Installing & Using the TCS TXM-26 Crystal Drive on your Bolex H-16 Spring-Wind Camera

1. Installation

1A. ***VERY IMPORTANT:*** First prepare the camera for motor attachment:

1. Turn the camera's **MOT** lever down to **O** to disengage the clockwork spring motor, and prevent it from stripping the gears in the crystal motor.
2. Remove the spring winding handle by folding it up as if to wind the spring, but turn it *clockwise* instead of counter-clockwise. It has a left-hand thread and will unscrew. If it is excessively tight use penetrating oil on the coupling point.
3. Set the speed dial to **64** or higher, fully clockwise. This is required to prevent the camera's mechanical governor, which is still connected, from fighting the crystal motor and causing overload and overheating.
4. Lock the release slide in the left **M** (lock-run) position to permit the mechanism to operate and not stall the crystal motor.
5. On H-16 Rex models with a variable shutter, remove the Rexofader if present, and lock the variable shutter in the **top** (fully open) **0** position. The setting can be varied during filming to do in-camera fades, which is generally not done these days, but normally we recommend always locking it in the **top** (fully open) **0** position for the most pleasing picture quality. Whatever the setting, be sure it is locked in place to prevent random changes of the exposure while running, or especially when you start and stop.

Warning: *Failure to follow these steps* ***before attaching the motor*** *will result in motor or camera damage that is not covered by your warranty, or in inferior quality film.*

Note: *Do not loosen the two large screws holding the motor housing to the base. They are locking in place the factory adjustment that correctly aligns the base to the drive shaft and winding handle screw.*

1B. Attach the motor to the camera by following these steps:

1. Lay the camera down on a cushion or other soft surface, with the lid side down.
2. If the camera bottom has a 3/8" to 1/4" thread adapter, add-on flat base adapter, or quick-release tripod adapter, this must be removed with a screwdriver.
3. Line up the motor drive shaft with the camera's 8-frame shaft. If the camera has two shafts, it is the one above and to the rear of the other. Place the spring-loaded motor drive shaft on the camera's shaft.
4. Attach the one or two 3/8" x 3/4" screws through the motor bottom plate up into the camera's one or two tripod threads. (Newer cameras will have two 3/8" tripod threads. Older cameras will have just one rear thread.) Tighten gently with a screwdriver or coin. If there is resistance, put oil or grease on the threads.
5. Some cameras have a winding shaft that does not protrude very far. If you notice a gap between the motor standoff and the winding shaft, first place one or two #10 plastic washers on the screw threads to prevent pulling the motor out of alignment when it is tightened. Gently tighten the winding shaft screw by turning it *counter-clockwise* with your fingers, as it is a left-hand thread. It does not need to be tightened with a tool. If there is resistance, put oil on the threads.
6. Turn the inching knob on the bottom of the motor slowly until the spring-loaded shaft coupling pops into place on the camera shaft drive pin. After this, turning the knob counter-clockwise will advance the camera mechanism and the film.

2. Operation

Power is supplied to the camera and crystal drive by the 4-pin XLR connector on the front. 12.6 volts DC is required. Pin 1 is negative (—) and pin 4 is positive (+). Reversed DC polarity will blow the fuse and could damage any connected accessories. If you are not sure your battery and all cables are correctly wired, do not use them until proper polarity is verified with a voltmeter. Do not apply more than 16.8 V as this may cause damage.

Running **speed** is selected by the rotary switch on the rear. The speeds are 7.5, 12, 15, 24, 30 and 48 FPS (frames per second.) All of these speeds except 48 are HMI safe for 60 Hz powering of the lights. This means that if you are filming under HMI or fluorescent lights, or discharge type street lights, you will get flickerless results when you film at any of these speeds except 48 FPS. None of the speeds are HMI safe for 50 Hz power; for these you connect the TEC-26 Euroframe Controller or TMC Milliframe Controller. If you are filming under daylight or high-amperage incandescent light, any speed can be used at will. No harm should be done by changing speeds while running. Remember that a speed change calls for a corresponding lens aperture change. Crystal speed will be reached rapidly at 24 and 30 FPS and will take longer at 48 FPS, which is helped by a higher battery voltage.

