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Intelligent systems in railway interlocking

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Abstract: Railway signaling and control systems to the industry since the beginning of the challenges associated with developing nations used to date technologies have been trying to fix it. Unfortunately, the industry is now a new Flywheel storage is perfect. In this paper, the composite flywheel and steel wheels to enable the system checkups and batteries that are used today as we review .It occupies the space of about 25 square feet is able to transmit power is 500 kW.

Keywords: control and signaling systems, flywheel systems, UPS, battery charge

1. Introduction

1825 marks the first man on horseback with a red flag before George Steffensen steam locomotives between Stockton and Darlington station was called on the motion.Before the invention of the telegraph poles in the United States of America 10/5 meters distance of 48 km. The other was placed on the ground that it was based on each agent. When the train was leaving the station of origin, Marks next to the post office once every few minutes using a telescopic camera that shot up the white flag on top of the first post to read.When the train approached the station to confirm he was going the same way to the next station.In 1872, William Robinson closed the circuit in normal mode (normal) invented The invention as the point went wide as a tool for more efficient and safe operation of the trains.As increasing numbers of trains (providing safety, transport) was changed to the more positive the more efficient operation.

2. The Role of Signals in Railway

In order to ensure the safety of the train, the rail or wagon should have no flaw or defect. Furthermore, in order to avoid the occurrence of accidents such as collisions, it is necessary for a train to maintain the proper distance before and after other trains and not to enter in a single-track lines in the opposite direction of another train between two stations. This method is called train control system. When the train or wagon move according to the signal in the route with switches. Moves to the safety of the train, the rail or rails should be no flaw and imperfection. Furthermore, in order to avoid the occurrence of accidents such as collisions, it is necessary to maintain the proper distance between the previous and next train and another train moving in the opposite Qtardrjht axis of a line between two stations not to say that these methods control the distance of the train. When Qtarya wagon track facade includes needle, according to the signal moves

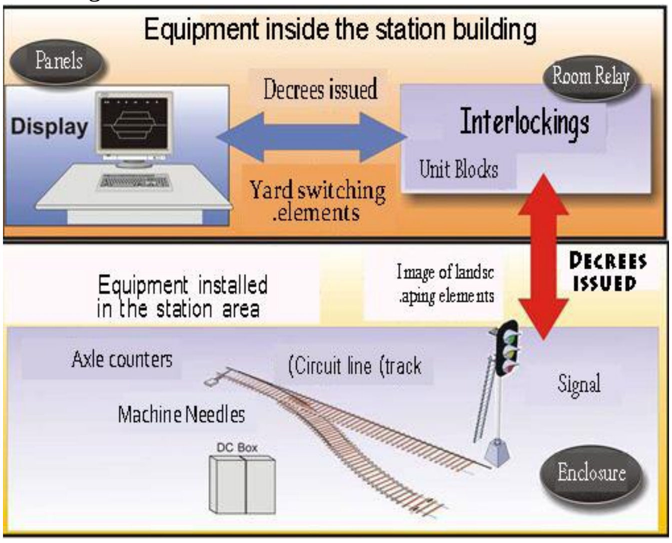

Figure1: System interlocking

3. Interlocking Device

The interlocking device is a system that locks all switches and other movable appliances in the route electrically and mechanically in order to meet the requirements for smooth and safe movements of trains. Due to the existence of many

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convergent and divergent lines in the station area and the need to perform complex operation such as entrance, departure and maneuver of trains, the signalman must repeatedly operate switches and signals. But since this operation is too repetitive and complex to be performed by personnel, therefore to avoid this difficulty, the interlocking system is employed by which any human error is prevented[1].

4. CTC System

Train's safety in a station is usually ensured by the operators that monitor control signal devices through control panels. In this case, safety depends on telephone communication among adjacent stations and traffic command centre and other stations. In the past, these communications were used as the source of information on the train's departure and consequently the source of any modification of the train's movements with the changes in the timetable. These process took a long time. With the application of CTC , this problem was resolved. CTC stands for centralized traffic control and is a modern and advanced control system. CTC requires the establishment of a traffic control system for a particular area or region. Once established, it enables the responsible personnel to control directly the interlocking system of any station remotely. Major equipment of CTC Command Center include control panels, display panels, train number display unit, blocked line panel, automatic system of program registration and monitoring table. Not only the full control of the train movements is possible with CTC display panel, train number display unit, line status indicator but also with its installation, immediate adjustment of the timetable is possible and thus the time required to restore program is reduced [2]

