Fall 2005 DUAL AVN Development

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Abstract

In keeping up with the dissemination of DVD video, DVD video playback features in car navigation systems are now almost standard, and there is a strong demand for the ability to enjoy video in vehicles. On the other hand, car navigation features are continually advancing, and from the need to store large amounts of map data, HDD navigation has become the mainstream and it is now possible to watch DVD video while still operating the navigation system.

However, the conventional car navigation system is restricted from displaying complicated operation screens such as destination settings, and TV or DVD images for safety while driving. This lead to a dissatisfaction from users, that even the passenger cannot view images while driving. As an answer for this dissatisfaction, a new revolutionary technology was applied to the development of a DUAL AVN, which is able to display 2 images on one screen.

1 Forward

In the car navigation market, we have expanded sales and market share over the years, but recently, many other companies have been entering this field and the competition is becoming tougher by the minute. In order to continue leading other companies as the pioneer of AVN, further differentiation and high performance is required in products to improve their appeal.

However, even as HDD navigation and DVD playback features improve, the display methods conventionally thought of as something unchanging, had not changed, and the restriction placed on displaying moving images while driving, and complicated operations such as destination settings, interferes with the full effectiveness of the new high performance features. We have focused in making a breakthrough in this area.

The DUAL AVN developed in the autumn '05 model introduces the world's first Dual View LCD, and allows a different image to be displayed for the driver and passenger. This feature enables a vehicle environment that was previously unthinkable, and succeeded in greatly improving the level of entertainment. This feature, the fundamental theory and technology are described here.

2 Overview of the DUAL AVN

By introducing the world's first DUAL AVN, we have identified this as the second generation of AVN, and we have made a clear distinction with other companies, and have proposed new uses for AVN hereafter.

2.1 Product concept

This summer, planning and development was performed under the concept of [New AVN Evolution], and a high performance navigation utilizing the new "Active Wing" control, and incorporating the "Ultima Engine" was developed. This autumn, for further AVN evolution, the [Next Stage AVN] was set as a concept to plan and develop a new form of AVN that goes beyond the traditional boundaries.

2.2 Product overview

Safety is extremely important in vehicle mounted devices, however this in itself was placing a restriction on the features and entertainment available inside a vehicle. The new product resolves these dissatisfactory issues, and balances safety and features even while driving.

The most significant feature of this new model, is the application of the

- **World's first, Dual View LCD screen.**

By equipping this LCD, map display can be viewed in full screen from the drivers seat, and DVD video can be viewed in full screen display from the passenger seat.

DVD video and other images that could not be displayed while driving can now be enjoyed in the passenger seat without blocking the map display of the navigation to the driver.

Also, some navigation features that were restricted during driving (for example, character entry of destination settings, phone number entry, etc.) are now allowed from the passenger seat while the vehicle is in motion.

Because this is for introduction into the open market, the DUAL AVN allows change of the right/left side screens (For a left hand drive car, the map display must be changed to the left side), but for safety, the setting is only allowed once after installation.

In addition, other features that were popular in the summer model such as the:

- **Active Wing**
- **Continuous 4x speed recording MusicJuke**
- **FMdeTITLE/FMdeTITLEplus**
- **High performance navigation with traffic avoidance search and detailed town route guide**

are equipped, to further improve product appeal.

Fig.1 AVN7905HD

3 Development of the Dual View LCD

3.1 Fundamentals of the Dual View LCD

The most important feature of this DUAL AVN is the Dual View LCD. A "parallax barrier" set on the TFT LCD display, which distributes the direction of light from the backlight to the right and left, enabling, two directional display of different images. (See Figure 2.)

