NAGRA IV-S TIME CODE

PORTABLE ANALOGUE AUDIO
TAPE RECORDER

INSTRUCTION MANUAL

(KSA code No. 20 06 007 161)

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CHAPTER 1 :   HOW TO USE THE NAGRA IV-S TIME CODE

1.1.1 INTRODUCTION

The Nagra IV–S was introduced originally in 1971. It is a portable 6.35 mm (1/4") analogue audio tape recorder designed for high quality music recording, cinema and television applications.

Many mechanical and electronic modifications have been made to the machine since its release, to adapt it according to modern day requirements. Despite all these modifications, the machine remains remarkably similar to the original. The last major development was made in 1984 when the SMPTE / EBU 80 bits centre-track time code was added.

The Nagra IV–S can be delivered in three different versions all of which are available in either NAB or CCIR equalization. These versions are as follows:

<div align="center">

NQS–LSP	Non pilot
NQS–L	Pilot
NQS–TC	Time code

</div>

Each version has three speeds: 38 cm/s, 19 cm/s and 9.5 cm/s (15, $7\frac{1}{2}$ and $3\frac{3}{4}$ ips) with the following standards: NAB, CCIR and NAGRAMASTER (at 15 ips only).

The Nagra IV–S is a stereo recorder with two 2 mm audio tracks (2.75 mm tracks on the NQS–LSP non–pilot machines) and a central track for pilot or time code uses, depending on the machine type.

The two audio channels may be used with either the two internal microphone pre–amplifiers (switchable between Dynamic, T power and Phantom power) or with a current line input, via the QCSE cable. The two potentiometers on the front panel may be mechanically "GANGED" together for easier control, by moving the small white lever located on the green control.

The NAGRA IV–S also contains a switchable limiter, a built–in loudspeaker, provision for connection to an external noise reduction system and an internal reference generator for line up, and calibration purposes.

Optionally the machine may be fitted with either the NAGRASYNC pilot option or the SMPTE/EBU 80 bits time code option.

The machine may also be powered from either an external supply ATN–3 or internal batteries. (See page 1-2).

The IV–S may also be used with the QGB 10" reel adaptor, to allow the use of larger reels for longer recording and playback.

1.1.2 POWER SUPPLY

All models of the NAGRA IV–S may be powered by an external power supply (ATN–3) or alternatively by internal batteries. The IV–S will accept voltages ranging from –11 V to –30 V with peaks of up to –35 V.

The batteries are placed in the bottom of the machine and the polarity is marked inside the compartment which is opened by turning the two fasteners with a screwdriver or a small coin. All the batteries MUST be orientated in the same direction as indicated on the base of the battery compartment.

The NAGRA IV–S houses twelve 1.5 V cells having a maximum diameter of 33.5 mm and a length of between 59.5 and 62.5 mm. The cells manufactured under the following standards are generally acceptable: CEI R–200, ASA"D" and L90.

It is important to remember that corrosive material can leak out of flat batteries, causing severe damage to the recorder, and therefore it is recommended not to leave batteries in the machine during periods of storage.

The external supply is fed into the machine via connector (48) on the right–hand side of the machine. Rechargeable batteries may also be used and can be charged using the ATN–3C (order no 14376) which includes the charger circuitry.

To check the state of the batteries or the external supply, set modulometer switch (12) to the "BATT" position: in this case the red needle of the modulometer indicates the battery voltage on the (volts / cell) scale and the green needle indicates the voltage needed by the motor. The difference between these two readings shows the battery reserve.

When the power supplied to the machine is insufficient for normal operation of the recorder, the rotary indicator "SPEED AND POWER" on the front panel of the machine will turn black.
The IV–S will function when the power is as low as 12 V (at 15 ips / 38 cm/s) and down to as low as 10.5 V at the lower speeds. (These figures correspond to a machine in perfect condition and working at room temperature).

NOTE: Time Code machines will stop recording Time code when the batteries become flat before the audio recording is affected.

When using an external supply, selector switch (3) must be in the "EXT" position. It must be in the "BATT" position when internal batteries are in use. It is not necessary to remove the batteries when working with an external supply (and vice versa).

NOTE: For information on power supply to the time code circuits of the IV–S TC refer to page 2-25.

EXTERNAL POWER SUPPLY

On the right–hand side of the machine there is a 6 pin Tuchel–type T 3403 connector marked "POWER PACK". The corresponding plug is the T 3400/1.

The connections are as follows:

> pin 1 = Battery negative
> pin 2 = Chassis (positive)
> pin 3 = Pilot playback output
> pin 4 = Speed correction signal input
> pin 5 = Negative external supply
> pin 6 = –10 V stabilized output.

1.1.3 DANGER OF REVERSED POLARIZATION

A reversed polarized power supply (negative to the chassis) WILL damage the machine. To reduce the risk of serious damage a diode is placed in parallel with the supply which will be short–circuited in the event of reversed polarization. If such an event occurs with normal "dry cells", they will be rapidly exhausted and no further damage will occur.

On the other hand, certain accumulators are capable of supplying sufficient current (in excess of 8 amperes) such that the internal wiring of the machine will become hot enough to cause its insulation to decompose. This will then liberate hydrochloric acid gas which causes considerable corrosion. If this happens, contact your nearest NAGRA agent immediately.

NAGRA IV-S TC
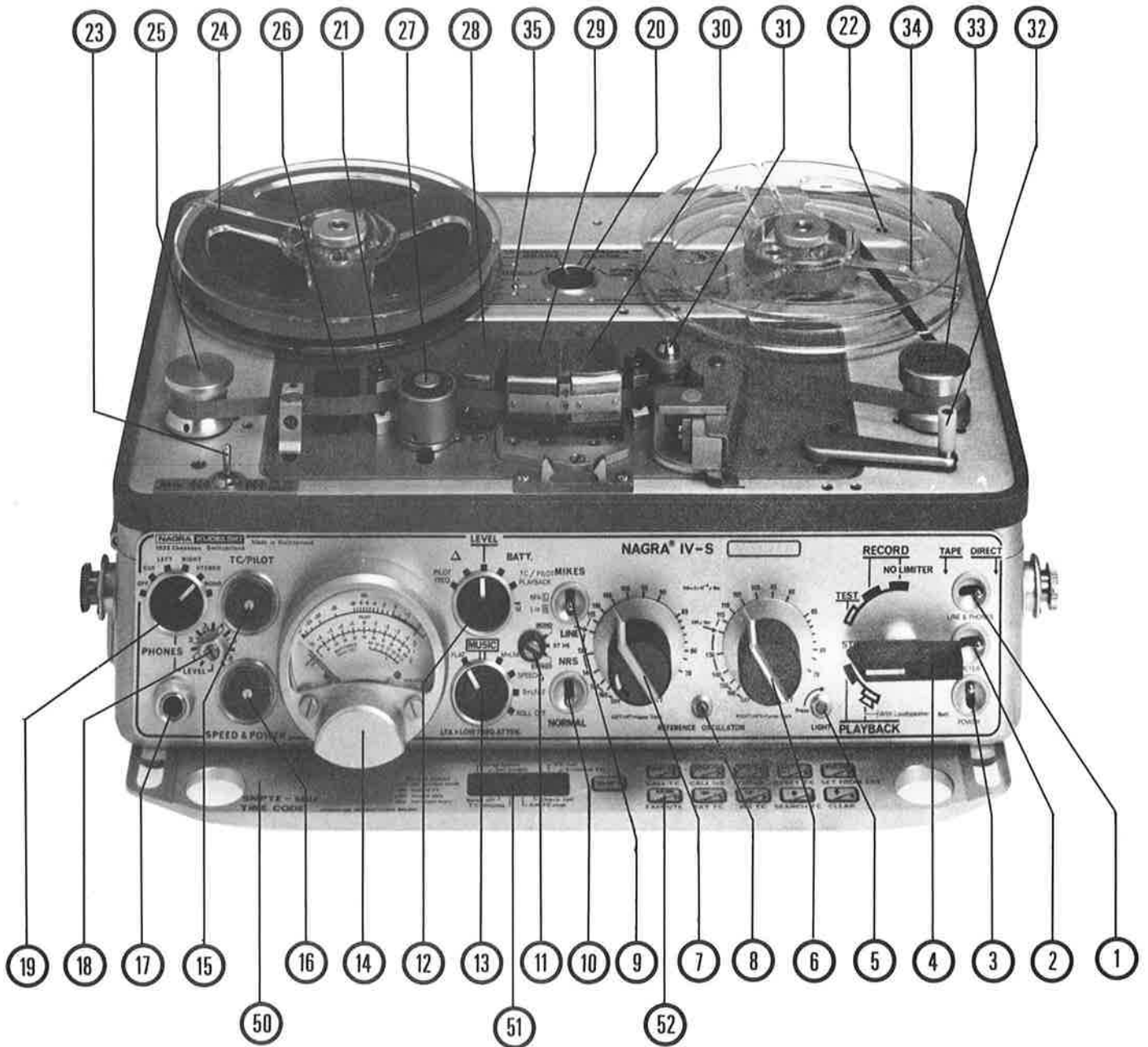
1.1.4 CONTROLS: DESCRIPTION AND USE

FRONT PANEL

1. TAPE / DIRECT SWITCH (line and phones)

When in "TAPE" position, the signal is reproduced directly from the tape.

When in "DIRECT" position, there are two posibilities:

    A. When recording, the signal is available before arriving on the tape.
    B. When playing back, the signal may be adjusted by means of the level controls and corrected by filter switch (13).

2. TAPE / DIRECT (snap switch)

This switch affects the meter in the same way that the previous switch affects the outputs. Thus when it is held to the left, the meter will display the "OFF TAPE" signal whereas normally it displays the "DIRECT" signal.

3. POWER SELECTION SWITCH (EXT / BATT)

The NAGRA IV–S may be powered by either internal batteries or by an external source which may be selected using this switch. See also the "POWER SUPPLY" section of this chapter (Page 1-2).

4. MAIN FUNCTION SELECTOR (six position rotary)

STOP	Stops the machine completely from any function, and will slightly move the pinch wheel away from the capstan to prevent a flat being caused on the pinch roller. In this mode no circuits are powered (with the exception of the RAM and REAL TIME CLOCK in machines fitted with SMPTE / EBU time code). See section IV "TIME CODE AND PILOT" of this manual for further details.
TEST	Will power all circuits and allow level adjustment by means of level controls (6) and (7). In this mode the motor is not powered. All indications of the modulometer will be of the DIRECT input, irrespective of the position of tape / direct switch (1).
RECORD	Is the first of the two RECORD positions and corresponds to RECORD WITH LIMITER where the recording level is limited to + 4 dB. This level remains constant when the input level is between + 4 dB and + 10 dB. Thus in this position tape saturation cannot occur and distortion is avoided.
RECORD (no limiter)	The limiter is inactivated in this position so that recordings that should be saturated can be made. (e.g. gun shots or explosions).
PLAYBACK	Is the first of the two playback possibilities and corresponds to playback of the tape to the headphones and line outputs only.
PLAYBACK (with loudspeaker)	This position is exactly as above, only it allows monitoring via the internal loudspeaker at the same time. This is also the only position of the main function selector that permits the FAST FORWARD function to be performed (see page 1-10).

5. LIGHT (push button)

When pressed, the modulometer (and time code display on T.C. machines) will be illuminated as long as the button is pressed, providing there is sufficient power available to the machine. If this button is pressed and then turned to the right the lamps will remain "ON". This button is active when the main function selector is in any position other than "STOP".

6. LEVEL CONTROL (right–green–lower track)

7. LEVEL CONTROL (left–red–upper track)

These are the main level controls for the two audio channels. They may be linked (ganged) by means of the small white lever situated on the left-hand knob (green) which activates a friction clutch. The 200 μbar point on each channel corresponds to an acoustic pressure of 200 μbar on the capsule of a 200 Ohm dynamic microphone having a 0.2 mV/μbar sensitivity. In this case the modulometer reading should be 0 dB.

8. REFERENCE OSCILLATOR (push button)

On the lower edge of the front panel, between the left and right level control potentiometers, there is the reference generator push button. When this button is pressed, a composite 1.1 kHz signal with a 10 kHz 9th harmonic at a level of approximately –8 dB is injected into the "DIRECT" chain of the recorder.

The modulometer will show –8 dB. It is useful to record a short burst of this signal at the beginning of each reel of tape so as to enable the level of the playback chain to be accurately calibrated before the real recording is made. This also permits adjustment of the record head azimuth in the field without test equiptment. At this point the subject of print–through should be mentioned. After a certain period of time, a recording may be copied (at reduced level) onto adjacent turns of a tape on a reel. This produces a perceptible echo during the silences preceeding or following a strong sound.

It is thus recommended to leave a pause of two or three turns of tape after recording the "REF" signal.

9. MIKES / LINE SWITCH

This three position switch is the main input selection switch. It allows the operator to select between MIC or LINE input on both channels simultaneously or "LINE" input on channel 2 (right) and simultaneously "MIC" input on channel 1 (left). The upper position allows "LINE" inputs to both channels via connector (41), and the other positions allow selection between "MIC" inputs (36) and (37).

10. NRS / NORMAL SWITCH

This switch allows the use of an external noise reduction system when connected to the IV–S via connector (42).

When an external "NRS" system is not being used, this switch should remain in "NORMAL".

11. MONO / ST HS / STEREO SWITCH

This switch is used to select the mode of the audio outputs. The position of this switch may only be changed by means of a small screwdriver, to prevent accidental modification while using the recorder, and it selects the mode of the "DIRECT" chain.

MONO   The input of each channel is fed to the output of both channels.

STEREO   Each input is connected to its corresponding output.

ST HS   (Stereo high sensitivity): As for "STEREO" but the sensitivity is 6 dB higher. This position is useful when the recording source level is very low. However, it must be noted that certain characteristics of the recorder such as signal–to–noise ratio and crosstalk are not quite as good in this mode.

12. MODULOMETER MODE SELECTION SWITCH

This is a six position rotary switch allowing different information to be displayed on the modulometer.
Each position is discribed below:

PILOT FREQUENCY

The red needle indicates on the pilot scale of the modulometer the frequency of the pilot signal from +4% to –4%, as determined by the QFMS frequency meter (if fitted), between the pilot signal either recorded or played back and the internal crystal or the external pilot reference signal via connector (44). (There will be no reading if the QFMS option is not fitted).
The green needle indicates on the dB scale the audio channel which has the highest recording level.

DELTA Δ

The red needle indicates on the % scale between 0 and 100%, the groove depth of a record made from recorded signals in accordance with NAB weighting, thus a 100% reading corresponds to a 50 μm vertical deviation of the cutting stylus.
The green needle gives the same indication as for pilot frequency.

LEVEL

The red needle indicates the "DIRECT" or the "RECORDING" level of the left channel (1) in dB.
The green needle indicates the "DIRECT" or the "RECORDING" level of the right channel (2) in dB.

BATT

The red needle indicates on the volt / cell scale the battery voltage.
The green needle indicates the voltage required by the motor.
The difference between the two readings shows the battery reserve.

TC / PILOT PLAYBACK

The red needle gives the same indication as for pilot frequency.
The green needle indicates on the % scale the level of the signal recorded or played back on the FM track. A deviation of 100% corresponds to an actual frequency deviation of 40 %.
On time code machines, the green needle indicates the time code playback level.

M (MOTOR)

The red needle indicates on the % scale the current through the motor. A reading of 100% corresponds to a current of 250 mA through the motor.
The green needle gives the same indication as in the pilot playback position.

13. FILTER SWITCH

This is a six position rotary switch affecting both channels.

FLAT   The machine has a linear frequency response between 20 and 20000 Hz (Direct chain).

MUSIC   A high pass filter is put in the direct chain, which has a response of –3 dB at 40 Hz.

M + LFA   This puts the MUSIC filter and LOW FREQUENCY ATTENUATION of –7 dB at 40 Hz and –3 dB at 400 Hz into the direct chain.

SPEECH   This puts a high pass filter of –3 dB at 80 Hz into the direct chain.

S + LFA   This corresponds to the SPEECH filter and LOW FREQUENCY ATTENUATION of –7.5 dB at 80 Hz and –3 dB at 400 Hz.

ROLL OFF   This position gives the direct chain strong low frequency attenuation, –10 dB at 100 Hz and –3 dB at 400 Hz.

14. MODULOMETER

This two needle meter is the visual indication of many functions and levels of the machine. The modulometer displays information according to the position of mode selector switch (12). All IV–S modulometers are fitted with two small lamps which will light up the display when switch (5) is pressed. The right–hand lamp will also light up the time code display, when the keyboard is out, via a small lens in the bottom of the modulometer on the time code version of the recorder.

The modulometer has 4 scales:

1. Recording level in dB
2. Frequency deviation in %
3. Groove depth and motor supply current
4. Battery voltage (volts / cell)

15. TC / PILOT INDICATOR

This rotary "SASS" type indicator shows a white segment when the frequency (in the case of a pilot machine) and the amplitude of the time code / pilot signal are correct.

NOTE: This only indicates the presence of a correct signal being fed to, or coming from the head, and does not guarantee correct recording of the signal. This should be checked by switching the modulometer to TC / PILOT playback (this does not function in the RECORD mode). In the case of a time code machine, the signal should also be verified by means of the display on the keyboard, because both the previous methods will show a signal even though the time code generator may have been stopped and the same time code will be recorded over and over again.
This indicator functions in all modes other than test.

16. SPEED AND POWER INDICATOR

This rotary "SASS" type indicator gives a quick visual indication that the machine is functioning correctly and will indicate a white segment when this is the case. It will turn black whenever any of the following conditions occur:

- The power supply voltage (batteries or external) becomes insufficient for correct operation of the machine.

- The motor current reaches its maximum limit, in this case voltage and speed stabilizer circuit A22 requires the motor to run faster, but this is not possible because the automatic current limiter circuit has been activated. (If this occurs during normal operation, then contact your nearest NAGRA agent.)

- WOW and FLUTTER is out of tolerance. (Contact NAGRA agent).

Thus, when a white segment is indicated, the operator can be absolutely sure that the power supply is sufficient, that the motor current is correct, and that the tape speed is within tolerance.

17. HEADPHONES OUTPUT

This 1/4" jack type socket (type 297) is the headphones output socket accepting headphones with an impedance of anything from 25 Ohm to 600 Ohm. (Optimum value is 200 Ohm).

18. HEADPHONES VOLUME CONTROL

This small potentiometer is adjustable using a screwdriver and adjusts the level fed to headphones output connector (17).
Position 1 is the minimum and position 6 is the maximum.

19. HEADPHONES MODE SELECTOR

This is a six position rotary switch allowing the operator to select the signal which is sent to the headphones connector. It selects between CUE channel (FM centre track), left audio channel, right audio channel, mono or stereo. The first position of the selector is "OFF".

TAPE DECK

20. TAPE SPEED AND STANDARD SELECTOR

This is a four position rotary switch permitting the selection of the speed and standard of the IV–S in both record and playback.

Possible settings are:

$3\frac{3}{4}$ ips (9.525 cm/s) NAB/CCIR

$7\frac{1}{2}$ ips (19.05 cm/s) NAB/CCIR

15 ips (38.10 cm/s) NAB/CCIR

15 ips (38.10 cm/s) NAGRAMASTER

For best quality recordings the 15 ips speed is recommended. The 15 ips NAB / CCIR position is chosen when the recorded tape is to be played back on any machine other than a NAGRA T-AUDIO or NAGRA IV–S.
However, when this is not the case it is recommended to use the NAGRAMASTER position which has a different equalization and gives a better signal–to–noise ratio.

For normal recordings, the $7\frac{1}{2}$ ips speed is supplied. The $3\frac{3}{4}$ ips speed is available for those cases where the length of recording time of the tape is more critical than the actual quality of the recording.

21. BIAS SELECTOR

This switch makes it possible for the operator to modify the bias voltage using a small screwdriver when recording on special tapes for which the machine has not been calibrated. Each position of this switch corresponds to a bias variation of 5%.

22. PLAYBACK EQUALIZATION SELECTOR

This switch (also adjustable with a small screwdriver) offers the possibility to reproduce tapes recorded using the CCIR standard equalization on a machine that has been calibrated to the NAB standard equalization, and vice versa.

23. REWIND AND FAST FORWARD SWITCH

REWIND is possible with main selector (4) in any position other than STOP, assuming pinch roller lever (32) is in the fully open position.

FAST FORWARD is possible only with main function selector (4) in the playback (with loudspeaker) position and pinch roller lever (32) fully engaged.

The central position of this switch is OFF and this is the position that the switch should be in whenever the machine is not required to spool. Keeping it in this position will prevent accidental spooling of the tape when opening the pinch roller gate or playing back a recorded tape through the internal loudspeaker.

24. & 34. TAPE REELS

The IV–S can be used with reels up to a maximum diameter of 5" (127 mm) with the plexi–glass lid closed, or up to 7" (178 mm) with the lid open. However, if the QSET option is fitted to the machine the 7" (178 mm) reels may be used with the lid closed.
If it is necessary to use reels of up to 10" (254 mm), then the QGB large reel adapter may be used. See page 3-13 of this manual.

25. & 33. TENSION ROLLERS

These two rollers keep the tape tension constant and ensure correct tape handling and positioning. During normal use neither of these two rollers should be at either end of its travel. If this is the case refer to the MECHANICAL CALIBRATION section of the service manual .

The two rollers can be replaced by either the QTIM or QLEN tape measuring rollers. The QTIM is supplied in the place of the take–up reel tension roller as standard equipment. QLEN instead of QTIM optional. (To be stated when ordering).

26. ERASE HEAD

This is a full track erase head. It means that it is not possible to record one channel on the IV–S while preserving the original recording on the other channel. This also includes the centre track whether Time Code or FM pilot.

27. STROBOSCOPE ROLLER

This roller comes in two versions: 50 Hz (CCIR machines) and 60 Hz (NAB machines). Using this roller, it is possible to check that the machine is running at the correct speed, either in record or playback. This works at all speeds and uses the stroboscopic effect whenever a mains powered lamp is shone upon it. When at the correct speed, the bars on the roller should appear stationary.

28. RECORDING HEAD

Two channel audio recording head.

29. TIME CODE / PILOT HEAD

Centre track head used for both recording and playback, of FM pilot, CUE and SMPTE / EBU time code, according to the type of machine.

30. PLAYBACK HEAD

Two channel audio playback head.

31. CAPSTAN SHAFT

Tape main drive.

32. PINCH WHEEL AND TAPE GUIDE CONTROL LEVER

This lever engages and disengages the tape from the heads and motor capstan shaft. It also moves the stroboscope roller and mobile tape guide in and out, to allow easy loading of the tape.

When it is in the open position, rapid rewinding is possible. (This lever should never be left in the open position for long periods of time as this may cause a "FLAT" on the capstan shaft "O" ring).

33. TAPE TENSION ROLLER (OR TIMER) (see 25)

34. TAKE–UP REEL (see 24)

35. EQUALIZATION ADJUSTMENT POINT (see Chapter II service manual)

POSITIONS 36 TO 49 SEE CONNECTORS (Pages 1-13 to 1-16)

50. KEYBOARD

This is the small slide–out control panel for the IV–S time code machines. It allows setting and modification of all time code functions (except frame rate). For further details see "TIME CODE AND PILOT" chapter 2 of this manual.

