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## Design and Practical Application of the 6+2-Channel High-Definition Television OB Van for Pujiang TV Station: Postprint

**Authors:** Zhang Shengbiao

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### Abstract

As the primary field tool, the high-definition television broadcast van plays an increasingly important role in HD television broadcasting and program recording for various major events, sports competitions, and cultural performances. This paper provides an overview of the procurement and construction plan for a 6+2 channel high-definition television broadcast van at Pujiang Television Station, and presents a detailed introduction to the vehicle's design philosophy and practical application.

### Full Text

## Design and Practical Application of the 6+2 Channel HD Television Broadcast Van of Pujiang Television Station

Pujiang County Media Convergence Center, Jinhua, Zhejiang 322200

**Abstract:** As the primary field tool for broadcast operations, high-definition television broadcast vans play an increasingly critical role in HD broadcasting and program recording for major events, sports competitions, and cultural performances. This paper outlines the procurement and construction plan for a 6+2 channel HD television broadcast van at Pujiang Television Station, providing a detailed examination of its design philosophy and practical application.

**Keywords:** HD broadcast van; network video live streaming; monitoring system; peripheral system

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To meet the requirements for HD live broadcasting and recording of major events, sports competitions, and cultural performances within the county, Pujiang Television Station procured a high-definition television broadcast van. The deployment of this HD broadcast van has significantly improved program recording quality and ensured the security of television live broadcasts and program recording. Equipped with program acquisition, production, and transmission capabilities, the van offers strong mobility and functions as a compact studio. Following technical evaluation and comparative analysis of various proposals, the station selected a SITRAK chassis, with the vehicle permanently equipped with 6+2 HD channels capable of producing both HD and SD versions of programs. The design is distinctive and highly functional. As the station's primary field tool, this broadcast van satisfies the HD live broadcasting and recording needs for important county events while offering cascade connectivity with other broadcast vans, satellite trucks, and audio vehicles. The following sections provide a detailed introduction to the van's design philosophy and practical application.

## 1.1 Design Principles

As the primary field tool for Pujiang Television Station tasked with HD live broadcasting and recording of important county events, the van's design must satisfy several key requirements. First, the channel count and system configuration should be designed according to the broadcast signal requirements of county-level events. Second, the broadcast van must employ advanced technology with stable performance, comprehensive emergency protocols, and safe, convenient, and efficient emergency operations. Third, the interior equipment layout must be rational and the system functions complete, enabling video signal acquisition, audio signal acquisition, video subtitle overlay, and long-distance optical fiber signal transmission. The system should also offer extensive expansion capabilities for convenient signal exchange with other broadcast van systems to collaboratively complete large-scale broadcasting tasks. The in-vehicle network should enable centralized management, configuration, and status monitoring of broadcast van equipment [1]. Fourth, guided by the design objectives of high quality, safety, and economic practicality, the broadcast van system equipment should deliver high cost-performance while meeting functional requirements.

### 1.2.1 Vehicle Overview

The van utilizes a SITRAK C5H chassis from China National Heavy Duty Truck Group, featuring 4 $\times$ 2 drive and a wheelbase of 5800 mm. The vehicle dimensions (length  $\times$  width  $\times$  height) are 9860 mm  $\times$  2496 mm  $\times$  3035 mm, with a side expansion compartment measuring 6000 mm in length and extending 1000

mm in width.

## 1.2.2 Interior Partitioning

The HD broadcast van interior is divided into two work zones: a technical area and a director/audio area. The technical area accommodates two workstations, while the director/audio area houses five workstations, enabling simultaneous operation by seven staff members. Additionally, a long bench sofa is installed on the side of the expansion compartment for personnel rest. The sofa features storage compartments for storing in-vehicle items.

## 1.3.1 Overall System Architecture

The broadcast van system employs a pure HD design capable of producing full HD programs while utilizing HD down-conversion to meet SD output requirements. The system centers on the SONY MVS-3000 production switcher, with a Utah 100/UDS64 router handling signal distribution to complete signal switching, conversion, emergency routing, recording, slow-motion replay, monitoring, and external panel signal allocation within the van. The tally system provides dynamic intelligent changes with tri-color lighting displays and enables source name tracking through control system integration, delivering prompt information during production processes such as on-air, preview, recording, slow-motion, and program return.

The van features eight channels: six optical cable channels, one wireless image transmission channel, and one unmanned aerial vehicle signal channel. The core equipment includes one large production switcher with a 32-input/16-output 2 M/E configuration, a master routing matrix with 64 inputs and 64 outputs, a recording system comprising four HD dual-channel hard disk recorders and two HD memory card recorders, and director area monitoring utilizing Astrodesign multi-viewer systems and 4K monitors for single-screen and split-screen displays, ensuring reliable quality with fine, aesthetically pleasing image presentation. The technical and recorder areas employ 17-inch professional LCD monitors with multi-viewer display, offering cost savings and convenient operation.

