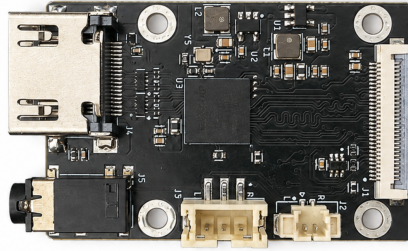


WarpKVM HDMI to MIPI Board

Product Specification: RK628H HDMI to MIPI CSI-2 bridge board

1 Product Overview



The WarpKVM HDMI to MIPI Board is a compact video-bridge module built around the Rockchip RK628H. It converts an HDMI source into a single-channel, 4-lane MIPI CSI-2 stream delivered to the host over a 30-pin FPC connector, allowing an application processor's camera interface to capture HDMI video with no external capture hardware. HDMI audio is recovered over I2S and converted to stereo line-level output by an on-board GC4344 audio DAC.

The board is the video capture front end for WarpKVM products. It has been validated on the Rockchip RK3576 (Firefly ROC-RK3576-PC) and is suitable for KVM-over-IP, video capture, and machine-vision applications.

2 Specifications

Parameter	Value
Bridge IC	Rockchip RK628H (FBGA144L)
HDMI input	HDMI 1.4 / HDMI 2.0 receiver, full-size Type A receptacle. RGB888 / YUV444 / YUV422 / YUV420, 8/10-bit. EDID and CEC supported. DVI compatible. HDCP 1.4 capable; see section 4.2.
MIPI CSI output	Single-channel 4-lane MIPI CSI-2, D-PHY v1.2, YUV422. Maximum 1.8 Gbps per lane. See section 3 for validated modes.
Video processing	On-chip scaler (arbitrary non-integer ratios, up and down), colour space conversion (RGB to YUV and YUV to RGB)
Audio output	HDMI audio recovered via RK628H I2S, GC4344 stereo DAC to line-level outputs (3-pin and 2-pin wafer connectors). Analogue only; see section 4.1.
Host control	I2C (1.8 V) plus reset and interrupt. Source detect optional.
Power input	5 V via FPC connector (pins 29 and 30)
Operating temperature	-20°C to +80°C, per RK628H recommended operating conditions. Board-level thermal validation not performed.
Dimensions	46.25 mm x 30 mm; four M2.5 mounting holes. See section 5.2.

3 Validated Modes

Per-lane rate is calculated as pixel clock x 16 bpp (YUV422) divided across four lanes. The single-port routing on this board does not use the RK628H dual-MIPI split, so all bandwidth is carried on one 4-lane link.

Mode	Pixel clock	Per-lane rate	Status
3840x2160 @ 30	297.00 MHz	1188 Mbps	Validated
1920x1080 @ 144	356.40 MHz	1426 Mbps	Validated, see 3.1
1920x1080 @ 120	297.00 MHz	1188 Mbps	Validated, see 3.1
1920x1080 @ 60	148.50 MHz	594 Mbps	Validated
1280x720 @ 60	74.25 MHz	297 Mbps	Validated
720x480 @ 60	27.00 MHz	108 Mbps	Validated

Measured on the Rockchip RK3576, 300 to 400 frames per mode. Inputs above 4K30 require the on-chip scaler, which is not validated.

3.1 Requirements above 60 Hz

1920x1080 at 120 and 144 Hz need the section 8 driver patches **and** the `continues-clk` property on the bridge's device tree node, which Firefly's stock tree omits. Without it, high-refresh capture produces continuous CIF size errors and delivers almost no frames; 4K30 and 1080p60 are unaffected.

4 Functional Notes

4.1 Audio path

HDMI audio is decoded by the RK628H and delivered over I2S to the on-board GC4344 DAC, which drives the analogue line-level outputs. Two consequences follow:

- The path bypasses the host processor. Audio is available only at the analogue outputs; it is not a host capture device and cannot be recorded or streamed without extra hardware.
- The RK628H gates its I2S transmitter on the video pipeline, so the outputs are silent unless the host is actively capturing. This is expected behaviour, not a fault.

4.2 HDCP

The RK628H supports HDCP 1.4 at the HDMI receiver and the board provides the necessary connectivity. Operation requires HDCP keys licensed from Digital Content Protection LLC, which are not supplied with this board. HDCP operation has not been validated by WarpKVM.

