

Synchronization of ARRI Cameras with 3rd Party Devices

TECHNICAL INFORMATION

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Version History

Version	Author	Change Note
2020-11	David Zucker	First Draft as “Recommended Practice”
2021-02-16	Jan Heugel	Revision as TI
2023-06-10	Stefan Söllner	Added Alexa 35 and LTC sync for Mini etc.
2023-10-11	Jan Heugel	Added 416 & ESU-1
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Table of Contents

Introduction	3
1 ALEXA Classic Cameras (ALEXA XT, SXT, LF and ALEXA 65)	3
1.1 Overview	3
1.2 System Setup	3
1.2.1 Device timecode tuning.....	3
1.2.2 Phase shifting.....	3
1.3 Camera setup.....	4
1.4 Setup diagram	5
2 ALEXA 35, ALEXA Mini LF, AMIRA and ALEXA Mini	5
2.1 Overview	5
2.2 System Setup Genlock.....	5
2.3 Camera setup.....	5
2.3.1 Phase shifting.....	6
2.4 Setup diagram	6
3 ARRIFLEX 416	6
3.1 Overview	6
3.2 Connecting the External Synchronization Unit (ESU-1) to your camera	6
3.3 Syncing the camera and the IVS	7
3.4 Enabling Genlock on the 416 IVS	7
3.4 Timecode and external sync	8
3 ARRICAM LT/ST	8
3.1 Overview	8
3.2 Synchronisation of the camera to external sources.....	9
Contact	10

Introduction

Various situations require to synchronize a group of devices to properly work together in order to avoid errors, artefacts or disturbances. This can include devices ranging from lighting fixtures, cameras, special effects to motion control devices or the example we will use in this document: a LED wall within a virtual set, where a camera needs to operate in sync with the wall setup.

To synchronize a camera to an external device, such as the LED wall processor, one needs to ensure all devices are synchronized to one another. This is facilitated by trigger signals sent from a single source (master or studio clock).

Our guide describes how to configure your ARRI camera and external devices to operate in a synchronized fashion. A common method to achieve synchronization amongst video devices is Genlock (tri-level and black burst), best is to have a master clock that supports tri-level, black burst, PTP and LTC.

1 ALEXA Classic Cameras (ALEXA XT, SXT, LF and ALEXA 65)

1.1 Overview

Since ALEXA Classic cameras are not equipped with a Genlock input, one needs to get creative. It is possible to trigger ALEXA Classic cameras with an external timecode feed while also providing synchronization to 3rd party equipment over Genlock.

1.2 System Setup

It is imperative that both sync signals originate from the same source clock. The source clock would need to generate both signals at the same time:

- Genlock (tri-level sync): External devices – such as an LED wall processor and other devices in your environment.
- Timecode: ALEXA Classic camera – the camera is fed a timecode via LTC; the sensor will be triggered according to that timecode signal.

An example of a device that can generate both timecode and genlock from the same master clock is the Ambient ACL Lockit box.

We have successfully used two Ambient Lockits during our tests: ACL 204 and ACL 203 or 202 (older models).

Ambient is of course not the only brand offering devices with this or a similar functionality but rather were the devices at our disposal.

The tri-level sync signal is an analog video signal. If you send it to multiple stations, we recommend using an analog video distribution amplifier. Otherwise, T-pieces would work for relatively short cable runs. Do not forget to terminate where necessary!

1.2.1 Device timecode tuning

It is a standard and highly recommended practice to tune all your timecode devices, including the camera and timecode devices, from a master timecode device capable of tuning external devices. If this step is not performed a sync drift could occur while the camera is recording.

1.2.2 Phase shifting

Some external devices, such as a LED wall processor, allow for phase shifting the incoming Genlock signal (Sidenote: Ambient ACL 204 also allows phase shifting the Genlock signal internally).

On a regular LTC signal, phase shifting is not possible. But you can apply a pseudo-phase-shift by feeding the timecode through an audio delay device on its way to the camera.

In the device setup scheme below this has been marked 'optional' due to phase shifting abilities in the rest of the signal chain.

