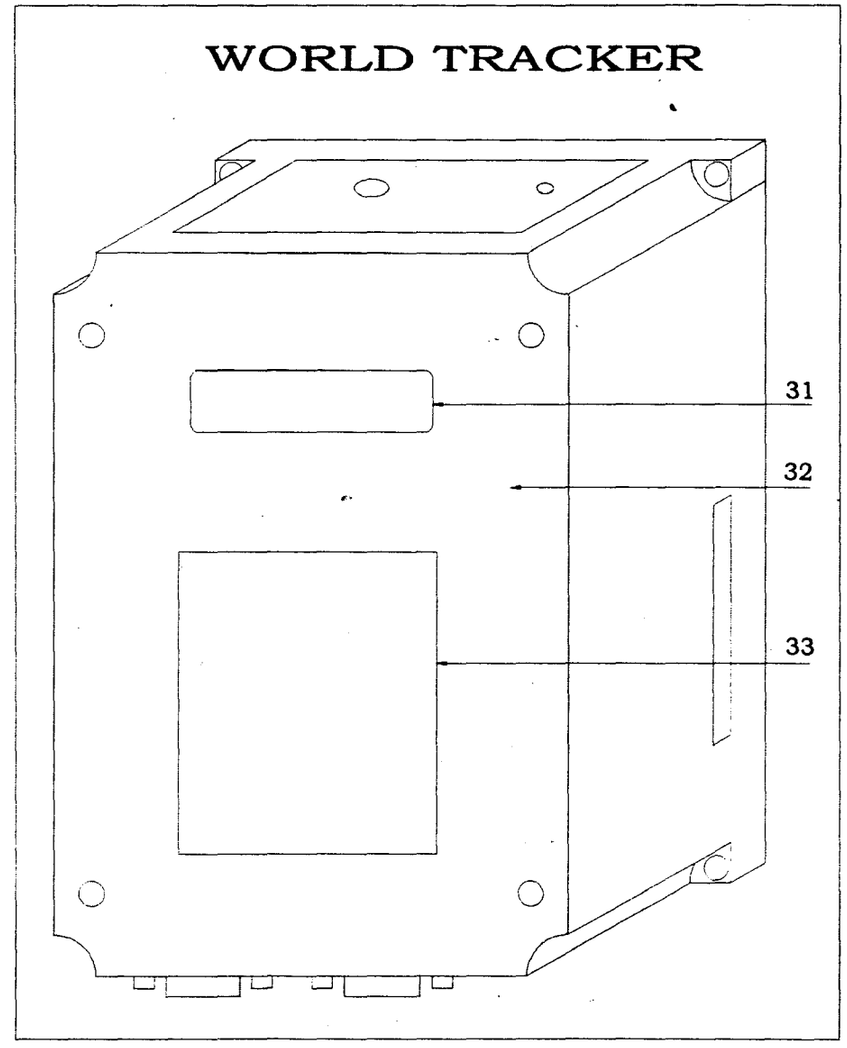

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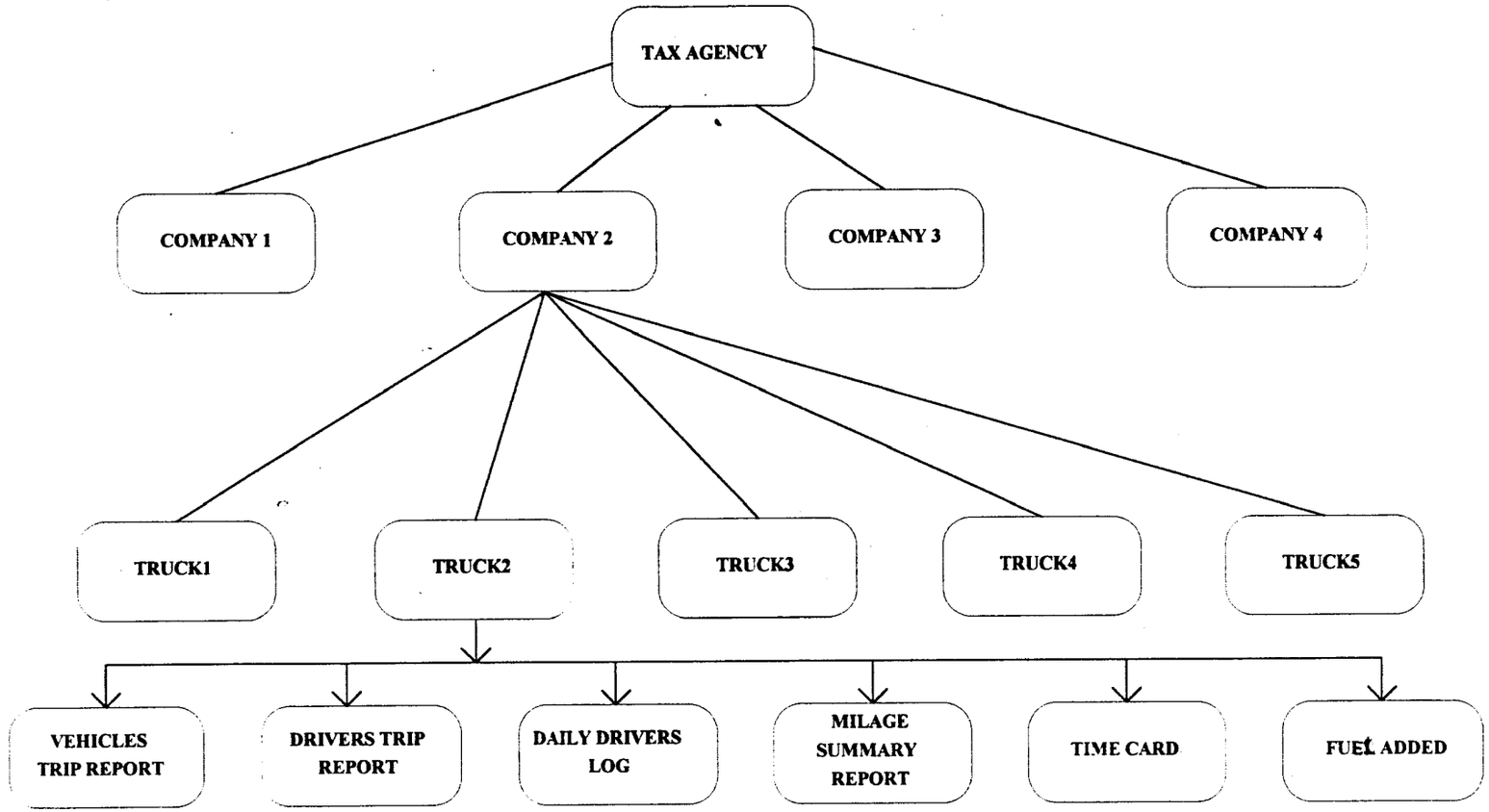
FIGURE NO: 8



SIGNATURE OF THE APPLICANT

SARAVANAN MANICKAM

FORM 2

THE PATENTS ACT, 1970

(39 of 1970)

COMPLETE SPECIFICATION

489/MAS/2001

19-6-2001

(See Section 10)

A system with modular hardware and customized software for tracking and logging real time information of any moving object using Global Positioning System and a communication module

29 JUL 2002

DUPLICATE

SARAVANAN MANICKAM
MAK CONTROLS AND SYSTEMS (P) LTD.
122, APPUSWAMY ROAD
RED FIELDS
COIMBATORE 641 045.

INDIAN NATIONAL

The following specification particularly describes the nature of the invention and the manner in which it is to be performed

A system with modular hardware and customized software for tracking and logging real time information of any moving object using Global Positioning System and a communication module.