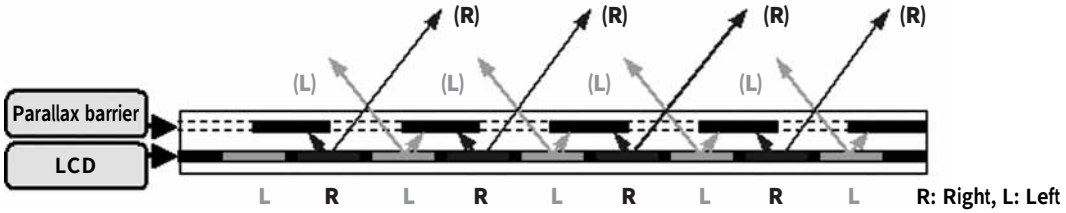

Fig.2 Dual View LCD theory

Many details of this principal belong to the LCD device manufacturer (Sharp Corporation) and most of this cannot be disclosed here, but the basic principle is based on the technology of the 3D LCD (3 dimensional visual display) developed by them in 2002. The 3D LCD distributes light to the left and right eyes of the viewer to display image data relating to left and right. The Dual View LCD successfully narrows the distance between the LCD panel and the parallax barrier, to widen the light distribution angle to a specific angle for two separate persons sitting in a typical drivers seat and passengers seat to view different images at the same time.

Also different from a 3D LCD, there is the added difficulty of displaying differing image data on the left and right sides.

For the resolution of the Dual View LCD, because the view will be separated to the right and left using the parallax barrier, the horizontal resolution will be halved. Therefore, the base TFT LCD display used is a type that we normally use as a wide VGA model, with a resolution of 800 (RGB)×480.

Section 3.2 describes the techniques used in order to minimize the unbalance of the display due to the halved horizontal resolution and to secure a display quality that is not inferior to previous models.

3.2 Device development for making the Dual View function possible

In order to make the Dual View feature possible, it was necessary to newly develop a new ASIC (Application Specific Integrated Circuit).

Figure 3 shows the ASIC block structure for the Dual View feature.

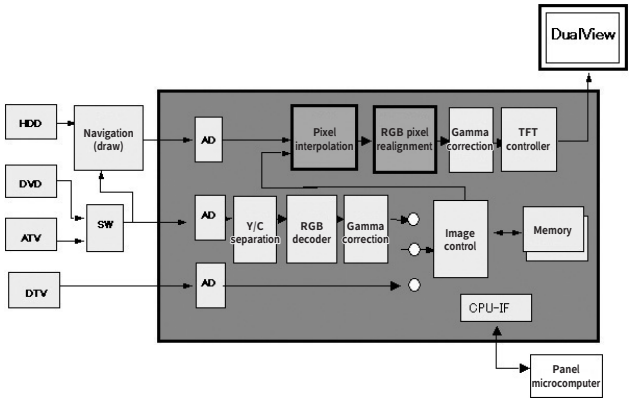

Fig.3 ASIC block diagram

Table 1 shows the overview of features.

Table 1 ASIC feature overview

	Feature	
Input Image Source	DVD/TV	Composite video signal
	DTV	EGA-RGB (400×234)
	Navi	WVGA-RGB (800×480)
Y/C Separation	3 line adaptive type digital com filter	
RGB Decoder	NTSC/PAL compatibility	
Gamma correction	Composite video, 2 RGB systems	
CPU-IF	IF for ASIC setting	
TFT Controller	Digital RGB (6bit ea.) output	
Pixel correction	Corrects WVGA-RGB images.	
RGB pixel realignment	Realign for Dual View image data.	

Next, the two circuit blocks required for the Dual View feature (RGB realignment, pixel interpolation) is explained.

- **Achieving a left and right independent display through RGB realignment**

Following display theory, pixel realignment processing is performed so that 2 types of images can be displayed alternatingly on the right and left, to create the Dual View feature.

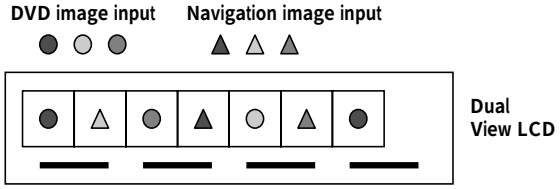

Fig.4 Pixel row realignment processing

- **Improvement of display quality through pixel interpolation**

When the Dual View LCD is a wide VGA (800×480) image display size and a wide VGA navigation software is used, the resolution in the horizontal direction will become halved to 400 dots.

Images for navigation that use thin lines will become rough due to the aliasing (Figure 5).

Therefore, an interpolation processing was performed on the image to improve display quality even when using a wide VGA navigation software (Figure 6).

