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Deploying Passenger Information System For Multimedia Promotion In Mass Rapid Transit (MRT) Carriages

White Paper

Index

Prefix

Current research forecasts that the output value of the global smart railway market will grow to US$36.58 billion by 2026. Globally, governments and manufacturers alike are investing in modern display solutions that act as an effective means for users to interact and communicate with rapid transit systems and services.

With the rapid development and popularization of information and communication technologies (ICT) such as edge computing, cloud computing, 5G, and the Internet of Things (IoT), ICT has been integrated into various vertical markets to provide next-generation solutions for operations and services. In transportation, globalization and urbanization have accelerated the demand for "smart" infrastructure. Many countries are dedicated to increasing support for research in developing a greater variety of smart transportation solutions such as self-driving cars, electric vehicles, and transportation service hubs. These solutions not only provide the public with safe, convenient and entertaining modes of transport, they assist in the creation of new and innovative business models for transportation operators and improve their operational performance.

According to a report issued by marketing research firm Mordor Intelligence, the total value of the global smart railway market reached US$15.85 billion in 2020, and it is estimated that by 2026, the smart railway market will reach up to US$36.58 billion. From 2021 to 2026, the compound annual growth rate (CAGR) will equal 15.14%, with the Asia-Pacific region having the largest individual growth rate. In terms of railway length, the Asia-Pacific region accounts for nearly 28% of the railway networks around the world, with China and India taking the lead. As ICT continues to progress, developed countries are actively deploying information systems relating to smart railway technology.

Figure 1-1: Smart Railway Market Trend and Application Scenarios

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A separate report from Global Market Insights predicts that among these ICT systems, the demand for real-time passenger information systems (PIS) will increase drastically. PIS systems provide passengers with real-time audio and video information, such as scheduling information, emergency alerts, as well as news broadcasts and other entertainment. These applications rely on displays to act as a communication intermediary for users to conveniently consume relevant information combined with a diverse interactive experience. Using display technology in this way enhances the integration of traffic information and provides passengers with a convenient and more comfortable service experience that will ultimately further accelerate the development of smart transportation application solutions in Taiwan.

To help attain its vision of a Smart City, the Taipei MRT has solicited innovative experimental projects, while the Taipei city government has also actively promoted a strategy review board and invited display manufacturers to create a new image of smart transportation.

The Taipei City Government is actively promoting the Smart Living Display Technology and Application Industry Strategy Review Board (SRB) and has invited many of the top companies in the display industry to join the Industrial Subsidy Project of Smart Life Display Technology and Application. The government expects to apply smart display solutions in four primary areas including retail, entertainment, medical care and mobility. In line with the Smart City trend, the Taipei MRT also announced its intent to solicit a transportation innovation experimental plan. Taking the Taipei MRT as its application scenario, Innolux cooperated with Litemax to propose a multimedia enhanced smart carriage to demonstrate their concept of an "Innovative MRT, Digital MRT".

Looking at the current state of Taipei MRT carriages, most information and advertisements still use printed media. Advertisers are charged a monthly rental fee and require continuing maintenance by over 5,000 MRT staff for cleaning and replacement, resulting in less revenue and increased labor cost. By introducing smart transportation technology, Taipei MRT management expects to reduce overall operational efforts while providing passengers with an improved transit experience. The use of convenient data applications and creative content can enhance passenger satisfaction with the system, attracting more people into taking the MRT, and thus increasing operating revenue.

In this project, Innolux entrusted Litemax to carry out the research and development (R&D) of flat- and curved-type display modules for MRT carriages, including the backlight module, control circuit, display design, among other technologies. R&D teams were faced with the challenges of creating a solution with a limited amount of space to fit in the required mechanical and communication components.

As the Taipei MRT system is constructed mostly underground, the quality of network communication is poor, with the available space in both the MRT carriages and in public areas being limited.

Many of the Taipei MRT trains have been in use for more than fifteen years, and as such, some of the original mechanical and electrical components cannot easily be modified. This results in any new LCD display modules requiring housings that must be individually customized. Additionally, the redesigned displays must pass the strict requirements of automotive shock and impact resistance tests. All these requirements needed to be taken into consideration by the R&D team.

