# Film Antenna for VICS FM Multiplex Broadcasting

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### Abstract

Fujitsu Ten has developed and is now ready to market a film antenna for VICS (Vehicle Information and Communication System) FM multiplex broadcasts, in which traffic jam information is transmitted to a navigation device for real-time display.

This new film antenna, a transparent film on which the antenna pattern is printed, is designed to be affixed directly onto a vehicle's front windshield. Since it does not protrude from the vehicle, the antenna will not detract from the vehicles's external appearance. Among its other beneficial characteristics, the film antenna affixes easily to the window surface, and does not affect the performance of any existing radio reception.

This thesis explains the new antenna's structure, its performance and distinctive features.

### 1. Introduction

In recent years, the use of the Vehicle Information and Communication System (VICS) has spread rapidly as a means of providing traffic jam information and other information to a navigation device for real-time display. VICS information is provided through FM multiplex broadcasts, i.e., as data multiplexed on existing FM broadcast waves.

Users who wish to retrofit a VICS device on their vehicles must have an antenna for receiving FM multiplex broadcast. Conventionally, the user would have to either install a dedicated pole antenna or split and supply signals received on the existing radio antenna to both the FM multiplex receiver and the existing radio.

However, some people voiced their dissatisfaction with these antennas, saying that the dedicated pole antenna detracts from the vehicle's appearance and the existing radio antenna adversely affects the receiving performance of the existing radio. Accordingly, demand began to grow for an antenna that could solve these problems.

Against such a backdrop, we started development of a film antenna described in this thesis.

#### 2. Goals of Development

We intended to develop a separate film-type of antenna that does not detract from the appearance of a vehicle and does not affect the receiving performance of the existing radio. At the same time, we also reviewed the installation position and the grounding method to improve the installation-related workability that was seen as problematic.

Table 1 shows the required specifications and features of this antenna.

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Item		Required specification	Feature
Film size		500mm X 40mm or less	414mm X 38mm
Installation position		Front windshield	Rim of front windshield on passenger side
Performance	VSWR	4 or less	2 or less
	Gain	0 dBi or more	1.6 dBi or more
	Directivity	Almost nondirectional	Almost nondirectional
	Reception ratio	Equivalent to a conventional one	10% better than a conventional one
Grounding method		Capacity coupling grounding	Capacity coupling grounding using 30x60 aluminum foil
Labor-hours required for installation		Less than a conventional one (2.4H)	0.8H
Cost		Less than a conventional one	10% less than a conventional one

Table 1 Required specifications and features

# 3. Realizing a Film-type Antenna

#### 3.1 Antenna Configuration

Fig. 1 shows the configuration of the antenna that we have developed.

We intended for the antenna to be separate to prevent it from affecting existing radio antenna in any way and to be taller than it is broad to allow it to be affixed on the rim of front windshield on the passenger side.

Additionally, we adopted the meander (folded) structure to provide the loading effect, which, together with the wavelength reduction effect of glass, allows the antenna element to be shorter.



Cross section of film tucked in the pillar

#### Fig. 1 Antenna structure

As a result, this antenna can be comprised of film as short as 414 mm x 38 mm (the section affixed on the glass) although it is intended for an FM band (76 through 90 MHz) that would otherwise require a  $1/4 \lambda$  mono-pole antenna as long as about 900 mm.

The film has the signal feed section tucked in the trim, thus hiding the connector and preventing any deterioration of appearance. The antenna pattern is provided through silver paste printing.

#### 3.2 Securing the Front Visibility

A check of laws concerning the affixing of antennas to the front windshield of cars revealed that the Japanese Automobile Standard (JASO) allows for a maximum of two patterns of antenna film 0.25 mm wide or narrower for affixing to the area shown in Fig. 2.

We therefore decided on this antenna's pattern width of 0.25 mm and the affixing area shown in Fig. 2.



Fig. 2 Area of front windshield on which the antenna can be affixed

# 4. Improving the Workability of Installation4.1 Securing Grounding using Capacity Coupling

Fig. 3 shows the structures of the conventional and new grounding sections. Conventionally, we used direct-

current grounding with screws, which required a large number of labor-hours to drill screw holes.

Since an antenna by nature will operate normally if the grounding is secured for the operating frequency, this antenna is provided with high-frequency grounding based on capacity coupling using foil seals instead of the conventional direct-current grounding.

Foil and body metal equally sandwiching the body coating and foil seal adhesive constitute the capacitor, through which a high-frequency current runs, securing conduction. Additionally, a pressure-weld-type capacitor is used to connect the foil and the grounding wire to secure conduction. Consequently, grounding required for the antenna can be secured.

We have used here an aluminum foil seal of 30 mm x 60 mm and ensured that the antenna input impedance is the same as when direct-current grounding is used.

This grounding method requires only the affixing of the seal, which has greatly improved the workability of grounding section installation.

We have also verified that this grounding method is sufficiently reliable.

# 4.2 Signal Feed from the A-pillar Section (Front windshield)

Retrofitting a vehicle with an antenna for the aftermarket requires quite a number of labor-hours, including peeling the trim off the windshield, installing the antenna, and then reinstalling the trim. Thus, considering the labor costs involved, both dealers and users alike were interested in an easy-to-install antenna.

Conversely, the trim in the A-pillar is generally the easiest among the cabin trims to remove and reinstall.

In consideration of the above points, we designed this antenna to have the signal feed section and the grounding section inside the trim in the A-pillar section.

Thus, in addition to the workability improvement due



a product that we have developed.

Conventional grounding structure

Fig. 3 Grounding section structure

to the capacity coupling described above, we succeeded in decreasing the number of labor-hours by 70% or from 2.4 H to 0.8 H.

# 5. Result of Characteristic Evaluation

#### 5.1 Result of Antenna Characteristic Evaluation

Fig. 4 and 5 show the VSWR and the gain and directivity, respectively.

Both of these required specifications are met.



Fig. 5 Gain and directivity on horizontal surface

#### 5.2 Result of VICS Information Reception Evaluation

Fig. 6 shows the result of VICS information reception evaluation (packet reception ratio evaluation) compared with a conventional reception system. Apparently, the performance of the film antenna equals or exceeds that of a conventional reception system.



Fig. 6 Evaluation results for VICS data reception

Additionally, we performed the evaluation of displaying VICS information images on a navigation device to find also that the performance of the film antenna equals or exceeds that of a conventional reception system as well.

## 6. Conclusion

The newly developed film antenna, intended to receive FM multiplex broadcast, can be applied to other uses if the pattern form is changed.

In the future, the need for even better antennas will likely go hand in hand the continuing diversification of the broadcast and communication media. In view of this, we will work toward making the film antenna one of the key communication methods such as those employing a pole or a patch, while effectively using the feature of not detracting from the appearance of an automobile.

## **Profiles of Writers**



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