Solution of DC Railway Traction Power Flow Systems Including Limited Network Receptivity

Dr.P. Selvam and G. Moorthy

Abstract--- This paper presents a new procedure based on a backward/forward sweep (BFS) speed direction for solving power flows in weakly meshed dc traction networks is presented. The proposed technique is able to consider the trains as nonlinear and non-smooth (no differentiable) voltage-dependent loads or generators. This feature permits the inclusion of the trains' over current protection and the squeeze control. With the use of the mentioned controls, the conventional power flow problem becomes a voltage constrained power flow problem, and the interaction between the trains and the network can be accurately modeled. However, the train control induces a highly no smooth voltage-dependent load characteristic, causing convergence problems in most of the derivative-based. The proposed method is faster, more robust, and more stable than the derivative-based ones.

Keywords--- Distribution System Modeling, Railway Systems, Voltage-Dependent Load Modeling, IOT.

I. INTRODUCTION

The Designing DC rail traction power system or modifying computer-aided techniques based on simulation achieves an existing one. Traction simulators are employed to establish equipment ratings, to assess train regeneration effects, and to verify that voltages remain within permissible limits and that rail potential, and earth leakage currents are kept according to specifications for safety and interference mitigation. Traction simulators are based on power flow calculations carried out at different time instants sampled from the study horizon; the locations and power demands of the vehicles vary over the study period, and each instance has the trains represented using the stationary equivalents for moving vehicular loads. A typical simulation study may require hundreds of sampled instants and consequently a significant computational effort; this effort increases with the sampling rate employed over the study horizon. The computational effort is further exacerbated with the simulation of regenerative train breaking and nonreversible substations, as this requires additional power flow iterations for modeling the behavior of the train local controllers. This paper proposes the use of a sensitivity approach as a means to enhance computational performance when modeling local controllers in DC traction power flow.

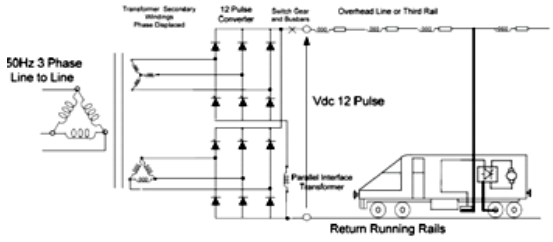

Figure 1: Rail Traction Power System

Different models and simulation approach for dynamic simulation of an automatic subway. For this purpose, several models are carried out from a dynamic model, which is validated by comparison with experimental measurements. Furthermore, two different simulation approaches are compared, i.e., backward and forward strategies. A simplified model is obtained and allows the

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reduction of the simulation time by 96 compared with the dynamic model by keeping an accuracy value of more than. The reduction of vitality utilization is a test for the next decade. New and more efficient systems are thus developed to face this challenge. Electric railway transportation systems such as trains, tramways, or subways are known for their high efficiency in comparison with other vehicles. Nevertheless, due to the environmental impact and the price of energy, which is the second most expensive item of a subway line, improving the global efficiency becomes essential.

II. LITERATURE REVIEW

New traction concepts and new structures of energy supply are envisaged by introducing energy storage systems or considering reversible substations. To assess the interest in new developments, new accurate simulation tools are needed. However, these tools can use different models and simulation approaches depending on different objectives. For example, dynamical models and forward approach are particularly used to study the control of a system. In this case, a closed loop is required, and the computation time is generally more critical than in a backward approach. However, any internal or external disturbance can be considered due to the closed loop. By contrast, backward approach and static models are often used to have a global overview of the energy consumption of a vehicle. In this case, no closed loop is required, but the drive cycle must be known in advance. The computation time is thus reduced because of the use of static models and no control loop. However, internal or external disturbances cannot be considered. Generally, the traction systems of subways and trams are not oversized to include a standard operation for the worst case. This paper compares different simulation models and approaches for the study of the energy consumption of a subway. The target model must have sufficient energy accuracy and low computation time for the extension to a complete line with multiple cars. Dynamical, quasi-static, and static models are studied in a forward approach using EMR as the common description tool. Moreover, a similar description is used for the backward approach. This presents two creative commitments identified with the consolidated AC/DC power control in railway power supply system (RPSSs). To start with, the vast majority of the power flow conditions (the straight ones) are communicated in a smaller grid system by utilizing the diagram hypothesis based convention. Such an approach improves the announcement of the brought together power stream issue and permitted the prepared movement to be demonstrated without changing the framework topology. Second, the issue is detailed as an Optimization Problem (OP) rather than utilizing the non-obliged control stream approach. This method enables the creators to recreate the impact of trains regenerative braking, considering system limitations, for example, the voltage limit, which determines the amount of available regenerated energy injected to the network, and burned through the resistors. Modern electric locomotive units include regenerative braking mainly for three reasons. The first one is the energy saving when a train injects part of the braking kinetic energy into the electrical grid, to be consumed by a nearby powering train or returned to the AC system through a reversible substation. The second one is a security reason. The pneumatic braking system cannot cover long distances with long gradients, and it must be combined with some electrical braking. In addition, the use of regenerative breaking instead other electric braking systems prevents from the tunnel temperature rising in underground railways minimizing energy consumption in air-conditioning or ventilating equipment. In these systems, the energy injected into the system by a train when it is other trains plus some electrical losses must consume braking, because in networks with no reversible substations, the energy cannot flow upstream through the non-controlled rectifiers. If the available regenerated braking energy is greater than the demanded energy, the train must activate the rheostat braking when the variable voltage reaches a given value. In this circumstance, it is important to create