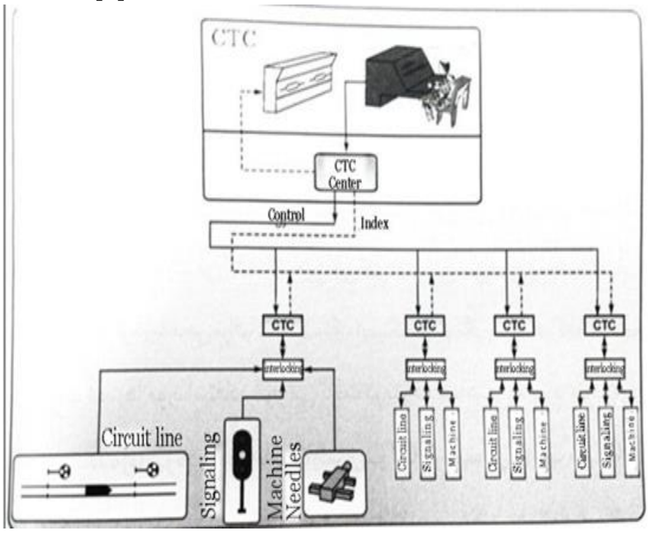


Figure2: CTC system

4.1.CTC Operation

Central unit recall each station and the recalled stations send the information on the status of themselves to the command center. This cycle consists of control cycle and display cycle. The display cycle is usually repeated so that the central system is able to cyclically receive the information about signal status in each station, train status and other appliances displayed on the monitor.

As the control cycle begins, the display cycle stops, for example, when the command of route control is sent from the CTC center, the control cycle is in charge until the system receive a response. When the control cycle ends , system return to the display cycle again. The role of CTC is mainly to send information which includesrequest from the information center. The display of the status of the stations, setting the rout and other safety operations in case of equipment failure is the responsibility of interlocking devices. When CTC fails, it loses the control of the stations and as a result, the local panels are used to adjust the routes[2].

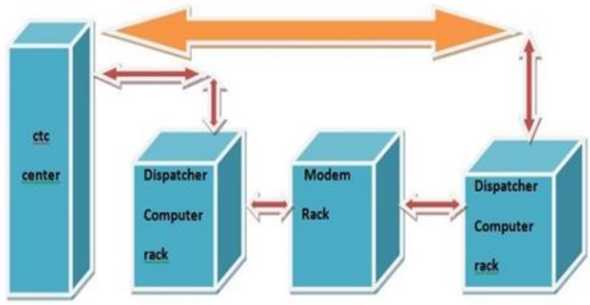


Figure 3: outlines the central CTC system

5. The dispatcher system of sub-centers

In these systems CTC consists of two rings that the m system is between the central unit and the sub-centers and the s system is between the sub-center devices and the stations under their command. PRS is composed of a central unit and sub-centers. The central unit coordinate the operation and surveillance the traffic and controls the train schedule. The duty of sub-centers is to monitor, track and trace the movement of a train and to change the train's number. Each day the operational plan is set for that day, the next day and two days after. Files containing information about the main program and updated data are stored as a file and after that the operational plan data is sent to each sub-centers at a fixed and determined time. Each sub-centers controls the data and controls the routs inwith the train status. Updated programs which are developed according to traffic coordination of the same day is always set by the control center and is sent to the sub-centers. A sub center receives these updated programs and alter the operational plan according to the latest data . Given that the control route operation is divided between sub-centers, one of the most important features of this system is that in case of failure, the entire line is not blocked [2].

6. The system of operation distribution by central system

In this system the central unit controls the interlocking of the station directly by CTC. The central unit is only in charge of tasks related to the commands such as control of train timetable and traffic coordination. Route Control such as station operation and manual adjustment of the route and blocking the line is carried out exclusively by sub-centers [2].

7. Route Control data storage devices for single-track lines

To reduce the manual operation of the command staff , CTC controls the direction of entrance and departure signals of the single track sections automatically. Train operations data is prepared in accordance with the route setting of each station and train sequence information with regard to train schedule. The route data are used automatically for storing train sequence for 24 hours for the routes of each station, thus the tasks are performed in reference to the control system of the schedule [2].

8.Train Number Display Unit

CTC display console is equipped with train number display unit. This console shows the signal status, position and number of the train which is moving in the last section. Since this system provide a brief account of the status of the trains at a glance, it is considered a cornerstone in decision making concerning facilitation of the operation. Every CTC central CTC display console CTC display console is equipped with train number display unit. This console shows the signal status, position and number of the train which is moving in the last section. Since this system provide a brief account of the status of the trains at a glance, it is considered a cornerstone in decision making concerning facilitation of the operation. Every CTC central system is equipped with train number display unit which uses CTC information to keep track

of trains and to adjust train number. The numbers from the train number display unit that are entered at the departure position is transferred to the middle block and with the movement of train it will be shifted to the next stations and blocks respectively. If after replacement, the train number display is still blank, the recorded numbers in train number setup is shown in sequence. Entering train number manually is also possible[2].