1.3 Camera setup

- Perform a factory reset via MENU > User Setups > Factory reset
- Setup your project in MENU > Project > Project frame rate; set it to e.g. 24 fps

MENU>PROJECT	
Sensor mode	16:9
Setting	23.976 fps
Project frame rate	24 fps
Camera index	25 fps
Camera index color	29.97 fps
Next reel count	30 fps

- Use the dedicated 'TC' button to access the timecode menu. Change the timecode settings in the timecode menu (access via the "Options" button).
- Set the parameters accordingly:
 - o Source: EXT LTC
 - o Mode: Free Run
 - o Generator: Regen

1.3.1 Home screen

The timecode on the home screen will blink if no external timecode is fed to the camera. The *info button* will tell you that an external LTC is missing.

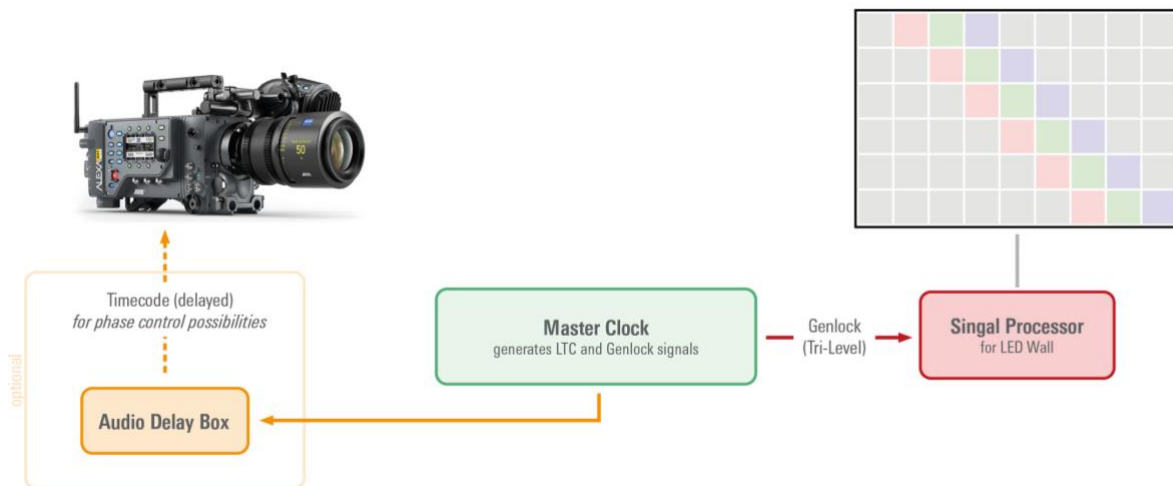
FPS	AUDIO	SHUTTER
24. ⁰⁰⁰	Off	180. ⁰
TC EXT 00:27:42 @24		16:9 • STBY
REEL A 001		ARRIRAW
BAT 1 26.0V CLIP C 004	Drive	
D BAT 2 14.8V DUR 0:01:12	⊙ 00:40:16	
800	INT: ARRI 709 REC: RAW	5600 ⁰
EI	COLOR	WB

- Connect the 5-pin Lemo if you haven't already done so.
- Wait a few seconds

The timecode should stop flashing and take on the new clock that is being supplied by the timecode generator or the LTC input.

As long as the sensor is set to the same rate as the project rate (in our example: 24fps), the camera will reference the incoming LTC timecode and trigger the sensor based on that clock.

1.4 Setup diagram



2 ALEXA 35, ALEXA Mini LF, AMIRA and ALEXA Mini

2.1 Overview

With ALEXA Mini LF, ALEXA 35 and AMIRA things are a little easier as you can feed the camera directly with a Genlock Signal, the sensor will be triggered according to that signal.

ALEXA Mini needs to be modified by ARRI Service to accept a Genlock signal. SDI-2 will be converted to "SYNC IN".

The camera's sensor needs to run at equal or double the framerate of the reference signal to establish synchronization. With an ALEXA Mini LF, please keep in mind the framerate limitation over the regular LF.

Still, all cameras can be synchronized via LTC with the routine described in the previous chapter. The "Sync Shift" feature (see below) will apply to this as well, so there's no need for an external shifting device. We'd always recommend using a tri-level synchronization due to the enhanced accuracy.