Table1-1: Current/Proposed Analysis

Multimedia MRT Carriage		
Current	**Goal**	**Proposed**
Over 5,000 employees for cleaning and maintenance	Reduce manpower	Digital Advertisements with Autoplay function Reduces worker engagement
Monthly Advertising Rent, Low Revenue	Increase Advertising Revenue	Advertisement Fee charges by time, Revenue increased x1000.
Low Communication Quality (Carriage B3/B4, underground)	Improve communication quality	High-Speed 5G transmission. Stable communication quality
Carriage Structural elements cannot be changed (15+ years old)	No modification on Carriage structure	Flexible interior carriage design

At present, most of the public transportation information and advertising billboards are printed paper or edge-lit LED displays. In the Taipei, Taichung, and Kaohsiung MRT trains, the system information displays are mainly edge-lit LED displays, while the advertising signboards are printed media. Because the MRT carriages cannot be extensively modified, it is impossible to directly install ordinary display products into the MRT carriages. In the past, sheer scale of large governmental public infrastructure projects required extensive cooperation and resources of manufacturers across different industries or technologies in a joint effort to achieve a common goal. For Taiwan's MRT information systems, this requires the participation of companies including display technology, communications, and data technology, which is partly responsible for the

reason why the in-carriage display and related information technologies are difficult to upgrade. However, in recent years, as the government continuous to support the development of smart cities, mass transportation has eventually begun to gradually transform.

In order to increase advertising revenue and reduce time-consuming and labor-intensive replacement of printed advertisements, this project intended to meet the customer's requirements for a slim and large-scale form factor with flat and curved displays, LCD splicing, inclusion of transmission and communication technologies, an automotive grade power supply, and compliance with automotive safety regulations, among other requirements. The goal was to achieve the best combination of a backlight module, display system and appealing design aesthetic.

During the planning stage, the initial research and analysis focused on the design and structure of the existing Taipei MRT carriage system, as well as researching other international mass transportation systems with the focus on their use of backlight modules, display systems, and mechanical/appearance design.

In the design stage, R&D was sub-divided to achieve the best integrated design of a full-color flat/curved display with high performance for transportation applications:

- High-brightness and energy-saving local dimming technology
- Flat and curved LCD splicing technology
- Customized mechanical design for flat and curved LCD displays

At the preproduction stage, R&D teams created electric and mechanical computer-aided design (CAD) files, and purchased materials and parts for a trial production run. At the development verification stages, integration and application tests were carried out.

The project was supported, in part, by the Industrial Bureau of the Ministry of Economic Affairs, Taiwan. Through the implementation of this project, Litemax has acquired the key technologies and high customization capabilities for traffic application displays. The research and development achievements from this project can be directly applied to Litemax's own products, with the ability to sell and promote the products under the "Litemax®" brand.

LITEMAX®

Litemax® Brand Logo

Table 2-1: R&D Key Points

Durapixel	
36" (1920*532)	48" (1920*248)
1000 nits	1000 nits
NTSC~80%	NTSC~80%
90W	57W
FHD	FHD

Technical Analysis

Table 2-4: Technical Analysis

Innovation	Before Project		After Project
Image			
Display Media	Printed	Edge-lit LED Backlight NTSC: >80% Brightness: 1000 nits MTBF: 50,000 hours	Edge-lit LED Backlight NTSC: >80% Brightness: 1000 nits MTBF: 100,000 hours
Display Method	Static Display	Arrival Information	Static and Dynamic Content Available
Cable Connection & Management	None	Complex Wiring and Connections (unorganized cable management)	Integrated 1-In 1-Out Connection (Simple and Organized)
Maintenance	Over 5,000 employees for leaning and maintenance per month	---	1. Digitized Advertisement Content 2. Autoplay reduces maintenance
Other Differences	1. Monthly Rent = Poor Revenue 2. 15+ year old mechanical structure: Cannot be modified.	1. Monotonous cutting screen and playback method. 2. 15+ year old mechanical structure: Cannot be modified.	1. Advertisement Fee charges by the second = Revenue increased x1000. 2. Highly Tailor-Made Solution provides pleasing design 3. Made In Taiwan with CE, FCC and other international certifications.