9. SWU System

This system is responsible for sending and receiving the commands and data to and from the central computer and stations . The SWU system's main duty is to find out which station produces the frame and that the produced frame should exit from which station (gate)? The switch unit has a serial communication card with an rs-485 standard. This card has 2 computers with screen panels for central computer communications: computers A and B. It also has 10 serial cards with rs-232 standard which are used to facilitate the communications between computers A or B and the stations. There are two cards for main communication with stations; one main line card and one subordinate line card which normally both of them are used to send and receive data to and from the RTU. Thus there are 10 serial communication cards on a unit switch.

There are 2 standard rs-232 ports on each card which are both 9-pin ports. One port to send and receive the data and the other to observe these exchanged frames via the 'spy' software. How the communications between A&B computers with the SWU system works?

This communication occurs through two connector boxes a&b. Each connector box has 16 rs-232 ports for sending and receiving data for SWU card and one port for sending and receiving data for the A&B computers. Since there are 12 communication cards on SWU, the 12 ports on the beginning of each connector box

connect to these 12 cards and connectors 13,14 and 15 remain unused. Port 16 is connected to the ONL module on the switch unit. The following figure shows the connectors on SWU module

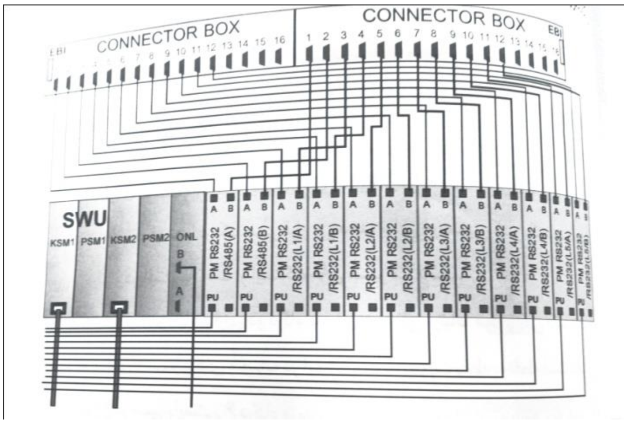


Figure 4: System SWU

10.Dispatchercomputers-communication modems

To communicate with the local stations, the CTC central system divides these stations to multiple groups. For example n=6 and puts each group in a route. For every route, one dispatcher computer is responsible for sending the commands from the center and receiving data from the route stations. Since each computer system has two serial ports for modem communications, and in this example, the connection between central system and the installed systems are point-to-point, thus by considering the number of stations in the route, there should be 6 input ports on each computer. To this end, there is a card installed on dispatcher computers to increase the input ports, which its responsibility is to convert each input port to 8 serial input ports. Thus each computer can connect to 8 modems, in this example 6 modems, and the

communications (data transfer) of each station may take place through this connections

All the communications with the dispatcher computers and the central computer are the same, that means all the output data from one communication port with dispatcher computers will be sent to all of them the same way.

The only remained issue is how to detect the address of the data? That means after arriving the data to the computers from central CTC, all of them start decoding the received data with the help of a designed and installed software, and they will be able to identify which station the data is sent to. Those computer which doesn't have that station in their communication route, will not show any reaction but those that have the station on their communication route, will refer to the data again and according to the station's number will recognize that the data should exit from which serial

exit port which now has became 8 ports. The information on the software will be explained n the software section