AC/DC combined power flow methods, considering the use of regenerative units in DC traction networks with voltage constraints and no reversible substations. A novel and generic three-phase power flow algorithm are formulated for the islanded micro grid. The algorithm is novel since it adapts the real characteristics of the islanded microgrid operation some of the distributed generation (DG) units are controlled using the droop control methods, and they're generated active and reactive power are dependent on the power flow variables the steady-state system frequency is considered as one of the power flow variables. The proposed algorithm is generic, where the features of distribution systems, three-phase feeder models, unbalanced loads and load models have been taken into consideration. Further, all possible operation modes of DG units have been considered. The problem has been formulated as a set of nonlinear equations. A globally convergent Newton-trust region method has been proposed to solve this set of nonlinear equations. The proposed algorithm is a helpful tool to perform accurate steady-state studies of the islanded micro grid. Different case studies have been carried out to test the effectiveness and the robustness of the proposed algorithm. The electrical power framework is at present experiencing a profound change as larger portions of its growing demand are being fed through the use of distributed generation (DG) units.

III. PROPOSED ARCHITECTURE

Multi-train modeling and simulation play a fundamental part in railway zap amid activity and arranging stage. Investigation of pinnacle control request and vitality devoured by every footing substation should be resolved to check that electrical vitality streaming in its railroad control nourishing framework is, and current infusion techniques are notable and generally acknowledged as an apparatus for electrical power organize solver in DC rail line control supply think about. In this paper, a disentangled footing control utilizing load examination technique has been proposed. The proposed technique utilizes an arrangement of current-adjust conditions at each electrical hub rather than the traditional power-balanced.

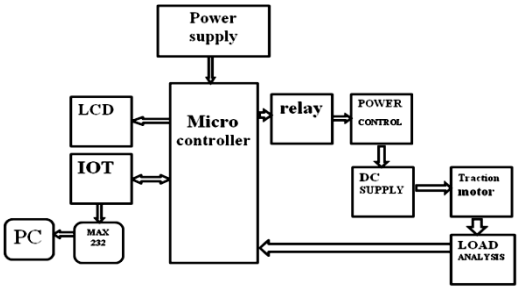

Figure 2: Proposed Architecture

Block Diagram Explanation

- An AC powered unlimited power supply usually uses a transformer to convert the voltage from the wall outlet to an alternate, these days generally lower, voltage.
- In the event that it is utilized to create DC, a rectifier is utilized to change over rotating voltage to a throbbing direct voltage, trailed by a channel, containing at least one capacitors, resistors, and some of the time inductors, to sift through the vast majority of the throb.
- Load flow studies decide whether framework voltages stay inside indicated confines under typical or crisis working conditions and weather gear, for example, transformers and conductors are over-burden.
- Load stream ponders are usually used to: Optimize segment or circuit stacking.
- In broadcast communications, control alludes to the way toward controlling the intensity of a transmitter to accomplish better correspondence flag or general nature of administration.
- It is primarily used to control the transmitting intensity of a specialized gadget to accomplish better execution.