Background of the Invention:

The invention relates to a system containing a modular hardware platform consisting of Global Positioning System (GPS) receiver, a programmable micro controller unit, a communication module and a software platform, programmable on site for different applications.

The Commercial Transportation industry requires management and monitoring of vehicle mileage, driver's log, the driving route and tracking of current position of the vehicle of multiple numbers of vehicles for cost effective fleet management. It is mandatory to submit reports regarding total miles driven in a state, driver's time, fuel added in a state, drivers hours of service etc. Generally this information is inaccurate due to the tracking method or method employed in collecting relevant information that leads to the wrong calculation of taxes and loss of revenue. Commercial Transportation industry need to enter this data manually for the above said purposes which is time consuming and prone to manual errors.

Various systems have been developed for this purpose. Some systems have GPS and a telecommunication module with no memory card interface provision. The telecommunication module employed in one current system transmits data via satellite to a base station computer. These systems are costlier jn nature and do not have provision for retrieval of information offline. Some systems employ only a memory card of lower capacity without a communication module. This defeats the purpose of tracking the vehicle online.

This invention was made based on the requirement of low cost alternatives for cost effective fleet management and to comply with the Federal tax return law.

This invention is aimed at developing a system, which would act as an automated mileage and route data collection device besides its various other functions. The feasibility of such a system has been studied in detail, under "Automated Mileage and Stateline Crossing Operational Test (AMASCOT)", jointly by the US Department of Transportation, Federal Highway Administration and Center for Transportation Research and Education and published in their final report dated May 1,1996.

This invention also aims at developing a system that will log and maintain and generate all reports as required by the International Fuel Tax Agreement (IFTA) as in the IFTA Procedures Manual.

This invention also aims at developing a system, which satisfy the Federal Motor Carrier Safety Administration (FMCSA) Regulation of being an Automatic on board recording device, as per Regulation " Federal Motor Carrier Safety Regulations - Regulation §395.15 Automatic on board recording devices".

This invention also aims at developing a system, which would log and store data pertaining to driver information as required by FMCSA.

Accordingly the invention has the following documents as few of its input references:

1. "Automated Mileage and Stateline Crossing Operational Test": Final Report published by the US Department of Transportation, dated May 1,1996.

2. IFTA Procedures Manual, effective July 1, 1998.

3. "Part 395"of the Federal Motor Carrier Safety Regulations

This invention aims at developing a system, whose functionality is not restricted to the commercial transportation industry but which can be used for other possible applications including Sea vessels, trains, and even by a trekker on the move. Hence the design is based on a modular hardware system and customized software support, which would make the device suitable for different applications with minimal hardware changes.

Brief Summary of the Invention

This is an invention of a System (Modular Hardware and Customized Software) called MAK WORLD TRACKER. This invention relates to a system for tracking and logging online real time information pertaining to any moving object. Information herein refers to the global location information, speed, miles, direction, fuel purchase and other parameters of the object depending on the application.

The information is collected from three basic sources

1) GPS receiver

2) Vehicle odo sensor

3) from driver for fuel purchase details. This information is collected on each sampling interval (e.g. 5 min) and stored in the built in memory. This information is copied to a memory card at the end of the trip or transmitted through the communication module at real time. Both the options are also available in a single module.

When the memory card is used, this serves as a backup memory storage system for the communication module where the communication network is not supported and also plays as the Driver's time card. Each driver will be provided a memory card with all the driver information programmed in to the card. The system can accept memory cards of variable sizes to hold driver's trip data from one week to one month. As such the system has the built-in memory for storage up to one-month period. At the end of the trip the memory

card will be handed over to the administrators at the terminal where the formatted raw data is down loaded in to the computer through a memory card reader writer. This system uses Cardlogix C152 memory card reader writer.

The customer has the option to buy the report generating software and load it in to his computer, which reads the raw data and updates its database and generates various reports. Otherwise the raw data is sent to a website hoisted by the data base administrator who handles the data and provides reports for the customer on request. This is automatically done by appropriate software installed in the website.