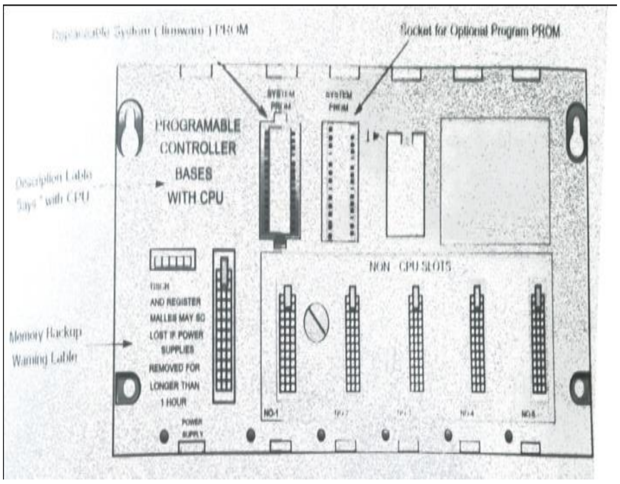
11. The RTU system

The RTU's responsibility is to receive the commands or the requests from the CTC center. In fact, this system responds to the requests from the CTC center according to the situation. So when the RTU receives a message from the center correctly, it will respond with a positive affirmation. But if it is unable tounderstand the message, it will respond to the center with a negative response. If the RTU receives a message in an abnormal form, it will not respond to it and after a specified period of time, the CTC will recover as well as the corresponding input port on the RTU. The RTU input ports become active or inactive according to the type of the receiving data from the interlocking. In fact, the RTU's buffer stores the status of the inputs. In a normal situation, only the changes in the inputs will be sent to the CTC from the RTU, but if the CTC requests for the status of all the inputs, the overall status of the inputs will be sent to it after the first restart process. According to the type of the outputs, the RTU's output commands will become active. Generally, there are three kinds of control commands: 1 output, 2 outputs and 3 outputs The internal storage of the events and errors: RTU is able to store the errors related to the hardware, software and also inputs and outputs in its internal memory. If the RTU detects an error that does not interfere with the normal process, it will send the error for the CTC[3].

11.1.components RTU

CPU: The responsibilities of this module are as follows: reading the situation of the inputs from the input modules and convert them to an understandable form for the CTC, decoding the received commands from the CTC and activate the appropriate output or outputs according to the received command from the CTC and managing the communications between the internal components of the RTU and managing communication with the CTC center. In order to accomplish all these assigned tasks, a software should be installed on the

RTU that is different and dedicated for each station due to the distinct input and output rate in each station and also due to each station's specific address [3].



. **Figure 5: System rtu**

12. CENTRAL I NTER LOCKI NG SYSTEM

The intemal structure of an interlocking module is illustrated in Figure5. The hardware features of the main interlocking processor are determined predominantly by the requirements of the redundancy management function and the need to exchange information with the panel and communications processors. Redundancy management requires parallel I/O for the control, testing and monitoring of the module isolation hardware

within its own module and within the two other modules of the redundant system. Serial I/O also required for the information exchange with the other modules necessary to prevent is divergence. Communication with the two panel processors is also in serial form, whereas the transfer of data to and from the three communication processors takes place over two4-bit and one 8-bit parallel connections. The various I/O functions are provided by three versatile interface adaptors and one ACIA. The memory space of the interlocking processor is decoded to allow the top 60 kbyte to be used for EPROM storage of program and data, with the top 20 kbyte allocated to program The lower 4 kbyte i~ allocated t, the memory mapped I/O and working memory, which it a. 2k x 8 bit CMOS static RAM This 'state-of-the-railway memory is capacitor supported to enable the system to survive power supply interruptions without losing certain controls on system behaviour which can only be input by a qualified technician The two trackside communications processors (TCPs) are identical minimal chip-set designs making use of the6802's onboard RAM for working memory. The internal communications processor (ICP), which handles information exchange with other interlockings, is broadly similar in design. All external connections to the modules are optically isolated. The only safety-related outputs are the serial data outputs from the communication processors, which are energized through the redundancy management hardware. The comparison and voting on these outputs is a software function and is described below. The serial the availability of the system that errors or malfunctions atdata exchange with the panel processors does not carry vital safety information, but it is nevertheless important to this interface do not prevent proper operation. To maximize availability in this area the three interlocking modules communicate individually with the panel processors, which each perform a two-out-of-three vote on the received data. The two panel processors send data to the interlocking modules alternately under individual interlocking processor control The redundancy management mechanism is, in effect, a redundant and testable means of removing power from the serial interfaces which carry safety information. The mechanism is operable, and also testable, by the parent processor acting alone or by the other two processors acting together. Any voting diagreement or failure of a redundancy management test results in the faulty module being removed from the system. When one of the three modules is removed in this way the surviving two automatically reconfigure as a two-out-of-two redundant system, and the failed module can be replaced and brought back into operation without In fact, the transfer of information necessary to educate the new module with the current state of the system takes about 150 ms, during which time the interlocking function is suspended [3].

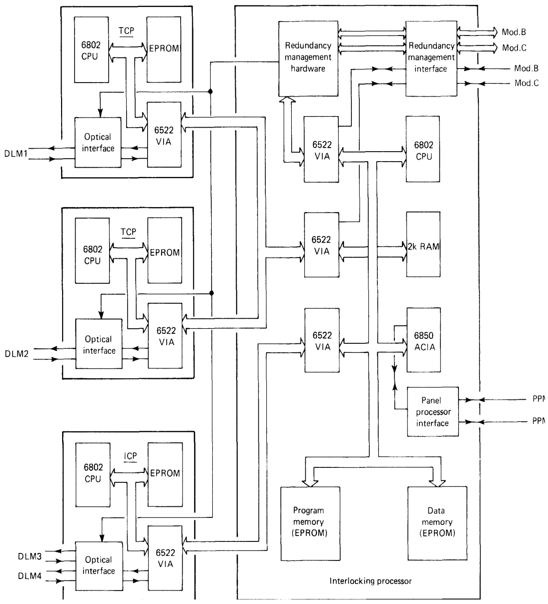


Figure 6: Internal structure of an interlocking module

12.in novation with power analysis based on Liner sysnchronouse motors(lsm)