Running is controlled with the front rocker switch. In case the camera has a film jam, be ready to stop the camera immediately to prevent blowing the fuse or causing camera or motor damage. A red stripe shows on the switch when it is in the Run position.

A **sync alarm** light is provided. It will light up whenever the chosen speed (internal or external) is not being maintained. The **fuse**, a 3 ampere GMA (5 x 20mm) 32 volt type, should never blow in normal operation. It protects all circuits from gross faults, such as reversed battery connections, that could melt or burn the wiring.

Three threaded holes are provided for mounting on a tripod; two have the heavy camera/European 3/8"-16 thread and one has the 1/4"-20 U.S./small-camera thread. A 3mm slot is present for anti-turn provision for certain handgrips or tripod accessories. The three holes are the same distance from the front of the camera as the original three holes in the Bolex flat base, but are of necessity displaced sideways.

If you are using a Rex-5, M-5, or SBM with a 400' film **magazine**, plug the magazine takeup motor into the socket on top of the TXM-26. Note that if using the **MM** takeup, you need to set the torque motor slide switch to the left-hand MM position. If you are using the **WM** takeup motor, set the switch to the right-hand WM position. With the **MM** motor, the TXM-26 will automatically vary the power going to the MM according to the running speed set on the TXM-26 speed dial. Note that the **MM** torque motor might not be able to turn fast enough, at the beginning of the roll, to safely run at speeds above about 40 FPS using a standard 2" core. The solution is to use a 3" core for takeup, or else do not film at high speeds for about the first 50 or 100 feet of the roll. With the **WM**, you must set the approximate speed also on the speed dial on the takeup motor. When using the **MM** with an external speed control, read the note***** below.

Your Bolex is not a self-blimped (quiet) studio camera. For sound filming, you must either use a blimp or barney indoors, or else film outdoors at a distance, or through a closed window.

For double-system **sound**, you should use a film sound recorder such as a Nagra, or else a stereo cassette recorder that has been modified to record a crystal pilot signal on one track, such as from a TCS model TX-10. (The normal speed in North America is 24 FPS with a 60 Hz pilot.) At the beginning of each sound take, you need to use a clapstick that can be seen by the running camera and heard by the running recorder's microphone, as a start mark. The crystal pilot is then used for resolving (transferring in sync) to 16mm perforated magnetic film that has the same number of holes per second as does the picture film. It may also be possible to use newer media such as DAT (digital audio tape), MiniDisc, Hi-Fi video tape, etc. Depending on how you are working, it may be necessary or desirable to film at 23.976 FPS instead of 24. Subsequent editing and mixing steps are beyond the scope of these instructions and we refer you to the books and courses on the subject.

3. Using External Speed Control

The TXM-26 has an 8-pin connector for external speed control. This permits running at some 45,000 speeds between about 5 and 50 FPS. This will accept the TCS **TMC** Milliframe Controller as well as the **TVCe** Videoframe Controller and **TEC-26** Euroframe Controller. The **TMC2** Milliframe Controller can also be used, however the TXM-26 does not have a frame pulse output and will not advance the footage counter in that model.

between about 5 and 50 FPS. This will accept the TCS **TMC** Milliframe Controller as well as the **TVCe** Videoframe Controller and **TEC-26** Euroframe Controller. The **TMC2** Milliframe Controller can also be used, however the TXM-26 does not have a frame pulse output and will not advance the footage counter in that model. The socket provides 12 V to the TMC, TMC2 and TVCe as long as the battery cable is connected, giving the required standby power to the controller. The TEC-26 however only draws power when the motor is running.

The TMC or TVCe draws very little current, and would take a week, 24 hours a day, to discharge the average battery, so to simplify operation no separate standby switch is provided. It is necessary to set the TXM-26 speed dial to the **48, MC** position to get the correct external speeds.

Using the **WM** torque motor, set its speed dial to the actual running speed selected in the external controller. With increased DC voltage, you may be able to achieve speeds up to 60 FPS. Do not attempt to run faster, as the Bolex camera governor may cause excessive drag and overheating, even though it is set to 64 FPS. Note that the **MM** torque motor might not turn fast enough, at the beginning of the roll, to run at speeds above about 40 FPS using a standard 2" core. The solution is to use a 3" core for takeup, or else do not film at high speeds for about the first 50 or 100 feet of the roll. Do not send excessive power to the torque motor as they have been known to burn out.