With the communication module present in the system, the unit can transmit the information in real-time. The unique feature of this unit is the information is directly routed to the specified Internet website. Once the data reaches the website the raw data is processed by the Fleet management software automatically and stored in a database. Provisions can be made to process this raw data either manually by the customer from his place or automatically with the web-installed software. Customer himself or supplier or a third party data base administrator can hoist this website. Provisions can be made to view the reports securely with appropriate access codes for the drivers, Management and Government authorities. The communication module can be any of the following based on the requirement: two way Pager / GSM or cellular / satellite communication modules. Each one has its own plus and minus points and based on the application requirement the modules are selected. When the vehicle is out of range of the communication network the data is stored in the memory and once it comes in to the coverage zone the data is transmitted to the website so that no data is lost. The system is so designed so that it adopts any module with minimum hardware changes. The only change required would be the software embedded in to the micro controller board. The micro controller board is based on Motorola MMC 2107 Mcore 32-bit controller with built in flash memory. The reports generated using the data transmitted to the website are described as follows.

The following example is specific for trucking Industry.

The report generated can be categorized into three groups as follows.

1. Management Reports
2. Drivers Log Reports
3. Paging function

Various report generated by these groups are listed below.

1. Management Reports

   a. Daily drivers log

      1. Daily drivers log detailed report
      2. Daily drivers log summary (for previous 7 days)
      3. Drivers log summary for selected period.
      4. Drivers log summary (monthly report)

   b. Fuel report

      1. Fuel purchase per vehicle date-wise / duration with location

   c. Mapping

      1. Graphical output
      2. Text report

   d. Timecard

      1. Drivers duty start and end time

   e. IFTA report

      1. State compliance (miles per state with respect to each truck or all trucks
      2. Miles driven
         a. Per vehicle / for duration
         b. All vehicle / for duration

2. Drivers Log Reports

   1. Daily drivers log detailed report (with out speed)
   2. Daily drivers log summary (for previous 7 days)
   3. Drivers log summary for selected period
   4. Drivers log summary (monthly report)
   5. Timecard

Paging function

1. Send the record periodically
2. Send messages on request

Automated state-wise mileage detection for Fuel tax report generation:

Two basic methods are employed for this purpose.

The unit is programmed to store or transmit the information collected on every periodic interval (eg.5 minutes). The logged data collected in the web site is further processed and the fleet management software detects the state-line border crossing and generates the appropriate report. The accuracy of this approach will be approximately 5 miles and this can be shortened by short storage interval at the cost of more memory space.

Second method employs the state-line border crossing detection in the hardware unit itself. The system stores the database of position data for all the state-line borders and a software algorithm checks this database each time a new coordinate is received and the moment the crossing is detected all the information including position and miles are stored or transmitted. The accuracy of this approach is few hundred meters. This method employs a memory module in the micro controller board.

In both the cases the IFTA fuel tax reports can be generated. Customer can choose any of the options provided.

Specific problems solved by the invention:

Existing Problems	**Solved by the Invention**
1. Man power	
Costly	Very less or no manpower required
Inefficient	Very Efficient
Prone to err	Error free
Undependable for 24 hour Management	Uninterrupted

Existing Problems	Solved by the Invention
2. Record Maintenance	
Cumbersome	Electronic data storage
Manually maintained	Fully Computerized
Complicated statutory Auditing system	Remote and easy auditing system
3. Fleet data	
Operator dependant	System dependent
Misuse undetectable	Easy monitoring
Unknown where about	Readily available

Various objects of invention:

The object of invention is to identify the technology and system at an affordable cost whereby any moving object is located and information is generated regarding the location, mileage, speed, and other information of the object on an online real time basis and also offline retrieval using memory card with large capacity.

Accordingly, the main object of invention is to develop a low cost novel technology and invent a new system and a method by which operational details of moving object are retrieved online or offline and reports generated there from.