2.2 System Setup

Genlock

Using an Ambient ACL 204 or a similar device, the output can be configured to feed a Tri-Level Genlock. For "Tri-Level" set the ACL 204 to 1080p and make sure to match the frame rate of all connected devices. 23.976 fps is NOT 24 fps!

One can use other devices to generate a tri-level signal like the AJA Gen10 to replace the Ambient ACL 204 and video distribution amplifier.

In testing, we have had mixed and quite unreliable results when using a Blackmagic Mini Converter Sync Generator as a genlock source.

Do not forget to terminate the analog video signal where necessary if you are working with T-pieces!

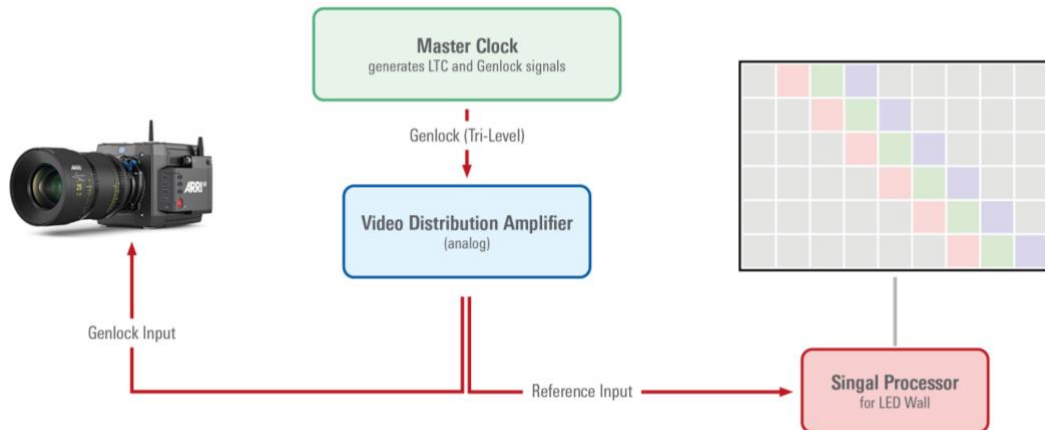
2.3 Camera setup

Enable the camera's genlock input via MENU > System > Sensor > Genlock Sync. Set it to "SYNC IN". The camera can still run at double the incoming genlock rate while maintaining sync reference with its input.

2.3.1 Phase shifting

If you find the camera and external device are not in sync, you can adjust the *Sync Shift* in the camera to apply an offset to the incoming tri-level sync trigger. This value is likely to depend on the LED wall technology and framerate you are using. It is not uncommon to use a value of around 1.000.000 as that equates to 6.7ms.

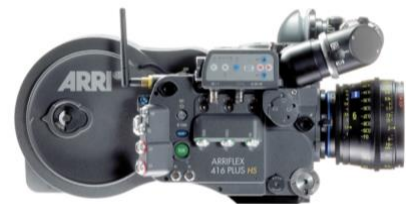
2.4 Setup diagram



3 ARRIFLEX 416

3.1 Overview

Joining the old with the new: shooting with a film camera in a LED volume is not a far-fetched idea. This chapter looks at the use of the ARRIFLEX 416/416 Plus.



Here's what you need:

- ARRIFLEX 416 (usually comes with the built-in video tap "Integrated Video System" (IVS))
- ARRI ESU-1 ("External Sync Unit")

3.2 Connecting the External Synchronization Unit (ESU-1) to your camera

The ESU-1 can be used with the ARRIFLEX 416 as well as with the 235, the 435 models, 535, 535B and 16SR 3/ Advanced. It allows the camera to be synchronized to other equipment such as TV monitors. By means of a BNC-socket, it is possible to synchronize to an external standard video signal (50/60 Hz) or, through an inductive pickup, to a CRT type monitor.



When connected, the camera display shows "ESU" in the upper line. The ESU-1 can be used for frame rates from 3 to 60 fps. The frame rate is indicated on the camera display in Mode 2 (please refer to the 416-user manual for details). A phase shifter and a pilot tone generator have also been integrated into the external synchronization unit. The phase relationship of the synchronization is retained even when the camera is switched off. (See TECHN. INFORMATION "External Synchronization Unit ESU-1" for more).