Traction Power Supplies

- A traction substation or traction current converter plant is an electrical substation that believers electric power from the shape gave by the electrical power industry for open utility support of a suitable voltage, current write and recurrence to supply railways, cable cars or trolleybuses with traction.
- Traction power supply means to design redundancy in such a manner that at no instant there is a discontinuity of power supply to traction vehicle for more than a tripping time plus the time takes for isolation and feed extension.
- By using IOT, we can get the load analysis of the traction motor and feedback given to the controller.

Relay

The relay is the device that opens or then closes the contacts to cause the task of the other electric control. It identifies the unbearable or unwanted condition with an appointed territory and gives the charges to the electrical switch to disengage the influenced zone. In this manner shields the framework from damage.

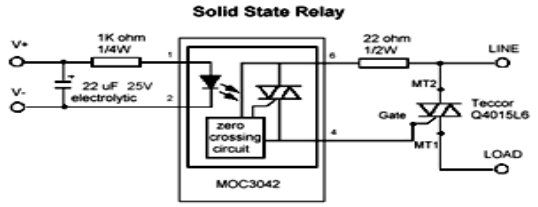

Figure 3: Relay

It works on the principle of electromagnetic induction. When the circuit of the relay senses the fault current, it energizes the electromagnetic field which produces the temporary magnetic field. The magnetic field moves the armature for opening or closing the connections. The little power hand-off has just single contact, and the power transfer has two contacts for opening the switch. The inward segment of the transfer appears in the figure underneath. It has an iron center which is twisted by a controlled curl. The power supply is given to the curl through the contacts of the heap and the control switch. The present moves through the loop deliver the attractive field around it. Because of this attractive field, the upper arm of the magnet pulls in the lower arm. Subsequently shut the circuit, which makes the present move through the heap. On the off chance that the contact is as of now shut, at that point, it moves oppositely and consequently opens the contacts

Power Controller

(a) Variable Voltage Regulator

The Variable Voltage, or VV, is a feature found in some individual vaporizers that enable the client to physically modify the voltage being given to the atomizer (or customizer) warming loops. D.C. variable seat supply (a seat control supply, for the most part, alludes to a power supply fit for providing an assortment of yield voltages valuable for BE (seat trying) electronic circuits, conceivably with a consistent variety of the yield voltage, or simply some preset voltages; a research facility power supply implies typically. It does not require external feedback elements are three terminal voltage regulator which regulates the output voltage at 5 volts for the unregulated input voltage over a predefined range.

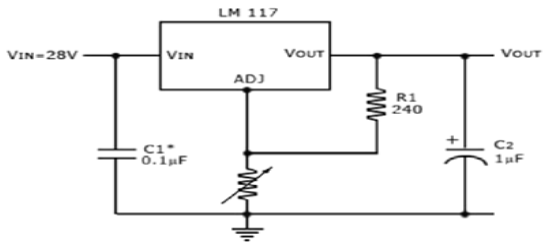

Figure 4: Variable Voltage Regulator

In some cases, capacitors may be used across input and output terminals. So suppose we want an output voltage of our PSU bench power supply, then all we have to do is connect a regulator too. As the PSU has already done the rectification and smoothing to the output, the main extra parts required are a capacitor over the information and

another over the yield. These extra capacitors help in the stability of the controller and can be anyplace between. The additional 100uF output capacitor helps smooth out the original ripple content giving it an excellent transient response. This tremendous value capacitor placed across the output of a power supply circuit is commonly called a Smoothing Capacitor. These series regulators give a maximum output current of about 1.5 amps at fixed stabilized voltages 24V respectively. But what if we wanted an output voltage of the regulator. If we increased this terminal voltage, then the output would also rise by an additional 4 volts providing there was sufficient input voltage. Then by placing a small 4 volt Zener diode between pin-2 of the regulator and ground, we can make a 5V regulator produce a volts output voltage. This is the circuit graph of a 1.2 V to 25 Volts movable voltage controller utilizing IC LM 117 IC. The LM117 arrangement of movable 3-terminal positive voltage controllers can give more than 0.5A over a 1.2V to the 37V yield extend. They are anything but difficult to deal with and require just two outside resistors to set the yield voltage. This power supply can convey a most extreme of 0.5 A current. The circuit is anything but difficult to collect and gives awesome outcomes. Protections R1 and R2 are utilized for the voltage change. Change pot R2 to get the required voltage. On the off chance that particular esteem segments are not accessible, attempt the closest ones. The parts list is given with. Voltage controller, any electrical or electronic devices that keep up the voltage of a power source inside worthy points of confinement. The voltage controller is expected to keep voltages inside the recommended go that can be endured by the electrical hardware utilizing that voltage.