Dynamic High-Brightness Backlight and
ECO-Dimming (Energy-Saving Local Dimming) Technology

For the design of the high-brightness backlight, not only did the different ambient light sources in the MRT carriages need to be considered, but also any exterior light sources that could reflect into the carriages and affect their performance. In order to ensure that the carriage displays could perfectly display images under any potentially strong light source, the Litemax R&D team developed a patented backlight module design that provides a high brightness backlight source. By utilizing the reflected light of an ambient light source and the transmitted light of the backlight module, the new design can effetely improve the readability of the display under high ambient light conditions. Even when the backlight module power is turned off, ambient light can be reflected back into the display, effectively lighting it up, which can both reduce the power consumption of the panel and extend its lifetime.
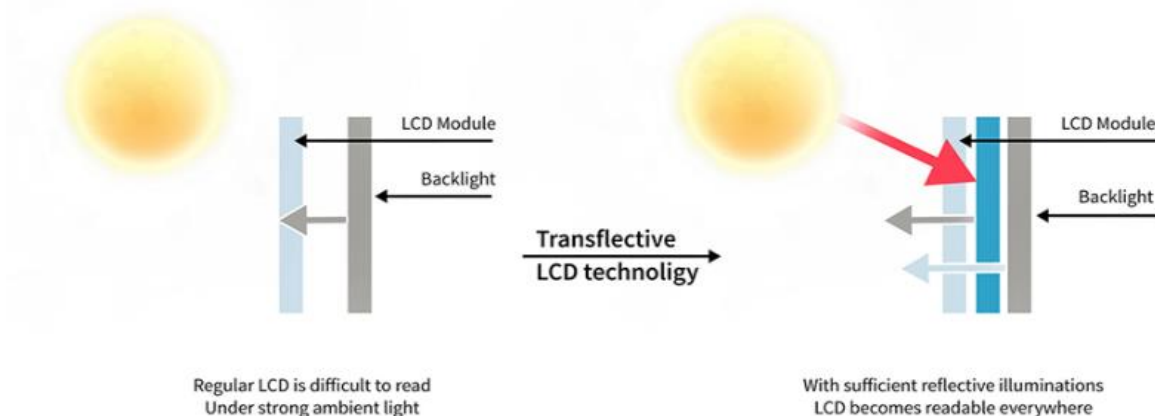

Figure 2-7: Differences in Sunlight Readable Display Technology

ECO-dimming (energy-saving local dimming) technology is widely used in mainstream LCD TV products. Through local dimming technology, Litemax introduces transportation displays that can achieve high dynamic range (HDR) and reproduce images with excellent color contrast.
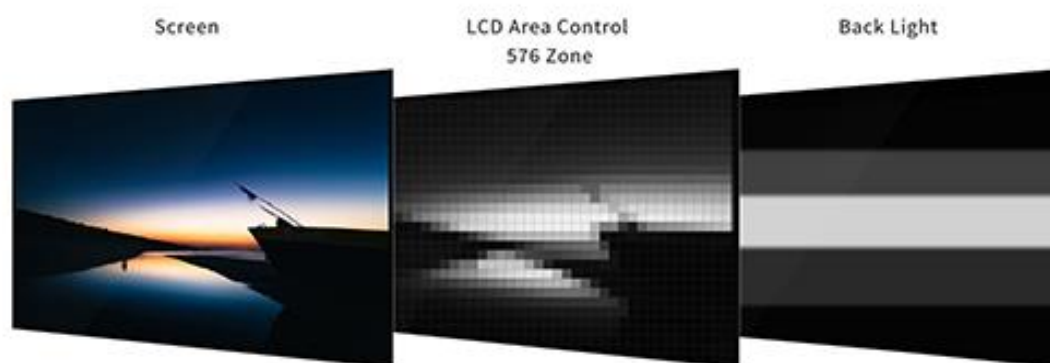

Figure 2-8: LCD Image with Dynamic Backlight Adjustment

Flat and Curved LCD Splicing Technology

A display module is composed of a microcontroller unit (MCU), display driver module, backlight driver circuit, sound effect processing circuit, signal connection interface and image distribution conversion circuit, that are connected to work together.