Fig.5 Before interpolation process

Fig.6 After interpolation process

3.3 Software development for creating the DUAL AVN

This section describes the screen control methods for the drivers seat (Drivers seat hereafter) and the passenger seat (Passenger seat) All examples described below are for the image mode: navigation, audio mode: DVD mode.

①When dual mode is OFF

The control/image signal flow when dual; mode is OFF, is shown in Figure 7.

When the user sets dual OFF, the navigation sends the "Dual OFF" command to the audio through communication. The audio which received the "Dual OFF command" sends the command to the panel through communication. The panel which received the command from Audio will control the selector in the ASIC.

In this example, the Navigation image is output to both the D and Passenger seats.

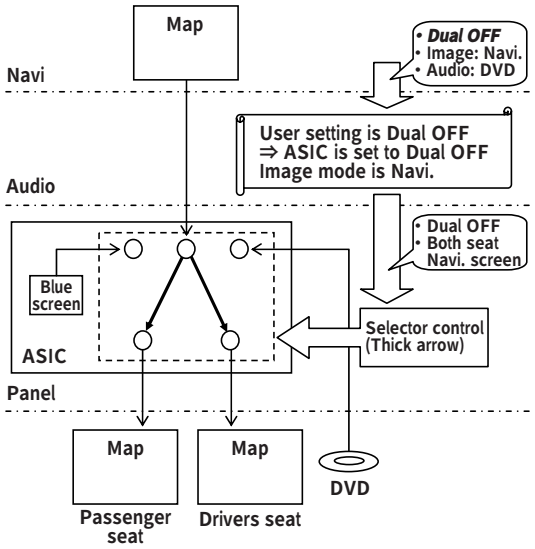

Fig.7 Flow of control/image signals during Dual OFF

②When dual mode ON and Passenger seat control mode OFF

Figure 8 shows the control/image signal flow when Dual ON, Passenger seat control OFF.

In the same manner as in example ①, the user setting is sent from the Navigation to Audio by communication. Audio which receives the user setting=Dual ON, determines what should be output to the Drivers seat and Passenger seat according to the image mode and audio mode at that time, and that information is sent to the Panel through communication (Grey area in Figure 8). The panel, upon receiving the command from Audio, controls the selector in the ASIC. In the case of this example, the Navigation image is displayed towards the Drivers seat, and the DVD image is output to the Passenger seat.

③Dual mode 1 ON with Passenger seat control mode ON

Figure 9 shows the control/image signal flow during Dual ON, Passenger seat control ON.

One feature of the DUAL AVN is that navigation operation that is restricted during driving, is allowed from the passenger side. This example is the control method for enabling this feature.

When the user sets the Passenger seat control to ON, the Navi disables the driving restriction (=performs the same operations as when the vehicle is stopped.) For all else, the same process as in ② is performed. The Audio receiving the user setting = Passenger seat control ON, will command "Drivers seat = Blue Screen" to the panel so that the image for which the driving restriction was disabled is not shown towards the Drivers seat (Grey area in Figure 9). In the case of this example, the blue screen output by ASIC is output to the Drivers seat, and the Navi image for which the driving restriction was disabled, is output to the Passenger seat.

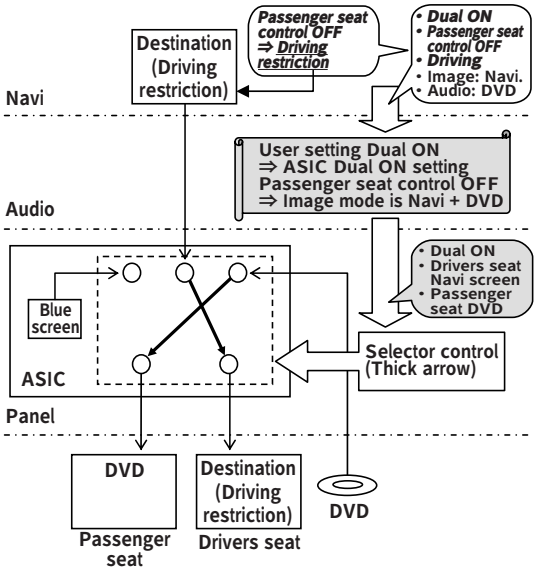

Fig.8 Flow of control/image signals during Dual ON (during driving / Passenger seat control mode OFF)