Load Analysis

(a) Voltage Sensor

The Voltage Sensor block represents a perfect voltage sensor, that is, a gadget that believers voltage estimated between two purposes of an electrical circuit into a physical flag relative to the voltage. Association V is a physical flag port that yields the estimation result. Sensors are a device which can sense or identify and react to certain types of electrical or some optical signals. Implementation of the voltage sensor and current sensor techniques has become an excellent choice for the conventional current and voltage measurement methods. There are two ways of converting the resistance of the sensing element to the voltage. First one is the simplest method that is to provide a voltage to the resistor divider circuit comprises a sensor and a reference resistor which is represented below

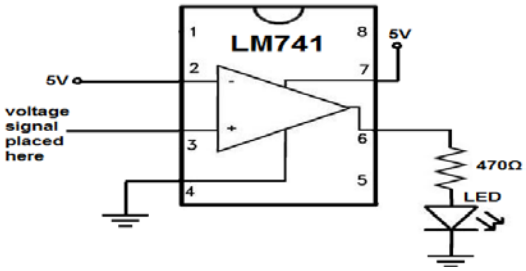

Figure 5: Voltage Sensor

As we realize that a capacitor involves two conductors or just two plates and in the middle of these plates, a non-conductor is kept. That non-directing material is named as a dielectric.

(b) Current Sensors

A current sensor is a gadget that identifies and changes over current to an effectively estimated yield voltage, which is corresponding to the current through the deliberate way. At the point when a present moves through a wire or in a circuit, a voltage drop happens. Additionally, an attractive field is produced encompassing the current conveying conductor. Both of these marvels are made utilization of in the outline of current sensors.

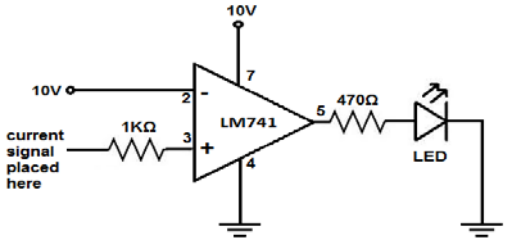

Figure 6: A Current Sensor

Hence, there are two sorts of current detecting: immediate and aberrant. Coordinate detecting depends on Ohm's law, while roundabout detecting depends on Faraday's and Ampere's law. Coordinate Sensing includes estimating the voltage drop related to the present going through aloof electrical.

Traction Motor

The name "diesel train" is deceiving, as the traction power is given by electric engines driving the wheels specifically, and the power to control the engines is created by an alternator driven by a diesel motor A traction control system (TCS), otherwise called ASR (motor slippage direction), is normally (yet not really) an auxiliary capacity of the electronic security control (ESC) on generation engine vehicles, intended to avert loss of footing of driven street wheels. Railroad electric footing depicts the different kinds of the train and various units that are utilized on jolt frameworks around the globe. A footing engine is an electric engine utilized for the impetus of a vehicle, for example, an electric train or electric roadway vehicle Traction engine alludes to a kind of electric motor.

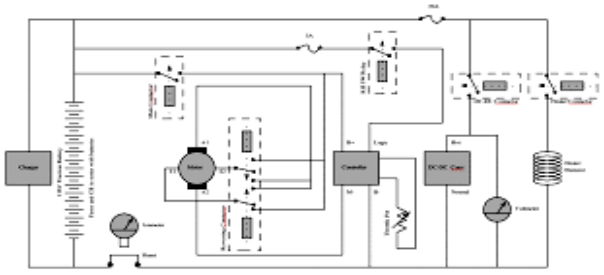

Figure 7: Traction Motor

A traction motor is utilized to make revolution torque on a machine. It is generally changed into a straight line movement. Footing engines are utilized as a part of electrically power rail vehicles, for example, different electric units and electric trains. When a vehicle without traction control attempts to accelerate on a slippery surface like ice, snow, or loose gravel, the wheels are liable to slip. The result of wheel slip is that the tires spin quickly on the surface of the road without gaining any actual grip, so the vehicle does not accelerate.