The **TEC-26** Euroframe Controller replaces the existing 12, 24 and 48 speeds on the TXM-26 speed dial with the European 12.5, 25 and 50 FPS speeds. The speed dial becomes changed to 7.5, 12.5, 15, 25, 30 and 50 FPS. The 12.5, 25 and 50 FPS speeds are 50 Hz HMI compatible. The 7.5, 15 and 30 FPS speeds are 60 Hz HMI compatible. Unplug the TEC-26 to restore the original 12, 24 and 48 FPS 60 Hz speeds. An increased battery voltage may be needed to reliably reach 50 FPS.

***Note:** only if using the **MM** torque motor, and only if selecting **TMC** speeds at or below 25 FPS, the pull on the takeup roll could be excessive, and the MM could overheat and be damaged. To prevent this, set the TMC to **double** the desired speed, and set the TXM-26 speed dial to **24** instead of 48, MC. This will give the correct speed without excessive torque. The Videoframe Controller **TVCe** should only be used at the 29.970 speed, as the 23.976 setting may cause excess heating of the MM torque motor. The TVCe does not have a provision of setting double the speed, unlike the TMC and TMC2. None of this applies when using the **WM** torque motor, or when filming 100' spools without the magazine.

External control permits “odd” speeds to be used, such as for filming when a video or computer monitor is in the scene, reducing shutter bar. It also permits the use of unusual HMI speeds, or traditional speeds, that are not provided on the camera’s speed dial. In addition, it permits keeping much closer sync when filming, say, a music video with DAT (digital audio tape) or CD playback. This is because the filming rate can be set to equal the Rank or Bosch NTSC video transfer rate of 23.976 or 29.970 FPS and eliminate sync drift on long takes of 20 or more seconds.

3A. Special considerations for filming from video or computers

Your eye is not fast enough to see it, but the image on a video monitor or TV is actually composed of a spot of light that scans across the face of the picture tube from left to right, and from top to bottom, to paint the rectangular “raster” area that your eye sees as a picture.

To conserve video bandwidth and increase the number of available TV channels, video employs “interlaced scan” which means that it writes the odd-numbered lines and then goes back and fills in the spaces with all the even-numbered lines. Each set of odd or even lines is known as a “field” of which there are 59.94 per second; a full set of lines is a “frame” and there are half as many, namely 29.97 per second. This works well when viewing the TV at a distance, but close-up your eye can see that the illuminated lines are alternating back and forth and this appears as “line crawl” so it looks like the lines are moving up or down. There are incidentally 525 nominal lines per frame, or 262½ lines per field, 15,734¼ lines per second. (European video in PAL or SECAM has 50 fields, 25 frames, 625 lines per frame.)

A regular cine camera has a shutter that is open half of the time or less, 24 times per second, and only part of each video frame is illuminated during that time. So, just pointing an ordinary camera at a TV set will yield alternating light and dark bands in a different place in each film frame, an irritating effect known as “shutter bar.”

How Other Cameras Do It

High-end professional cameras are able to include a regular video monitor in the shot by virtue of filming at 29.970 or 14.985 FPS (frames per second) with a 180° shutter opening, giving an exposure time equal to one field or one video frame respectively. The slight remaining shutter bar can be seen in the mirror reflex finder and moved, with the speed controller’s “phase” button, to the bottom of the monitor’s picture, where it will remain for the duration of the shot. People with unlimited budgets use instead special rented 24 FPS video equipment so they can film from it at 24 FPS.

Kinescope cameras used for video-to-film transfers solve this problem by instead employing a special fast-pulldown movement and about a 288.289° shutter opening, which is also in front of the lens so it is out of focus and is also very smoothly driven, to record 2 fields out of every 2½ without shutter bar, converting 29.97 FPS video to 24 FPS film.

How Your Bolex Can Do It

Your Bolex does not have a 180° shutter opening, so you can not film at 29.970 or 14.985 FPS because the resulting shutter bar will be very wide, though stationary, and you will not be able to see where it is through the viewfinder because the camera does not have a mirror shutter. Also, the Bolex shutter is very close to the film plane which will give greater difficulty with shutter bar owing to the small penumbra of the shutter edge. The shutter is also driven through multiple gear meshes so there may be increased random variation in shutter timing from one frame to the next.

