

Demonstration of electric system for electric train

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Abstract- This research is to construct the demonstration set of basic electric system for modern electric train. The proposed was demonstrated the drive operates for modern electric train that operates under specification as alternating current high voltage. Most of the modern electric train designed by AC-DC-AC traction system. The conversion electrical energy in modern electric train uses the power electronic for drive motor. The power electronic have three mainly circuits includes Four Quadrant Chopper (4QC), DC link capacitors (DC-Link) and Pulse Width Modulation Inverter (PWM). This demonstration operates under specification as single phase 220V 50 Hz line voltage and power input 0.5 – 1 kW. The 746 W three-phase squirrel-cage induction motor is used replace the three-phase asynchronous-traction motors because that have the same properties and smaller than three-phase asynchronous-traction motors. Signals can be used oscilloscope for measure at input and output of each circuit. Main circuit diagram, power electronics and signal are presented. This research describes the signals of each circuit and system. The experimental results show that the proposed power electronic driver circuit can operate well and validate the correctness of proposed control method. We are convinced that this research work contributes to promoting understanding of railway transportation system in the future.

Keywords: Electric train, Four Quadrant Chopper, DC link capacitors, Pulse Width Modulation Inverter.

I. INTRODUCTION

From the Thai government plan of developing the basic of Thai transportation around 2015-2024. There is a budget about 2.005 trillion Baht. It is divided into 4 kinds of developing Thai transportation: 1.By road 706,466 million Baht (36.45%) 2.By rail 1,021,903 million Baht (52.73%) by divided to double-rail 509,640 million Baht (26.30%) and BTS 512,262 million Baht (26.43%) 3.By Sea 76,666 million Baht (3.96 %) 4.By air 193,974 million Baht (6.86%) From the above plan, can observed that they played the important role in the developing of the transportations by rail. It can be observed that there gave over 50% of all budgets to rail transportation.

In the present, the Thai rail transportation use almost

100% import equipment then must use the knowledge workers. So these made Thailand imported all technology: start with planning, designing, managing and repairing. The important is propagating the technology to Thai employees that they don't have a high efficiency about rail transportation. The problems occur because it is lacked of the knowledge, skill and experience of employees. The report by concern the amount of the present employees showed that it would need more workers. The results giving that the important basic knowledge requires. Following by the developing plan of transportation by rail by national science technology and innovation policy office (www.sti.or.th) with the transportation of Chulalongkorn university seeing that the route expansion of the rail transportation both in Bangkok and nearby city are now proceeding in 2015. They will require the workers over 3,000 people. When we analyzed the worker requirement together with the government plan about the basic developing structure of Thai transportation in year 2016 – 2025 seeing when the transportation investment on the rail transportation have finished, there will be the requirement on the workers not lower than 10,000 people.

From those important problems, government concern and want to solve these lack of workers problem so they will play the important role in the development of the rail transportations of the country. They suddenly create the project “Developing and creating technical workers for rail transportation” start from the 2013 by Thailand Advanced Institute of Science and Technology – THAIST put in the developing subjects to start teaching and others. Now, there are 8 developing subjects. These are set to have the tutorial teaching technique for 4 vocation education school e.g. Nakhonpathom technical college, Samut songkham technical college, Siam technological college (Siamtech) and Pranakorn Sri Ayutthaya technical college. Therefore in semester 2015, there are other 5 schools that also start the transportation for rail class (These are not in the starter school in the above that have already mentioned).

The course are about the transportation by rail system is used the basic theory of the many department such as electrical engineer, mechanical engineer are applied to

use with the transportation by rail transportation but to understand about other theories. They are very difficult because it can be able to get the equipment through the classroom so students wouldn't be able to study and have a high efficiency. From the above problem, there is an idea to solve the problem by making the sample set. The aim of electrical transportation basic system is to state about the electrical converter and make the learners efficient.

II. ELECTRIC TRAIN WITH TRACTION CONTROL UNIT

The electric train generally gain the electricity from the outer and through the electrical converter system and give to the speed of the control system. Normally, using to control the pressure level of the plug. The electrical system that use in the electric train are in many levels depends on the design of the manufacturer such as the electronic system of the airport link by the electric that get to the airport link pressure will be depressed by the transformer. The pressure is divided into 2 levels are the pressure uses to force the airport link and the pressure uses to support the other systems.

The pressure that use to force the body and will be lift up to be higher to be suitable with the pull motor for example 460-750 V 250 kW etc. By turning the pressure higher has to control the pressure and frequency to support the velocity control of the pressure that use to support is the standard pressure at 400V 50Hz use with general electronic devices such as lightening, door system, the heat system, the heat releasing and also the customers service.