LCD

The Flat screen LCD and plasma screens work in a completely different way. In a plasma screen, each pixel is a tiny fluorescent lamp switched on or off electronically. In an LCD television, the pixels are switched on or off electronically using liquid crystals to rotate polarized light. Short for liquid crystal display show, a kind of show utilized as a part of advanced watches and numerous compact PCs. LCD shows use two sheets of polarizing material with a liquid crystal arrangement between them.

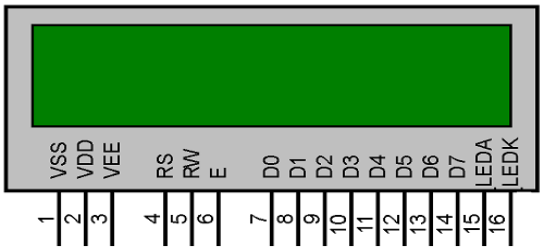

Figure 8: LCD Display

A liquid-crystal display (LCD) is a flat-panel display or another electronically balanced optical devices that use the light-adjusting properties of fluid precious stones. Fluid precious stones don't transmit light straightforwardly, rather than utilizing a backdrop illumination or reflector to deliver pictures in shading or monochrome. An electric current went through the fluid makes the gems adjust so light can't go through them.LCDs are accessible to show discretionary pictures (as in a broadly useful PC show) or settled pictures with low data content, which can be shown or covered up, for example, preset words, digits, and 7-section shows, as in a computerized clock.

IOT (Internet of things)

The IoT is short for the IIOT of Things. The Internet of Things alludes to the regularly developing system of physical items that component an IP address for web availability, and the correspondence that happens between these articles and other Internet-enabled devices and

system. The Internet of things (IoT) is the network of physical devices, vehicles, and other items embedded with electronics, software, sensors, actuators, and network connectivity which enable these objects to collect and exchange data. Experts estimate that the IoT will consist of It is also estimated that the global market value of IoT will reach The IoT allows objects to be sensed or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention. When IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies such as smart grids, virtual power plants, smart homes intelligent transportation and smart cities.

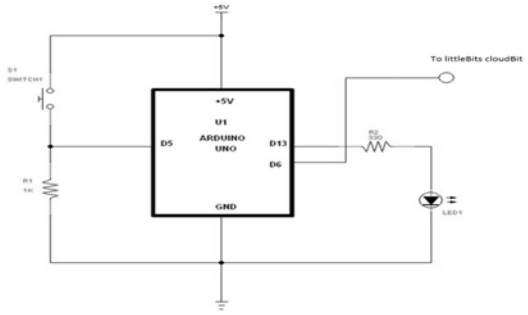

Figure 9: IOT (Internet of things)

Things in the IoT sense can refer to a wide variety of devices such as heart monitoring implants, biochip transponders on farm animals, cameras streaming live feeds of wild animals regarding "things" as an "inextricable mixture of hardware, software, data, and service. These devices collect useful data with the help of various existing technologies and then autonomously flow the data between other devices.

Max 232

Maxim Integrated Products design the Max232. This IC is widely used in RS232 Communication systems in which the conversion of voltage level is required to make TTL devices to be compatible with PC serial port and vice versa. This chip contains charge pumps which pump the voltage to the Desired Level. A solitary +5 volt control supply can control it, and its yield can reach +7.5 volts.MAX232 comes in 16 Pin Dip and numerous different bundles, and it contains Dual-Drivers.

It can be utilized as an equipment layer converter for 2 systems to communicate simultaneously.

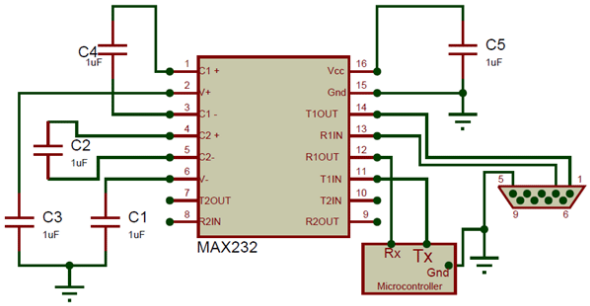

Figure 10: Max 232

Max 232 is one of the flexible IC to use in a large portion of the flag voltage level transformation issues. Generally MAX232 utilized as a part of 16-stick DIP bundle. It comprises of 3 noteworthy blocks. It must be controlled by 5 volts to influence it to control supply perfect with the majority of the implanted frameworks. The primary square is the voltage doubler in this IC exchanged capacitor systems is utilized to make the voltage doubler. Once the voltage is multiplied the second square will changes over that voltage to +10 and - 10. The third square comprises of 2 transmitters and 2 collectors which change over the voltage levels. Max232 requires least 4 outer capacitor. Their Value can run from 1uf to 10uf and16 volts or all the more appraising. There are a wide range of variants of this adaptable IC accessible every one of them Require diverse capacitor esteem for appropriate working.