In order to simplify the wiring and cable management of the flat-type information displays and the curved-type advertising displays, the R&D team designed a unique "1-in, 1-out serial connection" combining the video signal and power source so that each display could utilize the same splicing function and the same source video signal. This design is different from the traditional image transmission synchronization design as there is no need to install additional equipment such as video distributors or playback management devices. When displays are installed, they simply need to be connected serially, from one to the next, in order to function.

The curved displays required a more considered study of the MRT carriage structure to ensure a proper fit and finish of the curved LCD displays as well as placement of the power supply units. The R&D teams also designed tailor-made fiber-reinforced plastic (FRP) covers for the curved display to correctly fit into the MRT carriage panels, and selected a low-power playback host for the system. Each LCD display is equipped with a customized image control circuit board that is serially connected to a network for convenient installation and maintenance.
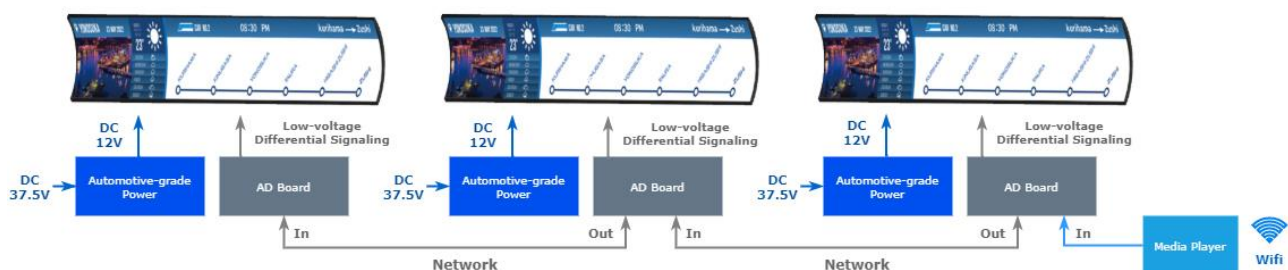
Figure 2-9: Curved LCD Display Splicing Connection for MRT Carriage Advertising

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The R&D team developed new software to synchronize the MRT information system with the information displays. The new software can display the corresponding station information when the train arrives and synchronizes with the specified coding. This new software is meant to optimize the visual experience and provide an easy to read display for the passengers.
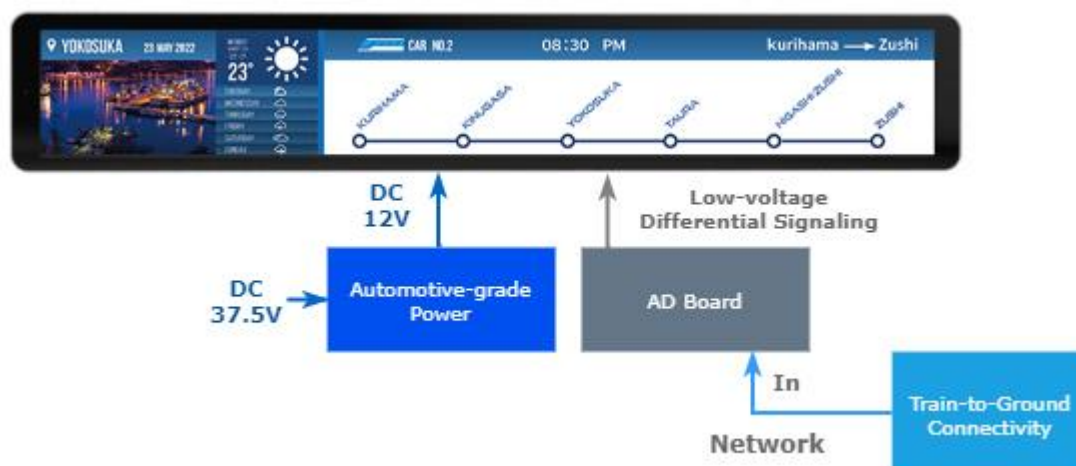

Figure 2-10: Flat Type LCD Display Splicing Connection for MRT Information System

The Tailor-Made Mechanical Design of

Flat and Curved LCD Panels

As previously described, the flat-type information displays utilized a custom display module with special consideration for the arrangement of the power supply unit and a tailor-made FRP cover for the information display to fit into the MRT carriages.