51. LIQUID CRYSTAL DISPLAY

This is the display for time code, user bits and status of the IV–S TC (See"TIME CODE AND PILOT" chapter 2 of this manual).

52. CONTROL KEYS

These eleven keys allow the operator to modify all time code functions except frame rate (see "TIME CODE AND PILOT"chapter 2 of this manual).

1.1.5 CONNECTORS
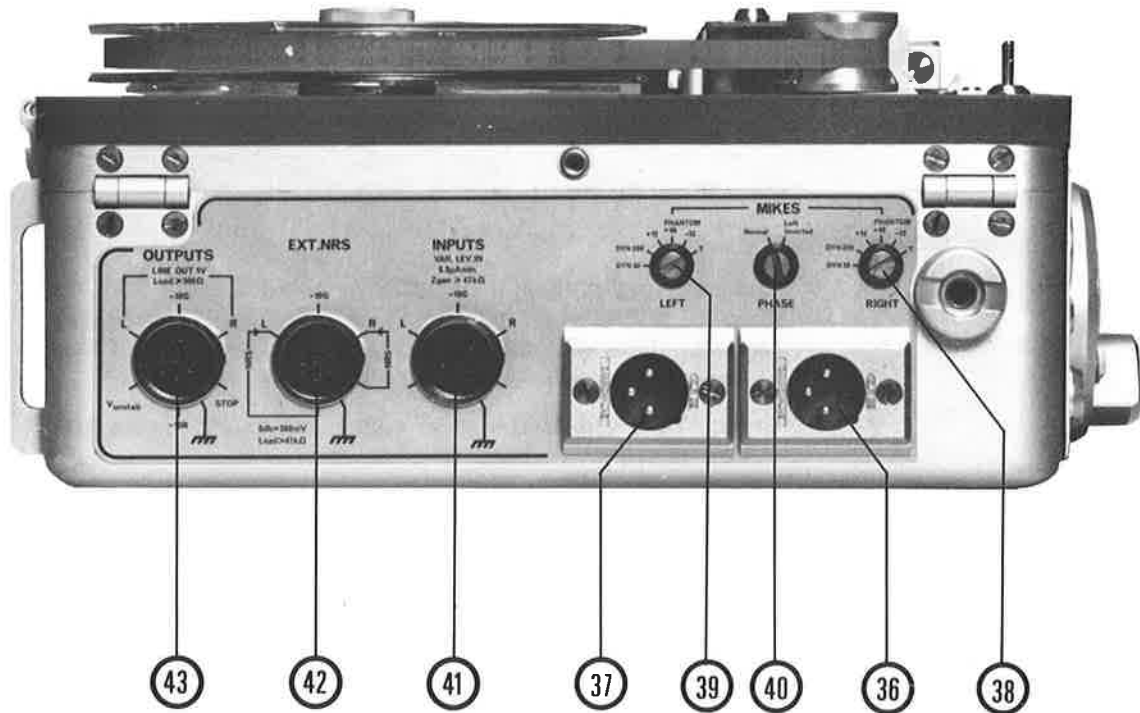
36. MIKES (RIGHT) (Channel 2)

CCIR   NAB
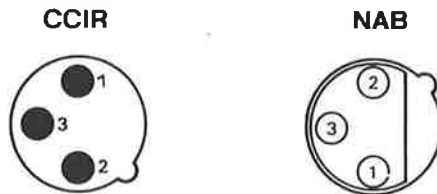
1 = Input signal Ground

2 + 3 = Balanced signal Input

37. MIKES (LEFT) (Channel 1)

Identical to No 36 above, but for the other channel.

38. SIX POSITION MICROPHONE TYPE SELECTOR, channel 2 (right)

DYN 50	= Dynamic microphone impedance 50 Ohm 0.1 mV / μbar (1mV/pa) sensitivity
DYN 200	= Dynamic microphone impedance 200 Ohm 0.2 mV / μbar (2mV/pa) sensitivity
+ 12	= Condenser microphone, 1 mV/μbar (10mV/pa) sensitivity + 12 V phantom powering
+ 48	= Condenser microphone, 1 mV/μbar (10mV/pa) sensitivity + 48 V phantom powering
- 12	= Condenser microphone, 1 mV/μbar (10mV/pa) sensitivity –12 V phantom powering
T	= Condenser microphone, 1.5 mV/μbar (15mV/pa) sensitivity + 12 V T powering
	(Tonaderspeisung since 1984)

39. SIX POSITION MICROPHONE TYPE SELECTOR, channel 1 (left)

(Identical to No 38) except for the other channel.

40. MIKES PHASE: Phase inverter for channel 1 (left) mic input

This can be used to invert the phase of the left channel.

41. INPUTS

Line inputs connector. (Both channels)
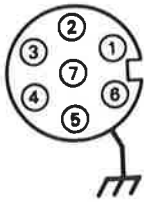
1 = Channel 2 (right) input: impedance variable from 0 to 5 kOhm (0 to 10 kOhm when switch 11 is in the ST.HS position). Current drive with minimum source impedance 47 kOhm. Current to obtain 0 dB at max. sensitivity is 7.8 μA.

2 = –10G: –10 V stabilized voltage output; maximum current 100 mA for all –10 V terminals

3 = Channel 1 (left) input. Identical to pin 1

7 = GROUND : For input signals

42. EXT. NRS

(External noise reduction system): Connection to external NRS. Output and input voltage 560 mV for 0 dB.
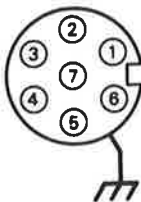
1 = EXT. NRS. output, channel 2 (right)

2 = –10G : –10V stabilized output. Imax = 100 mA

3 = EXT. NRS. output, channel 1 (left)

5 = EXT. NRS. input, channel 1 (left). Minimum impedance 47 kOhm

6 = EXT. NRS. input, channel 2 (right). Minimum impedance 47 kOhm

7 = GROUND : Ground for input signals

43. OUTPUTS

Line output connector.
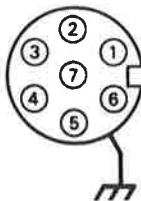
1 = Channel 2 (right) output: output voltage 1 V at 0 dB. Minimum impedance load 500 Ohm.

2 = –10G : –10 V stabilized voltage output. I max = 100 mA

3 = Channel 1 (left) output. Identical to pin 1

4 = V unstab: Unstabilized power supply voltage

5 = –10R stabilized voltage available in record only. I max = 100 mA

6 = STOP. Input for motor stop control. Connect to –10 V to stop the motor

7 = GROUND
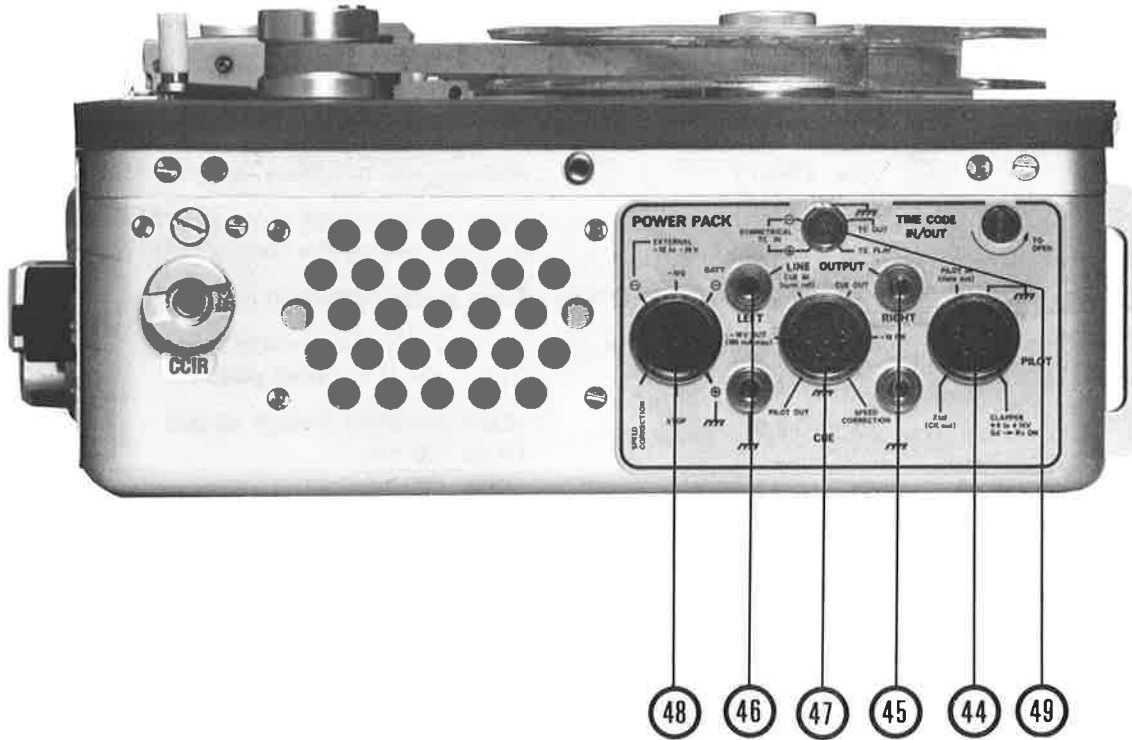
44. PILOT

Pilot signal input for pilot track.
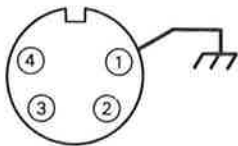
1 = GROUND

2 = Clapper : Reference oscillator or crystal pilot generator input

3 = X–TAL : 50 or 60 Hz internal generator output

4 = Pilot in : Pilot signal input

45. LINE OUTPUT (right) : Channel 2 (right) output on banana plugs.

46. LINE OUTPUT (left) : Channel 1 (left) output on banana plugs.

47. CUE

Connector for recording and playback of the pilot track:
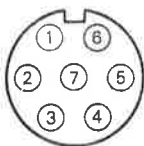
1 = Sync reference

2 = –10 V stabilized voltage output

3 = Pilot output

4 = Speed correction input

5 = –10 V FM connect to –10 V to activate modulator

6 = Cue output

7 = GROUND

48. POWER PACK

Connector for external power supply.
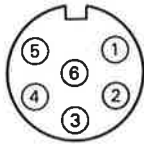
1 =	–BATT	: Negative pole of battery compartment.
2 =	+BATT	: Positive pole of battery compartment.
3 =	STOP	: Motor stop control terminal. Connect to –10 V to stop the motor.
4 =	SPEED CORRECTION	: Tape speed correction input.
5 =	EXTERNAL –12 to –30	: Input for external power supply –12 to –30 V negative pole.
6 =	–10 g	: –10 V stabilized voltage output, I max 100 mA

49. TIME CODE INPUT / OUTPUT (Only on NQS-TC)

1 = GROUND

2 = Time code input

3 = Serial input / output (for use with AATON origin C master clock) if QSIA optional interface is fitted

4 = Time code play

5 = Time code output

1.1.6 TAPE SPEED AND STANDARD SELECTION

The NAGRA IV-S is capable of running at three different speeds which can be selected by changing the position of "SPEED AND STANDARD" selector (20) on the top plate of the recorder between the two spools.

The speeds available are :

$3\frac{3}{4}$ ips (9.525 cm/s)

$7\frac{1}{2}$ ips (19.05 cm/s)

15 ips (38.10 cm/s)

Each position of this selector automatically selects the correct equalization of the machine according to the chosen speed. There are two different positions available for 15 ips (38.1 cm/s) the first being normal equalization NAB or CCIR, the second being the special NAGRA MASTER position.
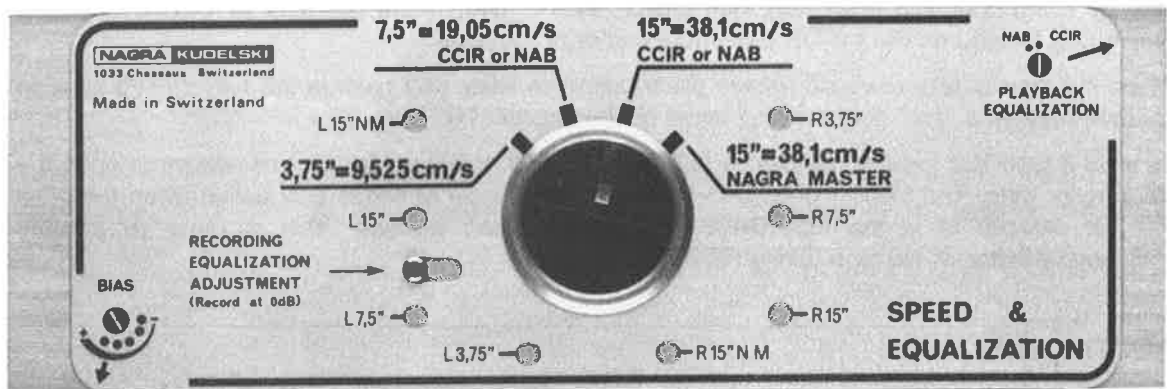
During playback the IV-S may also be switched between NAB and CCIR using switch (22) located in the right-hand rear corner of the deck.

NOTE: The NAGRA IV-S is only equipped with one recording bias oscillator and it is therefore only possible to bias the recorder for one specific tape type at any one time. However, it is possible to optimize the equalization at other speeds than the biased speed for different tapes.

1.1.7 LOADING A TAPE ON THE RECORDER

Select "STOP", then release the tape from the heads, guides and capstan shaft by pulling lever (32) forward, until it comes to a complete stop. Remove the spool retaining nuts and place a reel of tape on the left-hand turntable, with the loose end of the tape coming from the left-hand side of the spool. Pass the tape around the left-hand guide roller and across in front of the heads, and around the right-hand guide roller. Attach the end of the tape to the empty spool on the right-hand turntable. Replace the two spool retaining nuts, and close lever (32) until it reaches its original position, thus putting the tape into contact with the heads.

NOTE: It is important to lower the double head-shield before loading a tape, otherwise the tape may pass behind it, and thus not be in contact with any of the heads. When the tape has been loaded and lever (32) has been restored to its original position, the shield may be lifted in front of the heads.

1.1.8 FIRST TIME OPERATION

Main function selector switch (4) is on the front right–hand side of the recorder. It controls the mode of operation that the machine is in. By switching it to the "TEST" position all the circuits in the recorder are powered up but the motor is not.

Select "EXT" or "BATT" depending on the power available. It is now possible to check the supply to the machine by putting modulometer switch (12) to the "BATT" position as explained previously. After checking the power, put the modulometer switch back in the level position.

Using main function selector (4) the machine may be put into the "RECORD", "PLAYBACK" or "TEST" positions (for level checking etc.) depending on the desired mode.

To interrupt any mode on the machine, the main function selector should be put to the "STOP" position.

FAST FORWARD / REWIND

To rewind a tape put the main function selector in the "STOP" position, and open the pinch wheel gate by using operating lever (32) then select "TEST" and rewind the tape by means of toggle switch (23) located on the top left–hand front corner of the deck.

When the tape is fully rewound always place operating lever (32) back in the fully closed position (this will prevent a "flat" portion being made on the capstan "O" ring).

To wind a tape fast forward use switch (23) as for rewind. However, it is not necessary to open the pinch roller gate. The FAST FORWARD position of the toggle switch is only active when the main function selector is in the PLAYBACK (with loudspeaker) position. This is done to prevent accidental winding of the tape during RECORDING.

RECORDING

The NAGRA IV–S can make a recording using either microphones or a "DIRECT" line input signal.

RECORDING WITH MICROPHONES

When using microphones, connect a microphone to one or both of the two XLR type connectors on the left–hand side of the recorder. Check that the switches above each of the connectors are in the correct position corresponding to the type of microphone to be used. The possible selections are T–power, + 12 V and + 48 V phantom, powering 50 Ohm or 200 Ohm dynamic.

Set switch (9) to one of the two upper positions depending on which channel(s) is (are) to be recorded by microphone. The level of the signal coming from the microphones may now be observed by putting the machine into the "TEST" position and switching modulometer switch (12) to the "LEVEL" position. The gain may now be adjusted using potentiometers (6) and (7) on the front panel, which can either be adjusted seperately or together by moving the small plastic slider on the red control knob.

NOTE: The RED control corresponds to the left channel and the GREEN control corresponds to the right channel.

Turn the main function selector to either of the two RECORD positions, depending upon whether the limiter is required or not. Observe the modulometer to see that the levels remain correct throughout the recording.

Depending on the position of "LINE AND PHONES" switch (1) it is possible to monitor on the headphones output either the input signal, or the off tape signal during the recording. This is possible because the NAGRA IV–S is a three head machine. (Moving this switch will not affect the recording).

RECORDING A LINE SIGNAL

Set switch (9) to the "LINE" position and switch (10) to the "NORMAL" position. Feed line input connector (41) using a QCSE cable with the signal source to be recorded (minimum 0.5 V).

Set switch (11) to "STEREO" and switch (12) to "LEVEL". Turn the main function selector to "TEST" and adjust the levels using gain potentiometers (6) and (7). Finally switch the main function selector to one of the two "RECORD" positions to start the recording. When the recording is completed, select "STOP" then rewind the tape as previously described.

PLAYING BACK A RECORDED TAPE

Set main function selector (4) to one of the two possible "PLAYBACK" positions (either with, or without loudspeaker). The signal from the tape is now available on line output connector (43) or banana outputs (45) on the opposite side of the recorder. If line and phones switch (1) is in the "TAPE" position, then the signal is fed directly to the line outputs with no possibility of adjustment. However, if it is in the "DIRECT" position then each output may be adjusted with its corresponding control potentiometer.

The frequency response may also be modified using "FILTER" switch (13).

WORKING WITH HEADPHONES

If headphones are to be used, they can be plugged into the jack socket on the lower left-hand front side of the machine (17).

The level of the headphones may be adjusted using potentiometer (18). In record, the signals can be monitored either off tape or directly, depending on the position of the line and phones switch.

NOTE: When the machine is in the "TEST" position, the headphones output is always fed with the "DIRECT" signal.

The headphones output will accept a 1/4" stereo "JACK" connector (type 297) and can be used with headphones having an impedance from 25 Ohm to 600 Ohm. (Optimum value is 200 Ohm).

1.1.9 SPECIFICATIONS

The typical and maximum values stated below are defined as follows:

Typical value   :   Average value measured on 100 new recorders.

Maximum value   :   (shown in brackets) is the value above or below which a machine
                                                     is rejected, when going through final inspection.

DIMENSIONS AND WEIGHT

Dimensions of the box alone with cover closed, without knobs, feet, handle or handle mounts:

	= 12.6 x 8.8 x 4.4" 318 x 222 x 110 mm
Overall dimensions except handle	= 13.2 x 9.6 x 4.5 " 333 x 242 x 113 mm
Thickness of the box	= 0.08" or 2 mm
Thickness of tape deck	= 0.12" or 3 mm
Weight without batteries or tape	= 11.6 lbs or 5.25 kg
Weight with batteries and 5" tape	= 15 lbs or 6.4 kg

POWER SUPPLY

Power supply voltage necessary: D.C. (positive to chassis) −10.5 V to −30 V.

	non pilot	pilot	time code
power consumption			
"TEST"	100 mA	110 mA	140 mA
"LINE PLAYBACK"	175 mA	180 mA	200 mA
"LOUDSPEAKER PLAYBACK	230 mA	240 mA	250 mA
"RECORD"	250 mA	270 mA	270 mA
"RAPID REWIND"	280 mA	290 mA	300 mA
"STOP"	0 mA	0 mA	2.8 mA

Type of batteries: 12 x IEC standard R20 or ASA standard D or L90.

Approximate length of service when using regular dry cells:

4 hours in every 24 hours	:	10 hours
Continuous service	:	7 hours
Continuous service with high capacity cells	:	25 hours

MAGNETIC TAPE

Width of tape	1/4" (6.25 mm)
Admissible thickness	0.0005 to 0.002" (12–50 μm)
Maximum reel diameter (cover open)	7" (178 mm)
Recording time ($7\frac{1}{2}$ ips / 19 cm/s, 35 μm tape)	45 minutes
Maximum reel diameter (cover closed)	5" (127 mm)
Recording time (same conditions)	22 minutes
Rewind time (5" / 127 mm reels, 35 μm tape)	2 minutes

TAPE TRANSPORT

Switchable tape speeds:

$$15 \text{ ips} = 38.10 \text{ cm/s} < 0.1\%$$

$$7\frac{1}{2} \text{ ips} = 19.05 \text{ cm/s} < 0.1\%$$

$$3\frac{3}{4} \text{ ips} = 9.525 \text{ cm/s} < 0.1\%$$

The stability of the average speed depends on temperature, the position of the recorder and the power supply voltage.

WOW AND FLUTTER

(Weighted p–p value according to DIN 45507 standard)

15 ips (38.10 cm/s)	±0.05%	(0.07)
$7\frac{1}{2}$ ips (19.05 cm/s)	±0.07%	(0.11)
$3\frac{3}{4}$ ips (9.525 cm/s)	±0.12%	(0.15)

(Weighted rms value according to NAB standards)

15 ips (38.10 cm/s)	0.028%
$7\frac{1}{2}$ ips (19.05 cm/s)	0.030%
$3\frac{3}{4}$ ips (9.525 cm/s)	0.043%

STARTING TIME: < 3 SECONDS

AMPLIFIER CHAIN MICROPHONE INPUTS

Maximum sensitivity for 0 dB on the modulometer:

dynamic microphones 50 Ohm	0.1 mV / µbar	0.14 mV ± 10%
dynamic microphones 200 Ohm	0.2 mV / µbar	0.28 mV ± 10%
condenser microphones	1.0 mV / µbar	1.40 mV ± 10%
(phantom powering + 12 V, + 48 V and –12 V)		
condenser microphones	1.5 mV / µbar	2.20 mV ± 10%
(T powering)		

Distortion at 1 kHz in the condenser microphone position, T powering, input level 40 dB (420 mV) maximum sensitivity:

2 nd	harmonic	> 0.22 %	(0.3%)
3 rd	harmonic	> 0.05 %	(0.1%)

maximum input voltage for a distortion of 1 % at 1 kHz:

dynamic 200 Ohm	135 mV (	120 mV)
T– powering	1040 mV (	1000 mV)
+ 48 V phantom	655 mV (	600 mV)

Frequency response (output loaded with 5 kOhm) dynamic microphones:

50 Hz	0 dB	(–1.5 dB)
80–20 Hz	± 0.7 dB	(± 1 dB)

Signal-to-noise ratio of the microphone preamplifier when switched to dynamic, ASA A weighting, reference 1 mW   125 dBm   (124 dBm)

Noise level of the condenser microphone preamplifier, input ASA A weighted
0.6 µV (0.8 µV).

LINE INPUTS

The input impedance is variable from 0 to 5 kOhm or from 0 to 10 kOhm in the ST.HS position of the stereo / mono switch; this is a current input.
Input current for 0 dB on the modulometer, maximum sensitivity 7.8 µA ± 5%
Minimum input level for 1% distortion under the same conditions 24,5 µA (22,2 µA)
Signal–to–noise ratio at maximum sensitivity 86 dB (80 dB).