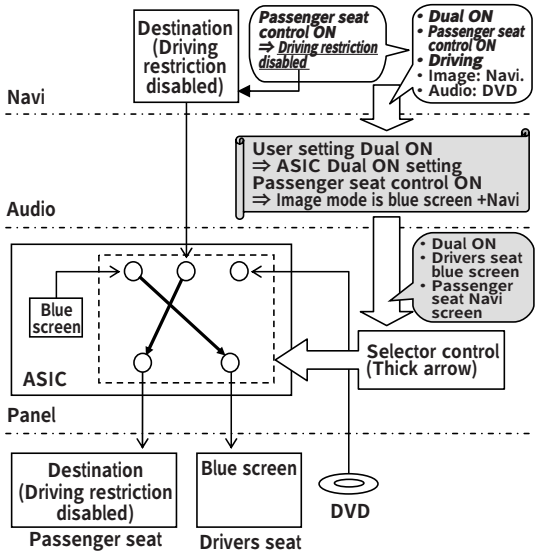

Fig.9 Flow of control/image signals during Dual ON (during driving / Passenger seat control mode ON)

4 Overcoming issues for the DUAL AVN

4.1 Improvement of image leakage and securing brightness

By adjusting the parallax barrier and LCD panel spacing, and changing the design parameters of the parallax

barrier itself, it is possible to control the light separation angle area, and image leak level. However, to balance

①Reduction of the image leakage level in a particular angle area, and

②Securing brightness in order to satisfy visibility (transmittance) as a vehicle mounted device

, and the rise in temperature of the new backlight, which was added to compensate for reduced transmittance (brightness) due to equipping a parallax barrier, all contradict each other and are in a trade off type relationship. With the additional factor of controlling process accuracy for mass production, the production of the Dual View LCD was a very difficult undertaking.

For this image leak and brightness, we performed trials on actual vehicles starting in July of 2004, when a mass production plan had not even been finalized. By evaluating applicability for large, medium and small vehicles, we provided feedback for the LCD device manufacturer. Focusing on PDCA from for each development step and into production thereafter, was one reason for being successful in this development.

In either case, it is obvious that many hours of repeated investigation and evaluation was placed into this project by engineers of both companies in order to satisfy the vehicle mounting conditions in this short amount of time.

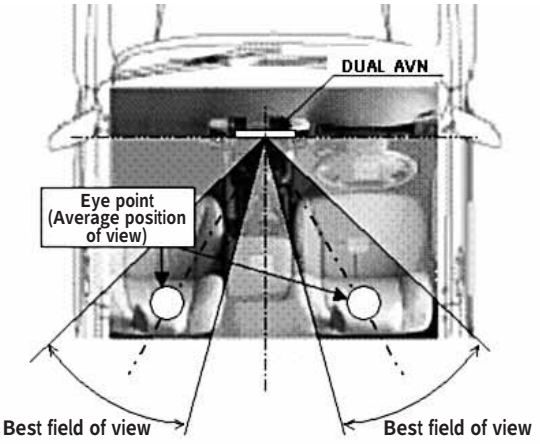

Fig.10 Best range of visibility for a Dual View LCD

4.2 Measures for increased temperature due to the high brightness backlight

In order to compensate for the loss of transmittance (brightness) due to the parallax barrier in the Dual View LCD, the backlight was made stronger by the agreement of both companies. However the increase in heat energy due to the increased brightness was not at a level that would pass as a vehicle mounted device, in the pre-prototype evaluation where an existing product was modified.

Given this result, the LCD was evaluated for various possible improvements, including the illumination efficiency of the fluorescent tube that was the heat source, thermal transfer efficiency of the heated area to the outer casing, revision of optical design, and they applied all those that had an effect. However, it still did not reach an equivalent level of existing models, so we took measures to reduce total temperature rise in our design.

The leading measures are as follows.:

①Equipment of an electric fan/heat sink (Refer to Figure 11)

Multiple ventilation slits were added to the top and bottom of the display unit case, and to actively move the thermal flow inside the display unit, a single direction electric fan was equipped to ventilate the heated internal air upwards.

