

Leekun
industrial
Systems

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INNOTRANS 2022

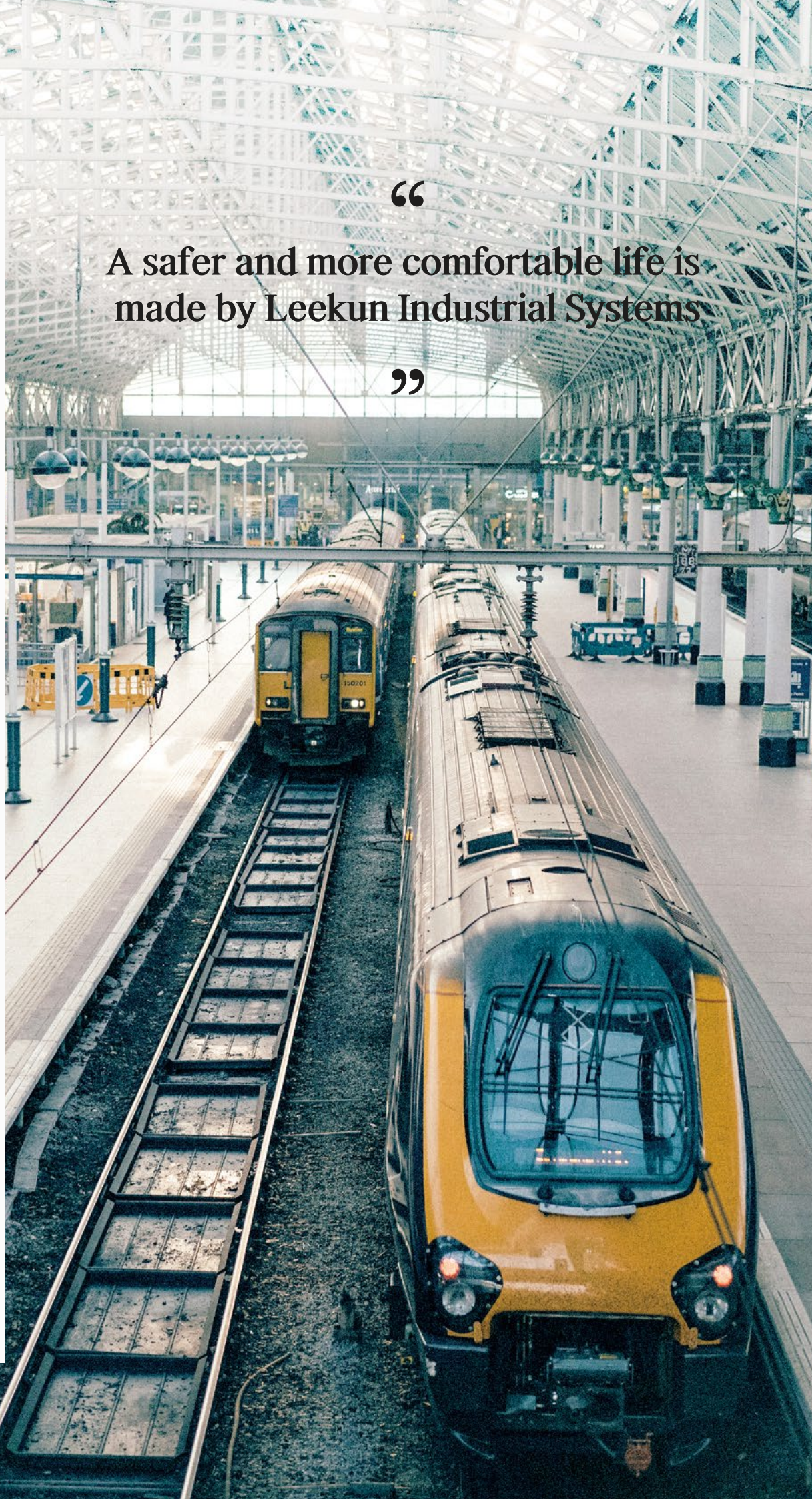
A company with trust, Create safe railway vehicle technology.



“

A safer and more comfortable life is
made by Leekun Industrial Systems

”



| Company Introduction

Leekun Industrial Systems Co., Ltd. is a company that researches, develops, manufactures, and supplies railway vehicle controllers and electronic equipment systems that combine the latest technology with railway vehicles.