It is also an objective of the invention that the said system would meet the following requirements:

1. IFTA Procedure for Record Keeping (Section P500 of the IFTA Procedures Manual)
2. IFTA Procedure for Electronic Data Recording System (Section P600 of the IFTA Procedures Manual)
3. Act as an "Automatic on board recording device" as per Regulation §395.15 of the Federal Motor Carrier Safety Administration.
4. Store and report data pertaining to driver information according to regulation "§395.8 Driver's record of duty status" of the Federal Motor Carrier Safety Administration.

It is also the primary object of the invention to make the developed system a generic unit, which can be customized for different related applications.
Further objects of the invention will be clear from the following description.

Detailed description of the invention:

Wherever device (or system) is mentioned in the description it is referred to the MAK WORLD TRACKER

The system accordingly is a sophisticated electronic data-logging device for any type of moving object. This device will give operation details to management, authorities, and drivers for those vehicles. The device is versatile as it supports small and large operations. The device offers many options to save money and reduce cost. One of the ways one can save money is on fines on tax Reporting. This device will provide the information for Tax Reporting to be 100% correct each and every month with little or no corrections. Another way that companies can save money is the time-consuming data entry time for Tax Reports as well as driver's timecards.

One can also reduce the time that a driver has to fill out daily driver logs and the high cost of storage and audits of those logs. This system will eliminate all of these things and automatically provide needed reports in managing daily operation.

This system is designed to electronically capture all the data about the driver and the vehicle. The Raw data that generated is placed on a unique memory card. This data memory card will store 7 days of data before it will copy over the information, which is expandable upto 1 month. The hardware module itself will store 30 days of information before it will copy over the data. This device is designed to be affordable and technologically sound for all sizes of operations.

The device according to the invention will collect, store the following data on the device and data memory card and transmit the same.

Date stamp
Odometer reading of vehicle
Routing
Driver license
Vehicle ID
Latitude and Longitude of the vehicle
Driver's start time
Fuel added
Price per Gallon
Route ID
Odometer of the GPS
Speed of Vehicle
Time stamp
Driver's finish time
Location fuelled
Driver's name

The device transmits the raw data over two-way Pager/ GSM or cellular/ satellite communication modules on each programmable interval time. A remotely located base station PC equipped with telecommunication devices receives data from various vehicle and stores in database. This raw data is then downloaded into the Internet. The company purchasing the device will have several choices of how and where they store the data. With data transferred to internet anyone with authorization will be able to find out where exactly the vehicle is moving at any given point of time with respect to state, city, street instantly.

The unique data memory card can store 128k (expandable) of data from the device. A data memory card will be assigned to each driver. The data memory card will be coded to each driver with his driver's license number. The data memory card can also be used as a fuel card with the company's approval. The data memory card will require few minutes to download all trip and drivers log data. The device will set to collect and store that data every programmable time interval (e.g. 1 min minimum)

The device according to the invention includes communication module [two way pager] for transmission of parameters at every programmable periodic interval.

The device is novel with reference to what is known in the prior art. This device will provide a cost efficient way to electronically collect data from a truck with little or no data entry requirement from the driver. The cost of this device is very nominal compared to the existing devices currently available in the market. There are several companies that give data but none can give the detail that device provide. The device is versatile. This is one of the salient features of the invention. The device will provide the user many choices of reports and other options.

The raw data that comes from this unit is coded for security. To retrieve the data from the unique data memory card or the unit requires company permission or data download through a Web page. The Web Page decodes the data before posting it on the Internet for the driver and company to access. The web page can be set for authorization by the company for access. Companies will also have the option to purchase the software for decoding the data if they want to store and provide the reports for their drivers.

Now the invention will be described in detail with reference to drawings accompanying the complete specification.

Preferred Embodiment of invention:

The nature of the invention and the manner it is to be performed is clearly described. The description of the invention will be in relation to drawings, which accompany the complete specification. The various advantages of invention and scope and ambit of the claim are appended at the end of the description..