The natural flow structure drawing in relatively lower temperature air from the bottom, and ventilating the heated air upward, was proven in actual test unit evaluation as well as in our thermal flow analysis.

Also by placing a heat sink on the heated upper section of the LCD, we succeeded in effectively reducing the rise in LCD temperature in combination with the previous forced ventilation.

Because the electric fan causes operation noise, it was set so that it operates only when necessary, along with the following "improvement of the circuit".

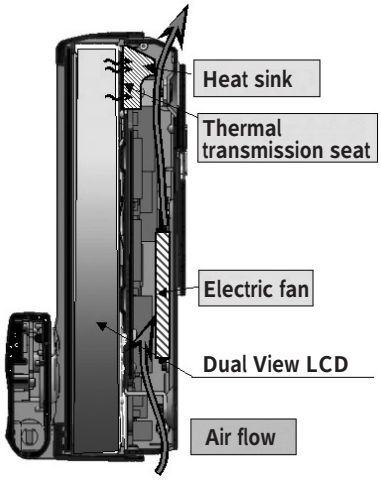

Fig.11 Cross section of display unit

②Circuit and circuit board design improvements

We were able to achieve the goals by adding the following improvements in addition to those above.

- **Revision of heated components such as transformers and transistors on the circuit board, and distribution of heated areas through revision of layout**
- **Control of tube current for fluorescent tube illumination efficiency loss, at above ambient temperatures.**

4.3 Overcoming issues on the audio circuit board

As explained in section 3.1, mounting of the parallax barrier for the Dual View feature reduces the transmittance (brightness) of the LCD in comparison to the wide VGA display utilized in the 2005 summer model HDD-AVN. To overcome this problem, the backlight was strengthened in the DUAL AVN, but doing so increased

the current flow of the backlight, and it was necessary to take extra consideration for current flow capacity and inverter noise than the summer model.

In consideration for effects to other power supply the backlight power was made independent and filter circuits were laid out separately.

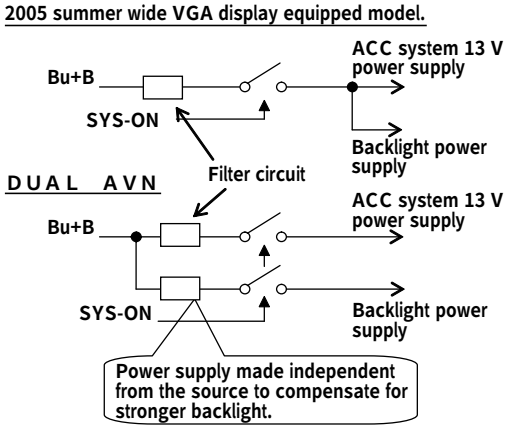

Fig.12 Independent arrange of power supply circuit

Through this, the effect of nose due to the backlight current increase was made equivalent to the 2005 summer model.

In this section, how we overcame 3 major issues in DUAL AVN development was described. It can be safely said that overcoming the issues in the main development item, the display, was what made the DUAL AVN possible.

5 Conclusion

Wanting to show TV and DVD to passengers while still adhering to the Japan Automobile Manufacturers Association stipulation of "The driver must not be shown moving images while driving". We took on this idea (dream) seriously, and the whole engineering group worked together in development without ever losing faith.

"We'll make it no matter what!"

"We want to make it better!"

"We'll never give up!"

With the above mentality, we succeeded in mass producing a seemingly impossible product into the market, in just two and a half years from when the development was first discussed in February of 2003.

The dual display feature has a possibility of opening a new future for all display related products, and we are full of dreams for our product development hereafter.

And we must note, that the existence of the Sharp Corporation was essential in achieving success in this development, and their enthusiastic support for our development approach, their full support and cooperation for our difficult specification requirements and development, is something that we as a company are sincerely grateful for.

We send our deepest gratitude for the Sharp Corporation, and all related companies that have participated in the development of this DUAL AVN.

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・Trademark

"Dual View" … Sharp Corporation

"DUAL AVN" "AVN" "Music Juke" "FM de TITLE" … FUJITSU TEN LIMITED

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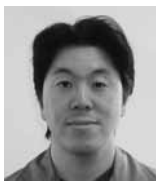

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