Corporate Name	Leekun Industrial Systems Co., Ltd
CEO	Yong Bum Lee
Contact	+82-31-534-2873
Location	42-110, Gyeongbokdae-ro baramgol-gil, Jinjeop-eup, Namyangju-si, Gyeonggi-do, Republic of Korea
Main business area	Development, production, and delivery of digital products for railway vehicles and vehicle parts



2009 - 2010

Electronic units development
CMSB BOX SIV Assembly

2016

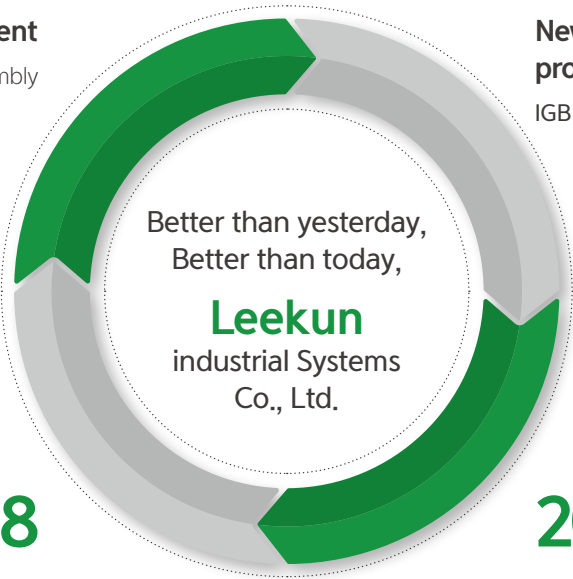
New technology/
product development
IGB type C/I STACK Energy saving device

2018

Development of modular IGBT
for electric vehicle power control
For mains power converters
Successful development of STACK

2017

Polymer insulator
improvement business
Incheon Airport Railroad



| Daegu Metropolitan Railway Line 2 Vehicle Information Display(ADU)

Summary

The on-board signal control devices for Line 2 electric vehicles, the ATP, ATO, and ALS, are implemented via the use of the ADU, a device that also shows the driving data and speed of the electric vehicle. The Automatic Drivers Unit (ADU) is situated in the control room and interacts with the Automatic Transmission Controller (ATC) to alert the driver of the state of the driver's electric car via voices, beeps, and LEDs. It is positioned both before and after the train and is controlled by both the primary and auxiliary automatic train controllers, depending on which direction the train is traveling.



Specifications

ITEMS	DESIGN
Power	DC100V(70V~110V)
Sign	Lamps, LEDs and audio output
Traffics	RS-422 (4-wire, 9600 bps)
Sizes	298(L)X206(H)X140(W)
Gravity	3.7kg

Development performance and achievements

For the purpose of the present vehicle test, ADU localization development was worked on for a period of one year, beginning in August 2013 and ending in June 2014. The vehicle's operability and maintainability were both enhanced as a result of the installation of 30 sets of 60 sets, which was necessary in order to replace the old items that had been discontinued. In addition, the ability to design one's own hardware and software not only makes it possible to protect one's technological assets, but it also makes it possible to seamlessly react to more demands from the law enforcement agency and other stations, such as the extension of a route. By alerting the driver of relevant vehicle information while they are behind the wheel, the driving safety of the car has been increased thanks to the addition of the voice guiding component.

| Korea Railway Corporation 8200 Electric Locomotive Screen Display (MMI), Steering Wheel Display(MFA), Wheel Slide Protection Device(K-Micro)

– Small and Medium Business Administration purchase conditional development task completed

Summary

In addition to displaying information pertaining to the vehicle signal system (ATP/ATS) of the 8200 electric locomotive, MMI, MFA, and K-Micro are responsible for the following duties.

- Display of ATP/ATS information
- Entering driver information, train data
- Indicate the actual speed of the train
- Warning lamp for overspeed, audible warning

A rectangular black display unit with a screen and several buttons.

Screen Display (MMI)

A black panel with two analog gauges and a row of buttons.

Steering Wheel Display (MFA)

A green printed circuit board with various electronic components.