MODULOMETER

The integration time for –1 dB	10 ms ± 20 %
Usable scale	–30 to + 5 dB.
Frequency response	40 Hz to 20 kHz ± 0.5 dB
Instrument class	1.5

CROSSTALK BETWEEN CHANNELS

0 dB on the modulometer   1 kHz   70 dB (65 dB)
                                  10 kHz   60 dB (50 dB)

Filters		Attenuation
FLAT	linear frequency response	
MUSIC	high pass filter	−3.0 dB at 40 Hz
M + LFA	music + low freq. attenuation	−7.0 dB at 40 Hz
		−3.0 dB at 400 Hz
SPEECH	high pass filter	−3.0 dB at 80 Hz
S + LFA 2	speech + low freq. attenuation	−7.5 dB at 80 Hz
		−3.0 dB at 400 Hz
ROLL OFF	strong low freq. attenuation	−10.0 dB at 100 Hz
		−3.0 dB at 400 Hz
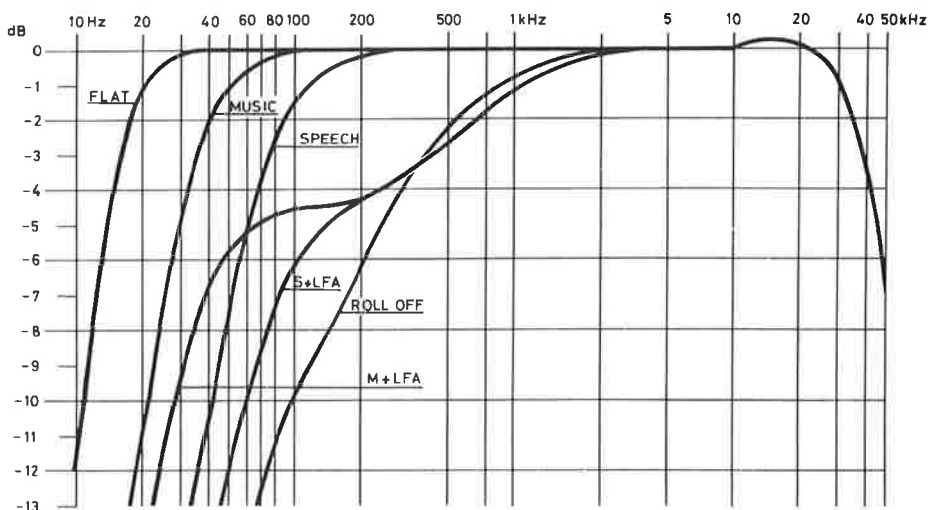
RECORDING AND PLAYBACK

Nominal recording level   0 dB = 510 nWb/m
Maximum peak recording level   +4 dB

The types of tape for which the machine is adjusted appear in the protocol of measurements, e.g.:

CCIR version	AGFA PEM 468	(15" and 7½")
	AGFA PEM 369	(3¾")
NAB version	SCOTCH 3M 808	(15", 7½", 3¾")
	SCOTCH 3M 226	(15" NAGRAMASTER)

Erase efficiency at maximum peak level   83 dB (80 dB)

Frequency response, recorded at −20 dB:

15 ips	(38.10 cm/s)	from 30 Hz	to 20 kHz	±1dB	(±2 dB)	
7½ ips	(19.05 cm/s)	from 30 Hz	to 15 kHz	±1dB	(±2 dB)	
3¾ ips	(9.5 cm/s)	from 30 Hz	to 10 kHz	±2dB	(±3 dB)	CCIR
3¾ ips	(9.5 cm/s)	from 30 Hz	to 8 kHz	±2dB	(±3 dB)	NAB

Distortion at maximum peak level, 15 ips STD 3rd harmonic 1% (2%).

Signal–to–noise ratio, record and playback, at maximum peak level:

15 ips (38 cm/s) NAGRAMASTER (13 µs)	NAB	74.5 dB (72 dB)	
	CCIR	75 dB (72 dB)	
15 ips (38 cm/s) STD	NAB	70.5 dB (68 dB)	
	CCIR	71 dB (69 dB)	
7½ ips (19 cm/s) STD	NAB	68 dB (65 dB)	
	CCIR	69 dB (64 dB)	

Non–pilot version (wide track)

Signal–to–noise ratio improved by approximately 1.5 dB
Phase fluctuation between channels 7½ ips (19.05 cm/s), 10 kHz ±5° (±20°)

Cross talk during record and playback   1 kHz   60 dB   (50 dB)
                                                                10 kHz   50 dB   (40 dB)

Insertion of a noise reduction system (NRS).

Low impedance output to NRS, voltage for 0 dB on the modulometer 560 mV.

Input for NRS, impedance approximately 10 kOhm, voltage for 0 dB on the modulometer 560 mV.

OUTPUTS

Line output voltage at 5 kOhm, for 0 dB on the modulometer 1 V.

Maximum output voltage for 5 kOhm, giving 1% distortion at 1 kHz 3 V (2.8 V).

Maximum output voltage to 200 Ohm headphones, for 0 dB on the modulometer, at 1 kHz = 560 mV ±20 mV.

PILOT TRACK

Possible speeds	3¾ ips / 7½ ips / 15 ips.
Carrier frequency	13.5 kHz.
Static linearity	(2%).
Maximum frequency deviation delta f0	±45% (±40 %).
Frequency response at –3 dB	0 to 2.7 kHz (0 to 2.5 kHz).
Signal–to–noise ratio for 40 % frequency deviation	> 50 dB.
Input voltage for 20 % frequency deviation	Pilot input ±1.4 V ±5%
	Cue ±1.0 V ±5%

Distortion for 40 % frequency deviation at 400 Hz < 2%

REFERENCE GENERATOR

1.1 kHz composite sine wave signal with 10 kHz component, level 0 VU = –8 dB ±0.2 dB.

OPERATING CONDITIONS

Temperature:	with alkaline batteries	– 4°	to + 160°F
		–20°	to + 71°C
	with external power supply	–67°	to +160°F
		–55°	to + 71°C

The recorder operates in any position.

TIME CODE TIME CODE SPECIFICATIONS see Chapter 2.

CHAPTER 2 :   TIME CODE AND PILOT

2.1.1 INTRODUCTION

Ever since the development of video tape recording in 1956, the television industry has been seeking a method of labelling each and every frame.
The most efficient and practical way found for doing this was to use time code, which numerically numbers every frame, making the location of particular sequences and eventual accurate electronic editing possible.

The NAGRA IV-S TC has been developed in order to enable accurate post production and editing of audio, frame accurate to the video, and to ensure that accurate frame synchronization can be maintained during post production.

The official presentation of the time code version of the IV-S was made during the 1984 NAB exhibition in Las Vegas.
The IV-S TC is available in two mechanically identical versions:

    NQS-TCC CCIR Equalization No   06007
    NQS-TCN NAB Equalization No   06008

Both models include the relevant mechanics and electronics to record and replay the SMPTE / EBU 80 bits longitudinal centre track time code. All existing frame rates can be internally generated, because both machines include an internal time code generator.

This section of the manual only describes the operation and use of the time code and pilot systems of the IV-S.

The text below relates to machines fitted with software version 1.94 (if this is not the case, then contact your nearest NAGRA agent in order to have the software updated).

2.1.2 MECHANICS

The NAGRA IV-S TC is physically very similar to the IV-S (2 track stereo) and the IV-SL (centre track pilot) versions. A slim slide out keyboard with 11 keys is fitted beneath the recorder. It is used to check (via a 7 segment 8 digit LCD. DISPLAY) and set the time code and user bits, into the desired mode.

It may be moved out of sight during actual operation of the recorder, to allow free access to the audio controls. The time code record / replay head is mounted where the pilot head is on the IV-SL, between the audio record and audio replay heads. A 5 pin LEMO connector is added to the connector field on the right-hand side of the recorder to allow external time code inputs and outputs. Other signals are found on the PILOT and CUE connectors (see pages 1-15 and 1-16) on pins that are otherwise used for pilot operation.

FRONT PANEL

All control functions of the time code system with the exception of the frame rate selection are located on the keyboard. Two indications are, however, given by existing elements of the front panel. The first being the indication of "off tape" time code on the modulometer, the second being the indication on the rotary SASS indicator to show whether a signal is being fed to the time code head.

OPERATION OF THE MODULOMETER AND PILOT INDICATOR

The "PILOT FREQ" function linked up with the presence of the QFMS has no significance in the time code version. The TC / PILOT PLAYBACK function provides an indication of the level of playback time code signal. The green needle of the modulometer will be displaced to the 50% point at a speed of 38 cm/s (15 ips) and to about 40% at a speed of 19 cm/s (7 1/2 ips). During playback at a speed faster than nominal, the needle will indicate between 80 and 100% according to the apparent level read from the tape.

The rotary pilot / time code SASS type indicator functions as it does on a pilot machine and will thus show a white segment whenever it detects a time code signal coming from or going to the head.

2.1.3 ELECTRONICS

The audio electronics of the time code versions of the IV–S are identical to those of the pilot machines. The time code circuitry is located on the top of the battery compartment, in the place where the pilot circuits are to be found in the pilot machines.
The heart of the time code system is a NATIONAL CMOS 8 bit, low power consumption NSC 800 microprocessor. All other integrated circuits used are also CMOS. The microprocessor performs several tasks, all according to the SMPTE / EBU standard:

> Time code generator
> Time code reader: off tape signal
> Time code reader: external source

These functions are in practice often combined. The off tape time code is read and regenerated by the internal generator in order to supply a clean signal to the time code output, free from drop outs and jitter. A time shift (see page 2-3) according to the speed is applied during this process to compensate for the distance between the time code and audio heads.
An external signal is also regenerated and time–shifted in the same manner before being fed to the time code recording amplifier and in turn to the time code head. When using an external time code source, the internal generator may be JAM SYNCED using the external time code reader to set the internal generator.

The microprocessor is powered when the main function selector is in any position other than STOP, to prevent excessive drain from the batteries when the machine is not in use. However, this does not mean that the time code generator itself is not running in the STOP position, the real time clock (RTC) and some circuits are powered continuously even in STOP. (Assuming there is sufficient power available). A large capacitor serves as a back–up power supply for a short time to these circuits in order to allow the batteries of the machine to be exchanged, without losing the relationship between the generator and real time.

The signal available at the output connector, when the machine is in the TEST position, is not shifted in time, and therefore corresponds to the time code being generated, and thus allows the IV–S TC to be used as a master clock.

2.1.4 RECORDING FORMAT

The recording format of the NAGRA IV–S TC complies with the standard as accepted by the EBU in 1984 for the recording of centre track time code on 6.35 mm audio tape.

This standard mainly prescribes the following:

Audio tracks	2 mm with 2 mm interspacing
Code track	0.35 to 0.38 mm in the centre of the tape

Code format	SMPTE 80 bits, longitudinal
Recording	bi-phase modulation
Recording level	721 nWb/m pp ±3 dB
Rise and fall time	65 microseconds ±10 microseconds

Time code and sound longitudinally coincident on the tape.

STANDARDIZATION

The different products and different manufacturers compatibility is, of course, a matter of vital importance. The quarter inch audio tape recorders considered here record the SMPTE / EBU–80 bits time code on a centre track for which the specification has been adopted by the EBU. This standard (as above) covers all parameters necessary to ensure compatibility of tapes recorded on different equipments. At present more than 10 different manufacturers have adopted this format. The differences in timing between the time code head and the audio heads is obviously different from one manufacturer to another, thus every tape recorder is expected to shift the incoming and outgoing time code signals in such a way that the audio and time code always remain in accurate phase on the tape, and of course on the input and output connectors, even if the recorder uses different heads for audio and time code.

The amount of shifting done in the NAGRA IV–S TC at each speed can be seen on the following page.

2.1.5 DISTANCE BETWEEN HEADS

Due to the mechanical design of the tape transport of the IV–S TC, and the fact that it is a three head machine, it is necessary to shift the time code in order to record the time code that corresponds to its particular piece of sound in the correct place on the tape.

The time code is delayed by varying amounts depending on the selected tape speed. It is also dependent upon the selected frame rate, and can therefore be expressed in terms of frames, bytes and bits according to the following table:

Standard	Tape speed cm/s	ips	Frames	Bytes	Bits
NTSC	9.525	3¾	7	2	4
30 F.P.S	19.05	7½	3	6	2
(2400 BITS / SEC)	38.10	15	1	8	1
PAL	9.525	3¾	6	0	3
25 F.P.S	19.05	7½	3	0	1
(2000 BITS / SEC)	38.10	15	1	5	1
FILM	9.525	3¾	5	8	0
24 F.P.S	19.05	7½	2	9	0
(1920 BITS / SEC)	38.10	15	1	4	4

NOTE:
1 bit = 1/80 th. of a time code word
1 byte = 8 bits or 1/10 of a time code word
1 frame = 80 bits or 1 time code word

2.2.1 KEYBOARD DESCRIPTION

The slide-out key panel contains 11 keys which are used to control all time code functions. It works in direct conjunction with the microprocessor and is activated when the main function selector is in any position other than "STOP".

All the keys with the exception of the SHIFT key have three functions: DIRECT, NUMERICAL and SHIFTED (see below). The status of the time code system can be displayed on the LCD display at any time.
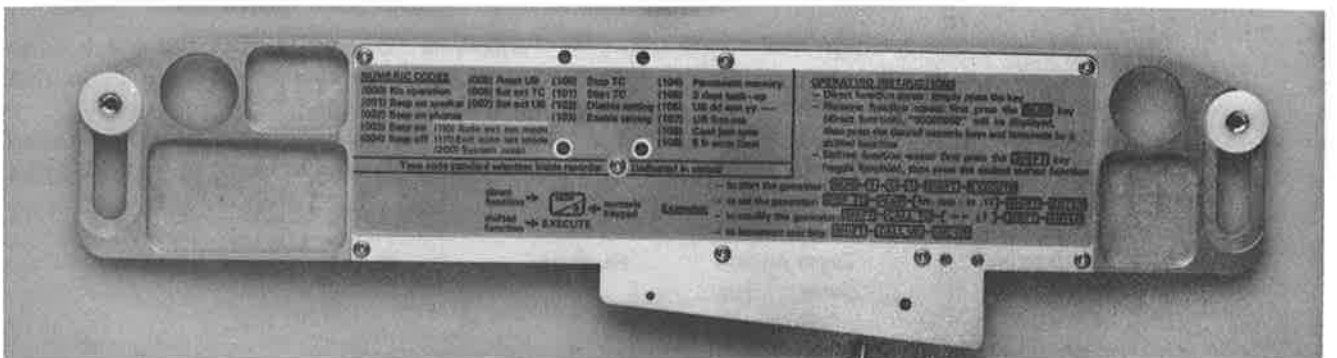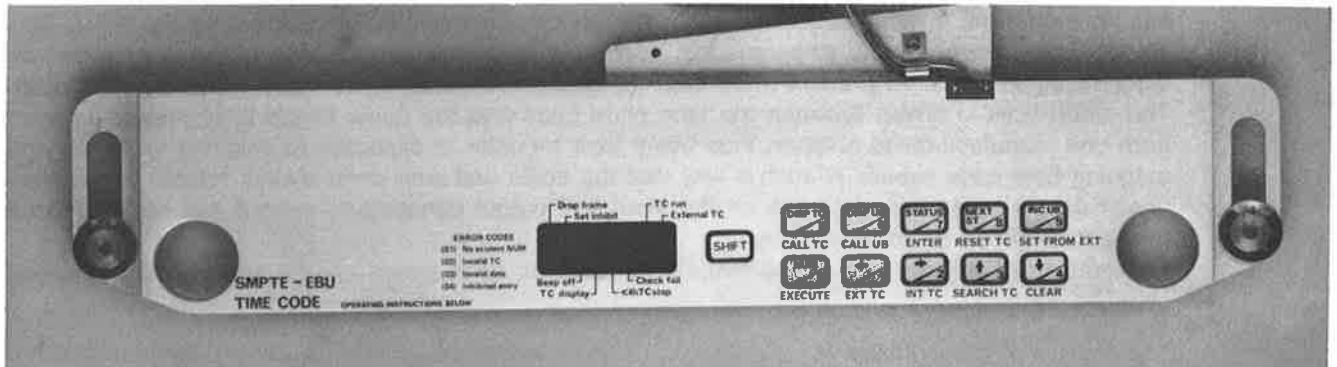
DIRECT FUNCTION   As printed on each key, the function is activated the moment the key is pressed.

NUMERICAL FUNCTION   The keys have their numerical value printed on them. When in the numerical mode, these are used for special functions and the entry of time code data.

SHIFTED FUNCTION   Printed in RED beneath each key. To activate these functions the shift key must be pressed first.

NOTE: If the SHIFT key is pressed by mistake, then press SHIFT a second time and the function is immediately cancelled.
Also note that the DIRECT functions never affect the operation of the system so as to prevent any interruption of the recording which is in process.

2.2.2 KEYS DESCRIPTION

NUM / 0
EXECUTE

Access to the numerical value of all keys.
Numerical value 0.
Execution of a numerical command, according to the value of the command presently on display.

← / 1
EXT.TC

Moves the flashing digit to the left when in CALL TC or CALL UB mode.
Numerical value 1.
Selects the external time code signal for display and recording.

→ / 2
INT TC

Moves the flashing digit to the right when in the CALL TC or CALL UB mode.
Numerical value 2.
Selects the internal time code generator for display and recording.

↑ / 3
SEARCH TC

Increment of the flashing digit when in CALL TC or CALL UB mode.
Numerical value 3.
Initialization of the playback search function.
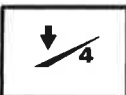
↓ / 4
CLEAR

Decrement of the flashing digit when in CALL TC or CALL UB mode.
Numerical value 4.
Resets the display to zero when in numerical mode.

DISP TC / 5
CALL TC

Causes the display of time code – Off tape
                         – Generator
                         – External.
Numerical value 5.
Displays the internal generator and starts the modification mode.

DISP UB / 6
CALL UB

Causes the display of user bits – Off tape
                         – Generator
                         – External.
Numerical value 6.
Displays the internal user bits and starts the modification mode.

STATUS / 7
ENTER

Starts the status display menu on the first line.
Numerical value 7.
Terminates the CALL TC or CALL UB modes and stores any modifications.

	NEXT ST 8	Selects the next line of the status menu.
		Numerical value 8.
	RESET TC	Resets the internal time code generator to zero.

RESET TC

Increases the value of the last two positions of the user bits, when in CALL UB mode. An internal ENTER command is performed automatically.

INC UB 9

Numerical value 9.

Causes a JAM SYNC of the internal generator from an external time code source.

SET FROM EXT

2.2.3 DISPLAY AND BEEP

The eight digit LCD display is not only used to visualize time code and user bit values, but can also be used to see the STATUS of the time code system. The time code or user bits on display may come from any of the following sources:

INTERNAL GENERATOR	Main function selector	TEST or RECORD
	Recording mode	Internal
EXTERNAL SOURCE	Main function selector	TEST or RECORD
	Recording mode	External
OFF TAPE SIGNAL	Main function selector	PLAYBACK

The time code system of the IV–S TC emits a beep signal on either headphones or the loudspeaker output to confirm various functions of the recorder:

Correct initialization after switching on
Correct execution of a numerical command
Acquisition of an external time code (set from external)
Acceptance / entry of new time code or user bits

The beep can be inhibited by means of numerical command 004 and turned back on again by means of numerical command 003. The beep may be switched to the internal loudspeaker by numerical command 001 or alternatively to the headphones by numerical command 002.

NOTE: The beep signal is always automatically inhibited whenever the machine is in the RECORD mode.

NOTE: The LCD keyboard display is powered in all positions of the main function selector except STOP. Thus, when checking the operating modes or making any modifications, it is necessary to select TEST.

2.2.4 STATUS DISPLAY MENU

One of the most important features of the NAGRA IV–S TC is that it allows the control and monitoring of the time code status of the machine and its functions during set up.

The first line of the status menu appears on the display when the STATUS key is pressed. Vertical lines will appear opposite the messages written around the display.

```
        ┌─ drop fr    ┌─ TC run
        │   ┌─ set inh │  ┌─ External TC
        │   │          │  │
     ┌──┴───┴──────────┴──┴──┐
     │                       │
     └──┬───┬──────────┬──┬──┘
 beep off ─┘   │       └─ check fail
  TC display ──┘       └─ 4 hr tc stop
```
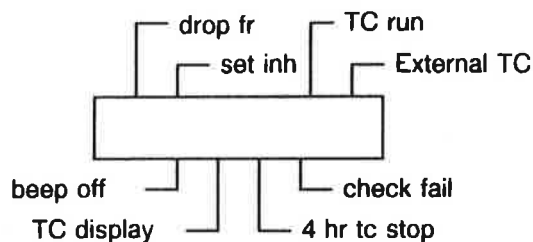
DROP FRAME	1 =	The selected frame rate is 29.97 or 30 drop frame
	0 =	(blank) Any other possible frame rate is selected.
SET INHIBIT	1 =	Numerical command 102 has been selected to prevent accidental modification of the real time clock.
	0 =	(blank) Setting / modification is possible. (Numerical command 103)
BEEP OFF	1 =	The beep tone is suppressed. Numerical code 004
	0 =	(blank) Beep is on.
TC DISPLAY	1 =	Unless an alternative choice is made the time code is displayed. This information is particularly useful when the tape is not running or the user bits are being used to store time data.
	0 =	(blank) Anything other than time code is on display.
4H TC STOP	1 =	Machine is in the 3 DAYS BACK UP mode (numerical command 105), and the power of the time code circuit will be cut off in 4 hours or less.
	0 =	(blank) Either the machine is not in 3 DAYS BACK UP mode or the 3 days limit is not within the next 4 hours.
CHECK FAIL	1 =	The delay imposed upon the time code signal by the microprocessor to compensate for the distance between the audio and time code heads is not correct. If the operator wishes to restore the phasing of the time code signal and the audio, he should just select STOP, using the main function selector. This will also show a "1" if there is any other problem with the time code system.
	0 =	(blank) All functions are correct.
TIME CODE RUN	1 =	the internal time code generator is running.
	0 =	(blank) The internal generator has been stopped.
EXTERNAL TC	1 =	The system is switched to external time code and the microprocessor will only take into consideration code features that originate from the external socket, for the display as well as for recording.
	0 =	(blank) The machine is set to run from internal time code.

OTHER STATUS AVAILABLE

After the STATUS key has been pressed, other information is available, by pressing the NEXT STATUS key:

1st press =   Selected frame rate, which is selected using the rotary selector on the time code circuit. (if the machine is in DROP FRAME mode then a vertical stroke will appear on the display when in the STATUS mode)

2nd press =   The display shows the mode in which the power is supplied to the time code circuits memory. Either CONT is displayed when in the permanent mode (numerical command 104) or 3 DAYS is displayed when in the 3 DAYS BACK UP mode. (numerical command 105).

3rd press =   The display shows the mode of the user bits. Either DATE UB is displayed when in the calendar mode (numerical command 106) or FREE is displayed when in the free user bits mode. (numerical command 107).

4th press =   The display shows the error correction mode selected.
Either 5 INC for the automatic correction of up to 5 consecutive errors received from the external time code signal (numerical command 109), or CONT INC is displayed for continuous correction of errors. (numerical command 108).

5th press =   The version of software installed on the time code circuit. For further information on software see SOFTWARE EVOLUTION (Appendix "B").