The statement of drawings, which accompany the complete specification, is as follows.

Fig.1 shows the block diagram of various components used in the device MAK WORLD TRACKER.

Fig.2 shows the block diagram of global positioning system (GPS) module

Fig.3 shows the complete Hardware circuit diagram of MAKWORLD TRACKER. (Fig.3 has 4 sheets.)

Fig.4 shows the top view of the MCORE CONTROLLER board

Fig.5 shows the bottom view of the MCORE CONTROLLER board

Fig.6 shows block diagram of pager module

Fig.7 shows the front view of the device MAK WORLD TRACKER

Fig.8 shows the application topology of the entire system

Refer fig.1 of the drawings.

The device has a GPS receiver module (2) intend to receive signal from satellites and gives RS-232 output to the Mcore controller board (1). Similarly a two-way pager module (no.3) is used in the device to receive and transmit information. The pager receives the information from base station and sends it to Mcore controller board (1). Likewise the pager transmits vehicle and driver information from there to Mcore controller board to base station. The pager and Mcore controller board is linked through an RS-232 serial interface. This is real time mode of data transmission.

The LCD module (5) is provided to display status information such as the latitude, longitude date, time and miles information of the vehicle. 4X4 Matrix keyboard (6) is connected to the motherboard used for data entry. A data memory card interface (7) is provided in the Mcore controller board. A dedicated RISC micro controller is used for this purpose, which communicates with the Mcore controller board through high-speed serial interface. At the end of each trip, the trip information can be downloaded into the data memory card. This is another mode of data retrieval, which is not real time, but at the end of each trip. The online transmission need not be equipped in all stations except a base station. All other Transportation company offices can be equipped with a Memory card reader and the software for generating appropriate reports from

the raw data available in the memory card and data received from the device through Internet. This is also very useful in areas not covered by paging network. The Mcore controller card also has provision for a RS232 serial port (4) for communicating with PC.

Fig.2 is a brief block diagram of Motorola M12 global positioning system or equivalent which has 12 channel tracking capability (specification enclosed). The GPS module continues to track the GPS satellites and calculates time/position information. The calculated information is transferred to the Mcore controller board through serial interface connector (12). The 3V power is also supplied to the module through the same connector. The GPS module serial connection works at 9600 bps, No parity 8 data bits 1 stop bit connection with m12 binary protocol.

Fig.3 gives a detailed hardware structure of the MAK WORLD TRACKER. The parts of hardware are Micro controller board, LCD board with keyboard. Micro controller board consists of two micro controllers. One acts as a master and another one as slave. The master (MOTOROLA MMC2107) controls all the function. The slave is used for memory card function. Max 232 RS232 transceiver IC is used to interface with PC. Serial flash is used for data storage. Optocoupler is used to sense the odo pulse input.

Refer fig.4 & fig.5 for the following description

The main power to the Mcore controller board is connected through the power connector (15). The motherboard has two micro controllers. One acts as a CPU (22) and another as a memory card controller (20). The CPU is Motorola Mcore MMC 2107 32-bit controller. The memory card controller (20) is an atmel AVR RISC controller .The CPU controls all the functions and controls the slave devices such as data memory card controller, GPS module (2), pager module (3) etc.

The Mcore controller Board (1) in the device which is the heart of the system processes the information received from GPS module, vehicle odo meter and transmit the information periodically or based on events and also store it in the on board memory (26). At the end of the trip all the process data is stored in the data memory card. A backup battery (25) is provided for storage of data in case of power disconnection. It has a 3V power supply (19) unit, which is an integrated switching regulator.

Fig.6 shows the block schematic of pager module, which has a serial interface through which the pager is connected to the Mcore controller board.

Fig.7 is the front view of the MAK WORLD TRACKER with keyboard (33) and LCD display (31) units.

Fig.8 shows the hierarchy of the application topology

This device when fitted on a vehicle monitors, stores and transmits the following data.