Wheel Slide Protection Device (K-Micro)

Specifications

• Screen Display (MMI)

ITEMS	DESIGN
Size (WxHxD)	Front part:300mm x214mm x95mm
Operating range (U _{MIN} &U _{MAX})	DC36~120V
Input power	50W max, 70W max with heater (± 10%)
Industrial PC	AMD ELAN, 16~64MByte Main Memory
Large storage	Hard disk or SSD card of 10 Gbyte or more
Display resolution	640x480 pixels, 256 colors
Contrast ratio	typ. 150:1
Backlight illuminance	6~250cd/m ²
Temperature range	Operating temperature (0℃~50℃) Storage temperature (–20℃~70℃)
MTBF	64,000h (without TFT–LCD backlight and fan)

• Steering Wheel Display (MFA)

ITEMS	DESIGN
Size (WxHxD)	Front part:592mm/434mmx243mm x95mm
Power supply	Input voltage: DC110V ±30% Output voltage: (+5V/3A, +5V/5A, +24V/1.1A)
Interface	Service Interface (RS232) DSK Interface (RS485) MVB interface (DATA)
Processors	80C166 (16–bit microcontroller)
Storage device	OTP EPROM (64KB), Flash EPROM (128KB), SRAM (32KB)
Temperature range	Operating temperature (–20℃~+55℃) Storage temperature (–30℃~+70℃)
Performance and characteristics	– Speed indicator (speedometer indicator) – Tracting/braking force (traction/braking force indicator) – Device Information (Signal Lamp Block) – Signal Information (Signal Lamp Block)

• Wheel Slide Protection Device (K-Micro)

ITEMS	DESIGN
Size (WxHxD)	Front: 261.5mmx70.5, PCB: 233.35x160mm
Power supply	Input: 36 ~ 140V Output 1: 5V (electronic module and MVB module) Output 2: 15V (pulse generator)
Speed detection	Pulse Generator (KMG–2H)
Temperature range	Operating temperature (–35℃~+70℃) Storage temperature (–40℃~+85℃)
Performance and characteristics	– Wheel slide protection device with computer control of 4 axles – Maintain a proper braking distance from slide by decreasing adhesive force – A rapid intervention function in the brake force of air brake with a two–step valve

Development performance

The development of MMI, MFA, and K-Micro localization was carried out for two years starting in 2014 as a conditional purchase project with demander Korea Railroad Corporation. Three categories of gadgets that rely on imports can bring the current import replacement effect. In addition to being highly beneficial for the product's stable operation, it also makes the product's pricing competitive with lower cost, leading to more demand.

Achievements

- MFA 10set for 8200 electric locomotive (2022)
- K-MICRO 6set for 8200 electric locomotives (2022)

| Master Controllers & Encoders

Summary

• Master controller

The master controller is installed in the operation room and is mounted horizontally on the top of the desk. The daytime controller has a flat frame with a main handle that controls reverse and braking, a reverse that specifies the direction of the train's progress, and a start switch for departure from auto mode. There is also a "Dead Man's" function on the reverse and braking control handles.

• Encoder Device

An encoder device transmits signals to major devices such as propulsion, braking, signaling devices, and TCMS by receiving the command value for propulsion and braking from the master controller device and modulates the duty ratio (PWM) of a constant voltage and outputs it. By improving the existing analog encoder device with the digital control method and redundancy, it secures the accuracy and reliability.



Seoul Metro Master Controller



Singapore Master Controller

Specifications

• Master controller

ITEMS	DESIGN
Appearance	Length: 400mm x Width:270mm x Height:290mm, Weight: 20kg± 10%
Potentiometer	Format: JT30, Input Voltage:DC 12V, Output Voltage:DC 0.5~4.5V Valid electrical degree: 340°, Producer: COPAL Electronics
Cam switch	Format: S826a, Contact Capacity: DC12V, DC24V 10mA ~ 10A, DC100V 10mA ~ 3A Publisher: SCHALTBAU
Pushbutton switch	Form: Round, Lamp Color:Green, Publisher:EAO
Input specifications	- Power source: DC100V±30% - PWM Control Input Voltage: DC 0~5V±0.2V
Output specifications	- PWM Output: DC 22V or more, 500± 2% - PWM Duty Ratio: 0~100% - Failure, normal lamp display - PWM output status display
Functions	- Redundant power supply and main control - Automatic switching in failure - Manual switching when automatic switching is not working - Status monitoring function through constant monitoring of input/output - PWM output status display function - Fault display function (if one fails, only the broken PCB is replaced)