For the curved-type advertising displays, Litemax leveraged its curved surface bending and bonding technology with the addition of polarizing filters to manufacture custom form factors and curvatures for displays.

In this project, Litemax worked closely with Innolux to fulfill the goal of installing curved displays into the MRT carriages. Litemax used a heat-bending process to custom fit the display modules to the MRT carriage structure, modifying the mechanical design and arrangement of the power supply to ensure proper installation. A tailor-made FRP cover for the curved displays completed the installation into the MRT carriages.
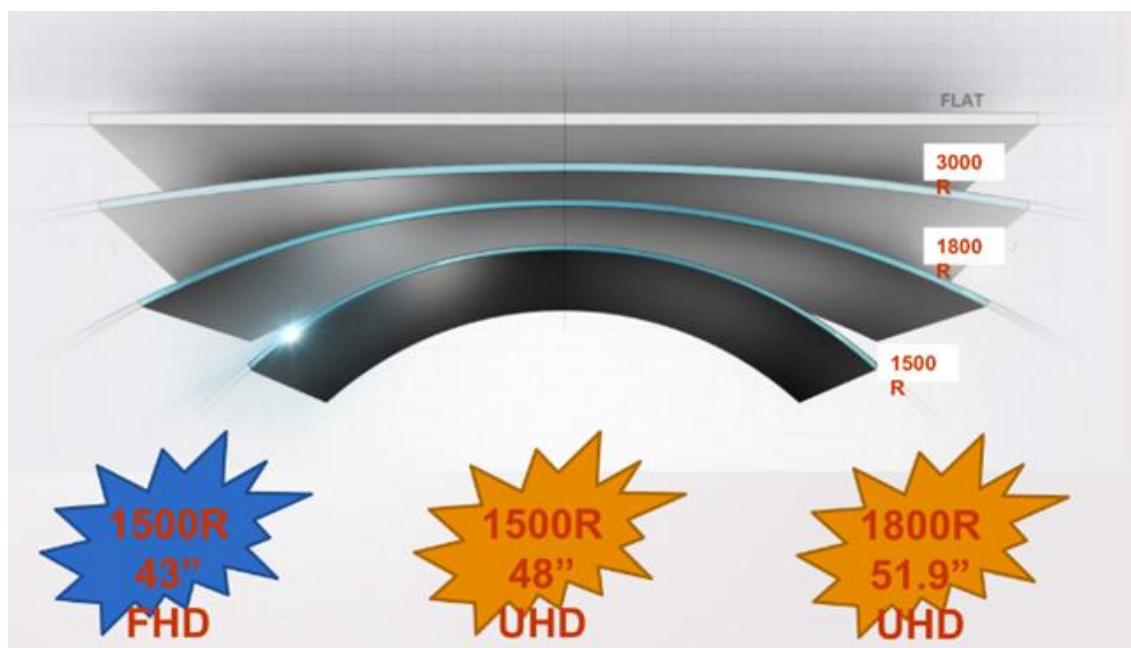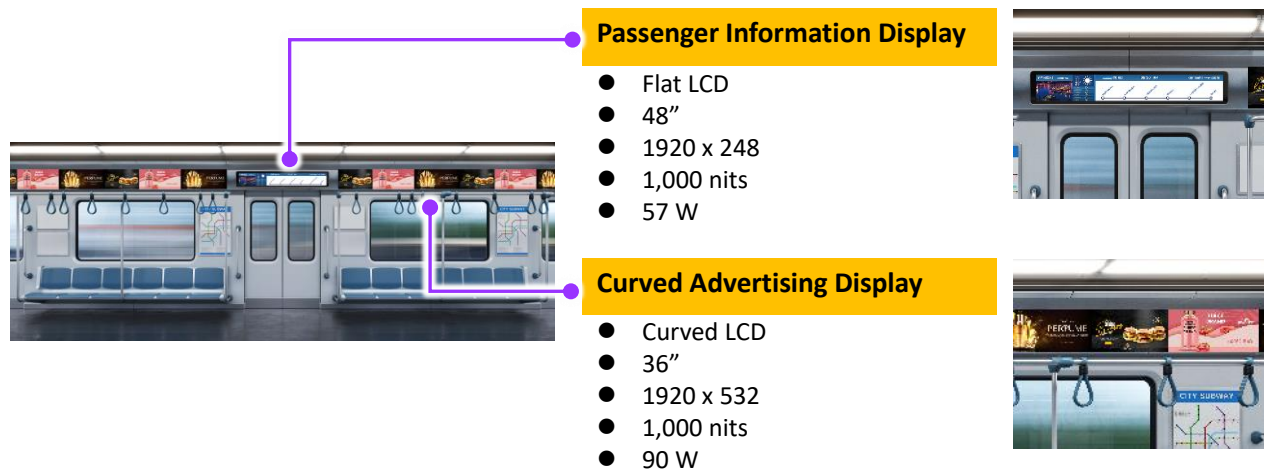