2.2.5 NUMERICAL COMMANDS

The numerical commands allow selection, and in some cases memorization of the function, thus allowing to a certain extent personalization of the system by the operator. Numerical commands are all entered via the time code keyboard, and are silk screened under the keyboard, along with the error messages of the machine.

To enter a numerical command it is necessary to press the NUM key. Then enter the three digit code using the numbers on the keys, corresponding to the desired code "XXX". When this is done press SHIFT and then EXECUTE in succession. When reading a numerical command, the machine will only take the three right-most digits into consideration, thus if the display shows all zeros, it is not necessary to enter the preceeding zeros in the code.

If an error is made when entering a code, then press CLEAR followed by SHIFT then EXECUTE to return the display to all zeroes. Then enter the correct number.

If the function NUM was selected in error, just enter the code 000 or press SHIFT then CLEAR, followed by SHIFT then EXECUTE, to return to the original state.

In the event of an unknown numerical command number being entered, the error message "ERROR 01" will appear on the display. To delete the error message press NUM again then enter the correct number.

Numerical commands

000   NO OPERATION: Cancels the NUM function, and is used only to remove the NUM function entered in error.
This also allows to quit from a SET FROM EXT when no external time code is present. As the code is 000 it can be performed by simply pressing SHIFT then EXECUTE.

| 001 | BEEP ON SPEAKER: Directs the beep signal to the internal loudspeaker. |

001   BEEP ON SPEAKER: Directs the beep signal to the internal loudspeaker.

002   BEEP ON PHONES: Directs the beep signal to the headphones output.

003   BEEP ON: Activates the beep feature and directs it to the headphones and the loudspeaker.

004   BEEP OFF: Deactivates the beep signal. This is indicated when in the STATUS mode by a vertical line opposite the BEEP OFF mark.

005   RESET UB: Resets the user bits to zero.

006   SET EXT TC: This allows only the internal time code generator to be set from an external source.

007   SET EXT UB: This allows only the user bits to be set from an external source.

100   STOP TC: This stops the internal time code generator causing the same number to be sent continuously to the output.

101   START TC: This starts the internal generator.

102   DISABLE SETTING: Inhibition of all the functions used for setting the internal generator. This selection is indicated by a vertical line oposite "SET INHIBIT" when in the STATUS mode. However the user bits remain accessible and can be changed as required.

103   ENABLE SETTING: Allows the setting of time code. This function only needs to be used if numerical command 102 had previously been selected.

104   PERMANENT MEMORY: The data and modes of operation of the time code system are saved, and the internal time code generator will function until the batteries are no longer capable of supplying enough power. This mode is visible on the display after the operator has selected STATUS and pressed the NEXT STATUS key twice.

105   3 DAYS BACK UP: The internal generator will be supplied with power for three full days, allowing stored functions to be kept, after the last operation of the machine. The operation of this mode may be seen on the display after the operator has selected STATUS and then pressed the NEXT STATUS key twice. When there is 4 hours or less remaining before the power to the memory is cut off a vertical line appears opposite the 4 HR STOP position when in the STATUS mode.

106   UB dd–mm–yy: The user bits are only to be used as a calendar. This function can be seen after the operator has pressed STATUS followed by NEXT STATUS three times, the display will show 3 dAYS.

107   USER BITS FREE USE: The user bits are not in calendar mode and can be programmed in HEX (0–F), according to needs. This mode can also be seen on the display after pressing STATUS followed by NEXT ST three times.

108   CONT JAM SYNC: The system automatically corrects errors in the time code coming from an external source, and continues to generate time code, even after a break in the external link. If this occurs then the display will indicate alternately the generated time code value and ERROR 02. The selection of this mode can be seen on the display by the message CONT INC after the operator has pressed STATUS followed by NEXT ST four times.

109 5 FRAME ERROR LIMIT: This is the normal operation mode.
The system will correct the first five consecutive errors received from the external source, and will then display ERROR 02. The selection of this mode is indicated by the message 5 INC after the operator has selected STATUS followed by NEXT ST four times.

110 AUTOMATIC SET FROM EXTERNAL: When connected to an external time code signal, the internal generator will automatically make a SET FROM EXTERNAL as soon as it detects a difference between its own time code and the external source. A beep will be heard after each successful SET FROM EXTERNAL.
When no external time code is available then the display alternately flashes time code of the internal generator and the message AUTO SET.

111 EXIT FROM AUTO SET: This takes the machine out of the auto set mode, and returns the generator to normal operation. It also allows the exit from the continuous jam sync mode (NUM 108).

200 RESET : This function causes the microprocessor to make a total reset, and will cause stored numerical commands to be lost and the default values to be stored instead.

If no special numerical commands are fed into the system, the following "default values" will be in the system (this is also the case after numerical command 200 has been performed).

—	– Generator will start at 00.00.00.00
107	– Free user bits, value of 00.00.00.00
104	– Permanent power supply to the memory and generator
103	– Non protected updating
003/001	– Beep on, and fed to the internal loudspeaker
109	– Correction of errors in external input up to 5 consecutive errors.

NOTE: After entering NUM 106 (date ub) and then entering the display user bits mode the last software revision date will automatically be displayed (18.03.87 for the 1.9 version).

2.2.6 ERRORS AND ERROR CODES

In the event of keyboard errors, or incorrect operating modes, the microprocessor is programmed to show an error message. These error messages only appear when the machine is displaying either time code or user bits, and do not appear during the status mode in order to enable the operator to locate the problem as quickly and easily as possible.

When an error occurs, the display will indicate "ERROR" followed by two digits that indicate the type of error. The error code list is printed on the bottom of the keyboard.

ERROR 01   Non existent NUM

Cause   The numerical command number is not recognized by the microprocessor and appears after the operator has entered an incorrect number. To correct this, press NUM followed by the correct number. Then press SHIFT followed by EXECUTE.

ERROR 02   Invalid time code.

Cause   The machine is set to external time code operation but there is no readable signal at the time code input, or the machine is set to 5 INC (error correction mode) and it has detected the 6th consecutive error from the time code source. This error message will appear alternately with the time code when the input signal is of insufficient quality or is no longer present, when in CONT (continuous increment) mode, and this means that the internal generator has taken over.

ERROR 03   Invalid date

Cause   The calendar mode of the user bits has been selected and the date entered is either non existent or does not conform to the dd.mm.yy.xx format.

ERROR 04   Inhibited entry

Cause   DISABLE SETTING has been selected, and an attempt has been made to set the internal generator.
To cure this select numerical command 103

ERROR CORRECTION MODES

When recording a time code from an external source, an error detection and correction system is provided to protect against "drop outs" of the signal.

Two different modes of correction are provided:

– Automatic correction of the first five consecutive errors detected, and then at the sixth, the microprocessor automatically stops the recording of time code and displays the error message "ERROR 02" (invalid time code). This mode is selected through the keyboard, using the numerical function, numerical command 109, or alternatively at the time of power up.

– Automatic correction of all errors in the signal originating from the external source, and alternating the display of time code with the error message ERROR 02. The time code will continue to be recorded correctly on tape without interruption. The time code recorded on the tape is no longer the original external time code source, but a time code generated by the internal generator. This mode is especially useful when working with a cable connection between the IV–S TC and the camera or the video recorder and there is a possibility of connection failure. This fully automatic mode of error correction is also programmable via the keyboard with numerical command 108.

2.2.7 KEYBOARD USE

CHANGING THE DISPLAY MODE

Simply press one of the following DIRECT keys :

- DISP TC
- DISP UB
- STATUS
- NEXT ST

To display the status of the time code, first press the STATUS key. In this mode the status of the machine is displayed as either "1" or " " (nothing), and the vertical lines lie directly in line with the written messages around the display.

EXECUTION OF A NUMERICAL COMMAND

First press the NUM key, in order to enter the numerical mode, and then enter the three digit numerical code, which corresponds to the desired function. Then execute the command by pressing SHIFT followed by EXECUTE. If an error is made while setting the number, it can be corrected before pressing SHIFT then EXECUTE, by pressing SHIFT then CLEAR. Only the three least significant digits are taken into account by the microprocessor. If an invalid command number is entered that the microprocessor does not recognize, the error message ERROR 01 will appear.

When a correct numerical command has been entered, the display will immediately return to its previous display mode and a beep signal will be emitted.

SELECTION OF AN INTERNAL OR EXTERNAL TIME CODE

To select an external time code simply press SHIFT then EXT TC: the machine will automatically only accept external time code, and this will be displayed immediately on the display. Before selecting external time code make sure that an external source is connected to the five pin LEMO connector, or ERROR 02 will be displayed.
To return to the internal time code simply press SHIFT then INT TC.

NOTE: If numerical command 102 (disable setting) has previously been selected, then internal and external time code selections are not selected, ERROR 04 will be displayed. Numerical command 103 will enable setting again.

SETTING FROM AN EXTERNAL TIME CODE

To make a setting of the time code generator (time code or user bits) from an external source simply press SHIFT then SET FROM EXT. Before making this selection make sure that an external source is connected to the LEMO external time code input. If this is not the case then ERROR 02 will be displayed.

To set time code only (leaving the user bits untouched) execute numerical command 006, or to set only the user bits (leaving the time code untouched) execute numerical command 007.

NOTE: If numerical command 102 (disable setting) has previously been selected then the above functions will not be executed, and ERROR 04 will appear on the display.

INCREMENT USER BITS

To use this function, the user bits must be in the FREE mode (numerical command 107). To increment the least significant digit of the user bits press SHIFT then CALL UB then INC UB.

A beep will be heard each time the user bits are successfully incremented. This function is especially useful for "TAKE" numbering, however, it will only increment the last two digits of the user bits up to a maximum value of 99.

2.3.1 INTERNAL GENERATOR

The NAGRA IV-S TC is fitted with an internal time code reader / generator, using the SMPTE / EBU 80 bits code, at any frame rate presently in use. It will generate code accurate to one frame in eight hours (providing that there is sufficient power available). The IV-S TC also incorporates a time code reader that allows the code to be read back from the tape at nominal speed, or at variable speed from 0.5 to 6 times the recorded speed.

The microprocessor automatically compensates for the distance between the time code and audio playback heads when running at nominal speed.

The time code is available in two forms at the output when replayed at nominal speed :

    – As supplied by the microprocessor (regenerated and shifted according to the speed) and hence correctly related to the audio.

    – As read directly from the tape by the time code head in advance with respect to the audio)

The time code reader / generator also contains an automatic error correction system that can work in two different modes. (See error correction page 2-11).

2.3.2 SELECTION OF FRAME RATE

All frame rates currently in use in both film and video use are available in the NAGRA IV-S TC.

    – 24 frames per second for cinema (according to the SMPTE standard)
    – 25 frames per second for cinema and european television (according to the EBU standard)
    – 30 frames per second for cinema and american black and white television (according to the SMPTE standard).
    – 29.97 frames per second * for american television.
    – 29.97 frames per second * with image compensation (DROP FRAME) for american colour television.
    – 30 frames per second with drop frame to allow conversion between cinema and television in the NTSC countries.

*   The operation at 29.97 frames per second requires the use of an optional extra crystal (not fitted as standard in the CCIR machines).

The selection of the operating frame rate is made inside the recorder on the time code circuit as follows:

- Put the recorder in the STOP position.
- Slightly loosen the two screws located on the right–hand side of the machine marked "OPEN".
- Open the deck completely by lifting to the left–hand side.
- Select the desired frame rate using the rotary selector located on the time code board on top of the battery compartment, in the centre of the machine.
- Do not forget to retighten the box fastening screws.

The frame rate may easily be seen by looking at the first line of the STATUS DISPLAY menu i.e. press STATUS then NEXT ST and the first line of the menu will appear.

NOTE: Alterations of the frame rate are only considered when a total microprocessor reset is made (numerical command 200), or alternatively when the machine is switched to STOP and then to ON again.

2.3.3 USER BITS SETTING

As explained earlier, the SMPTE / EBU 80 bits time code standard reserves eight bits of the code for user information.
As a general rule these are used to identify static information serving as identification of a particular sequence such as the scene number, camera number, scene or take number or any other information of this type. These user bits can also be used to indicate the date and therefore the IVS–TC offers two different modes of operation:

FREE USE   "FREE UB" This mode is selected via the numerical mode using numerical command 107, and allows the operator to enter any value from 0 to F (hexadecimal) for each of the eight positions.

CALENDAR   "DATE UB" This mode is selected via the numerical mode using numerical command 106, and allows the operator to enter, using the six left–most positions of the display, the date in the DD MM YY format. The remaining two positions on the right of the display are still usable in the free mode for any value from 0 to F. When in the CALENDAR mode, the date is automatically advanced when the time code passes 23:59:59:XX and is programmed to remain correct until the year 2100.

The mode, of the user bits, can be seen using the STATUS mode, and pressing the NEXT ST key twice. If they are in the FREE mode, then the message FREE UB will be displayed whilst if in the CALENDAR mode the message DATE UB will be displayed. It should be pointed out that these user bits will be recorded on each and every frame in the form in which they were entered.

SETTING OR MODIFICATION OF USER BITS

The operator has the possibility to modify the user bits at any time (except during a recording) and this modification may be done either using the keyboard or an external source.

USING THE KEYBOARD

Two possibilities are available:

- Call up the user bits by means of the DISP UB key

- Press the NUM key and then enter the values corresponding to the correct value, in the form DD:MM:YY:XX when in the DATE UB mode, or   alternatively in the XX:XX:XX:XX format when in the FREE UB mode. When in the CALENDAR mode ERROR 03 will be displayed if any of the digits are invalid.

PROTECTION OF DATA

In order to prevent unintentional modification of time code or user bits, numerical command 102 may be executed, which will inhibit any attempt to modify the internally stored data. If an attempt is made to modify data in this mode ERROR 04 (inhibited entry) will be displayed. It should be noted that numerical command 102 will only protect the internal time code generator from modification and allows free access to the user bits which may still be set from either the keyboard or an external source.

TIME CODE OR USER BITS MODIFICATION

All modifications are possible as long as numerical command 102 is not set.

SETTING TIME CODE OR USER BITS

When setting the time code or the user bits, it is not necessary to stop the internal generator.
First press the NUM key and select the desired time code value or user bits, then press SHIFT followed by ENTER. Both the time code and date can be modified in this manner. However, it is whichever was on the display before the NUM key was pressed which will be modified. If any of the information fed in is in the wrong format, then an error message will be displayed.

NOTE: The modification is not made while the numbers are being entered, but at the moment that the ENTER key is pressed.

MODIFY TIME CODE

With this mode the internal generator is automatically stopped. First press the CALL TC key, and the left–most digit will start blinking to indicate that it is in the modify mode. This blinking digit may be changed using the left and right arrow keys, and the blinking digit may be either incremented or decremented using the up and down arrow keys. When the modification is complete and ready to be implemented, simply press SHIFT followed by ENTER. The value is immediately fed into the internal generator which will start counting from this new value.

MODIFY USER BITS

This function does not stop the internal generator and can be used to modify or set the user bits. The means of setting these is exactly as above except that the CALL UB key must be used. The changing of the digit values is as above. When using the INC UB key then an ENTER command is automatically executed each time it is pressed.

2.3.4 SETTING FROM EXTERNAL TIME CODE

To make a setting of the internal generator from an external time code source, simply press the SET FROM EXT key. Before doing this make sure that there is a time code source connected to the LEMO connector, otherwise ERROR 02 will be displayed.

When the internal generator has correctly set itself from the external source a short beep signal is emitted to tell the operator that correct setting has taken place.

If the microprocessor detects an error in the external signal then ERROR 02 will be displayed. It should be noted that when using this function both the time code and the user bits will be amended at the same time.

NOTE: If the user bits of the machine are set to a different format with respect to those of the external signal (DATE UB or FREE) then ERROR 03 will be displayed (see numerical commands and error messages).

EXTERNAL TIME CODE

Always check that the frame rate setting of the IV-S TC corresponds to the frame rate of the external source.

To record external time code rather than just set the internal generator from it, press SHIFT followed by EXT TC. The moment this is done a "1" will appear on the display in the STATUS mode opposite the external time code message around the display. In this mode the time code recorded will be the external source. However a time code link must be kept at all times between the external source and the IV-S TC. This mode is useful especially when working with a system where all the machines are recording time code from one master clock. Thus the IV-S TC can remain in perfect correlation with all the other machines.

In order to use the IV-S TC as the MASTER CLOCK all the time code signals present at the time code output are available with no offset (to compensate for the distance between the time code and audio heads), when the machine is in the TEST position.

2.3.5 SIGNALS AVAILABLE AT THE OUTPUT

During recording the following signals are available :

CUE connector

sync ref   reference frequency   76.8   kHz at 30 frames per sec.
                                                          64.0   kHz at 25 frames per sec.
                                                          64.44 kHz at 24 frames per sec.

Time code connector (LEMO 5 pins)

TC output   Time code signal according to the SMPTE / EBU standard (0 V to 5 V
                               bi-phase modulation)

The signal on the time code output pin appears in two different forms according to the position of the main function selector. In the TEST position the signal is identical to that furnished by the internal generator. However in the RECORD position of the main function selector the signal present is offset, in order to correspond to the audio signals present at the audio outputs.

The signal present on the TC PLAY pin of the time code input connector is not usable during recording.

2.3.6 AUTOMATIC SET FROM EXTERNAL

In video applications, this mode of operation is particularly useful, as it is annoying to keep opening the carrying case of the machine and then sliding out the keyboard to make a SET FROM EXTERNAL every time the video camera is switched on. (This needs to be done because all video cameras "colour frame" themselves thus moving their time code generators forward to get into the next colour framing sequence). It is for this reason that the IV-S TC is equipped with the AUTOMATIC SET FROM EXTERNAL function (numerical command 110). When this function is selected, and whenever the IV-S TC is connected to an external time code source, the internal generator will automatically make a set from external if it detects any difference between the incoming time code and the time code it is generating internally.

Each time a successful SET FROM EXTERNAL is made a beep is emitted. This function can also be used as a warning, to tell the operator that the frame rate of the external signal is not the same as that of the IV-S TC. If this occurs, the machine will make a SET FROM EXTERNAL when it is first connected to the incorrect source, then it will immediately make another one as it will see a difference straight away. This will continue as long as the problem is present. Thus a series of beeps will be heard acting as a warning.

If the cable is removed after a successful SET FROM EXTERNAL while the machine is in the automatic set from external mode then the display will alternately show the incrementing time code from its internal generator and the message AUtO SEt. However this does not occur when the IV-S TC is in the RECORD mode.

3.7 USING THE IV-S TC WITH THE AATON ORIGIN "C"

CAMERA   ORIGIN C   IV-S TC
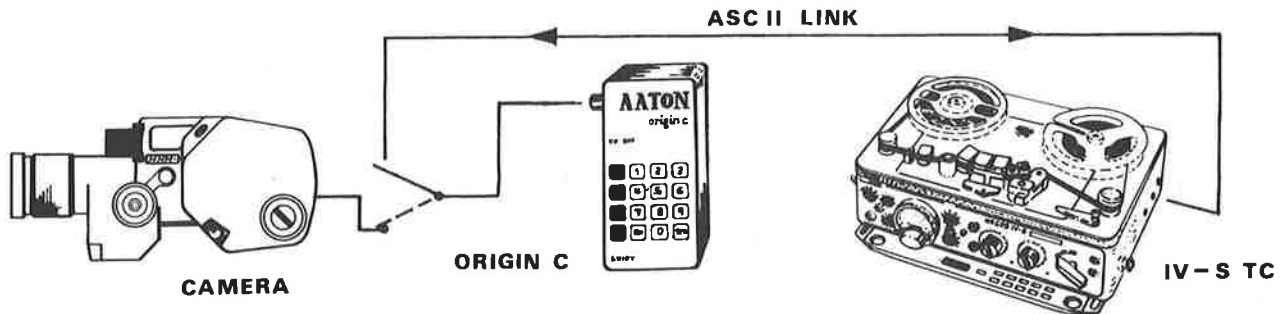
To enable the IV-S TC to communicate with the AATON origin "C" master clock in a film environment, a QSIA interface must be fitted into it.

When the machine is connected to the clock, it will automatically execute numerical command 106 (date user bits) (Version 1.9 software onwards only)

To set the time code proceed as follows:

- Turn on the IV-S TC and the master clock, the IV-S TC will beep and the origin "C" will display Pr 00 (blinking).

- Check that the frame rate of the IV-S TC is set to the correct frame rate by means of the STATUS mode. Also check that the user bits are in CALENDAR mode by pressing NEXT ST twice. If not, then execute numerical command 106.

- Setting the AATON origin "C" is done by pressing the "#" key. The origin "C" then displays y-000000. Introduce the current date in the year / month / day format. Each group of two digits is entered by pressing the "#" key. The origin "C" then displays h-000000. Introduce the correct time as above in the format hours / minutes / seconds (HH MM SS).

  The origin "C" now displays Pr 00 (blinking). Press the " * " key and it will display " – " (blinking). This operation starts the clock count.

–   Transmission of the time code to the IV–S TC is made by pressing the " * " key on the origin "C". The clock will display the following sequence: "control"; "out"; "control"; "Good" and the time code has then been sent to the IV–S TC. If it is not the first time the time code is sent to the IV–S TC from the AATON, the sequence will be: "control"; "bAd"; "rEloAd?" then press the " * " key to reload the time code, and the AATON will display "control" "good" assuming everything is correct.

SETTING THE AATON ORIGIN "C" FROM THE IV–S TC

Set the internal time code of the IV–S TC as explained earlier in this manual.

CHECKING THE TIME CODE ON THE IV–S TC

Connect the origin "C" to the NAGRA then press the " * " key and the origin "C" will display the following sequence EnG ; In ; control ; Good ; followed by "–" and this means that the time code has been entered. If the reply to the origin "C" is not Good, then press " * " again when the option rEloAd? is displayed.

NOTES ON THE ORIGIN "C"

IMPORTANT: The origin "C" is fitted with a power saving system and therefore it will automatically switch itself off after approximately 5 minutes. This occurs whether the operator is in the process of setting the time code at that moment or not.

It is not possible to work with the IV–S TC in the FREE UB mode as the AATON does not accept an invalid date (such as 00). It is important to check that DATE mode has been selected otherwise the reply from the IV–S TC to the AATON will read "bAd", even if the time is correct.

2.4.1   PILOT

The IV–S TC can be fitted with an F.M. centre track pilot system as found in the IV–SL. This changeover from time code to pilot can be made in a matter of minutes by the operator. However, it must be mentioned that the non time code IV–SL version of the IV–S cannot be modified to take the time code circuit as easily.
This requires major mechanical and electronic modifications. This RETROFIT can be done at the factory in Switzerland, and the price depends on the age and the overall condition of the machine. Your nearest agent is at your disposal to submit a quotation.

The modification of the IV–S TC to pilot is fully explained in our TECHNICAL INFORMATION sheet number 06–5 which can be found in chapter 6 of the service manual.

All existing accessories for the pilot version of the IV–S can be used on the time code version when it is in the pilot configuration.