Achievements

- Singapore LRT 146 (2020)
- Korea Railway Corporation EMU 150 (2020)
- Korea Railway Corporation Daegoksosa Line 40 (2020)
- Seoul Metro Line 2 & 3, 196 (2019)
- Seoul Metro Seoknam Extension Line 16 Rents (2019)
- Seoul Metro Line 2 (200) (2018)

| IGBT inverter stack

Summary

The inverter stack is a vital component of a train's power control system that directly affects propulsion performance. It also plays a significant role in operating effectiveness, on-time performance, maintenance efficiency, and cost. To improve the performance of the power control and enhance the STACK unit to retain vehicle compatibility, the GTO power element, the current switching element of the inverter stack, is upgraded to the inverter STACK applied by IGBT. In addition to conveniently check fault monitoring of the power control unit, STACK also detects fault data and permits short-range communication, increasing the efficiency and convenience of maintenance.

Specifications

ITEMS		DESIGN
Inverter method		2 LEVEL 3-phase voltage type PWM
Element rating	Main circuit element	3.3kV-1500A Modular IGBT
	Overvoltage control device	6.5kV-300A (thyristor)
Cooling method		Natural cooling method using heat pipes
Rating	Input voltage	Continuous Rating: DC 1500V
		Max: DC 1800V
		Min: DC 900V
	Outputs	Voltage: 3-phase 0V to 1,200V (rms)
		Maximum rated output: 1300KVA
		Frequency: 0~160Hz
Control method		VECTOR control, slip and slide control
Control power		DC 100V (70V~110V)
PWM modulation method		CAREER Distributed asynchronous PWM ⇔ Overmodulation ⇔ 1P MODE
Ambient temperature		-25~+40℃

Development performance and improvement achievements

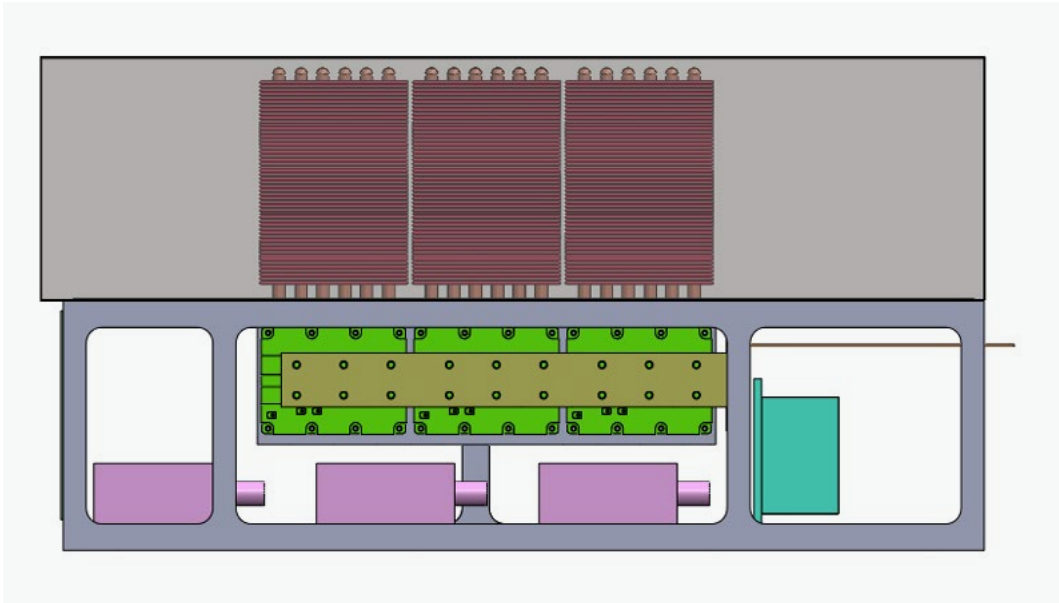
The purpose of extending the useful life of trains is to enhance operating efficiency by reducing the amount of wear and tear experienced by main subsystems. Because of the many automobile models that are released and utilized based on the line and time of introduction, it is possible to avoid having components that are interchangeable and to keep upkeep to a minimum. The strain of employees and the expense of upkeep are both significant as well. Moreover, in the event of a breakdown, parts standardization and localization technology for major parts are required due to the long-term standby condition based on the supply and demand of overseas materials and the possibility of discontinuation of parts. In order to guarantee a steady supply of parts, the GTO STACK, which is slated for discontinuation, is converted to an IGBT STACK with a low-cost investment by creating the technology to improve the GTO pressure welding method of the STACK for the main power converter to an IGBT module. This new development meets the requirements for maintenance efficiency and maintenance cost reduction of urban railway vehicle operators, and satisfies the energy saving industry policy by reducing the weight of trains.