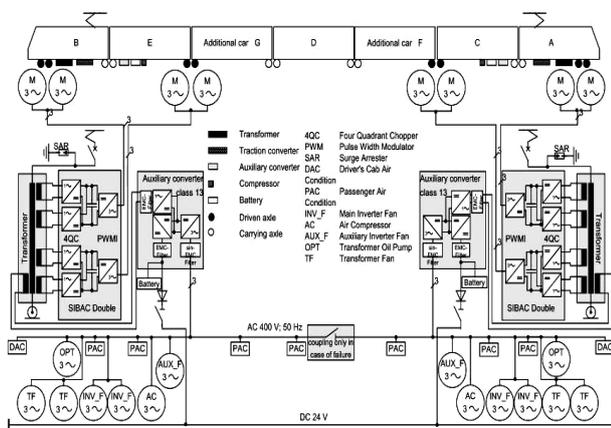


Fig. 1. Electric system within the train. [7]

From Fig 1, the electrical system within the train that get the AC from Overhead lines. Mostly the electricity will get from overhead lines there will be the pressure at Kilo Volt level. The aim is to decrease the inductor. The current will get through transformer to decrease the pressure by the current will give out the transformer will be divided into 2 parts: the main electricity system and the support system.

1. The main electricity system generate the electricity to the motive system that is called "Traction motor". The electrical traction motor is the three inductive motor that has many ways to control the motor but mostly use modulation the length of the pulse (Pulse width modulation : PWM) to give the 3 phases AC to generate to the electrical motor. There are a lot of benefits of PWM for example low cost and response the sudden

changing etc. The input pressure of the PWM system. There is a condition because there is the three systems:

1.1 Four Quadrant Chopper system (4QC) use for changing AC from the supply origin to DC. This system consists of 4 bridge diodes.

1.2 DC link system supply the DC from 4QC system to get the smoother by use more than two capacitors.

1.3 PWM system use to change the DC that gain from DC link to be 3 phases AC that this system can control the pressure and the gain frequency. So this is able to change the speed of the traction motor.

2. The electricity support system giving the electricity to the other support systems such as computer system, lightening system, door system and heat releasing system etc. There is the electricity inverter that is similarly to the main electricity but the size will be smaller because there is less of the use of support system. The differential of the electricity support system will has the UPS that can supply the electricity to the computer. Therefore, it must give the electricity to the computer system all day because there is a process that use to control electric train.

III. CIRCUIT IMPLEMENTATION

The demonstration set of basic electric system for modern electric train was designed before construct. The design is composed of the table that has panel (to install system and electrical measurement). On the table, there are speed of the motor and electric train sampling set. Motor of UPS is stored under the table as shown in Fig 2.

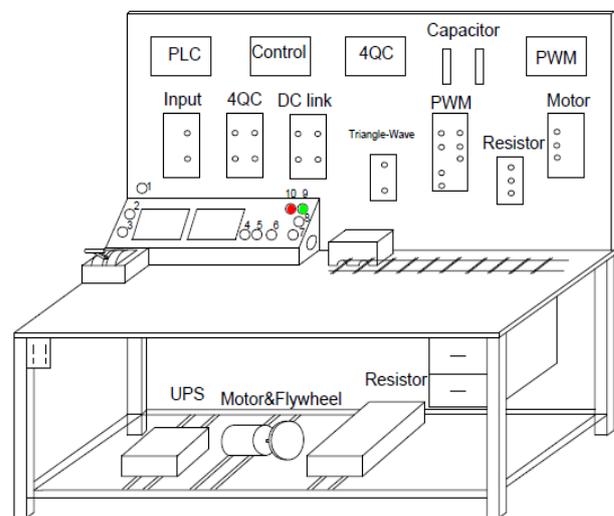


Fig. 2. The design of demonstration set.

The part of basic electric system for modern electric train is demonstrated in the Fig. 3



Fig. 3. The demonstration set of basic electric system for modern electric train.

1. Main Distribution Board

The electrical equipment will be stored in the Main Distribution Board such as Circuit breaker UPS and Motor drive. The UPS will give the electricity to the control circuit when there is no electric input. In motor drive will build up the electrical power to give to 3 phases motor.

2. Driver's desk

These three devices will cooperate that use to control the current that giving to the motor. There are 1. Display screen 2. Keypad and lighting indicator 3. Speed adjustment lever.

3. Programmable logic controller

Programmable logic controller or PLC is the middle processor unit. To do in the step in order to received data from the user and uses this information to send to the other parts.

4. Controller

The controller will receive the signal from Programmable logic controller (PLC). It is the part that drives the motor to reprocessing and sends the data to the power converter.