Up/down/cross converters and embedders/de-embedders are connected at the broadcast van's signal input and output terminals to facilitate flexible signal routing. The system reserves analog/digital video interfaces, sync interfaces, audio interfaces, tally interfaces, intercom interfaces, VGA interfaces, HDMI interfaces, telephone interfaces, network interfaces, and optical fiber signal input/output interfaces. This enables convenient cascading with other broadcast vans, microwave trucks, studios, on-site signals, and flyaway expansion systems, ensuring excellent connectivity and scalability. The interior equipment layout is rational with high space utilization and bright lighting, reflecting a human-centered design that allows staff to work comfortably for extended periods without feeling confined. Equipment selection follows mainstream domestic broadcast products that are safe, stable, and widely deployed at national, provincial,

and prefecture-level television stations.

### 1.3.2 System Equipment Composition

The HD broadcast van utilizes mature, stable, and technologically advanced system equipment from the broadcast industry to ensure system safety and reliability. The camera system employs six sets of Sony HDC2580 16-bit CCD HD cameras, with optical fiber connections between cameras and CCUs ensuring high-quality signal transmission. The HDC2580 features newly adopted Power HAD EX HD CCDs (2.2 megapixels) with sensitivity up to F11, reducing lighting requirements for nighttime broadcasts. The signal-to-noise ratio is continuously adjustable from 55-60 dB, with modulation depth reaching 60%, effectively reducing noise in dark areas and delivering rich detail in high-definition images with enhanced clarity.

The van's video switching employs a SONY MVS-3000 production switcher, a 2 M/E mid-size switcher processor supporting up to 32 inputs and 16 outputs, with a maximum of two channels of digital effects and four DSK channels in a compact 4U chassis. The emergency switching and distribution system utilizes a Utah 100/UDS64 multi-format router configured with 64 inputs and 64 outputs. This rich configuration provides ample flexibility for emergency routing, recording, slow-motion, monitoring, and external panel signal distribution, significantly enhancing system flexibility.

The peripheral system plays a pivotal role in the HD broadcast van, with equipment selection determining final signal quality. After careful comparison, the station selected Axon peripheral systems from the Netherlands, which are widely deployed in domestic broadcast institutions with stable quality and multiple functions well-suited to Pujiang Television Station's requirements. The director area monitoring system employs eight 42-inch Astrodesign broadcast-grade 4K LCD monitors paired with Astrodesign multi-viewer systems to ensure post-split monitoring images remain HD quality. The single-screen plus split-screen display delivers fine image quality with an aesthetically pleasing overall appearance.

The audio system supports HD and SD program live broadcasting and recording, capable of meeting various large-scale event audio recording requirements for the station. It can complete mono recording, stereo recording, audio transmission, and monitoring. The audio console employs a main/backup configuration, with the primary console being a YAMAHA 01V96 and the backup a STUDIOMASTER 122BP. All external MIC or LINE signals are input to both consoles through high-quality distribution amplifiers, with the processed console outputs delivered to required equipment via main/backup switching.

The van's intercom system includes wired camera intercom and wireless radio communication using Party-Line configuration. One 4-channel master station serves the director area, while three dual-channel remote stations serve the technical, camera, and recording areas. Camera intercom and wireless communica-

tion devices connect to the intercom system through 4-wire/2-wire converters. Equipment includes Clercom MS-704 4-channel master stations and RM-702 2-channel remote stations, with wireless communication using a KENWOOD NXR810 radio repeater and MOTOROLA GP328 radios. The wireless repeater extends coverage distance, ensuring smooth communication in relatively large or obstacle-rich venues, allowing field personnel to access the intercom system via radio for coordinated fixed and mobile communication.

## 2. Practical Application

Since its delivery in September 2018, the HD television broadcast van has undertaken over 50 live and recorded broadcast missions. Following a series of practical adjustments, the equipment currently operates stably with normal functional performance.

### 2.1.1 Broadcast Van Engine Maintenance

The broadcast van engine system requires regular maintenance, including inspection of the vehicle braking system to ensure safety and reliability. First, the engine battery must be checked. Due to the relatively low usage frequency of county-level broadcast vans (typically twice monthly), the engine battery is prone to discharge when the vehicle remains parked for extended periods, causing low voltage that prevents engine ignition and delays work. To prevent battery discharge, the battery output switch should be turned off promptly after parking the van in the garage [2]. Second, the urea filler opening must be checked for blockages. The van's diesel engine requires urea addition during operation to meet national emission standards. When the urea filler opening becomes blocked, the dashboard displays a yellow warning light requiring immediate maintenance.

### 2.1.2 Vehicle Body Structure Inspection

Regular inspection of the van's body structure is essential. First, the hydraulic support system must be checked to ensure all four support legs can extend and retract normally. During operation, instances of support legs failing to extend have occurred due to incomplete retraction during the previous use, where the support system power was turned off prematurely before the legs fully retracted. Second, the side expansion system must be inspected to ensure smooth operation. The expansion system offers two modes: automatic and manual. Under normal conditions, the automatic mode indicator illuminates, and pressing the activation button extends the expansion compartment. During one remote broadcast, the automatic mode indicator failed to illuminate after power-on, and the expansion compartment did not respond when the button was pressed. In this emergency situation, manual mode was used to open the expansion compartment. The cause was determined to be a faulty transformer power module in the expansion system. Third, the cable reel motor operation

must be checked to ensure the motor flywheel can drive the reel chain. The electric flywheel at the rear cable reel failed when excessive resistance caused mechanical damage, rendering electric reeling impossible and requiring manual operation. The problem was resolved by replacing the flywheel with a higher-tolerance component.