• C/I BOX GTO-IGBT MODULE Improvement Development

(Future Railway Project Completed Project by Land, Infrastructure, Transport and Tourism Science and Technology Promotion Agency) — KORAIL (2012)

Korea Railroad Corporation's VVVF vehicle propulsion control system (C/I Box:Converter/Inverter Box) GTO of CONVERTER/INVERTER MODULE was upgraded to IGBT.

- CONVERTER/INVERTER MODULE GTO to IGBT parts improvement.
- Replace DET 07/08 parts in the controller unit.
- Provide services for efficient operation to reduce the incidence of aging failures
- Improve the supply and demand of parts and the difficulty of replacing parts, and increase work efficiency.
- Reduce maintenance costs due to parts and structural improvements.

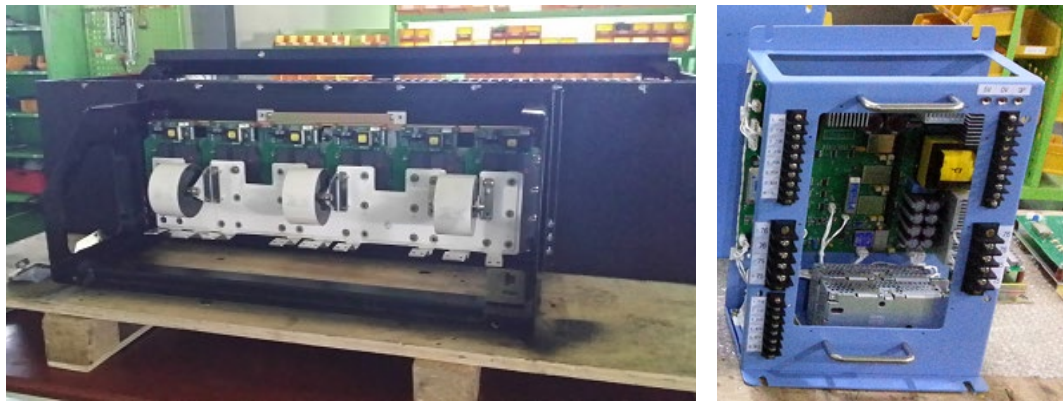


• Line 4 train C/I IGBT performance improvement development

(modular IGBT development for electric vehicle power control – Completed the project of Land, Infrastructure, Transport and Tourism Science and Technology Promotion Agency) — Seoul Metro (2014)

Seoul Metro Line 4 VVVF Vehicle Propulsion Control Device (C/I Box: Converter/ Propulsion Box) Improved parts and performance of GTO of CONVERTER/CONVERTER/CONVERTER Stack with IGBT Module.

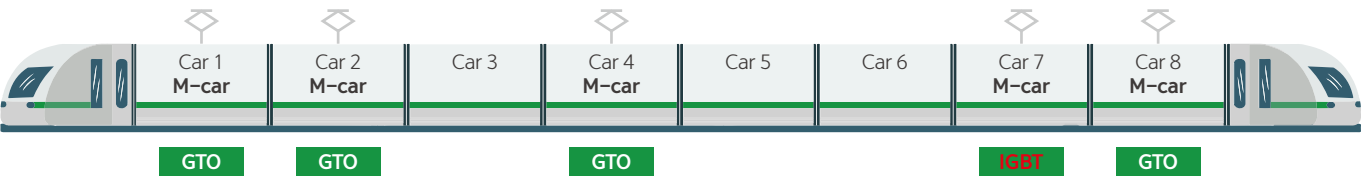
- Improvement of the stack structure (improving maintenance efficiency by simplifying the structure)
- Development of cooling technology for Stack (calorific value calculation and simulation)
- Maintain compatibility with an interface board
- Reduce weight and energy savings in power supplies (1/2 the weight and volume compared to the previous one)