2.4.2   PILOT COMPATIBILITY

The NAGRA IV–S TC has been designed in such a way that compatibility with the existing pilot formats is maintained. Normal recording, as well as playback recording and transfer practices have been taken into account. These goals can be achieved in two different ways :

QSIP pilot interface

This external accessory is essentially a time code to pilot transducer, and it transforms the off tape time code signal into a pilot signal when the IV–S TC is in playback. This signal can be used to resolve an external device. It is also possible to use the existing QSLS resolver unit in conjunction

with the QSIP in order to resolve and control the tape transport of the IV–S TC. This is possible not only against an external pilot reference but also against the internal time code generator, allowing the machine to SELF RESOLVE.

PILOT TRANSFORMATION

All electrical connections to the pilot circuit exist in the cable harness used in the IV–S TC without interfering with the wiring for the time code electronics in any way. Mechanically the same fixations that are used for the time code circuits are used for the pilot circuit. Hence it is easy to remove the time code system and replace it with the pilot option. To do this, no recalibration or special tools are required. (See technical information sheet 06–5 of feburary 1985 in chapter VI of the NAGRA IV-S TC service manual.)

NOTE: The internal crystal pilot generator QSGX–3 and the internal frequency meter circuit QFMS 50 / 60 are not listed on this modification sheet in the parts list. The QGX–3 is necessary unless another external pilot source is available. The QFMS 50 / 60 frequency meter circuit is an optional accessory and is not essential for pilot operation.

MODULATION METER

An approximate indication of the off tape pilot or time code level (depending on the configuration of the machine) is given by the meter when its selection switch is set to TC / PILOT PLAYBACK and the machine is in playback at nominal speed. The green needle shows approximately 50 % at 38 cm/s (15 ips) and about 40 % at 19 cm/s (7 1/2 ips)

NOTE: The meter has no significance at any speed other than nominal speed.

2.4.3 F.M. PILOT

The pilot signal 50 or 60 Hz, with a level of 1 V is supplied to the recorder through pilot input connector (44). To obtain the same output level of the signal during playback cue connector (47) is used. The pilot (or commentary) is recorded on the centre track between the two audio channels. All conventional CLAP signals can be used.

Conventional clapper board: This consists of a slate bearing the take number and giving both an audio and video indication (as is still used in cinema today).

Electrical clapper: This is where the film in the camera is fogged for a few frames, a signal is simultaneously transmitted to the NAGRA via a cable, and an oscillator tone is recorded onto the audio tracks.

Clapper by pilot signal suppression: Instead of recording an oscillator signal on the audio tracks, the pilot signal is cut during the start period of the camera.

An optional QFMS circuit allows the monitoring of the camera speed by monitoring the frequency of the pilot signal. If meter switch (12) is in the PILOT FREQ. position, the red needle will indicate the frequency. With switch (12) in position TC / PILOT PLAYBACK the green needle will indicate the depth of modulation of the sync pulse signal recorded by F.M. (or of the commentary respectively). A full scale deflection of the needle corresponds to a degree of modulation of ± 40%. That limit must not be exceeded.

CUE DEVICE

When the NAGRA IV-S is fitted with NAGRA SYNC (Pilot) facilities it is also possible to record commentary on the centre track, even simultaneously with a sound take with pilot. A special commentary microphone QSCM-2 is used for this purpose. It has a filter eliminating the frequency of the sync pulse signal, as well as an automatic level control (ALC). Due to the bandwidth available, the sound quality of the centre track recordings is poor. It is also possible to record commentary during playback, assuming no pilot signal has been recorded previously as it would be erased. The cue track may be monitored on headphones by switching PHONES switch (19) to the CUE position, and the volume may be adjusted by means of control (18).

2.5.1 USING THE IV-S TC

Before discussing the operation of the time code functions of the IV-S TC it should be mentioned that it is not necessary to continuously manipulate the keyboard. The keyboard is only used to select the time code operating mode, to reset the internal generator (time code and user bits), to change the time code or user bits and finally to verify correct operation of the time code system using the STATUS modes.

FIRST TIME OPERATION

On the first utilization, or when reusing the machine after a period of storage, and hence memory loss, it is necessary to start by selecting the desired modes of operation. The frame rate is a function that is not lost during storage, as it is selected with a hardware switch and is not user programmable via the keyboard. This is however selectable internally using the rotary switch on the time code circuit. All other modes of operation are to be selected through the keyboard, either by use of the direct function keys or by executing numerical commands as explained on page 2-8.

All the normal functions of the IV-S TC that are not related to time code, are explained in chapter 1 of this manual.

2.5.2 HOW TO RECORD A TIME CODE

Firstly it is necessary to select the desired frame rate as explained on page 2-13.

REAL TIME (ACTUAL TIME OF DAY)

This is the simplest method of working and requires the minimum amount of keyboard manipulation throughout the day.

The time code system of the IV-S TC has been developed to improve, amongst other things, the manoeuvering freedom of the camera operator and the sound technician. This allows filming with frame accurate audio, and allows operation without the need for a cable link between the video camera (or film camera) and the audio recorder. To achieve this we use the sequential time code method. A completely sequential time code without breaks cannot be made on the IV-S TC, because the IV-S TC cannot detect when the video camera has stopped. Thus it is generally preferred to record real time of day. To do this proceed as follows:

- Start by setting the time code and user bits, either manually or from an external time code source as explained on page 2-16.

- The correct time of day will be stored and incremented within the IV-S TC as long as there is sufficient power supplied, if the permanent memory mode is selected or alternatively for 3 days if the three days back up mode is selected.

- The date (if in the CALENDAR mode) of the user bits will automatically be updated at midnight, and is programmed to remain correct until the year 2100.

- When the time code is accepted by the microprocessor an audible beep will be emitted from the internal speaker, or the headphone output, depending on the selected mode. At this moment the internal generator will start running.

- The first recording may now be made as explained on page 1-18. Before each new take, it is possible to increment the user bits as explained on page 2-14, thus storing the take number in the time code to make the post production work easier.

- This mode of time code recording ensures that the time code values of each take are of a higher value than the previous take.

- If working with video rather than film, it is always necessary to re- JAM SYNC the IV–S TC and the video recorder each and every time the video camera is switched on.
  See page 2-17 Auto set.

2.5.3 SYNCHRONIZED RECORDING

To record a time code that is synchronous with another, for example a VTR such as the NAGRA VPR–5 or a film camera (single camera or multi camera), one of the machines should be allocated as the master machine (hence master clock), and all the other machines should have their time code generators set from the master. It is also, of course, possible to use a completely separate master clock such as the NAGRA TCGR, and set all machines in the system from this.

When using the IV–S TC in the above situation, all that has to be done to set the internal generator is to press SHIFT followed by SET FROM EXT (make sure that there is an external time code connected to the time code input). This will immediately synchronize the internal generator to the external source, and a beep will be emitted (make sure the two time codes are of the same standard i.e. frame rate and user bits mode to avoid ERROR 02 being displayed).

The user bits can be modified at any time without disturbing the time code of the internal generator. The internal generator of the IV–S TC is stable enough to work for eight hours, with a drift of less than one frame, when used within the specifications of temperature etc. (see specifications page 1-19).
When working with time code, it is always a good idea to make a note of the frame rate used to make the original, as this takes time to discover during post production (especially note whether drop frame mode has been used).

RECORDING AN EXTERNAL TIME CODE

If the system is running from an external time code source, it is only necessary to select SHIFT followed by EXTERNAL TC. In this case the incoming signal is delayed to compensate for the distance between the heads, and then recorded in perfect correlation with the audio without any modification to its contents.

2.5.4 READING A TIME CODE

As soon as the IV–S TC is put into the PLAYBACK mode the time code from the tape is displayed, as opposed to that from the internal generator. However if the EXTERNAL TC mode has been selected, then this will be displayed. It is also important to remember that the internal generator does not stop counting, even though it is not on the display.

The time code from the tape can be read at nominal speed, at slow speed and also during fast forward. However, the head offset compensation and error correction of the first five consecutive errors (after which the display is normally frozen) are only possible at nominal speed.
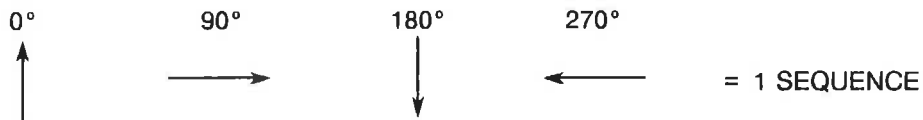
NOTE: No time code is available at the time code output when the machine is at any speed other than nominal.

When the tape is stopped manually by squeezing the two halves of the pinch roller assembly, the last time code value read from the tape will be left on the display, and will remain there as long as the tape is stationary.

2.5.5 USE OF THE IV–S TC IN VIDEO

All video recorders interlock their time code generators in both phase and speed, with the synchronizing signal provided by the video camera. In order to align the time code signal and the image while complying with the requirement for COLOUR FRAMING of the image, it is necessary to always use the time code signal furnished by the video system as the master clock.

As a result, each time the video camera is switched on the time code generator is moved by 1, 2 or 3 frames, depending on how many frames the video system needs to move to get into the next sequence of colour framing.


```
     0°          90°        180°        270°

     ↑       ─────────→      │       ←─────────
     │                       │                      = 1 SEQUENCE
     │                       ↓
```

In theory the time code needs never move more than 2 frames, however, in practice a video system always moves the generator forwards. Due to this effect, it is necessary to JAM SYNC the internal generator of the IV–S TC each time the video camera is started. Despite the fact that the internal generator of the IV–S TC is accurate to 1 frame in eight hours, as the video time code is changing at the start of each take, a JAM SYNC must be made to prevent accumulative errors in the time codes throughout the production.

It is for this reason that the IV–S TC is equipped with the AUTO SET function (see page 2-17), to minimize the amount of keyboard manipulation for each take.

Providing this is remembered, then working in video applications without permanent cable link is possible.

2.5.6 WORKING WITH A CABLE LINK WITH ONE OR MORE CAMERAS

This working mode is only used normally when the internal generator of the video camera does not allow FREE RUN (or real time) time code to be used.

Firstly switch on the camera(s), and set all their time code generators, if there are several cameras, and check that the GEN LOCKS have been performed correctly. Then connect the IV–S TC to the time code output of the video that has been chosen as the master. Check that all the frame rates etc. are the same (using the STATUS mode and NEXT ST MODE on the IV–S TC), modify where necessary, and make sure that the automatic error detection/correction on the IV–S TC has been selected. Finally press SHIFT followed by EXT TC and start the shooting.

If the internal generator detects a problem with the incoming time code ERROR, 02 will be displayed.

In this configuration, the IV–S TC will record exactly the information furnished by the video generator. That is to say that if the external source stops then no more time code will be recorded and the message ERROR 02 will be displayed, thus informing the operator that the video machine has stopped. During the post production stage of the production it will be sufficient to manually cut out all these "blanks" and thus leave one continuous time code on the tape for editing purposes. Most video editing systems can cope with any remaining jumps.

NOTE : The length of the time code link up cable between the IV–S TC and the master is a function of the quality of the time code signal furnished by the master. The signal is automatically regenerated and reshaped by the internal generator of the NAGRA before being recorded and, should the input signal be or become too weak, the message ERROR 02 would be displayed and the recording of time code would stop. The possible modes of error correction can be selected via the keyboard, depending on the desired mode of operation (see page 2-11).

2.5.7 TIME CODE IN FILM

At this time, no final standard has been laid down for the recording of time code on film, and as a result, several different methods are in use.

Many people ask "what is the need for time code in film?" as manual editing of film, using edge numbers, clap marks etc. have been used for many years without problems. The answer to this question is the transfer of film onto video tape, which has no sprocket holes, edge numbers, or visible clap points.

Two different recording media for time code in film are presently in use, and these are: a magnetic strip along the side of the film and optical recording on the film itself. The NAGRA IV–S TC has been developed in order to be compatible with both types providing the final product is an SMPTE / EBU longitudinal time code. In the optical field of time code there are various different methods of recording such as block matrix and bar code. We are not involved in this problem of recording and reading time code on film, our concern is only the compatibility of the IV–S TC with all the other systems.

To use the IV–S TC with film the procedure to follow is almost identical to that of video, except that the continuous need to make a SET FROM EXT each time the camera stops is not necessary, as colour framing problems that occur in video applications do not occur with film.

For use of the IV–S TC in conjunction with the AATON origin "C" please refer to page 2-17 of this manual.

SMPTE / EBU TIME CODE

CAMERA

IV–S TC
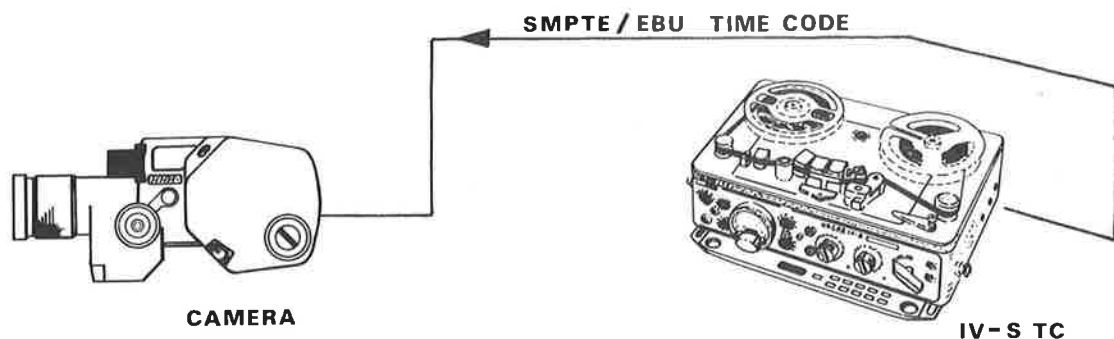
2.5.8 THE PLAYBACK SHOOT

Music videos are becoming increasingly popular in television productions, and production of a "clip" often requires, like many other types of programs, picture recording during the playback of the already recorded audio. The editing of such a program includes the tedious task of manually synchronizing the pictures and the sound. This usually has to be done without the aid of slate points as they cannot possibly be recorded on the already recorded sound track. Secondly there may possibly be dozens of identical takes all corresponding to the same piece of music. The use of the IV–S TC and its time code facilities can overcome all these problems.

Firstly the MIX MASTER of the audio is received, onto which time code can easily be striped using a centre track time code studio machine, such as the NAGRA T–AUDIO TC, which can now be used as the main editing and synchronizing reference while the IV–S TC plays back a copy of this original (containing the same time code), the transport of the IV–S TC is resolved to the time code generator of the video recorder. This is done for two reasons, firstly to ensure that the sound is replayed at the same speed each time, and also to ensure that the sound time code is in phase with the video signal and hence the video time code, as they are recorded onto the video tape.

The sound time code is also fed to one of the audio tracks of the video recorder, thus giving the video two time codes, one being the reference for the script and the other being the sound synchronization. As both are synchronous to the video, colour framed edits and synchronization are always possible.

To replay a previously recorded time code, put the main function selector in either of the two PLAYBACK positions, the "off tape" time code is then fed to the time code output, the LCD display and the modulometer.

SIGNALS AVAILABLE AT THE TIME CODE OUTPUT

During playback, the system supplies signals on three different connectors all located on the right-hand side of the machine:

PILOT CONNECTOR	– Data out and clock out, level –5 to 0 V
CUE CONNECTOR	– Sync ref. reference frequency:

<div style="text-align:center">

76.8   kHz at 30 f.p.s.
64.0   kHz at 25 f.p.s.
64.44 kHz at 24 f.p.s.

</div>

TIME CODE CONNECTOR	– 5 pin Lemo
	– Bi–phase time code output according to the SMPTE / EBU standard, between 0 and +5 V.
	– Time code direct play, –1.5 to +1.5 V

During playback as well as recording, the microprocessor automatically compensates for the distance between the time code and the audio heads (see page 2-3 for timing details). This offsets the time code signal by different amounts according to the speed of the tape transport, in such a way that the time code and audio signals are always exactly aligned on the TIME CODE OUTPUT. A time code signal is also available on the TIME CODE DIRECT PLAY output, however, this is not corrected and comes directly from the time code head.

In playback the error detection / correction mode is automatically set to 5 INC. (numerical command 109) see page 2-10.

NOTE: This mode is not remembered, and the machine will automatically return to the previously programmed mode (assuming it differs) as soon as the playback function is stopped.

PLAYBACK OF TIME CODE AT A SPEED OTHER THAN NOMINAL

The time code circuit of the IV–S TC is capable of replaying tapes recorded at nominal speed, and at speeds varying from 0.5 to 6 times the recorded speed. It will display the time code on the LCD display at any speed within this range, and it can also search for time codes within these limits.

NOTE: Time code is available on the time code output at nominal speed only.

2.5.9 SEARCHING FOR A TIME CODE

The SEARCH TC function permits the retrieval of any time code, whether the value is recorded on the audio tape or whether it is supplied by an external source. Once the value has been located, the machine will emit a single beep, to inform the operator that the chosen point has been reached, however, neither the transport nor the internal generator will stop at this point.

SEARCHING FOR A TIME CODE ON THE AUDIO TAPE

This function relies on the fact that the value to be found is recorded on the tape of the supply reel.

- Press the NUM key and enter the value of the time code to be sought.
- Press the SHIFT key followed by the SEARCH TC key to initialize the search function
- Set the recorder in either of the two PLAYBACK modes.

The tape will now run and a beep signal will be heard when the selected value is
read from the tape.

SEARCHING FOR A TIME CODE ORIGINATING FROM AN EXTERNAL SOURCE

- Press the NUM key and enter the value of the time code to be sought.
- Press the SHIFT key followed by the SEARCH TC key to initialize the search function.
- Select SHIFT followed by EXT TC (making sure that a valid time code signal is being
. fed to the time code input, to prevent ERROR 02 being displayed.

The machine will emit a beep signal as soon as the selected value is read by the external time code reader.

2.6.1 POWER SUPPLY TO THE TIME CODE CIRCUIT

MEMORY AND CLOCK POWERING

There is a choice of two different modes of memory and internal time code clock powering.

PERMANENT	This mode will conserve the contents of the memory and keep time as long as there is sufficient power supplied to the machine. In this mode 2.8 mA are required when in the STOP position, which corresponds to a battery discharge of 1.92 % per day when using 2.5 Ah batteries.
3 DAYS BACK UP	This mode conserves the contents of the memory and keeps time for three days after the last use of the machine (assuming the power supply allows this). Three days were chosen to allow information to be guarded over a weekend (Friday evening to Monday morning).

This leads to an overall battery drain of 5.76 % for the duration of the back up period. At the end of this period the supply is cut off and the power consumption falls to 560 μA, which corresponds to a battery drain of 0.54 % per day for 2.5 Ah batteries. Despite this tiny current drain, it is recommended to remove the batteries before long periods of storage. When there are only four hours or less remaining before the power to the memory and clock is cut off, a flag can be seen on the display and this warning is accompanied by an audible beep. A second beep will be heard when the 4 hour limit is reached. However, if the machine is in the TEST mode, then the power to the memory will only be cut when the main function selector is returned to the STOP position.

The time code circuit of the IV–S TC is fitted with an extremly large capacitor of 0.22 Farads, which maintains power to the real time clock and the ram memory for a period of two minutes in the absence of batteries, thus allowing flat batteries to be replaced without loss of data. When the machine has been left for a period of time with no power at all, it is necessary to wait for approximately 30 seconds after the first power up for this capacitor to charge up. The time code will remain blank during this time. If this occurs just wait for a short time.

AUTO SELECTION

Switch (3) for internal or external supply, located on the front panel of the IV–S TC has no bearing on the time code circuit. The time code circuit automatically chooses between the internal and external supply depending on which is higher.

For all information regarding batteries and external power supply for the IV–S TC please refer to Chapter 1 of this manual.

2.7.1 TIME CODE SPECIFICATIONS

GENERAL

Tape width	6.35 mm 1/4"
Audio track width	2 X 2.00 mm
Time code recording level	700 nWb/m pp. ±3 dB
	(250 nWb/m rms sine wave)
Rise and fall time	65 μs ±10 μs

CROSSTALK

Residual time code on 2 mm audio tracks is below −88 dB

TIME CODE PLAYBACK

Playback speed from 0.5 to 6 times nominal speed

COINCIDENCE ERROR (between audio and time code)

Max 1 time code bit (500 μs) with the EBU standard. (The tape travel time compensation is made internally by the microprocessor)

INPUTS AND OUTPUTS

Input: Unbalanced, input impedance greater than 100 kOhm
Level: Min 500 mV peak to peak, max 24 V peak to peak
Output: CMOS logic, +5 V

GENERATOR

Stability of 1 ppm from +10 to +40°C, which corresponds to an error of one frame in 9 hours operation at 30 frames per second, or 11 hours at 25 frames per second.
Maximum ±2 ppm from −10 to +60°C

POWER CONSUMPTION OF TC CIRCUIT

26 mA full operation
2.8 mA standby
560 μA Stop mode

2.8.1 APPENDIX "A" DROP FRAME

In video the time code generator is locked to the video signal. In other words, the time code and the video image advance at exactly the same rate.

For black and white television (monochrome) in America, the frame rate is 30 frames per second. On the other hand, the american colour television system does not actually use a whole number of frames per second, as the NATIONAL TELEVISION STANDARD COMMITTEE has, in fact, fixed its frame rate at 29.97 frames per second (or more exactly 29.97002617 frames per second). This means that a signal measured at 30 frames per second would have a delay of 0.03 frame each second. Thus, at the end of one hour of recording, the cumulative timing difference between a clock, and the code recorded on the tape, would be 108 frames or 3.6 seconds.

In order to restore the time code reading and make it correspond to real time, the television industry has developed the DROP FRAME compensation system.

The problem is to find a way to lose 108 frames per hour and the solution adopted by the NTSC was not to count the first two frames (00 and 01) at the start of each new minute. If the calculation is now made, 120 frames would be lost each minute. However, this is twelve frames too many that have been ommited during one hour's recording. In order to recover these twelve frames it was decided to count the first two frames every tenth minute.

To summarize this, when using the DROP FRAME mode, the NTSC system eliminates the counting of two frames each minute, except in minutes 00, 10, 20, 30, 40 and 50.

Passage of minutes hh.mm.ss.ff	Passage of tenth minute hh.mm.ss.ff
12.45.59.28	12.49.59.28
12.45.59.29	12.49.59.29
12.46.00.02	12.50.00.00
12.46.00.03	12.50.00.01
12.46.00.04	12.50.00.02

This mode thus permits the recording of time code that advances at the same rate as the clock. All calculations of the duration based upon the compensated code will be corrected except for the fact that the standard is not exactly 29.97 (see above) and the drop frame mode will accumulate an error of 75 ms per day.

2.9.1 APPENDIX "B" SOFTWARE EVOLUTION

The time code section of the IV–S TC is essentially a microprocessor controlled system, which performs numerous functions. Thus, the time code system is software based, which makes it a very flexible system in view of practical applications. It also allows for future modifications to the system, should future developments in the field of time code require it.

The updates of the software have been grouped wherever possible to minimize the number of software versions. It is not necessary to open the IV–S TC to inspect the version of software installed, as this can easily be done via the STATUS mode followed by the NEXT ST key four times, as explained on page 2-7.

When this is on the display, the first digit indicates the hardware compatibility, and the second digit indicates the version itself. This means that a software version 1.X can be replaced by version 1.X + 1 without (or possibly minor) modifications to the hardware. However, significant modifications may be needed on the time code circuit before version 2.X can be installed.