The best you can do is film at an FPS rate, suited to your shutter opening, so that your exposure time is exactly 1/29.97 or 1/59.94 of a second per frame. This will give an optical splice that is in a different place in each frame, but it may not be too visible if conditions are right. You will be using “odd” filming rates so double-system sound filming is probably not feasible.

In the following formula, you can calculate the FPS rate if you know your camera’s exact shutter opening, and the video frame rate which is 29.970 in the U.S., 25 in Europe.

$$\text{Filming Rate (FPS)} = \frac{\text{Video Frame Rate} \times \text{Shutter Opening}}{360}$$

Thus, in the U.S., if your shutter is 131° you would film at 10.906 or 21.812 FPS. If your shutter is 143° you would film at 11.905 or 23.810 FPS. If your shutter is 170° you would film at 14.153 or 28.305 FPS. Use the lower speed if the monitor is large in the film frame; you could get away with using the higher speed if the monitor is small in the film frame and the audience may not notice the absence of every second scanning line.

For filming from a computer monitor you would need to find out the frame rate, generally 60 to 75 on non-interlaced monitors and 30 to 37.5 on interlaced ones, to enter into the above formula. You may be able to establish a frame rate by removing the lens and pressure plate, and running the camera without film while looking through the running shutter. Vary the speed to get a stationary shutter bar. This computer frame rate is then entered into the above formula to calculate the filming rate.

4. For Technicians

The 48, MC position is normally used when connecting the Milliframe Controller. However, as described above, when using the MM torque motor and speeds of 25 FPS or lower, double the desired speed is set in the TMC and the motor speed dial is set instead to 24, to prevent possible damage to the MM torque motor. It is also possible to set four times the desired speed in the TMC, and set the motor speed dial to 12.

The Milliframe Socket is numbered from right to left. Pin 1 of an RJ-12 plug is +12V switched variable source and

the motor speed dial is set instead to 24, to prevent possible damage to the MM torque motor. It is also possible to set four times the desired speed in the TMC, and set the motor speed dial to 12.

The Milliframe Socket is numbered from right to left. Pin 1 of an RJ-12 plug is +12V switched variable source and TEC-26 power, pin 2 is +12V always for TMC power, pin 3 is open for internal crystal and grounded for external, pin 4 is 100 PPF (pulses per frame) external reference of 5V CMOS logic into 10kΩ, pins 5 and 7 are ground, pin 6 is ground (not used for a signal in this model and would be frame pulse in others), pin 8 is variable input. If using a 6-pin RJ-11 plug, the pin numbers are reduced by 1 count, with no pin 0 or 7.

The Torque Motor socket is for either an original Bolex 5.95mm x 2.1mm locking inverted power plug, or a standard 5.5mm x 2.1mm locking inverted power plug, preferably a Mouser 1710-2120. Center is positive, outside is negative. The power level supplied to the torque motor depends on the setting of the MM - WM slide switch, and the speed setting on the dial. For the WM, power is a solid +12V and the torque is adjusted using the knob on the torque motor. For the MM, power is +12V at 30 and 48 FPS, and +12V through 18Ω 2W for 24 FPS and below. Using the accessory TEC-26, MM power is +12V at 30 and 50 FPS, and +12V through 18Ω 2W for 25 FPS and below. Do not send excessive power to the torque motor as they have been known to burn out.

If it is necessary to adjust the crystal frequency, use a counter of known accuracy and attach it to the TP test point and case. Adjust trimmer capacitor for 6.144000 MHz ± 20 Hz.

Tobin Cinema Systems, Inc.

http://www.tobincinemasystems.com

TXM-26 48 FPS Upgrade

TXM-26 crystal motors of recent manufacture incorporate a circuit improvement, to enable reaching 48 frames per second without need for an increased battery voltage.

To accomplish this, the TXM-26 now is fitted with an interior lithium cell (battery) to provide an increased bias voltage for the motor drive circuit. No current is drawn from the cell, so it should last for its shelf life of 10 to 20 years. When the motor is no longer able to reach 48 with a normal 12 volt battery that is in good condition, the lithium cell should be replaced.

Motors that include this improvement have a blue dot next to the serial number sticker.

Tobin Cinema Systems, Inc.
http://www.tobincinemasystems.com