4.3 EDID

The bridge presents an EDID to the HDMI source, which determines the modes the source will offer. The default EDID supplied by the Rockchip driver advertises 1920x1080 @ 60 with audio. Custom EDIDs are required to obtain higher refresh rates and need the driver fix described in section 8; without it, EDID writes are accepted by the bridge but never read by the source.

5 Interface Definitions

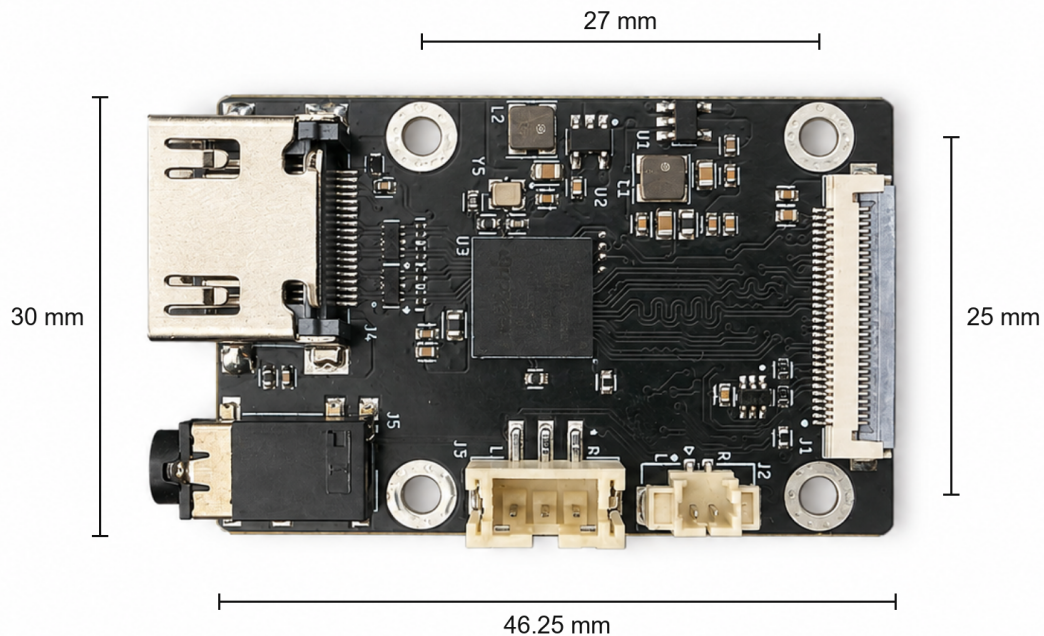
5.1 LINE_OUT connectors

Two parallel analogue line-level outputs. Both carry the same stereo signal from the GC4344 DAC.

Connector	Pin	Definition
3-pin, 2.0 mm pitch wafer	1	OUT_R
	2	GND
	3	OUT_L
2-pin, 1.25 mm pitch wafer	1	OUT_L
	2	OUT_R

5.2 Mechanical

Board outline 46.25 mm (W) x 30.0 mm (H). Four M2.5 mounting holes on a 27.0 mm x 25.0 mm rectangular pattern, centre to centre. The HDMI receptacle shell overhangs the left board edge.



Board outline and mounting hole pattern. Dimensions in millimetres.

6 J1: MIPI CSI Host Interface

30-pin FPC, FPC30-T1T1-2021-A.

Pin	Definition	Level	Pin	Definition	Level
1	SDA_CAM_1V8 (I2C data)	1.8 V	16	GND	n/a
2	SCL_CAM_1V8 (I2C clock)	1.8 V	17	MIPI_CSI0_CK_P	n/a
3	HDMIIN_PWR_EN/DET	n/a	18	MIPI_CSI0_CK_N	n/a
4	HDMIIN_RSTN (reset, active low)	1.8 V	19	GND	n/a
5	GND	n/a	20	MIPI_CSI0_D2_P	n/a
6	SW1 / MIPI_PWR0_CAM_OR_5V	n/a	21	MIPI_CSI0_D2_N	n/a
7	HDMIIN_INTN (interrupt, active low)	1.8 V	22	GND	n/a
8	HDMIRX_DET_N (source detect, active low)	1.8 V	23	MIPI_CSI0_D3_P	n/a
9	SW2	n/a	24	MIPI_CSI0_D3_N	n/a
10	GND	n/a	25	GND	n/a
11	MIPI_CSI0_D0_P	n/a	26	NC	n/a
12	MIPI_CSI0_D0_N	n/a	27	NC	n/a
13	GND	n/a	28	GND	n/a
14	MIPI_CSI0_D1_P	n/a	29	VCC5V0_SYS (5 V input)	5 V
15	MIPI_CSI0_D1_N	n/a	30	VCC5V0_SYS (5 V input)	5 V