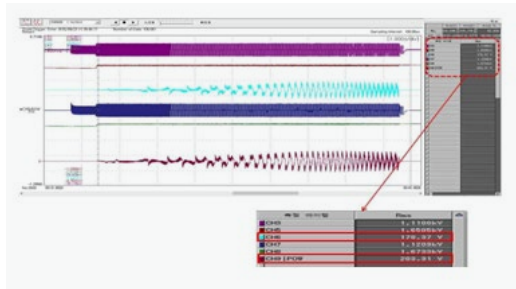
Busan Metro Line 2 train power control system Inverter MODULE GTO to IGBT parts improvement

- Budget savings by improving parts with the same performance
- Energy savings by reducing the weight of electric vehicles
- GTO and IGBT (pressure welding) elements are improved only as a unit module (stack)
- Technology that can be used in combination with GTO and IGBT
- Secure status information data in case of failure with short-range wireless communication technology
- Complete commissioning and development of the main line in February 2021
- Complete delivery and commissioning of 30 units in October 12, 2021
- Designated as an innovative product by the Public Procurement Agency in December 2021
- Selected as a test purchase product for technology development products by the Ministry of SMEs and Startups in 2022

① Composition of test vehicle: Mixed installation of GTO Type and IGBT Type in one electric vehicle



② Experiment results

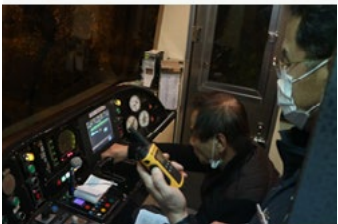
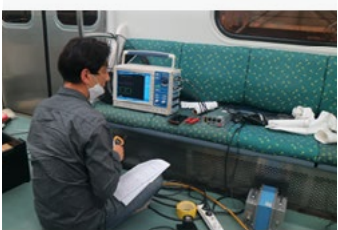


DATA 1. Operation waveforms measurement of GTO vehicles and IGBT vehicles

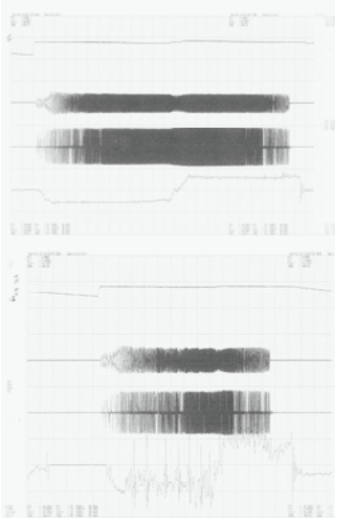
구분	채널	측정항목	측정값(RMS)	비고
IGBT Type (7차)	CH3	컨버터 1군 AC입력전압	1.1108 kV	
	CH5	인버터 FC 전압	1.6505 kV	
	CH6	인버터 U상 전류	178.37 A	
GTO Type (8차)	CH7	컨버터 1군 AC입력전압	1.1209 kV	
	CH8	인버터 FC 전압	1.6733 kV	
	CH9	인버터 U상 전류	203.31 A	

DATA 2. Data comparison between GTO and IGBT vehicles

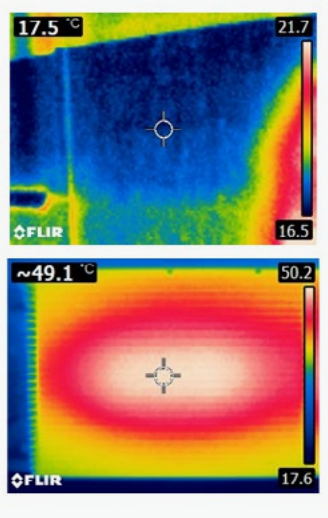
- Seoul Metro Line 4 10set (2020)
- Seoul Metro Line 4 5set (2018)
- Seoul Metro Line 4 5set (2016)
- Seoul Metro Line 1 10set (2022)
- Seoul Metro Line 1 10set (2021)



Trial run photos



Voltage, Current, Jerk
Measurement



Stack temperature
measurement

| Brake Electronic Control Unit(ECU)

Summary

The Seoul Metro Line 2 VVVF Electric Vehicle Brake Electronic Control Unit (ECU) is installed in the braking field (BOU) of M car and T car to control air braking. The propulsion control device receives the regenerative braking pattern signal from the ECU via braking pattern calculation based on average load value. Also, it regulates the lack of air braking power by electro-pneumatic operation using the propulsion control device's signal for successful regenerative braking. Moreover, to stop the wheel from sliding, it also monitors the shaft speed of each axle and adjusts the pressure control valve when sliding is detected.