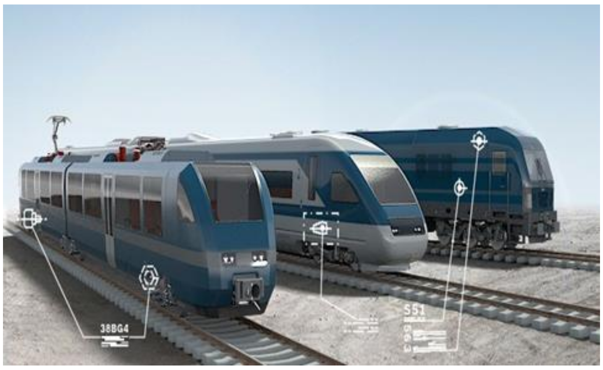


Figure 7: System SWU

Linear arrays of magnetic rotor attached to the stator three-phase diesel , have fixed the LSM / HA. (Linear Synchronous Motor) represents the amplitude , phase and frequency of the stator currents are providing the acceleration or deceleration of the rotor are designed for diesel . Large-scale arrays of permanent magnet linear synchronous drives for example, has been used in commercial systems , is that they function effectively . In addition to retrofitting electric propulsion LSM / HA Linear Synchronous Motor) a Top of Form

The major advantage is that the energy can be easily converted to electric brakes .dissipated as heat into electrical energy, which results in reduced operating costs and minimize the power consumption [3].

13.LSM/HA Railcar Retrofit Design

The LSM stator consists of three serpentine windings interlaced as shown in Figure 1. The windings are excited by three-phase currents in such a way that the time-varying magnetic field produced by the windings forms a systolic action capable of pulling a magnet rotor along the length of the stator. The magnet rotor is formed as an"inverted U" geometry housing a that by the strategic placement of individual magnets the field on one side of the array is greatly enhanced and the field on the opposite side is greatly diminished. Both of these features are significant to the design. By placing two Halbach arrays in opposition to each other in the "inverted U", the field between them is roughly doubled and the residual field outside of the array is nearly non-existent. While benefit of the increase in magnetic field strength should be apparent, the reduction in field strength outside of the array has unique safety and operational aspects as well.

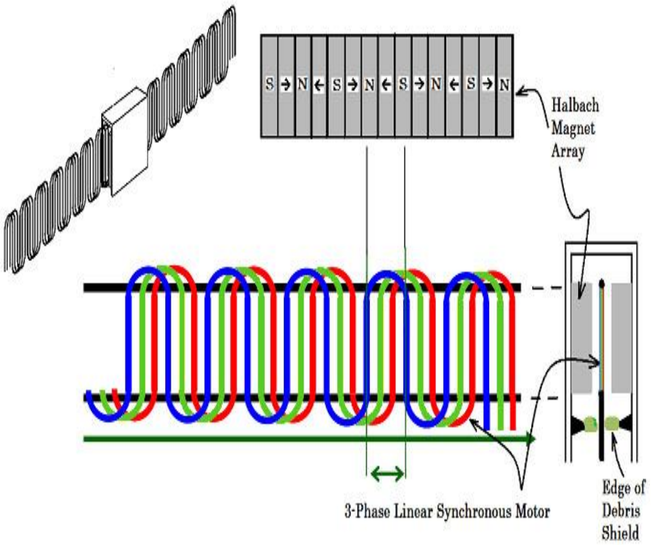


Figure8: Three-Phase Synchronous Motor and "Inverted U" Geometry Housing Doubled Halbach Arrays

When considering how to attach the arrays to a railed vehicle it can be noted that the bogie assembly remains at a relative constant elevation with respect to the track, although there is the possibility of horizontal motion (side to side) of as much as 40 mm. The car body, however typically has some type of suspension that would introduce not only greater vertical and horizontal motion but also pitch, roll and yaw. Making an attachment system for the car body that could compensate for this greater degree of freedom would significantly reduce the simplicity of the concept and possible require additions to the vehicle to compensate for any loss of strength this might create. While there may be some advantages to installing the rotor and stator horizontally, the proposed system will mount the stator and rotor vertically on both sides of the railcar. This design is based on the concept that the array will be mounted on the bogie as shown in Figure 2 and will be able to operate with 40 mm of horizontal play.