Figure 2-11: Bending Angles of Curved LCD Display

After the integration and assembly process, a series of reliability and safety tests were carried out to test the displays. The initial deployment of four flat-type information displays and eighteen curved-type advertising displays were installed in the Taipei MRT system for testing and demonstration purposes. All the displays were equipped with HDMI, Wi-Fi and 5G communication modules to connect to the MRT and government information systems. In the future, the curved-type advertising displays will be connected to the Taipei MRT advertising system.

Passenger Information Display

- Flat LCD
- 48"
- 1920 x 248
- 1,000 nits
- 57 W

Curved Advertising Display

- Curved LCD
- 36"
- 1920 x 532
- 1,000 nits
- 90 W

	Display Technology	Display Module	Application System
Multimedia Display in Carriage	+Passenger Information Display x 4 + Curved Advertising Display x 18	+Display Module	+ Arrival and Government Information System - Intelligent Passenger Flow Detection and Alert system - Intelligent Microtargeting Advertising system
Operation Partner			
+5G Enterprise Web Deployment + Mechanical, Electrical, and Communication Deployment			

"+" R&D and implementation for the project

"-" R&D and implementation in future

Figure 2-12: 5 Year Technology Development of Taipei MRT and Multimedia Displays in Carriages

Innovation PIS Solutions

IPPC-3583-APL2-ZNC0-5001: 35.8", 500 nits, 1920*532, R800.AD8891H+LID.APIX-APL2-4200, 8GB DDR3L.32GB mSATA, 2 LAN/1PWR.EN50155, DC34~62V

Table 2-5: Innovative Features of IPPC-3583-APL2-ZNC0-5001

Key Features	IPPC-3583-APL2-ZNC0-5001
1. 35.8" Bar Type Intel® Apollo Lake Panel PC 2. Resizing LCD 3. Short-side curve 4. Ultra-Wide Screen (16:4.4) 5. High Brightness 1000 nits 6. Sunlight Readable 7. Wide Viewing Angle 178°/178° 8. Low Power Consumption 9. Slim Bezel 10. BL MTBF: 100,000 hours	

IPPC-4805-APL2-ZN00-5001: 48", 500 nits, 1920*248.AD8891H+LID.APIX-APL2-4200, 8GB DDR3L.32GB mSATA, 2LAN/1PWR.EN50155, DC34~62V

Table 2-6: Innovative Features of IPPC-4805-APL2-ZN00-5001

Key Features	IPPC-4805-APL2-ZN00-5001
1. 48" Bar Type Intel® Apollo Lake Panel PC 2. Resizing LCD 3. Ultra-Wide Screen (16:28) 4. High Brightness 1000 nits 5. Sunlight Readable 6. Wide Viewing Angle 178°/178° 7. Low Power Consumption 8. Slim Bezel 9. BL MTBF: 100,000 hours	

ABOUT LITEMAX

Founded in 2000, Litemax has enjoyed a strong reputation for expertise in high-brightness LCDs, sunlight-readable LCDs, resizing LCDs, industrial motherboards, embedded systems, edge computing and panel PCs There is so much more that we offer. Through advanced computing capacity and customizations service, we raise the standards of industrial-grade displays, digital signage applications and embedded computing to enable intelligent vertical market platforms around the world. From powering the devices in your surroundings and the machines you depend on, we create value for our customers, shareholders and ecosystem, with one ultimate goal: engineering excellence in everything we do. Our technology and innovation can be found in our high-performing, ultra-efficient solutions for transportation, digital signage, smart automation, gaming, and AIoT/Industry 4.0.

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