- Driver information
- Vehicle information
- Time
- Speed
- Latitude of the location of the Vehicle
- Longitude of the location of the Vehicle
- Direction of travel of the Vehicle
- State line crossing mileage

The data stored in the unit can be ported to a discretely accessible Internet data storage location either through a pager system for on line tracking or through unique memory card – store and transfer system.

The following description gives the specification and the operation parameters of the following components:

a) MAK WORLD TRACKER

b) GPS module

c) Communication (Pager module (or) GSM/Cellular module (or) Satellite module

a) **WORLD TRACKER OPERATING SPECIFICATIONS:**

GPS Module	Motorola M12 ONCORE
Communication Module	Motorola Creata link 2XT for pager
CPU	Motorola 32 bit embedded controller
Inbuilt Memory	128kb Non volatile memory for trip storage
Memory Card memory size	64Kb /128kb (Expandable)
Memory card Interface	Designed for 64Kb/128kb memory card (upgradeable)
Memory card reader/writer	A stand-alone mcore controller is used for this Function.
Display	2 X 16 LED display with LED back light
Key board	4 X 4 matrix feather touch keypad
LED Indications	Power LED Card LED Status LED
Serial port	RS232 serial port for PC interface for diagnosis purpose
Parallel I/O	Optional I/O lines are available at request
Power supply	9 TO 36 VDC

Data Log Parameters	▪ Driver ID ▪ Driver name ▪ License number ▪ Vehicle ID ▪ Route ID ▪ UTC time ▪ Stop time ▪ Date ▪ Latitude ▪ Longitude ▪ Speed ▪ Heading direction ▪ GPS fix status ▪ GPS status word ▪ Mileage ▪ Fuel added ▪ Price per gallon ▪ Type - bulk/retail ▪ Starting odo ▪ Ending odo ▪ Vehicle stopped time ▪ Break time ▪ Driver hours of service ▪ Version
Programmable parameters	▪ Driver ID ▪ Driver name ▪ Driver license number ▪ Driver License State ▪ Route ID ▪ Fuel added ▪ Price per gallon ▪ Starting odo ▪ Odo ratio ▪ Log period ▪ Vehicle ID ▪ Location ID ▪ Ending odo ▪ Password ▪ UTC offset ▪ Pager Number

M12 ONCORE

Specification:

Receiver architecture	▪ 12 parallel channels ▪ LI 1575.42 MHZ ▪ C/A code (1.023 MHZ chip rate) ▪ Code plus carrier tracking (carrier aided tracking)
Tracking capability	12 simultaneous satellites
Dynamics	
Velocity	515 m/s (1000 knots); >515 m/s at altitudes < 18,000 m
Acceleration	4 g
Jerk	5 m/s^3
Vibration	7.7G per Military standard 810E
Acquisition time (Time To First Fix, TTFF)	▪ <15 s typical TTFF – Hot (current almanac, position, altitude, date, time, ephemeris) ▪ <45 s typical TIFF – Warm (current almanac, position, altitude, date and time) ▪ <60 s typical TTFF – Cold (no stored information) ▪ <1.0 s internal reacquisition
Positioning Accuracy	▪ 100 meters 2dRMS with SA as per DoD specification. ▪ Less than 25 meters, SEP without SA.
Timing Accuracy PPS	<500 ns with SA on
Datum	▪ WGS – 84 ▪ One user definable datum