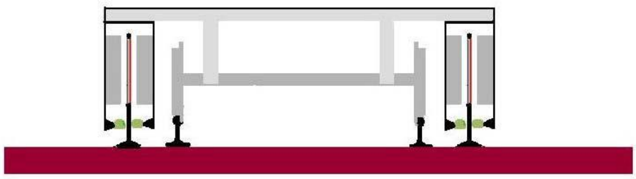


Figure 9: Linear Synchronous Motor/Halbach Array Geometry for Railcar Bogie Attachment

The expected size of each of the Halbach arrays mounted on both sides of the bogie would be a 39 element, (10 wave length) array that measures approximately 2.0 m in length by 0.5 m in height which produces a sinusoidal field with a peak field strength of about 1 Tesla [4].

14.Computer Model Formulation of LSM/HA Bogie Retrofit

When a straight conductor, such as a rung of one phase of an LSM, carrying an electrical current is placed in a magnetic field (Halbach Array), each of the moving charges in the conductor experiences a force called the Lorentz force. The amount of force on the entire conductor can be calculated by the following equation:

$F = IL \times B$ **(1)**

where:

F = Force, (newtons)

I = current in wire, (amperes)

B = magnetic field vector, (teslas)

L = length of conductor in magnetic field, (meters)

When a conductor moves through a varying magnetic field, the conductor experiences an induced voltage that creates a referred to as "back electromotive force (emf)" or "motional emf". The amount of this current which opposes the motion.

This phenomenon is voltage induced on the conductor can be calculated by the following equation

$\mathbf{E} = vL \times B$

where:

E = Electromotive force, (volts)

v = velocity of the conductor, (meters per second)

B = magnetic field vector, (teslas)

L = length of conductor in magnetic field, (meters)

In fact, these equations can be interpreted as the equal and opposite force on the Halbach array fixed to the mobile railcar, and the emf produced in the LSM by the moving magnet How does one vary the force to accelerate or decelerate the vehicle? The strength of the magnetic field is governed by the size and geometry of the magnets, once built the magnitude of the magnetic field will not change. The current in the LSM stator is varied such that its phase varies at the same rate as the movement of the magnetic array so the magnetic field appears to be constant to the LSM. By inspecting the first equation one can see that if the magnetic field remains constant, the force can be increased either by increasing the current or increasing the length of wire. Higher current requires a larger more costly power electronic system. The simplest method to increase force seems to be increasing the length of wire by making multiple passes through the magnetic field with the same wire effectively increasing the length without increasing the current. From the second equation it can be seen that there is a penalty for increasing the length of wire by increasing the "back emf", or opposing force, which will require a higher voltage to generate the same current during acceleration. During deceleration at high speeds this increased voltage makes it difficult to capture that energy for storage and subsequent reuse At low speeds (when v is small) the back emf poses little problem The general result of equations 1 and 2 is that a finite electrical power source can supply current until the back emf is so large that the voltage of the source and hence the drive current cannot increase beyond a "terminal" current at which time the power delivered is zero and the LSM reaches a terminal velocity. The mechanical equation of motion for the LSM/HA vehicle is the final fundamental equation to determine the systems frrst-order performance.

MV = Mass of the Vehicle (kilograms)

a = acceleration of the vehicle (meters/sec2)

CRR = Rolling resistance coefficient of steel wheel on rail

ρ = air density (kilograms/meters3)

AF = Vehicle frontal area (meters2)

CD = Coefficient of drag

v = Vehicle speed (meters/sec)

vW = Component of wind speed in the vehicle's moving direction (meters/sec)

g = Acceleration due to gravity

α = Track angle

The computational approach involved specifying a reasonable velocity profile and determining the requisite acceleration and hence propulsive force required to accomplish the specified velocity profile. The propulsive force required certain current and voltage(depending upon the resistance of the LSM segments) in order to overcome rolling friction and wind resistance as it was meeting the input velocity profile. From those calculations the power requirements to accelerate the vehicle and maintain its constant trip velocity was determined [4].

15.DC Link Retrofit with Flywheel

The typical form of commercial flywheel for this application consists of a 3-phase permanent magnet synchronous motor-generator connected to a 3-phase inverter for bidirectional interface to the DC bus. The flywheel spins in a vacuum, is levitated on active magnetic bearings, and stores 3.0 MJ (3000kWs or 0.833 kWh) at 36 krpm. Coupling multiple flywheel systems in parallel allows for significant energy storage. Sophisticated computer control within the flywheel system monitors the DC bus and stores or releases the electric energy depending upon the rise or fall of the voltage level; thus maintaining the voltage while supplying the necessary current. The rate of energy storage or release is the power; the form of flywheel described here stores and releases energy at a rate of 100 kW. As previously discussed, the efficiencies of the motor-generator energy coupling, energy loss in maintaining the vacuum, and inverter efficiency all combine to form a storage/release efficiency of about64% (efficiencies of 90% have been achieved, but not commercially available for the energy and power levels being considered).