This section of the manual is designed to give a short description of the differences between the versions of the software.

SOFTWARE IV–S TC

VERSION 1.0
Original software containing time code reader / generator. Allows all usual time code functions.

VERSION 1.1
Installation of numerical codes 108 and 109.
Improvement of time code error correction.
Improvement of time code precision.

VERSION 1.2
Modification to prevent jamming of the internal generator, when switching rapidly between STOr and RECORD without observing a momentary pause in the TEST position.

VERSION 1.3
Increase the number of lines and hence of the amount of information in the STATUS display menu, including the introduction of the software version.
Implementation of numerical command 200

VERSION 1.4
More accurate time code generation.
Improvement of the speed and the accuracy of time code setting.

VERSION 1.5
Correction of the 1 frame offset caused when making a SET FROM EXT.

VERSION 1.6
Improvement of the INC UB when in the CALENDAR mode.
Protection of the original value when changing mode.

VERSION 1.7
Installation of the software necessary to allow use of the AATON origin "C" master clock (some hardware modifications may be necessary)

VERSION 1.8

Improvement of the DROP FRAME function, especially in conjunction with the AATON origin "C" and after a power off followed by a power on again.

Exit from SET FROM EXT mode now possible with NUM 000.

Improvement of the time code output when manually stopping the tape transport.

Installation of the AUTO SET mode (NUM 110 to enter autoset mode and NUM 111 to cancel it).

30 frames with DROP FRAME is installed in this version.

Error messages made more accurate.

VERSION 1.9

Correction of timing when using the AATON origin "C" in DROP FRAME mode when the time passes midnight.

Synchronization of time code to audio improved.

Installation of the beep function when initialization of the system is not made correctly.

After a NUM 200 or a complete initialization the last software date is displayed when in DATE mode (NUM 106) in the DISP UB mode. This must be 18/3/87 for version 1.9, 26/03 87 for version 1.91, and 27/08/87 for version 1.92.

In versions 1.91 and 1.92 only the synchronization process has been modified to avoid time code shifts of ±1 byte or ±1 frame when performing a SET FROM EXT.

In version 1.9 or 1.91 when in CALL TC mode and trying to set the frame unit digit to 5, a complete freezing of the display occurred. This has been corrected in version 1.92

In the IV-S TC the time delay between the heads is calculated using a ring memory buffer which delays the time code read from the tape so that it is synchronized to the audio. Occasionally the buffer was initialized at the wrong moment and this has now been corrected. The maximum initialization time should now be about 1 second.

In all three versions of the software when setting from the AATON origin "C" in 29.97 drop frame mode the synchronization has been made more precise. Special correction routines have been introduced in order to calculate the delta correctly.

Finally, in all three versions of the software a "beep" has been introduced and will sound each time a check fail error is displayed. It will sound each time an initialization is made and it will sound very frequently if the frame rate of the internal generator is set to something different than that of the incoming external time code. This function is displayed in PLAY and RECORD modes with version 1.91 and version 1.92 and for version 1.9 it is enabled all the time.

VERSION 1.93, 1.94, 1.95

Introduction of two new numeric commands :

NUM 202 Time code output all "0". This means that the output will be a square wave signal of 1 kHz (at 25 fps).

NUM 203 Time code output all "1". This means that the output will be a 2 kHz square wave at 25 fps. This was introduced to make measurements on the time code signal easier. To indicate that either of these modes are being used ERROR 08 or ERROR 09 are displayed respectively. Exit from these modes can be made either by putting the machine into the STOP mode or by execution of numerical command 200.

TIME CODE GENERATOR V 1.93, 1.94, 1.95

Cancelling of the mode Disable Setting (NUM 102) when executing NUM 000 (ESCAPE) no longer occurs.

V 1.95

When the machine is set to the internal generator (INT TC) and the generator is in "HOLD" mode (NUM 100), the time code will be incremented as normal upon passing into the RECORD mode. The time code will stop again when the machine is put into the TEST mode. This firstly avoids the recording of "frozen time code" on the tape at any time, and more importantly provides a new

feature. This is a form of CONTINUOUS time code on the tape. There will be "drop outs" on the tape at the points where the machine is started and stopped.

TIME CODE READER V 1.95
Correction of "frozen time code" when the machine was in the EXT TC mode and the internal generator was on "HOLD" the display showed normal running time code however the time code recorded on the tape was "frozen".

RS 232 COMMUNICATION V 1.95
If the internal generator of the IV-S TC is on "HOLD" and an attempt is made to set it from the AATON "origin C" this will act initially as a NUM 101 (start TC).
The IV-S TC will reply "IDLE" when it receives an enquiry (ENQ) after a NUM 200 (reset). A non-initialized origin C will in this case display VOID although the data link is OK, it will also display VOID when there is no data link but with a noticeable delay.

MISCELLANEOUS,V 1.95
It is now possible to switch from external time code (EXT TC) to internal time code (INT TC) even during the PLAYBACK mode. The display will display the external time code if there is one connected, if this is not the case then it will display ERROR 02. When in the internal mode, the display will show the time code read from the tape.
If a SET FROM EXTERNAL is attempted and no external time code is connected then the ERROR 02 will be displayed instead of frozen time code as before. To exit this mode it necessary to select INT TC.

V 1.96
The "START TC" command (NUM 101) did not work properly with V 1.95 if user bits were not set at 00000000. This has been corrected on V. 1.96.

"BEEP ON LOUDSPEAKER" mode is reset to "BEEP OFF" at every power-up (V 1.97 modifies that behaviour again).

V 1.97
When in "HOLD" mode the tc generator was restarted upon pressing "ENTER" making it revert to the "RUN" mode. This has been suppressed and now the generator stays in "HOLD" mode.

"BEEP ON" mode is not reset any more to "BEEP OFF" mode each time the IV-S goes in "STOP". The default mode after a power-up or after a NUM 200 function (reset to default) is "BEEP" mode the machine is set, the status display has been enhanced to show following characters in the "BEEP OFF" column:

I	=	Beep off
S	=	Beep on Speaker
P	=	Beep on Phones

After a NUM 200 function the default mode is "3 DAYS BACK-UP" in order to avoid any permanent current draw from the batteries thereafter. Previously the default mode was "PERMANENT MEMORY". In addition the 3 days counter is now restarted with zero each time the IV-S is put in operation (not only after an internal generator setting).

To avoid recording TC on tape during record start-up time before the tape speed is stabilized, the first 10 frames are recorded with an unrecognisable Sync Word (only 0's). This should improve resynchronization at each new tc start during ulterior transfer operations.
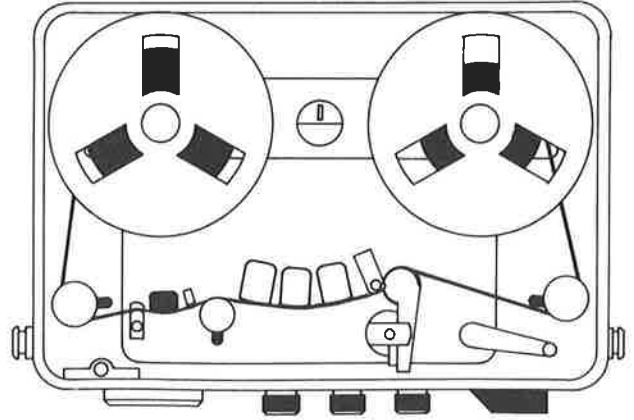
TABLE OF CONTENTS

NAGRA IV-S

CONFIGURATOR
**Modulation audio and cue
and power supply**

Modulation input

QSHZ	16400	Unbalanced high impedance external amplifier
QCSE	16900	Line input cable
QSEF	16425	External preamplifier with balanced input
QSNES	16525	Accessory with balanced inputs and outputs for insertion of noise reducing system
QSQC	16500	Parallel connection unit for 2 to 4 NAGRA IV-S
QCQC	16509	Additional cable for connecting a 3rd or 4th NAGRA to the QSQC
QSCM-2	16025	Commentary microphone with ALC
QSSC	16475	Synchronizer for slide projector
QSSF	16450	Amplifier with balanced outputs
QCSS	16901	Line output cable with banana plugs
QCSSC	16902	Line output cable with CINCH plugs
QCSSD	16903	Line output cable with DIN plug
QCSR	16905	Cable to transfer sound from one IV-S to another

Power supply

ATN-3	14375	Mains power supply
ATN-3C	14376	Mains power supply and charger
QCAS	98001	Mains cable with swiss plug
QCAW	98003	Mains cable without mains plug
PPD	14150	Multiple connection box
PA-2.5	98251	Set of fifteen 2.5 Ah rechargeable cells with extension
PA-4	98254	Set of twelve 4 Ah rechargeable cells

NAGRA

CH-1033 Cheseaux / Lausanne

NAGRA IV.S
Configurator
modulation audio and CUE
and power supply

14375 ATN-3

14376 ATN-3C

or

98oo1 QCAS

98oo3 QCAW

or

1415o PPD

QSV2

or

POWER PACK

98254 PA-4

98251 PA-2.5

or

internal circuits

INPUTS   **EXT. NRS**   **channel 1**   **channel 2**   **CUE**   **OUTPUTS**

or   or   or   or

164oo QSHZ

16425 QSEF

16525 QSNES

16475 QSSC

16o25 QSCM-2

1645o QSSF

169oo QCSE

165oo QSQC

1656o9 QCQC

1656o9 QCQC

169o5 QCSR

169o1 QCSS

169o2 QCSSC

169o3 QCSSD

or

Microphones

Dynamic

Cond.+ T

Cond. phant.

Ribbon

or   or

3-3
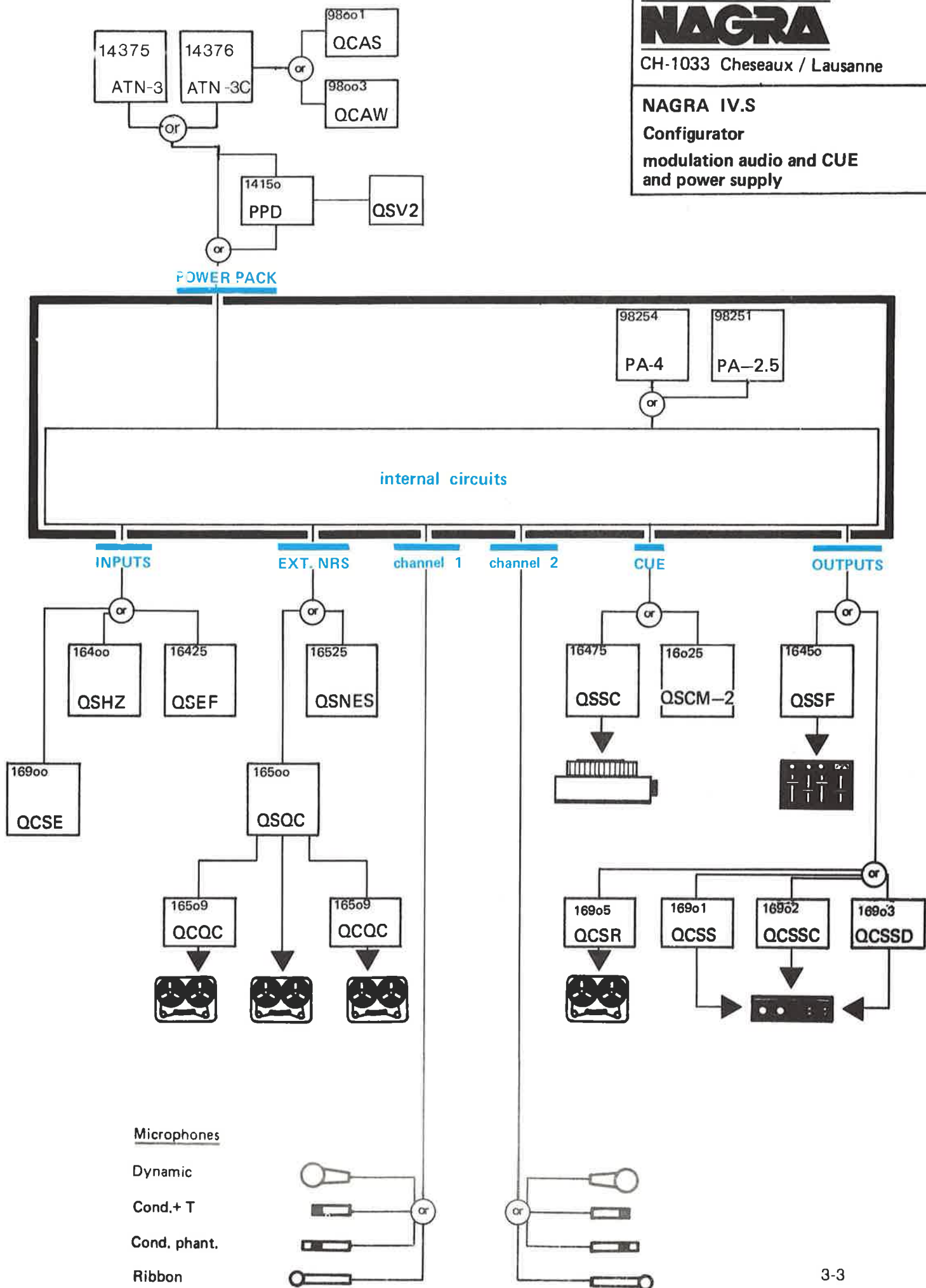
NAGRA IV-S

CONFIGURATOR
Synchronization and accessories
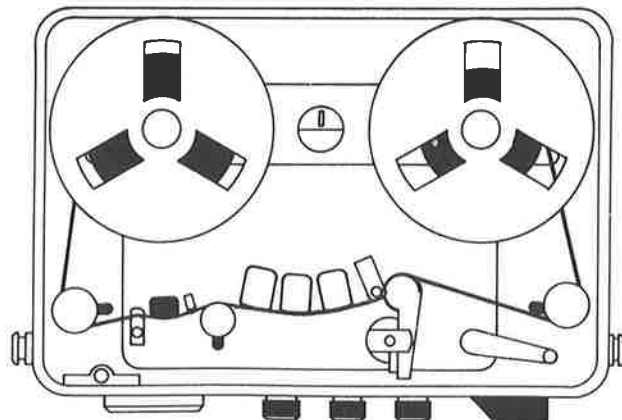
External electro–accessories

QCA	14102	Start–stop cable for remote control
QGB	14001	$10\frac{1}{2}$" (267 mm) reel adapter
TPBC	18907	Cine–type reel holder
QGBN	14006	NAB–type hub holder
QGBA	14007	AEG–type hub holder
DSM	14700	Field monitor and amplifier
IACC	17910	Rechargeable cells unit for DSM monitor
MAG–220	90801	Electronically–controlled degausser 220–240 V
MAG–110	90802	Electronically–controlled degausser 110–117 V

Mechanical accessories

QRAC	06260	Tape cleaning blade
QLEN	14655	Tape driven counter graduated in feet
QTIM	14650	Tape driven timer
QSET–2	14130	Lid for 7" (178 mm) reels

Carrying cases

QTS	99027	Standard carrying case with pocket
QTS–C	99225	Special QTS top half for QSET–2 lid
QHC–2	14127	Spare carrying strap
QHP	14120	Carrying handle
QHCP–2	14123	Special strap for carrying a recorder equipped with a QHP handle

Headphones

DT48ST	96241	Beyer DT 48–ST stereo–headphones

Internal electro–accessories

QFMS50	06780	Frequency meter for 50 Hz pilot signal
QFMS60	06781	Frequency meter for 60 Hz pilot signal
QSGX–3	06697	Switchable crystal pilot generator 50–60 Hz

Synchronization

QCLS	16300	Adapter for connecting an SLO to a NAGRA IV–S
SLO	13400	Automatic synchronizer with cathode ray tube for visual check
SLQ–3	13429	Crystal pilot generator for SLO
QSV–2	14600	Manual speed variator
QSLS	16350	Synchronizer for NAGRA IV–S

Camera cables

QCE	14107	For connecting a NAGRA IV–S to an Eclair NPR camera
QCX	14108	For connecting a NAGRA IV–S to an Arri ST/BL or a Bolex 16 RPO camera

1412o
QHP

14127
QHC-2

14123
QHCP-2

96241
DT48ST

14oo6
QGBN

14oo7
QGBA

189o7
TPBC

14oo1
QGB

98oo3
QCAW

98oo1
QCAS

99027
QTS

99225
QTS-C

9o8o1-2
MAG

141o2
QCA

1791o
IACC

147oo
DSM

1413o
QSET

1465o
QTIM

14655
QLEN

o626o
QRAC

mechanical accessories

external electro accessories

internal electro accessories

o6697
QSGX—3

o678o-1
QFMS

141o7
QCE

141o8
QCX

Eclair
NPR

Arri
ST/BL
Bolex
16PRO

146oo
QSV-2

1635o
QSLS

163oo
QCLS

134oo
SLO

13429
SLQ-3

synchronization

KEY

Electro connections —

Mechanical connections ▷

Operating requisites ▶

3-5
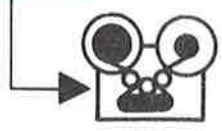
ATN-3

**MAINS POWER SUPPLY
14375**

ATN-3

ATN-3C

**MAINS POWER SUPPLY
AND CHARGER
14376**

ATN-3C

ATN-3   Mains power supply for NAGRA IV–S, IV–SJ, 4.2 and E (110 to 240 V, 50 or 60Hz). Also supplies a mains frequency pilot signal of 1 V RMS.

SPECIFICATIONS

Output voltage , unloaded	35 V
Nominal output voltage	27 V
Nominal output current	0.5 A
Maximum current	1 A

Meets the following safety requirements: UL 1012, IEC 65 (= VDE 860)

Supplied with a mains cable

Dimensions	153 x 82 x 46 mm (6 x 3 3/4 x 1 3/4 ")
Weight	880 g (2 lbs)

ATN-3C   Same specifications as above but including a 2–position charger for 2.5 Ah and 4 Ah cells, and a timer automatically switching to trickle charge after 14 hours.

Can be used to power a NAGRA while simultaneously charging its accumulators.

Note: In order to activate the charger function of the ATN–3C, always place the small charger slide–switch to the "OFF" position and then to charge, after having connected the ATN–3C to the mains and switched it on.

MAG

ELECTRONICALLY CONTROLLED DEGAUSSER
90801 (220–240 V)
90802 (110–117 V)

Operating instructions

It is advisable to switch off the recorder completely to prevent damage caused by the voltage induced in the heads to the amplifiers.

Preparation

After removing its cover plate, mains powering the MAG and switching it "ON" place the coil on the heads or on the parts which are to be demagnetized.

Operation

The demagnetization switch being in the "OFF" position, throw it to "ON": the indicator lights up and slowly goes out. When the light is off, switch back to "OFF". Repeat the operation three or four times to ensure a thorough demagnetization.
The MAG is an electronically controlled degausser for recorder heads and mechanical parts which are in continuous contact with the tape.

There are two versions:

MAG 90801 220 – 240 Volts mains
MAG 90802 110 – 117 Volts mains

SPECIFICATIONS

Mains supply	220 to 240 V
	or 110 to 117 V
No load power consumption	10 mA
max. power consumption:	
peak current	300 mA
Max. field strength	270 gauss
Field strength after 100 ms	135 gauss
FST fuse standard	630 mA for 220 V
	1.25 A for 110 V

to magnetic coil

mains supply

ALL RESISTORS ± 5%

~	R1	R2	R3	C1	C2	C3	L1	F1	F2
110 V 117 V	100K 1W	0	33 Ω 10 W	25 μF 400V	590 μF 200V	590 μF 200V	1035 sp ⌀ 0,4 L 3,3	1.25 A	1.25A
220 V	100K 2W	68K 1W	100 Ω 10 W	25 μF 400V	290 μF 400V	290 μF 400V	2070 sp ⌀ 0,4 L 3,3	630 mA	630 mA

CIRCUIT DIAGRAM

DEMAGNETIZER MAG

3-8
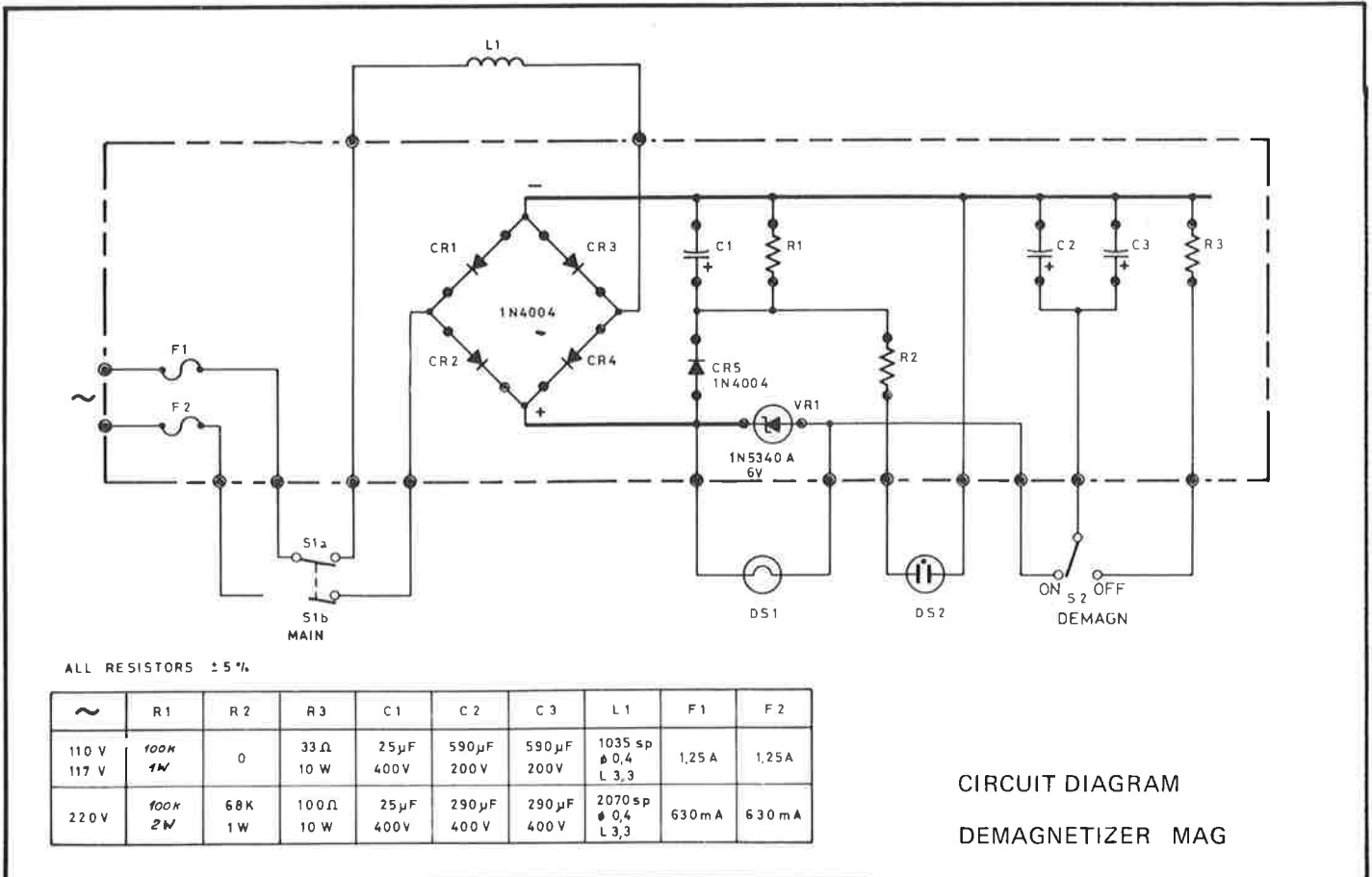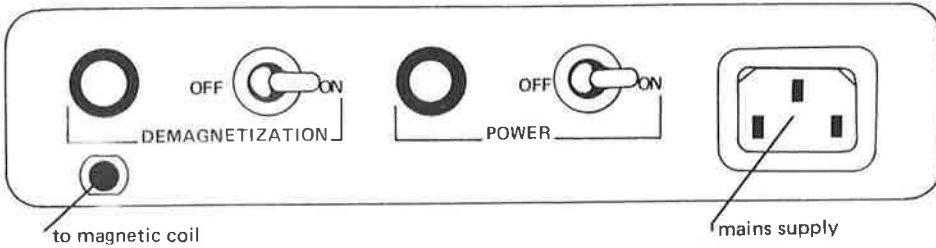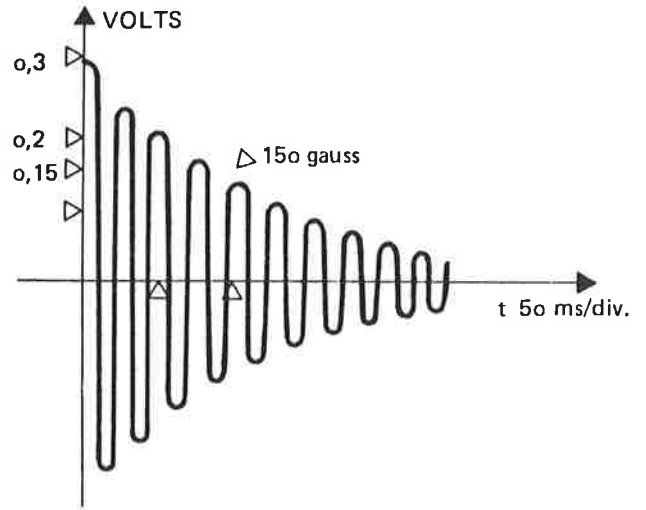
DSM MONITOR