Specifications

ITEMS	DESIGN
Control system	16bit CPU Micro processor
Input voltage	DC100V(60V ~ 110V)
Power consumption	520W
Commercial commanding brake	TCMS communication
Regenerative braking request signal	PWM signal output
Retrograde load signal	PWM signal output
Interface	RS-485 Serial Communication
Monitoring function	PC and RS-232 communication
Main features	Jerk control, load calculation, braking pattern calculation, major braking operation control, braking force calculation, air brake control, braking status monitoring function, slide monitoring, monitoring

Development performance and achievements

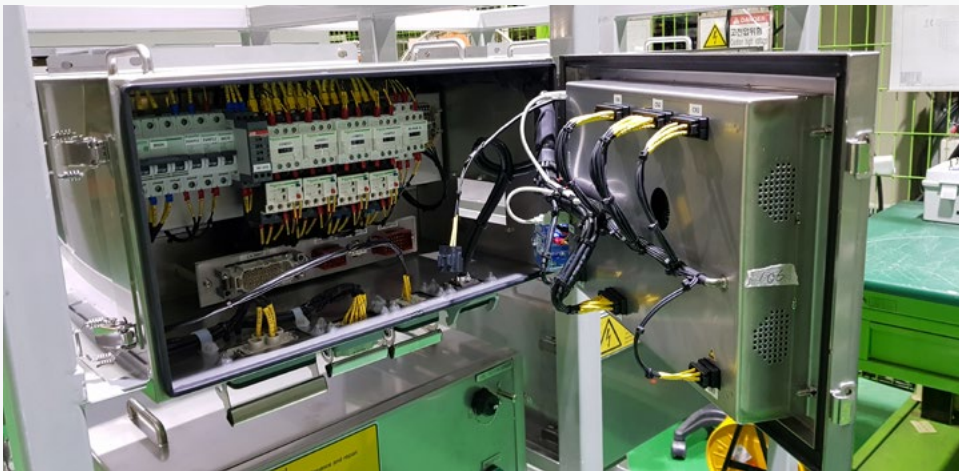
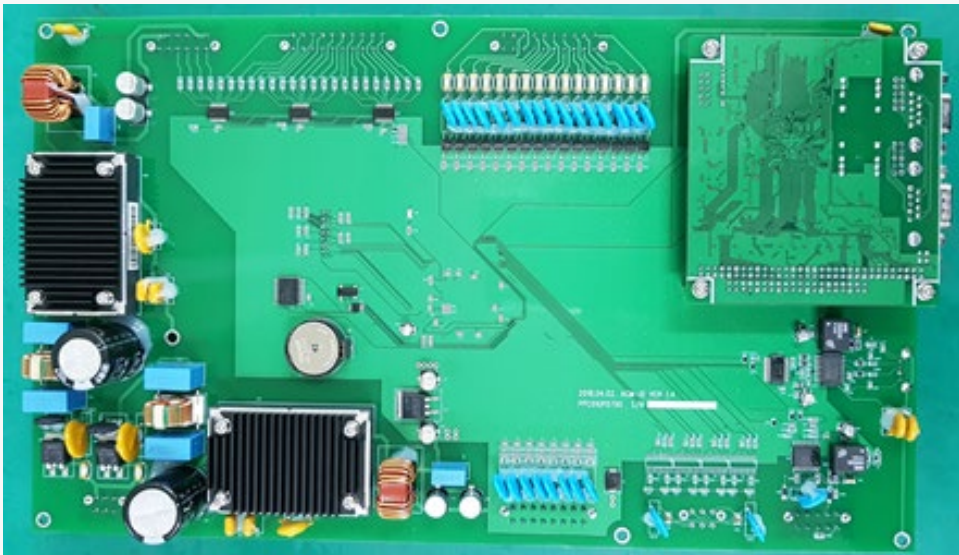
It is helpful for the stable operation of various regular inspections to develop replacements for existing parts that have been discontinued. This is helpful for a number of reasons, including the expansion of the domestic market, the reduction of the period of time needed to procure products, and the increase in stability and efficiency during maintenance work. Additionally, the purchasing price might be lowered if measures are taken to ensure that the final product maintains its price competitiveness.