Connector shield (SH) is tied to GND. CSI pairs are D-PHY v1.2 differential signals. I2C operates in the 1.8 V domain; do not drive at 3.3 V. Pins 3, 6 and 9 are system control signals; see the host integration guide.

7 Host Requirements

- MIPI CSI-2 receiver: 4-lane D-PHY v1.2. Required per-lane rate depends on the target mode; see section 3. 1188 Mbps per lane covers 3840x2160 @ 30 and 1920x1080 @ 120.
- I2C master at 1.8 V for RK628H configuration.
- Two GPIOs required: reset (HDMIIN_RSTN) and interrupt (HDMIIN_INTN). The interrupt pin must be interrupt-capable on the host.
- Source detect (HDMIRX_DET_N) is optional. The Rockchip driver treats an absent detect signal as "source always present", which is appropriate for permanently connected installations.
- 5 V supply on FPC pins 29 and 30.
- Validated with the Rockchip RK3576, on the Firefly [ROC-RK3576-PC](#).
- Expected to work with the Rockchip RK3566, RK3568, RK3588 and RK3588S. The Rockchip BSP carries the same bridge driver for these parts and Firefly ships HDMI-to-MIPI-CSI hardware against them, but WarpKVM has not validated this board on them. Any SoC with a MIPI CSI-2 camera input meeting the requirements above can be supported with a suitable driver.

8 Software Support

The Rockchip BSP includes the `rk628-csi-v4l2` driver, which supports this board. On a Firefly ROC-RK3576-PC running unmodified factory firmware, the board is recognised without installation or reflashing, and 3840x2160 @ 30 and 1920x1080 @ 60 capture plus analogue audio all function as shipped.

8.1 Verifying capture on Linux

The following script displays the captured video locally using GStreamer. It runs unmodified on the Firefly factory image.

```
#!/bin/bash

export DISPLAY=:0
export XAUTHORITY=/home/firefly/.Xauthority
export LD_LIBRARY_PATH=$LD_LIBRARY_PATH:/usr/lib/aarch64-linux-gnu/gstreamer-1.0
WIDTH=1920
HEIGHT=1080
SINK=xvimagesink

gst-launch-1.0 v4l2src device=/dev/video0 \
! video/x-raw,format=NV12,width=${WIDTH},height=${HEIGHT} \
! videoconvert ! $SINK
```

Substitute `kmssink` for `xvimagesink` on a system without an X session, or `waylandsink` under a Wayland compositor. The capture node is normally `/dev/video0`, but device numbering depends on probe order; confirm with `v4l2-ctl --list-devices`.

8.2 Stock driver limitations

Three limitations of the stock Rockchip driver affect deployments beyond 4K30 and 1080p60. All are addressed by the WarpKVM patch set.

- **Refresh rates above 60 Hz.** The stock driver locks higher-rate modes at the HDMI receiver but does not sustain capture at them. Note that the driver patches alone are not sufficient; see section 3.1.
- **Runtime EDID changes.** The stock driver de-asserts hot-plug detect while writing an EDID and does not re-assert it, so the source never re-reads the new EDID and the display is lost until the HDMI cable is physically replugged. Custom EDIDs are required for any mode not in the default EDID, which makes this a prerequisite for automated mode switching.
- **Bridge recovery.** Replugging HDMI on a powered board can leave the RK628H unresponsive on the I2C bus, after which it serves no EDID and the source loses the display. The stock driver sequences the reset and enable lines once at probe and has no recovery path, so only a cold power cycle restores it. The WarpKVM driver detects the condition and recovers automatically in approximately two seconds using a reset-GPIO cycle, which requires no I2C access.

Contact WarpKVM for the patch set and integration notes.

9 References

- Rockchip RK628H Datasheet, Rev 1.1, 2024-07-02
- WarpKVM HDMI to MIPI Board mechanical drawing
- WarpKVM RK628H Getting Started guide (Firefly ROC-RK3576-PC)