To connect the ESU-1 cable to the camera, use the 235/416 Accessory Expansion Cable (KC-88-s) from the camera's "REMOTE" socket to the ESU-1. The RCU-1 can be connected to the other socket of the accessory expansion cable if need be.



3.3 Syncing the camera and the IVS

The ARRIFLEX 416 and its PAL IVS are not synchronized per se. If you need a gen-lock for both, send a black burst signal to the camera through the ESU-1 and send the same signal in parallel to IVS Gen-Lock input.

The ARRIFLEX 416 doesn't have a separate Sync-In, all feeds through the ESU.

Please note: ESU-1 does not support tri-level. The IVS can only process black burst.

3.4 Enabling Genlock on the 416 IVS

It is possible to synchronize the IVS to an external video signal, thus allowing the user to switch between different video signals without synchronizing problems.

- Connect a standard video signal of the same type as the video system (PAL or NTSC) to the Video output with no data (C-Output).

Enter the Video/Text Adjust submenu from the main menu. (The main menu is displayed on the monitor screen when the on-screen programming is activated by pressing the Enter/Insert key for more than three seconds. An illuminated LED indicates that the on-screen programming is activated.

- Move the cursor > with the keys [↑] and [↓] to the line – GENLOCK
- Pressing the [←] or [→] key will switch genlock ON or OFF.

The video signal out of the connector for video with data is now synchronized to the incoming video signal connected to the other BNC socket.

Please note:

- GENLOCK is only available if the output is on VBS mode.
- **GENLOCK auto-switches to GENLOCK off after each power-cycle** of the camera/IVS (IVS is rebooted after power down/power up) to avoid accidental operation.

If the ARRIFLEX 416 with PAL IVS is set to 24fps, can it be synchronized with a black burst PAL signal. The camera will go to 25fps, even if it is set to 24fps because PAL black burst is 25fps and in this mode the back burst will override the setting of the camera. The IVS will output 25fps anyhow, as it is a PAL device.

However, you might send a 24fps clock signal to your ESU and from there to the camera. Depending on the ESU you are using, the camera will get phased to this clock. Please refer to the manual of your ESU.

However, as the IVS is PAL, it will output 25fps. It will double approximately every 24th frame to bridge between the two frame rates. It is possible to flag those dubbed frames. Please see the manual of the IVS for more information.

3.4 Timecode and external sync

When using the external synchronization unit ESU-1 for synchronizing the camera to other equipment, timecode can still be recorded. The difference between the external synchronization and the TC frame rate must be less than 1%. If the difference exceeds 1% the TC recording and the "TC" symbol in the display switches off.

If the speed comes back to within 1% of the TC frame rate, TC recording switches on again and the "TC" symbol appears on the display. Even if an external synchronization unit is used, it is necessary to set the expected frame rate on the camera, before attaching the ESU-1.

3.4 LED Wall specifics

Your LED wall processor needs to be synchronized to the same source as your camera. Most processors will accept Tri level synchronization. This means you need a synchronization source capable of producing different signals from one clock.

Please refer to the LED wall processor's user manual to find out what framerates the processor can be synchronized to.

Lastly make sure you have sync shifted either the camera or the LED wall processor to capture or display the frame at the same time. This ensures the avoidance of frames from the LED wall processor bleeding into each other, when captured by the camera. This effect is commonly referred to as "ghosting".

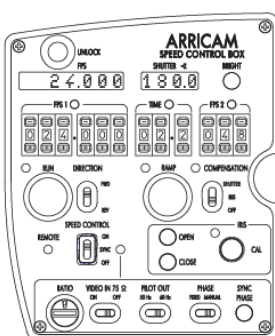
4 ARRICAM LT/ST

4.1 Overview

After covering 16mm, shooting 35mm in a volume follows a similar principle.

Here's what you need:

- ARRICAM LT or ST
- ARRICAM Speed Control Box (SCB)



For general camera operation please refer to the ARRICAM System User Guide.

4.2 General operation of the Speed Control Box

Speed Control

The SPEED CONTROL switch determines which functions are active.