### 2.2.1 Video/Audio Synchronization Processing

The HD television broadcast van represents a large-scale system integration project where video and audio signals passing through multiple stages can easily develop lip-sync issues. To ensure synchronization, the broadcast van system employs three solutions. First, the digital audio consoles feature delay adjustment functions that can be used to align video and audio signals. Second, the system includes AXON HXT100 boards with video switching, embedding, and delay adjustment capabilities. When embedding audio signals, the boards can adjust delay to achieve synchronization. Third, the system includes two FOR.A cross-format converters capable of handling HD/SD up/down conversion, embedding/de-embedding, and audio delay functions. By routing PGM signals through these devices via the router, video and audio signals can be synchronized.

### 2.2.2 Network Video Live Streaming

To accommodate media convergence development and meet network video live streaming requirements, the broadcast van has been equipped with network video live streaming encoders. The director area 预留了数字视频输出接口、音频接口、HDMI 接口、网络接口等。Digital video and audio signals consist of live program signals switched by the Sony MVS-3000 production switcher according to live broadcast requirements. Network connectivity comprises external fiber optic network signals (telecom or mobile) and 4G multi-card aggregated network signals, with external fiber serving as the primary connection and 4G aggregation as backup. Two LiveU Solo multi-network aggregated video streaming encoders are installed on the desktop control console, utilizing LiveU's portable streaming devices to push live video to streaming platforms with one-click operation. This transforms the HD broadcast van into a complete, efficient, and convenient multi-camera network video live streaming scenario that fully satisfies network video live streaming requirements [3].

### 2.3.1 Pre-Event Site Survey

For large-scale evening live events using the broadcast van, thorough pre-event site surveys and on-site debugging are essential. The pre-event site survey must address several issues. First, transportation conditions to the event site must be assessed, carefully confirming road integrity, height restrictions, and determining accessible routes for the broadcast van. Second, parking location and power supply routing must be considered. The parking position should be determined based on distances to power sources and camera signal cabling, combined with

on-site environmental conditions. The parking area must be level and solid to accommodate support leg deployment and expansion compartment extension. The broadcast van is not equipped with a generator and requires external power supply. The external power supply must be a dedicated three-phase power source with adequate capacity and stable delivery, preferably not shared with lighting, audio, LED screens, or other on-site equipment to avoid interference. Third, signal transmission issues must be resolved. Program signals are transmitted to the station via fiber optic network, requiring advance coordination with network providers for fiber signal testing.

### 2.3.2 On-Site Debugging

On-site debugging involves several critical steps. First, the video system must be deployed. Advance communication with event organizers is necessary to understand the event theme, careful observation of program rehearsals is required, and the number and positions of cameras must be determined. All signals are connected to the broadcast van, with camera and CCU parameters adjusted to optimal states. Second, the audio system must be deployed. The broadcast van audio console interfaces with the on-site audio console, with audio isolation transformers connected at the input stage to test for clean audio without interference or noise floor. During the event, the broadcast van audio engineer must maintain continuous communication with the on-site audio engineer to ensure transmitted audio signals remain normal. Third, cables must be organized and return signals tested. After on-site system deployment, all cables must be organized and secured along edges to prevent personnel from tripping over them, with cable bridges added when necessary to prevent damage. Before the program begins, adequate time must be allocated to coordinate with the station's broadcast control department to test the primary and backup optical transceiver video/audio fiber signals.

### 2.4 Improving Broadcast Van Utilization

Given that the broadcast van is only used for a limited number of large-scale events annually and remains idle at other times, this represents poor capital utilization. To improve usage rates, Pujiang Television Station leverages the van's multi-camera channel advantage by connecting it to the station's studio. The station's four-channel studio can interface with the broadcast van, with van cameras connected via fiber optic and studio cameras connected through reserved SDI interface panels on the van, supporting up to 12 signal channels. This reserved interface panel greatly facilitates camera signal connection, making broadcast van signal access more flexible and significantly improving utilization rates.

The deployment of this broadcast van has substantially elevated the station's broadcast equipment standards, significantly improved audio/video recording quality for in-house programs, enhanced long-distance signal transmission capabilities, and expanded television service offerings. After numerous tests in

large-scale live events, the HD television broadcast van system has demonstrated stable operation with all functions performing normally. The excellent program recording quality and operational convenience have received positive feedback from production staff, providing technical assurance for Pujiang Television Station to produce more high-quality television programs.

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**Author Biography:** Zhang Shengbiao (1980-), male, from Jinhua, Zhejiang, engineer. Research focus: television broadcasting.

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*Note: Figure translations are in progress. See original paper for figures.*

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