NAGRA DSM PORTABLE BATTERY / MAINS POWERED MONITOR / LOUDSPEAKER
14700
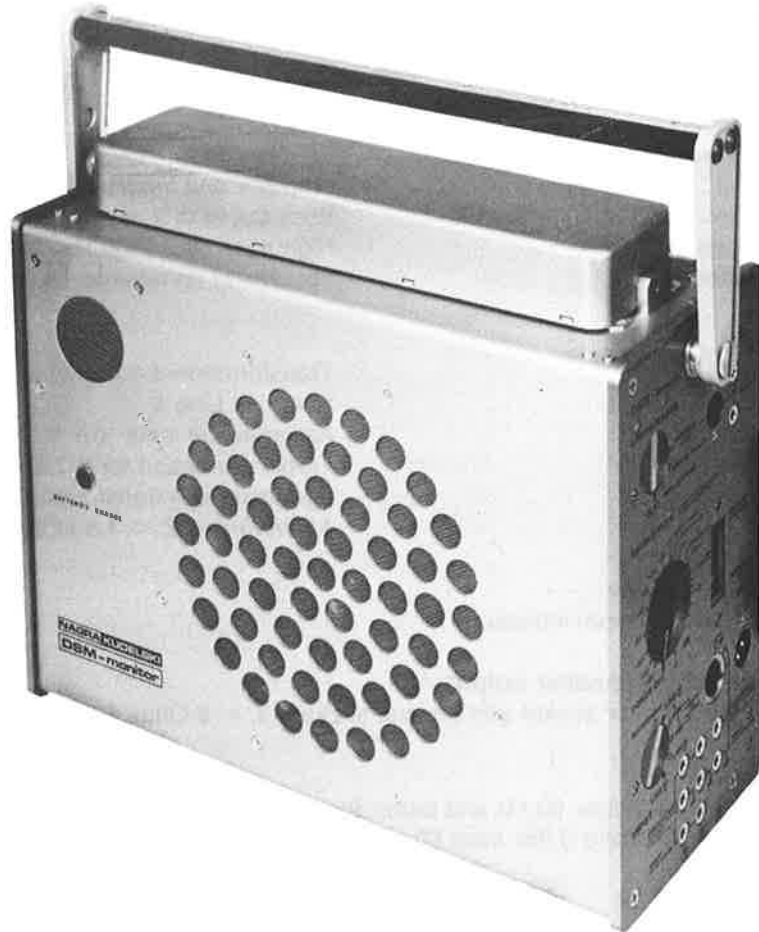
Applications

High quality sound reproduction for mobile installations, playback filming, independent powering using rechargeable nickel–cadmium batteries. Thanks to its dynamic microphone input the DSM can also be used as a public address speaker.

SPECIFICATIONS

Powering
–   Mains powering 110 or 220 V ±20%, 48 to 440 Hz, or +11 to +30 V, with built–in short – circuit protection.

Consumption
–   20 mA (without input signal)
–   240 mA max signal output
–   Nickel–cadmium rechargeable battery pack IACC 12 V 1.8 Ah ensuring approximately 9 hours of operation at average level
–   The IACC can be recharged by the DSM.

Amplifier

Sine power 7 W powered by fully loaded rechargeable cells.

Sine power 15 W min: when powered by external power supply.

| **Frequency range** | 60 Hz – 15 Hz ± 4 dB |
| External loudspeaker output | 60 Hz – 20 kHz ± 0 dB, –3 dB |

Loudspeakers
- The DSM is equipped with 2 speakers, the crossover frequency being 2.2 kHz
- Low frequency resonance correction for built-in woofer giving an extremely flat response curve
- Very efficient speakers ensuring low battery drain
- The amplifier can drive an external speaker

FUNCTIONS

Loudspeaker
– Flat	Amplifier and loudspeaker
– Max. loudness	Bass cut to prolong battery life
– Speech	High pass filter (300 Hz) for better voice rendering
– External flat	For driving an external loudspeaker

Inputs
– Line1	Transformerless symmetrical input 0.4 V, Z = 47 kOhm
– Line 2	Same as Line 1
– Line 3	Assymetrical input 0.1 V, Z = 27 kOhm
– SNN	Treble correction for 1 7/8 ips
– MICRO	Dynamic mike transformerless symmetrical input 1.6 mV/min.; Z = 1.5 kOhm

Voltage reserve
- Battery reserve indicator

External loudspeaker output
- Loudspeaker socket and banana sockets Z = 8 Ohm, P = 20 W max.

Distortion
- Max. 3% below 80 Hz and better than 1% for frequencies above 80 Hz
- Amplifier alone 0.3% from 60 Hz to 16 kHz

Housing
Manufactured from semihard aluminium, the rear of the housing is reinforced to avoid vibrations. The housing is splashproof.

| Dimensions | 320 x 130 x 240 (12 5/8 x 5 1/8 x 9 3/8") |
| Weight | 6.3 kg (13 lb 14 oz) without batteries |

QGB
10 1/2" REEL ADAPTER
14001
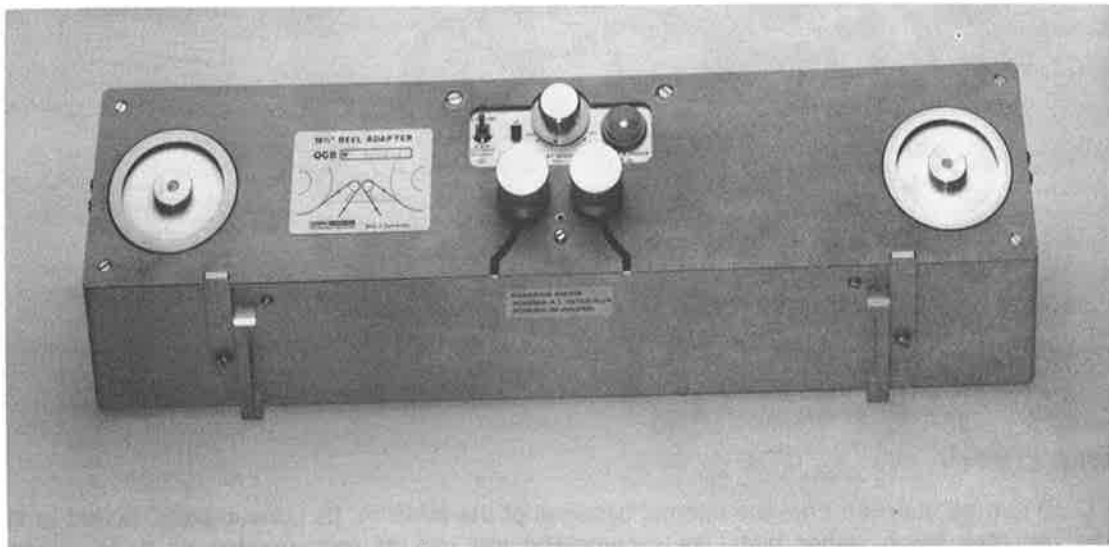
DESCRIPTION

The QGB adapter is an accessory developed for NAGRA self–contained monophonic, stereophonic and instrumentation recorders model E, 4.2, IV–S and IV–SJ. It permits the use of 10½" (267 mm) reels with cine-type reel holder and flanges with NAB or AEG–type hubs, which can hold 2400 ft (730 m) of 2 mil (50 µ) tape giving about 1 hour of recording. This very sophisticated unit is fully automatic. The QGB ensuring a stable tape speed and very fast forward and rewind functions, smaller reels can also be used with advantage. The reel supports accept interchangeable adapters fitting all existing types of hubs. These are coupled to the servo–motors controlled by the tensiometers, maintaining the tape tension within very narrow limits.

POWER SUPPLY

The QGB can be supplied from the internal batteries of the NAGRA. Its consumption, added to that of the recorder being rather high, we recommend the use of rechargeable or large capacity batteries (alkaline or manganese cells). The NAGRA–QGB system can also be powered by an ATN–3 mains power supply (or equivalent) which connects to the "power" socket of the QGB. In order to avoid unnecessary battery drain, the QGB is equipped with an Automatic Stand–By switch. In OFF position the QGB is continually operative, whether the tape is transported or not. This is the position normally used with the holding brakes locked, whenever the tape stops. Power consumption is then very low. The action of the holding brakes at the time of each start and stop of the tape produces a light click. In case this click is disturbing, the OFF position should be used, despite the increased consumption.

SPECIFICATIONS (Typical values)

Dimensions   435 x 96 x 110 mm (17 1/8 x 3 7/8 x 4 3/8")
Operating temperature   0 – 70°C (32 – 158°F)
Weight   3 kg (6 lbs)
Rewinding time:

(ATN–3, 26.5 cm (10 $\frac{1}{2}$") reels 730 m (2400')	
Full reel	2 min
Half reel	1 min

Power supplied by fully charged cells in NAGRA: rewinding times multiplied by 2.5

Power consumption

Normal transport	220 mA
Fast winding	300 mA
Stand–by	5 mA
Stop (without tape)	1 mA

Power reserve with rechargeable cells installed in NAGRA.
Recording and rewinding

4 Ah cells	8 h
2.5 Ah cells	5 h

QSIP
RESOLVER INTERFACE
16550
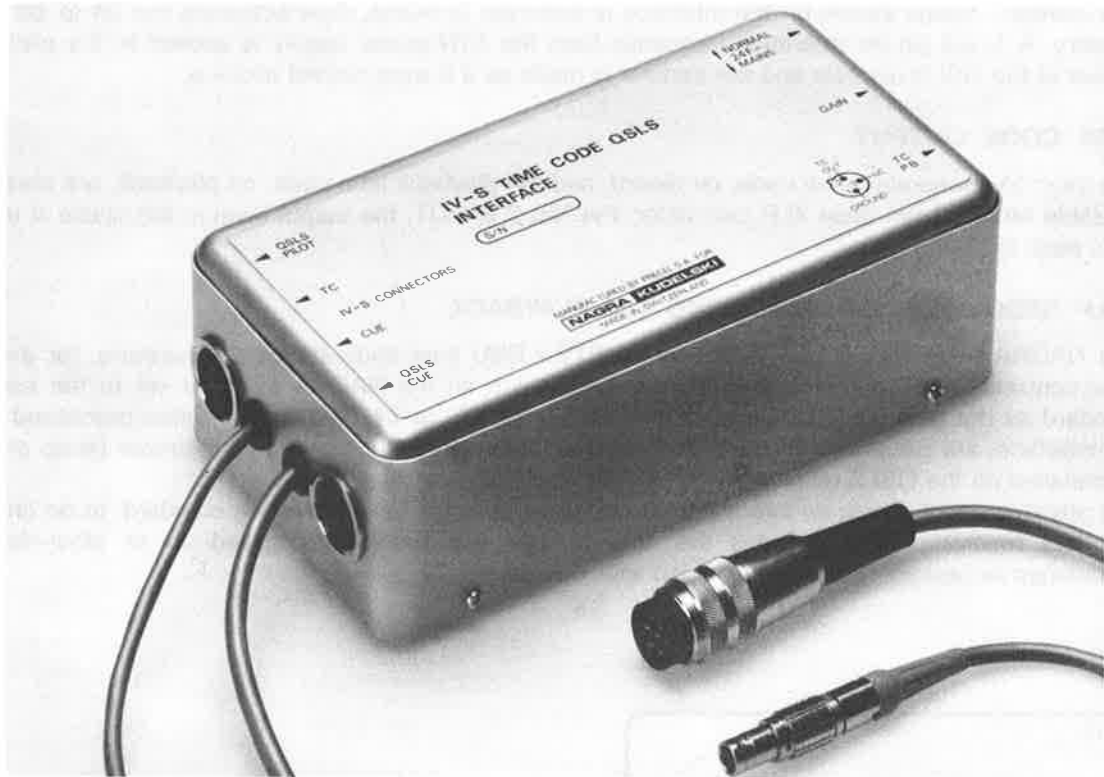
The QSIP resolver interface is an operationally transparent box which is installed between the NAGRA IV–S TC and the QSLS resolver.

FUNCTIONS

– to process the played–back SMPTE time code and internal clock outputs into signals which the QSLS resolver can read as normal pilot

– to provide a 24 frame time code to 60 Hz conversion for resolving time code tracks to mag film in normal pilotone fashion

– to provide a buffered, variable level output of either recorded or played–back time code on a standard 3–pin XLR connector.

ATTACHMENT

The interface is attached by plugging the LEMO connector into the mating time code connector on the NAGRA IV–S TC and connecting the TUCHEL 3–pin connector to the cue socket of the NAGRA. The pilot and cue connectors on the QSLS are plugged into their respective receptacles on the interface.

OPERATION

The only operating controls are the screwdriver–adjustable gain control for the time code output level, and the toggle switch to select normal operation (or 24 fps to 60 Hz conversion).

RESOLVING TO AN EXTERNAL TIME CODE

The external reference time code will have to be reduced to its field rate before being suitable as a resolving standard. Most time code generators can provide this. The field rate is twice the frame rate, therefore 24 becomes 48, 25 becomes 50, 30 becomes 60 and 29.97 becomes 59.94. The field rate signal is applied to the external pilot input connector on the QSLS resolver.

RESOLVING 24 fps TIME CODE FOR SYNC TRANSFER TO MAG FILM

The Normal / Mains switch on the interface is switched to mains, thus activating the 24 to 60 Hz circuitry. A 1-volt 60 Hz reference frequency from the ATN power supply is applied to the pilot-in socket of the QSLS resolver and the transfer is made as if it were normal pilotone.

TIME CODE OUTPUT

The internally generated time code, on record, and the playback time code, on playback, are always available on the 3-pin male XLR connector. Pin No. 2 is HOT, the output level is adjustable 0 to 2 volts peak to peak.

SELF RESOLVING, OR RESOLVING ON PLAYBACK

The NAGRA IV-S TC will play back any SMPTE / EBU time code standard. Therefore, for exact synchronization the internal time code standard switch on the NAGRA must be set to the same standard as the tape, i.e. 29.97 drop frame, 29.97, 30, 25, or 24. The signals, once processed by the interface, are passed on to the QSLS resolver. It is necessary that the pilot jumper (strap plug) be installed on the QSLS resolver.

It is possible, by choosing an internal clock rate other than the tape time code standard, to do cross standard resolving. This provides the very precise and predictable speed-up or slow-down sometimes necessary when matching film with videotape.

FREQUENCY RELATIONSHIP TIME CODE/PILOT

NQS-TC TIME CODE GENERATOR	NQS-TC SYNC.REF OUTPUT	QSIP REF OUTPUT	NQS-TC OFF-TAPE TIME CODE	QSIP PILOT OUTPUT	QSIP SWITCH POSITION
24 FPS	61.44 kHz.	48 Hz	24 FPS.	48 Hz.	normal
			24	60	24/60
25	64	50	25	50	normal
30	76.8	60	30	60	normal
29.97002617	76.723267	59.94005234	29.97002617	59.94005234	normal

3-14

QSCM-2
COMMENTARY MICROPHONE WITH ALC
16025

Hand microphone for recording a commentary on the pilot track of the NAGRA IV-S and IV-SJ tape recorders.

Features

Capacitor microphone system: intelligibility of the message is heightened. Sintered bronze acoustic screen effectively protecting the diaphragm. Built-in preamplifier.
Automatic level control: optimum modulation without manual adjustment.
Filters determining a bandwidth adapted to speech reproduction.
Operation by push-button.

The NAGRA IV-S and IV-SJ tape recorders may be fitted with a third track for the recording and playback of a pilot signal which will permit subsequent synchronization. In addition to the pilot signal, or in its place, the third track can receiv a commentary for identifying the sequences recorded, or giving instructions for editing.
The QSCM microphone is connected to the cue socket of the tape recorder. A commentary can be recorded at two different stages:
- during the recording of the modulation tracks, with or without simultaneous pilot signal, all previous information being erased on the three tracks;
- during the playback of the modulation tracks, with partial erasure of the signals previously recorded on the pilot track.

The microphone system is mounted on the housing which contains the preamplifier and the automatic level control; the latter ensures a practically constant output voltage when the input level varies from −20 to + 10 dB with respect to the nominal sensitivity. A high–pass filter cuts the frequencies below 250 Hz to avoid any influence on the pilot signal in case of simultaneous recording. In spite of the relatively low carrier used for the FM recording, the upper limit of the bandwidth allows excellent speech reproduction. The push–button connects the output of the preamplifier and switches on the FM modulator of the third track.

SPECIFICATIONS

Normal output voltage with automatic level control 700 mV, gives a frequency deviation of ±20%

Operating range of the automatic level control from 3 to 100 μbar

Stabilized supply voltage	−10 V
Consumption	2.5 mA
Dimensions	120 x 40 x 28 mm (4 3/4 x 1 5/8 x 1 1/8")
cable length	140 cm (4'8")
Weight with cable and plug	200 g (7 oz)

QSEF

EXTERNAL PREAMPLIFIER WITH BALANCED INPUT
16425

Description

When fitted to the 7–pole Tuchel input connector of the NAGRA IV–S, this accessory makes it possible to obtain two balanced line inputs insulated from the ground. The QSEF prevents parasitic voltages due to the leakage current flowing between the grounds of the various accessories connected to the NAGRA from being added to the signal.

The QSEF provides two high impedance transformer inputs which are ideal for use with professional signal sources with an internal impedance of not more than 600 Ohm and which produce voltages of less than 8.8 V RMS. With a high impedance source, but not exceeding 10 kOhm, the maximum admissible voltage is 2 V RMS. The QSEF if fed by the NAGRA.

Use

Each input has two active leads and one ground available on a 5–pin Tuchel connector. When the signal source has a symmetrical output, the two output leads should be connected to the two active leads of the QSEF; the third lead being the common ground .

When the signal source is asymmetrical, the output lead is connected to one of the active leads and the output ground to the other; the general ground is connected to the third lead. In practice, these two grounds are often identical.

The signals at the recorder input are in phase with the signals applied to the "Hi" input leads. The phase can therefore be inverted by crossing the "Hi" and "Lo" leads.

SPECIFICATIONS

Measurements taken a 600 Ohm source impedance.

Power supply	−10 V from the recorder
Power consumption	6 mA

Input voltage for 0 dB on the recorder modulometer from 50 Hz to 20 kHz:

minimum 160 mV Maximum 8.8 V	on STEREO
Minimum 80 mV Maximum 8.8 V	on STEREO HS

Frequency response	30 Hz to 20 kHz ±0.5 dB
Distortion at 1 kHz and maximum level	≤ 0.1%
Signal–to–noise ratio, ASA A weighted	≥ 75 dB
Crosstalk at 10 kHz	> 60 dB
Common mode rejection	> 55 dB at 10 kHz
Input impedance	600 Ohm (maximum 10 kOhm)
Dimensions	7.5 x 4.5 x 2.5 cm (2 x 1 3/4 x 1")
Weight	200 g (7 oz)

QSGX-3

## SWITCHABLE CRYSTAL PILOT GENERATOR 50 - 60 HZ
06697
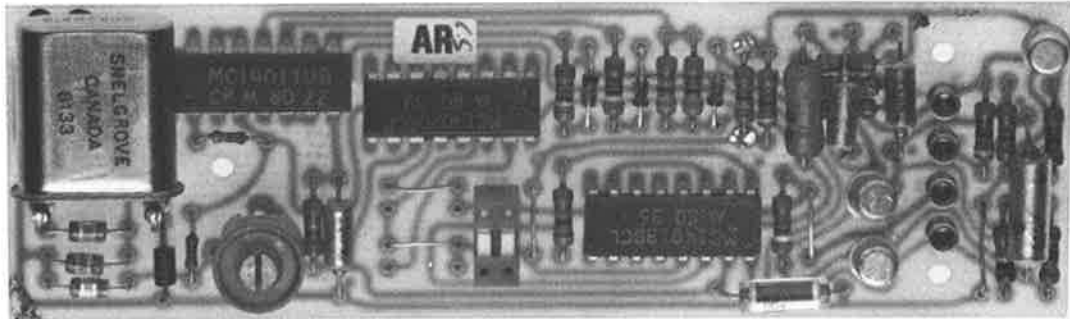
The crystal pilot generator fitted in the NAGRA provides a 50 or 60 Hz sinusoidal syncronization signal. This signal, recorded on the pilot track, allows filming with synchronous sound without cable between the recorder and the camera, the motor of which must be crystal controlled.

SPECIFICATIONS (Typical values)

Pilot signal frequency (switchable)	50 or 60 Hz
Output voltage	1 V RMS ± 10 Ohm
Output impedance approximately	150 Ohm
Total harmonic distortion	≤ 2 %
Power supply	- 10 V
Power consumption approximately	4 mA
	(≤ 8 mA)
Crystal fundamental frequency	307.200 Hz
Frequency precision	$\pm 1.10^{-6}$

Thermal drift:
Between + 10 and + 30°C:
   Thermal coefficient ± 5 ppm corresponding
   to a maximum of 1 frame in more than
   2 hours of filming at 24 frames/sec.