I/O Messages	▪ Latitude, longitude, height, velocity, heading, time ▪ Motorola binary protocol at 9600 baud ▪ NMEA 0183 at 4800 baud (GGA, GLL, GSA, GSV, RMC, VTG, ZDA) ▪ Software selectable output rate (continuous or poll) ▪ 3V digital logic interface ▪ Second COM port for RTCM input
Power Requirements	▪ 2.8 to 3.2 Vdc 50 mVp-p ripple (max)
"Keep-Alive" BATT Power	External 1.8Vdc to 3.2Vdc, 5µA (typical @2.7Vdc @ +25°C
Power consumption	<0.225 W @ 3V without antenna
Dimensions	40.0 X 60.0 X 10.0 mm (1.57 x 2.36 x 0.39 in.)
Weight	Receiver 25 g (0.9 oz)
Connectors	
Power/Data	10 pin (2 x 5) enshrouded male header on 0.050 inch centers (available in right angle or straight configuration)
RF	Right angle MMCX female (subminiature snap-on)
Antenna	▪ Active micro strip patch Antenna Module ▪ Powered by Receiver Module at selectable 3 or 5 V
Antenna to Receiver Interconnection	▪ Single coaxial cable with 6db maximum loss at L1 (active antenna) ▪ Antenna Sense Circuit ▪ Antenna gain range 16 to 30 db
Operating Temperature	-40°C to +85°C
Storage Temperature	-40°C to +85°C
Humidity	85 % Relative Humidity at 85°C
Altitude	▪ 18,000m (60,000ft.) maximum ▪ >18,000m (60,000 ft.) for velocity < 515 m/s (1000 knots)
Standard Features	▪ Motorola DGPS corrections at 9600 baud on COM port one ▪ DGPS Master Site Capability ▪ RTCM SC – 104 input Type 1 and Type 9 message for DGPS AT 2400, 4800 or 9600 baud on COM port two ▪ NMEA 0183 output ▪ Inverse DGPS support

Backup	Lithium battery backup
OPERATING PARAMETERS	
Power supply	9 TO 36 VDC
Operating temperature	- 40 °C TO +85°C (-40°F TO +185°F)
Storage temperature	- 40 °C TO +85°C (-40°F TO +185°F)
Relative humidity	0-100% RH
Random Vibration	20 to 2000HZ < 3 grms
Mechanical shock	0 to 100G (using vehicle mounting method)

COMMUNICATION MODULE SPECIFICATIONS:

Coding format	Reflex 50
Serial protocol	CLP or third-party application
Operating temperature	-40°C to +85°C
Interface	22-pin vertical shrouded header for combined power supply, serial, and parallel I/O interface. 8-pin vertical shrouded header for JTAG interface; SMA connector for antenna
Power supply requirements	5-12Vdc, 2.5A minimum, 100mVpp ripple up to 5 MHZ (worst case estimate if sourcing/sinking I/O at max values)
Backup battery/alternate transmit power supply requirements	3-9Vdc, 1mA if used for RAM backup only. 5-9Vdc, 1.4A minimum, 100 mVpp ripple up to 5 MHZ if used for transmitter supply (battery voltage must be equal to or less than the main supply voltage)
Physical dimensions	
Length	3.75in (95.25mm)
Width	1.75in (44.45mm)
Height	0.7in (17.78mm)
Weight	1.5 oz. (42.5grams)
Antenna connector	50 Ohm SMA female connector

TRANSMITTER SPECIFICATION:	
Frequency	901-902 MHZ
RF power output (at antenna port)	0.5W, 0.75W, 1.5W and 2.0W
Transmit data bit rate	9600 bits per second (bps)
Modulation	4 – level Frequency shift keying (FSK)
Frequency stability	1 ppm on transmit
RECEIVER SPECIFICATIONS:	
Frequency	940-941 MHZ
Sensitivity	-115 dBms in to SMA antenna connector
Receive data bit rate	6400 bps
Modulation	4-level FSK
Channel spacing	50 KHz
INPUTS/OUTPUTS	
HVIO-0 – HVIO-5 (configured as outputs)	12Vdc maximum pull-up voltage. 25mA maximum sink current (@12Vdc pull-up)
HVIO-0 – HVIO-5 (configured as inputs)	12Vdc maximum input
HVIO-6 & HVIO-7 (configured as outputs)	Driven to supply voltage (12 Vdc maximum) maximum sourcing/sinking current is 350 mA
HVIO-6 – HVIO-7 (configured as inputs)	Maximum input limited to that of supply voltage