- ON** Fps 1 (with 0.001 fps accuracy), Fps 2 and the ramp time can be set and monitored. Forward and reverse run can be set with the DIRECTION switch. The fps setting of the SCB has priority over the setting of the Camera Control Panel. Automatic speed/shutter and speed/iris ramps can be programmed and executed.
- SYNC** The SCB can synchronize the camera's frame rate to an external signal, e.g. video, another camera or projector.
- OFF** The SCB controls neither speed nor shutter. Only the RUN, BRIGHT and iris OPEN/CLOSE buttons still work.

Setting frame rate and direction

Set the SPEED CONTROL switch to on. Enter the desired frame rate with the FPS 1 selector. Select FWD or REV with the DIRECTION switch (Reverse run is not possible with Lite magazines). If the Manual Control Box is connected to the camera, make sure its MANUAL CONTROL switch is set to OFF or ∇ .

4.2 Synchronization to external sources

With the SPEED CONTROL switch set to SYNC, the SCB can synchronize the frame rate to an external source, e.g. video signal, pulse generator or monitor. No sync function is possible when using a cable longer than 15 m/50 ft to connect the camera and SCB.

There are three different input signals that the SCB can accept, only one is relevant for LED walls:

1. A video signal can be fed to the VIDEO IN (BNC) connector.
2. The ARRI Pick-up Unit can be connected via the Cable KC 66-S (10m/33ft) to the SYNC IN (4 pin Fischer) connector. The Pick-up Unit will sense the frequency of a CRT monitor when placed on or around it.
3. Any signal from 3 to 30 V with a frequency of 3 to 240 Hz can be input to the SYNC IN (4 pin Fischer) connector. Pin 3 is SIGNAL, pin 4 SIGNAL GND.

Note:

- If a signal is present on the VIDEO IN and on the SYNC IN connector, the VIDEO IN connector has priority.
- In SYNC mode, the Speed Control Box will override the fps function of the Manual Control Box.

RATIO selector

The RATIO selector sets different ratios between input frequency and output fps. Use the table of examples below to help choose the correct ratio for any given shot. Input frequencies can be from 3 - 240 Hz, keeping in mind the top speed of the Studio (60fps) & Lite (40fps). For two seconds after the input frequency or RATIO is changed, the FPS and SHUTTER displays show the input frequency and ratio respectively. If the input frequency is present and valid, the FPS display will then show the output fps (indicated by an arrow). Otherwise it will show "Syn".

Setting	Ratio	Input Frequency (Hz)	Resulting Output fps	Notes
0, 5 - 9	1:1	24	24	(e.g. projector)
1	2:1	48	24	
		50	25	
		59.94	29.97	(NTSC video signal)
		60	30	
		70	35	
2	3:1	72	24	(e.g. computer monitor)
		75	25	
3	4:1	100	25	
4	5:2	59.94	23.976	(NTSC video signal)

Note: The shutter angle should be adjusted to 180° for all settings, except for the 5:2 ratio which should be 144°.

Other settings:

- Usually, set the VIDEO IN 75 switch to ON when feeding a video sync signal to the VIDEO IN connector. In case the video signal is forwarded (T connector) to a monitor, try ON or OFF to see which works better.
- If you feed a PILOT tone to the audio recorder, check with the sound department if they need 50 or 60 Hz.
- The PHASE setting determines the start of the exposure for each film frame in relation to when the image is drawn on the video monitor. The result is the angled horizontal bar visible on the monitor seen through the camera's viewfinder. To prevent exposing the bar on film, the bar should not be visible through the viewfinder of the running camera. First try the FIXED position of the PHASE (FIXED/MANUAL) selector; FIXED is a phase value that works in most cases. If the horizontal bar is still visible, switch to MANUAL and use the SYNC PHASE button to move the bar to where it is least visible. The camera remembers this phase setting (the position of the bar) until the SYNC PHASE button is pressed again.

Note:

- An exception to this rule is when shooting with the RATIO selector in setting 0 or 5 - 9 (1:1). In this case the worse the image in the viewfinder, the better it will be on film.

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Contact

In case you have questions or recommendations, please contact the Digital Workflow Solutions group within ARRI via email: digitalworkflow@arri.de