- Seoul Metro Line 2 20set (2022)
- Seoul Metro Line 1 8set (2021)
- Seoul Metro Line 4 12set (2020)
- Seoul Metro Line 1 16set (2020)
- Seoul Metro Line 2 25set (2019)
- Seoul Metro Line 1 14set (2019)
- Seoul Metro Line 2 15set (2018)
- Seoul Metro Line 2 15set (2018)
- Seoul Metro Line 4 10set (2017)

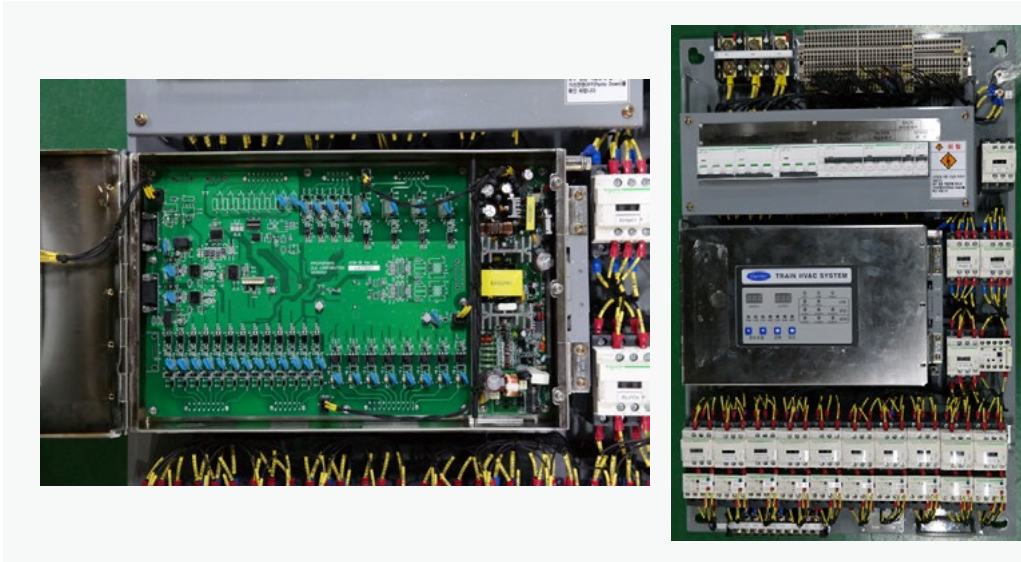
| Cooling System Switchboard Controller

Summary

The cooling system switchboard controller (MICOM) controls the air conditioner for trains installed on the train roof. For the comfort of passengers, it receives information from the indoor temperature sensor installed at the intake air inlet inside the air conditioner and self-diagnoses the operating status by the controller (MICOM) in the switchboard to automatically perform ventilation, semi-cooling, full cooling, and stop. In addition, when there is a problem with the air conditioner, MICOM automatically sends the information to the operating room through communication with TCMS for the safe and quick response.



Malaysia KVMRT2 Air Conditioning Switchboard MICOM



Busan Metro Line 1 320 Volume Improved Cooling System Switchboard MICOM

Specifications

ITEMS	DESIGN
Control system	2bit CPU Micro processor
Main circuit power and control circuit power	1) Main power: 3-phase AC380V 60Hz 2) Control circuit power: DC100V 3) MICOM Internal Power: DC 5V, DC 24V
Control command	TCMS communication
Interface	MVB Communication RS-485 Communication
Monitoring function	PC and RS-232 communication
Main features	Cooling automatic/manual operation drying function sequential start control

Achievements

- Malaysia KVMRT2 232 Cooling system switchboard Controller (2017)
- Indonesia Jakarta 12R Cooling system switchboard (2016)
- Cooling system harness improvement for 320 cars on Busan Metro Line 1 (2015)
- Cooling system improvement for 60 cars on Seoul Metro (2014)

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