Server PC

PC is short for a personal computer or IBM PC. The first personal computer produced by IBM was called the PC, and increasingly the term PC came to mean IBM or IBM-compatible personal computers, to the exclusion of other types of personal computers, such as Macintoshes. In

its more general usage, a personal computer (PC) is a microcomputer designed for use by one person at a time. Prior to the PC, computers were designed for (and only affordable by) companies who attached terminals for various clients to a substantial solitary PC whose assets were shared among all clients.

IV. CIRCUIT DIAGRAM

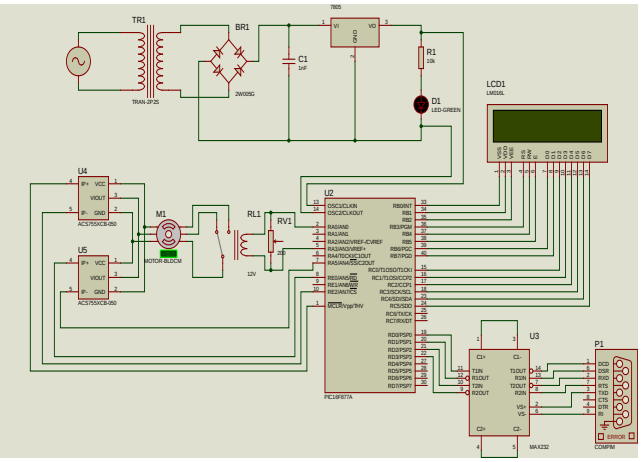

Figure 11: Circuit Diagram for the Proposed Method

Circuit Diagram Explanation

The proposed model has been analyzed and controls transaction motor under different operating range. The mainly constant load can be maintained in this process. For that purpose, the current and voltage (0-5) amps and (0-12) v voltage is maintained if it exceeds the controller will trip the circuit using relay (0-5) v. By using IOT, we can get the load analysis of the traction motor and feedback given to the controller. All the analysis will account and monitored in the LCD monitoring.

V. RESULT AND DISCUSSION

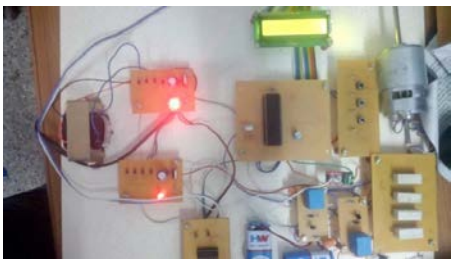

Figure 12: Hardware Model Photo for DC Railway Traction

Hardware Output

Parameters	Specification	Input	output
Power supply	Conversion	(230)AC	12AC
Relay	Fault trip	(0-12)DC	On/off the device
Controller	Analyze and control	(0-5)DC	Trip under fault
Variable regulator	Modify voltage	(0-5)DC	Vary voltage
DC motor	Series motor	(0-12)V DC	Specific voltage

Advantages

- Load analysis of the traction motor is easily findable.
- Control of the traction motor is easy and simple.

IOT based control is able to control and monitoring the load parameters

Application

- Railway system.
- Electric vehicles.
- Industrial application.

VI. CONCLUSION

This paper presented a two-phase approach for simulating local controllers in DC traction power flow applications that model limited network receptivity. The strategy builds on the commonly adopted CI power flow technique. Phase-1 is a sensitivity method for adjusting the regenerated power that is fed back to the network in blended regenerative/rheostat braking; the power adjustment is computed to keep the changes voltages within their permissible limits but assumes that the stations are reversible. Phase-2 accounts for limited network receptivity due to nonreversible substations; this is achieved in the CI method by switching each of the regenerating trains to a voltage-current source model whose resistance value is computed from the voltage solution in phase-1 without iteration, in contrast to. Numerical results show that the sensitivity based CI method obviates the need for many of the power reduction steps in, and gives a speed-up factor that significantly increases with the network size and the number of regenerating trains.

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