5. Four quadrants chopper and pulse width modulation

Four quadrants chopper and pulse width modulation is the main of the converter system because is converter device to convert AC to DC and invert DC to AC respectively.

6. DC link capacitors system

DC link capacitors system are composed of 4 capacitors (main devices) used for filter the DC signal to be smooth and will have the least noise.

7. Train simulation

Train simulation is the train mock up to show the user show the movement of the train that shortens distance that shows the relative of velocity control and the movement of modern electric train.

8. Induction motor

Induction motor is used for the works same as use in the modern electric train (by set in the sampling sets is used the induction motor 3 phases 0.75 kW. We can controlling the motor by command via Master control.

9. Brake resistor

Brake resistor is the device used for eliminates the power and can give the power backward. While the motor is breaking, the brake resistor uses the 50 Ohm 1000 W resistor.

10. Spot checking of four quadrants chopper system

It is consist of 2 checking spots: the input and output. They are used for observing the signal changed.

11. Spot checking of DC link capacitors system

It is consist of 2 checking spots: the input and output. They are used for observing the signal changed.

12. Spot checking pulse width modulation

It is consist of 2 checking spots: the input and output. They are used for observing the signal changed.

IV. EXPERIMENTAL RESULTS

The experiment to determine the stability and the stability of the system by measure the current and the rpm. at different frequency in three times then find the average of them. From the experiment see that the current will changing lower than 8.51 % as shown in Table 3 and Fig.4. rpm. will changing lower than 1.99% as shown in Table 4 and Fig.5.

TABLE 1. 3 TIME OF CURRENT (A) AND AVERAGE WHEN FREQUENCIES VARYING.

Frequency (Hz)	Current (A)			
	First	Second	Third	Average
0.00	0.00	0.00	0.00	0.00
8.00	0.40	0.41	0.39	0.40
16.50	0.44	0.47	0.43	0.45
24.50	0.49	0.50	0.48	0.49
32.80	0.55	0.56	0.57	0.56
42.00	0.68	0.69	0.66	0.68
50.00	0.78	0.80	0.82	0.80

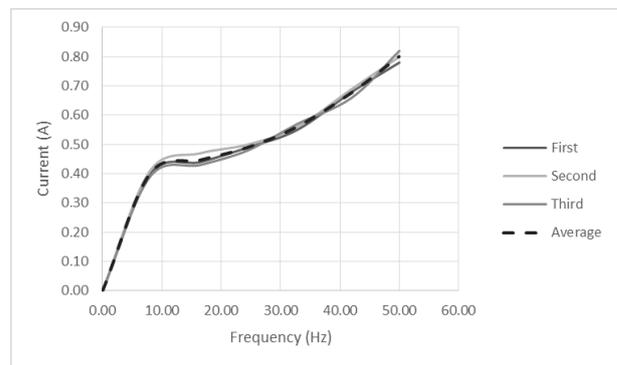


Fig. 4. Current (A) 3 time and average when frequencies varying.

TABLE 2. 3 TIME OF REVOLUTIONS PER MINUTE AND AVERAGE WHEN FREQUENCIES VARYING.

Frequency (Hz)	Revolutions per minute (rpm)			
	First	Second	Third	Average
0.00	0	0	0	0
8.00	247	251	246	248
16.50	494	495	490	493
24.50	736	732	732	733
32.80	984	980	981	982
42.00	1121	1126	1115	1121
50.00	1250	1253	1248	1250

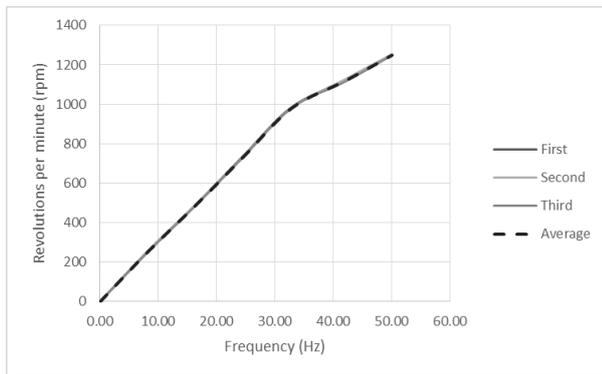


Fig. 5. 3 time of revolutions per minute and average when frequencies varying.

V. CONCLUSION

The demonstration set of basic electric system for modern electric train was introduced. The circuit implementation of proposed drive was applied. Input single phase voltage was supplied and was inverted to three phase voltage for meeting the requirement of the demonstration set of basic electric system for modern electric train. Measuring the electric signal to find the basic sampling set. As the result, determine the stability of the sampling set by doing the experiment in three times. The results see that the sampling set is reliable and good efficiency, which has a great practical value.

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