Applying the parameters of the aforementioned flywheel to the energy generated during stopping the cargo vehicle and energy needed to start the vehicle, shows that at least four such flywheels in parallel are needed to absorb the 10.5 MJ of stopping energy. The 6.4 MJ released at a constant rate of 200 kW will deplete the energy in about 30 seconds while the acceleration phase is approximately 60 seconds in length. The flywheel computer control process of maintaining the constant voltage should provide a time varying current waveform similar to the waveform of Figure 7 with smaller current values, so the power follows the “64% power efficiency” curve of Figure 9.[4].

16. UPS SYSTEM

Due to the growing station , typically enough Flywheel UPS systems are based on real time . Most engineers UPS measurements in real time to grow 30 to 40 percent greater than design. When the UPS system is to a certain extent , flywheel UPS is also exactly the same size . UPS , so all rankings are based on number of KVA and KW . Ranking used for power applications depends on the amount of kW .
For example : A UPS 275kVA power factor (PF) score of 0.9 or function results in an output rating of kW 248 for UPS loading real work at UPS 80 % or less typical example our kVA275 (80% loaded) or the DC power 207kW flywheel support needs. These ratings are used to measure flywheel power rating and appropriate to ensure a reasonable amount of time needed for implementation . Most of the energy produced by the flywheel by users with runtime graphs much easier to have made it to the flywheel . As shown in Table 1 , using two Flywheel run-time model was 26.6 seconds . Flywheel Model 2 in ETA
28/6 seconds to start up , so this solution is tailored to the needs of most broadcast stations .

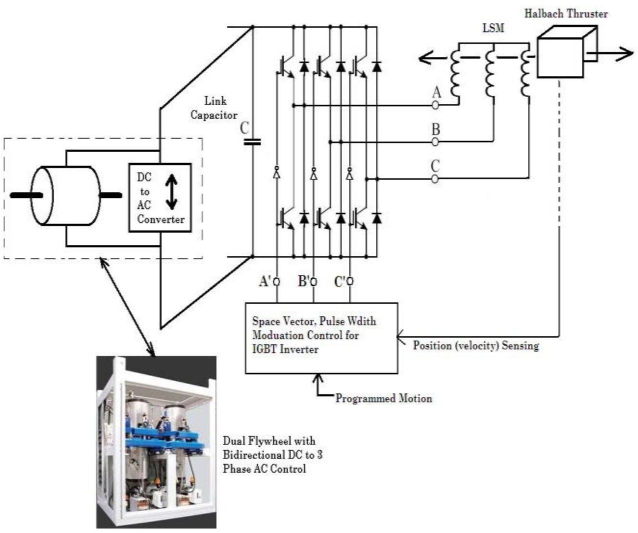


Figure 10: Three-phase LSM / HA E drive with flywheel energy Arbitration

The UPS with three-phase and three-phase inverter Rectifiers, which are offered in different strengths. The UPS has a battery 170 that provides a total VDC230.
Acid or nickel cadmium batteries are. The charging system devices manually (Outomatic Boost, Float) is. UPS Uninterrupted Power Supply in word meaning and word combination is as follows Using this device, the presence or absence of supply voltage capable Network load with constant voltage and constant frequency will Problems in the network include: changes in voltage and frequency. The impact of switching voltages in the network will be sudden . Typically refers problems on the voltage of the following factors exist that UPS (UPS) to transfer the load will prevent these problems . Automatic cut-off switch is opened under load causing impact on the voltage . Protective relays to operate against the ground , causing a voltage is disconnected . Add heavy load on the network abruptly , causing the voltage and frequency will be momentarily .
Working with other agencies or similar thyristor electronic switches are used , such as motor driver causes harmonics on the Network will. [5].

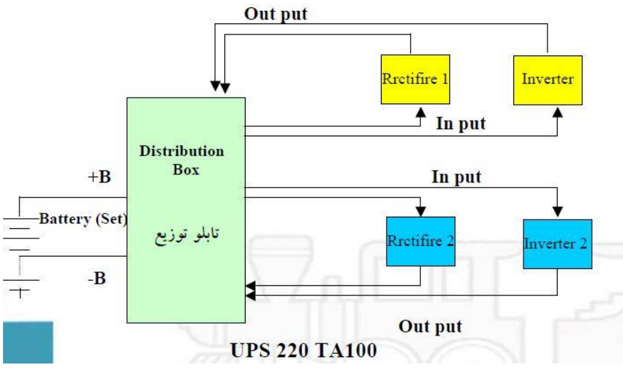


Figure 11: Structure UPS

16.1. By Ups Function

Performance UPS charge of keeping a source of stored energy in the name of a battery to power failure , the energy source used , and once fed . , So the first step is to convert AC voltage grid into DC voltage to charge the batteries is that operation or battery charging is done so by RECTIFIER . The second step converts the energy stored in the batteries as DC to AC inverter or converter so that the operation is performed. [5].

.16.2 Rectifiers The Tasks Of The

Responsible for converting AC to DC voltage and DC voltage required to charge the batteries and the inverter is . The following features convert AC to DC voltage through a bridge rectifier diode Protection against input current Measurement and control of DC output voltage Measurement and control of DC current to charge batteries
Measurement and control of DC current applied to the inverter

16.3 The Tasks Of The Inverter

The duty inverter converts the DC voltage to AC voltage to supply the load . These are the following features to help bridge converts DC to AC Inverter IGBT Vatazh Protection against output overcurrent Protection against short circuit at the output Protection against overcurrent battery Stabilize the output voltage at nominal voltage. [5].

16.4 The Static Switch

The task of determining the direction of energy transfer to the load side of the switch matrix or grid inverter has. This section contains the following features Transfer of energy from the inverter to the grid and vice versa path using back-to- back thyristors.

16.5 Rectifiers

The different charging mode for charging batteries Rectifiers are:

16.6 Different States Of Charge

Most of the time needed to charge batteries quickly and not only be putting a voltage on them to prevent them from being discharged [5].

16.6.1.Charge Storage FLOAT CHARGE MODE

Most of the time needed to charge batteries quickly and not only be putting a voltage on them to prevent them from being discharged. In this case, charging device acts as a voltage source and the voltage applied to the ends of the batteries tries to keep a constant. [5].

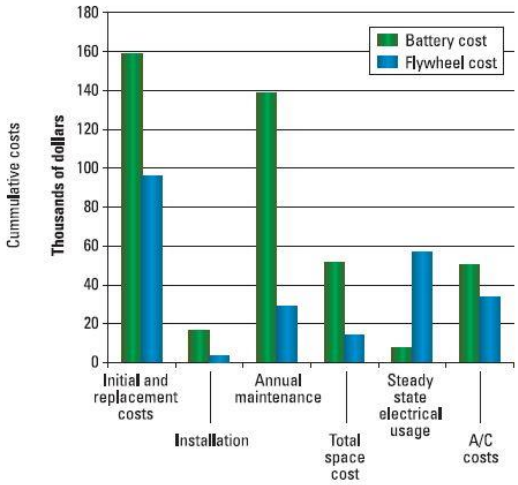


Figure 12: Graph charging mode

16.6.2 Rapid charging BOOST CHARGE MODE

Typically, a continuous function of time that the batteries have discharged and the voltage is lower than the nominal input voltage , they need a quick charge . In addition, rapid charging interval will increase the useful life of the batteries . In quick charging mode , the charging device tries to the pump flow constant charging batteries do. This causes the batteries to charge completely sure we [5].

16.6.3 automatic recharge mode

In this mode, the system automatically recharge the batteries state of charge and fast charge mode voltage of either keeping one chooses . First Vltazhbatryha card Rectifiers (6) of the control voltage is compared to normal batteries and If the voltage of the batteries is lower than normal voltage to a timer determines the maximum time allowed for rapid charging , will command . This time Taymrsystm for rapid charging operates. The fast charge mode Sharzhng•hdary state at the end of the timer count will occur. [5].

16.7 INVERTER

Inverter 220 VDC input received from the Rectifiers or the battery voltage by using a bridge transistor INVERTER DC to AC Voltage 380V three phase turns [5].

Table 1. R ailway flywheel system

Specifications	
Rated power	**500 kw**
Usable energy storage	**12 sec**
Flywheel rotational speed	**6000 kw-sec**
Input	
Input voltage	**450 – 1000 VCD**
Recharge rate	**12 sec**
Output	
Voltage discharge	**400 – 980 VCD (adjustable per application)**
Voltage regulation	**+/-1%**
DC ripple	**Less than 2%**
Environmental	
Operating temperature	**-4°F to 104°F(-20C to 40°C)**
Humidity	**95% non-condensing**
Altitude	**5000ft.max without derating**
Audible noise	**66 dBA at 3.3 ft (1m)**

17. Conclusion

Systems due to the possibility of visiting the station set up signs in the area , during the installation it is necessary to determine the proper installation location is closing assembly screws , wire connectors , ensure the accuracy of the system (the room interlockings yard stations) and absence of voltage fluctuations and the precautions necessary to prevent damage to electronic systems and ..... the purpose of staffing professionals and electronic devices are equipped with the innovative power analysis based on linear synchronous motors (LSM): represents the amplitude, phase and frequency of the stator currents are providing the acceleration or deceleration of the rotor are designed for diesel . The power needed to accelerate and maintain a constant speed diesel it has been set .

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