Between – 25 and + 70°C:
   Thermal coeficient ± 80 ppm corresponding
   to a maximum of 1 frame in 10 minutes
   at 24 frames/sec.

Dimensions	134 x 50 x 15 mm (4 1/2 x 2 5/8")
Weight	0.025 kg (4 1/2 oz)

QSIA

AATON INTERFACE
06570
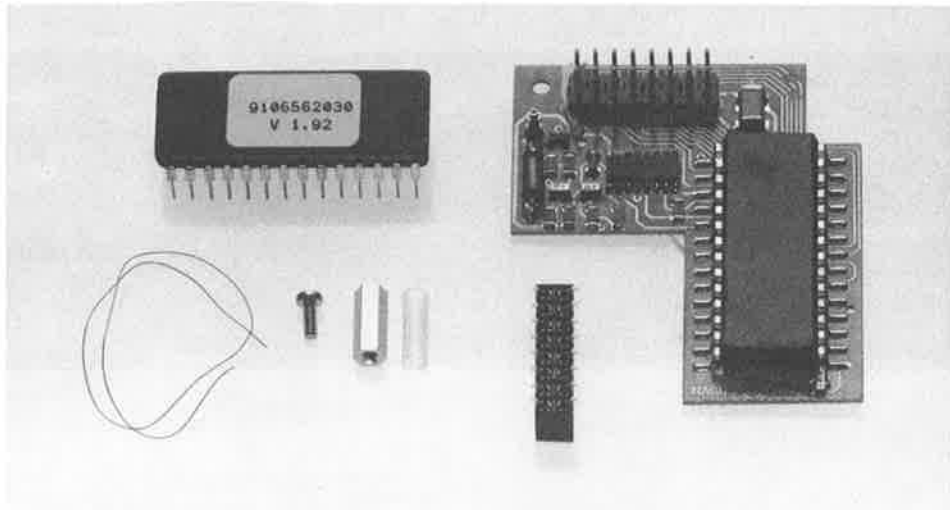
The QSIA is an RS 232 ASCII interface for the IV–S TC. It consists of a small "piggy–back" circuit to be installed internally on the time code circuit. Fitting instructions are included with the option. The machine must be fitted with the software version of at least 1.7 in order for the option to function. (This can be seen by looking at the last line of the STATUS menu on the keyboard).

The QSIA allows communication between AATON time code cameras and the ORIGIN C AATON master time code clock. With this option the internal clock of the IV–S TC can be set from the ORIGIN C and vice versa. The internal generator of the NAGRA must however be in the DATE UB (numerical command 106) mode as the ORIGIN C does not accept FREE UB.

QSHZ

UNBALANCED HIGH IMPEDANCE EXTERNAL AMPLIFIER
16400

Description

When connected to the 7–pole input connector of the NAGRA IV–S, this accessory makes it possible to transform the current inputs of the recorder into very high impedance voltage inputs.

Use

The use of the QSHZ is recommended when the signal source cannot be loaded with a low impedance, as with most high–fidelity installations, or when a low amplitude signal is supplied.
The QSHZ is powered by the NAGRA.

**Warning:**   The source load impedance decreases when the recorder is on STOP.

If the input signal has a high impedance, the cable connecting it to the QSHZ should be short to avoid attenuation of the high frequencies; this may involve extending the cable between the QSHZ and the recorder. The QSHZ high impedance input is a one 6–pole Tuchel connector.

SPECIFICATIONS (Typical values)

Supply voltage —10 V from the recorder

Power comsumption 3.3 mA

Input voltage for 0 dB level on the recorder

on STEREO   : 20 mV to 2 V
on STEREO HS : 10 mV to 2 V

Input impedance 80 MOhm/25 pF

Frequency response from 30 Hz to 20 kHz ±1 dB

Maximum input voltage 2.4 V (use input dividers if higher)

Signal–to–noise ratio, ASA A weighted > 70 dB

Crosstalk > 60 dB at 10 kHz

Source impedance ≤ 100 kOhm

Dimensions 77 x 47 x 25 mm (3 x 1 7/8 x 1")

Weight 230 g (8 oz)

QSLS

PILOT SYNCHRONIZER FOR NAGRA IV-S
16350
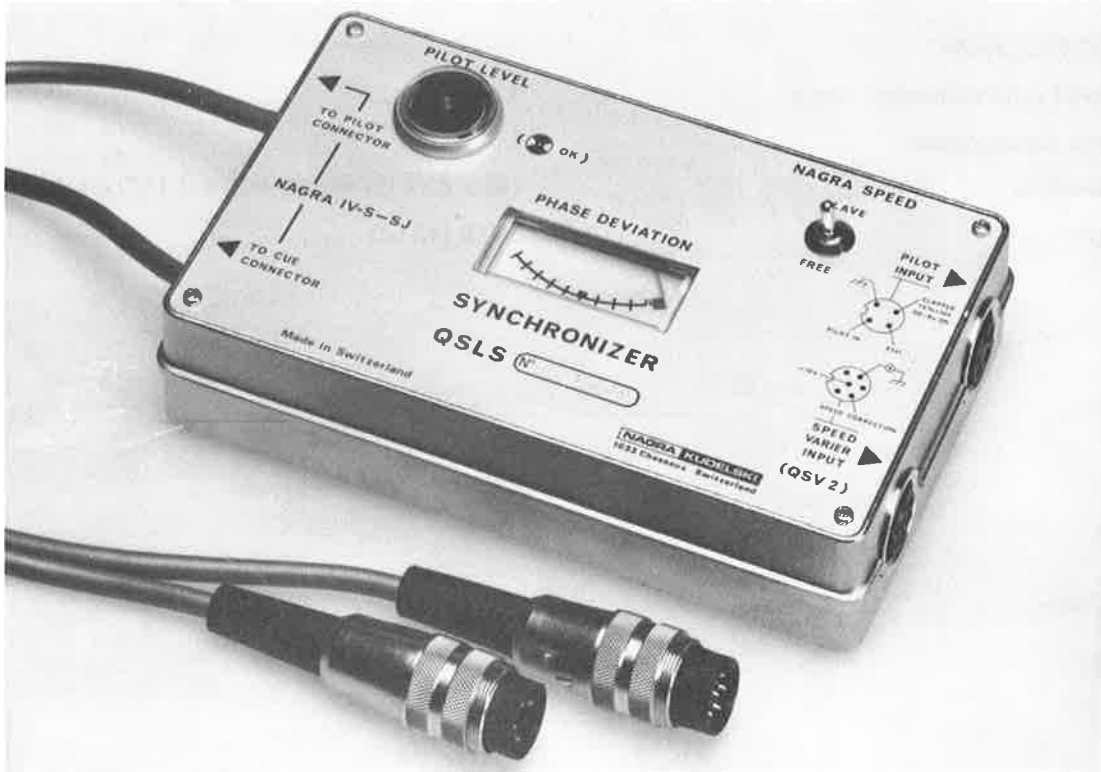
External synchronizer. It varies the tape speed of the NAGRA to resolve the playback pilot signal to a pilot reference signal.
The QSLS can be connected to the PILOT & CUE inputs on the right-hand side of the NAGRA IV-S or IV-SJ.

The synchronization signal must be applied to the PILOT INPUT connector which also carries the reference signal from the internal crystal pilot generator of the NAGRA; this signal can be used for synchronization. This offers the possibility of playing back the signal at the speed at which it was recorded, with about 0.001% accuracy.

The QSV2 speed varier can be connected to the SPEED VARIER INPUT when it is necessary to extend the synchronization range (± 12%).
The meter gives two readings:

- if the NAGRA SPEED switch is in FREE, i.e. not slaving, it indicates the frequency error between the playback pilot frequency and that of the synchronization signal. One complete oscillation of the needle left / right / left, in two seconds, indicates a speed difference of 1%.
- if the same switch is set on SLAVE, the synchronizer adjusts the tape speed, slaving the playback pilot signal to the reference signal. The meter needle then shows the phase difference between the two signals and should not oscillate.

If the desired speed correction is beyond the slaving capability of the device (± 3%), the meter needle begins to oscillate; use of the QSV-2 speed varier will extend the slaving range by ± 12%.
The PILOT LEVEL indicator becomes black if there is no pilot signal or if it is not sufficient for good synchronization.

Applications

- Filming on playback
- Transfer of sound recorded on a NAGRA to a film or perforated (Mag Stripe) tape
- Correlation of signals recorded on several recorders
- Synchronous measuments etc.

SPECIFICATION

Nominal synchronization range	± 3%
corrent consumption	8.8 mA
Dimensions	140 x 82 x 30 mm (5 1/2" x 3 1/4" x 1 1/4")
Weight	360 g (13 oz)

QSNES

ACCESSORY WITH BALANCED INPUTS AND OUTPUTS FOR INSERTION OF A NOISE REDUCTION SYSTEM
16525

With this external accessory a noise reduction system, a compressor or any other external accessory can be inserted into the recording chain of a NAGRA IV-S.

Description

The QSNES provides two balanced inputs and two balanced outputs by means of amplifiers with transformer: the inputs and outputs are available on 5-pole Tuchel connectors. This accessory connects to the EXT. NRS connector of the recorder.

Use

When the QSNES is connected and the NORMAL / NRS switch of the recorder is on NRS, the signal entering the recording chain is diverted into the QSNES through the EXT. NRS connector. After treatment by the accessory connected to the QSNES, it re-enters the recording chain of the recorder.

The nominal input voltage of each channel can be switched separately to 0.775 V, 1.55 V, 3.1 V or 4.4 V. The phase of each of the balanced outputs can be inverted.

SPECIFICATIONS (Typical values)

Frequency response	from 50 Hz to 20 kHz ± 0.5 dB
Distortion at nominal level	< 0.2%
Signal-to-noise ratio, ASA A weighted	> 90 dB
Crosstalk at 10 kHz	> 70 dB

Balanced inputs:

Input level to obtain the nominal input
level (0 dB = 560 mV) on the recorder   0.775 V, 1.55 V, 3.1 V, 4.4 V

Maximum input level on 4.4 V   + 7 dB
in the other position   + 10 dB

Input impedance   > 600 kOhm

Balanced outputs:

Nominal output level for 0 dB = 560 mV
 on the recorder   1.55 V without load

Minimum load impedance   400 Ohm

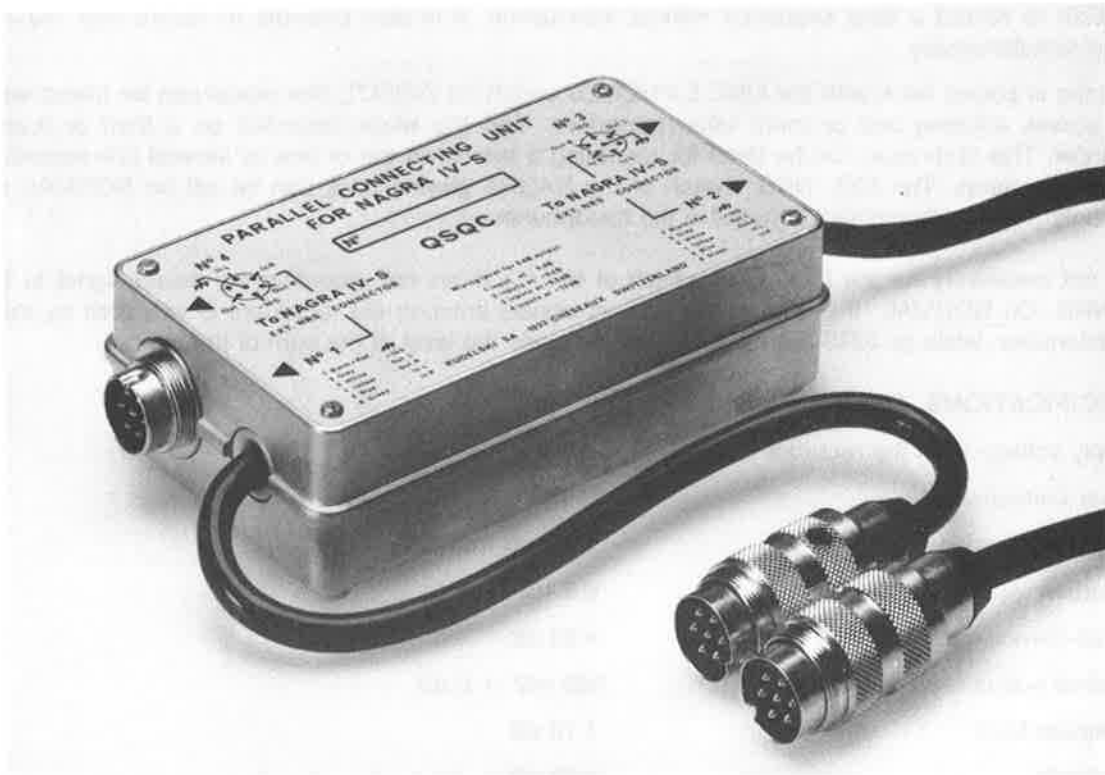Maximum output level   + 8 dB = 3.9 V

Dimensions   15 x 8.5 x 3.5 cm (5 x 3 3/8 x 1 3/8")

Weight   530 g (15 oz)

QSQC

EXTERNAL PARALLEL CONNECTING UNIT FOR NAGRA IV-S
16500

Description

This external accessory can be used for connecting the direct chains of two, three or four NAGRA IV-S recorders in parallel. The QSQC has two cables with Tuchel connectors which can be fitted to the EXT. NRS connectors of the two recorders to be operated in parallel. If more than two recorders are being used, a QSQC extension cable can be fitted to connectors 3 or 4 of the QSQC and the EXT. NRS connector of a third and / or fourth recorder.

The QSQC contains two amplifiers which mix the signals from all left channels and, separately, the signals from all right channels. The sum of the left channel signals is thén sent back to the left recording channel and the sum of the right channel signals to the right recording channel of each recorder.

Applications

The QSQC can be used for:
- mixing several NAGRA recorders
- making several master tapes simultaneously
- tape duplication
- re-recording
- editing for special effects
- lengthy recordings using two NAGRA recorders alternately.

Use

Set the EXT. NRS switch of each recorder to NRS; the signals at the inputs, regulated by the potentiometers of the recorders, are passed to the QSQC where they are mixed and sent to each recorder. The mixed signals can be taped on one single machine, while the other recorders are used as a mixer: in this case the main function selector of each machine should be on TEST. When the end of one tape is reached, recording can be continued on a second machine, making it possible to record a long sequence without interruption. It is also possible to record four master tapes simultaneously.

If a tape is played back with the LINE & PHONES switch on DIRECT, this signal can be mixed with the signals entering one or more other recorders and the whole recorded on a third or fourth recorder. This technique can be used for recording a soloist on top of one or several pre-recorded accompaniments. The EXT. NRS switch of the NAGRA playing back can be left on NORMAL so that only the accompaniment is heard in the headphones.

It is not necessary for the EXT. NRS switch of the machines not recording the mixed signal to be on NRS. On NORMAL the level of the various signals entering the recorders is indicated by their modulometer, while on NRS the modulometer indicates the level of the sum of the signals.

SPECIFICATIONS (Typical values)

Supply voltage from the recorder	−10 V
Power consumption	11 mA
Frequency response	± 0.5 dB from 30 Hz to 20 kHz
Distortion	≤ 0.1%
Signal–to–noise ratio, ASA A weighted	> 90 dB
Nominal output level	560 mV = 0 dB
Maximum level	+ 10 dB
Crosstalk	> 60 dB
Input level of nominal output level	with one input 560 mV with two inputs −6 dB = 280 mV with three inputs approx. −9.5 dB = 190 mV with four inputs approx. −12 dB = 140 mV
Dimensions	11 x 6 x 3 cm (4 1/4 x 2 1/4 x 1 1/8")
Weight	300 g (10 1/2 oz)
Additional equipment	QCQC cable, length 1.2 m (4 ft)

QSSC

EXTERNAL SLIDE PROJECTOR SYNCHRONIZER FOR USE WITH NAGRA IV-S AND IV-SJ RECORDERS
16475
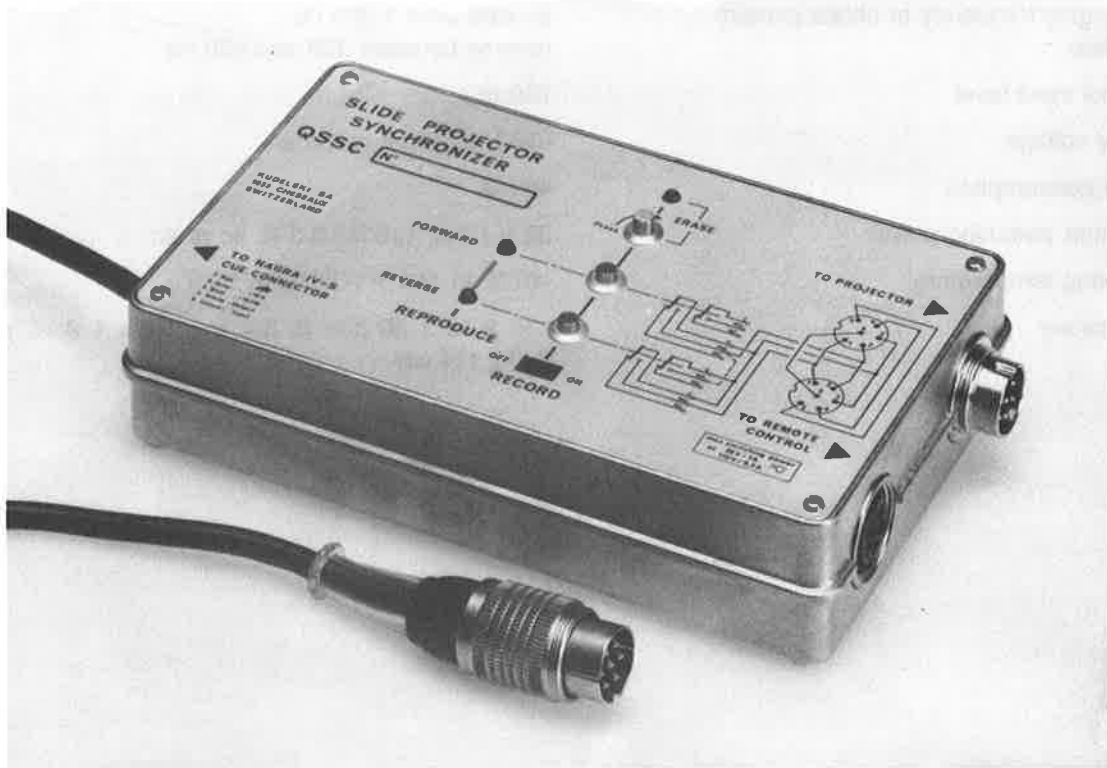
Description

This accessory can be used to record synchronization pulses on the third track of NAGRA IV-S and IV-SJ recorders: these signals can then be used to drive a slide projector or any other accessory. The QSSC is connected to the recorder by a cable with a 7-pole Tuchel plug and to a slide projector or other accessory through its 6-pole Tuchel male output connector. If the projector used has a remote control device, it is also possible to connect it to the QSSC using its 6-pole Tuchel female output connector.

Use

Synchronization pulses can be recorded at the same time as the sound, or later. To record pulses, connect the QSSC to the NAGRA and set the RECORD switch of the QSSC to ON. At desired intervals, press the FORWARD or REVERSE buttons to record the appropriate pulse signals. Pulses recorded with the FORWARD button will cause the slides to move forward, and the REVERSE button will make them move backwards. The indicator on the left of each button lights up to show the signal has been recorded. To erase pulses, press the ERASE button and turn it slightly to lock it in position. The erase function has its own indicator. When the required signals have been recorded the RECORD switch should be set to the "OFF" position to avoid any accidental pulses.

The wiring of the PROJECTOR and REMOTE CONTROL connectors is shown on the control panel to allow other switching possibilities when the QSSC is to be used with an accessory other than a slide projector, or when the slide projector remote control connector is not of standard type.

SPECIFICATIONS (Typical values)

Output signal frequency	forward 2 kHz reverse 500 Hz
Nominal output level	1 V RMS
Input signal frequency to obtain correct operation	forward from 1.350 Hz reverse between 320 and 800 Hz
Nominal input level	700 mV
Supply voltage	−10 V from the recorder
Power consumption	40 mA
Maximum switching power	30 V / 1 A, 110 V / 0.3 A, ac or dc
Operating temperature	−67°F to 158°F (−55°C to 70°C)
Dimensions	146 x 88 x 30 mm (5 3/4 x 3 1/2 x 1 3/16") 390 g (14 oz)

QSSF

EXTERNAL BALANCED OUTPUT AMPLIFIER
FOR NAGRA IV–S AND IV–SJ
16450

This accessory can be connected to the unbalanced outputs of a NAGRA IV–S or IV–SJ recorder in order to obtain balanced floating outputs (1.55 V / 600 Ohm). These outputs are available for the right and left channels on two XLR 3–pole connectors and also on banana connector sockets. A stereo jack is provided for connecting stereo headphones. The signals at the outputs marked 3 are in phase with the output signals of the recorder. The 7–pole Tuchel connector of the QSSF cable connects to the output connector of the NAGRA.

Use

If the output of the NAGRA is to be connected to a line which requires a voltage higher than the nominal voltage of the recorder, the QSSF output amplifier can be used. It prevents earth loops between the recorder and the equipment connected to its outputs. The QSSF supplies 1.55 V on a 600 Ohm load. The maximum output level of the NAGRA can exceed the nominal level by more than 4 dB, but as the saturation level of the QSSF is higher than + 8dB , it can easily withstand the level increase.

SPECIFICATIONS (Typical values)

Power supply	–10 V from the recorder
Power consumption	14 mA, no load
Output voltage,	NAGRA IV–S0 dB = 1.55 V
	NAGRA IV–SJ +20 dB = 1.55 V
Minimum load impedance	400 Ohm
Headphones output voltage at nominal level	no load, 180 mV 10 Ohm load, 80 mV
Frequency response	30 Hz to 35 kHz ± 0.5 dB
Distortion at 1 kHz for 1.55 V output level	< 0.1%
Saturation level with reference to nominal level	> +8 dB
Signal–to–noise ratio ASA A weighted	> 100 dB
Crosstalk	> 60 dB
Dimensions	14.5 x 9 x 3 (5 3/4 x 3 1/2 x 1 1/4")
Weight	500 g (1 lb 1 1/2 oz)

QSV-2

SPEED VARIER FOR NAGRA IV–S, IV–SJ AND 4.2
14600

When connected to the NAGRA, the Speed Varier allows all 3 speeds 15"/s – 7.5"/s – 3.75"/s (38 cm/s – 19 cm/s – 9.5 cm/s) to be varied manually up to ± 12%.

Sound transfer applications:

–   To adjust the pilot signal frequency to a reference.
–   To compensate for a missing pilot signal or to adjust the synchronization when the pilot signal frequency fluctuates.

Dimensions	142 x 62 x 38 mm (5 3/4" x 2 1/2" x 1 5/8")
Weight	0.450 kg (1 lb)

QTIM

TAPE DRIVEN TIMER
14650

This timer is graduated in minutes and is installed in place of the right tension roller. The gear ratio is so calculated that one revolution corresponds to 30 minutes at $7\frac{1}{2}$ ips (19 cm/s).
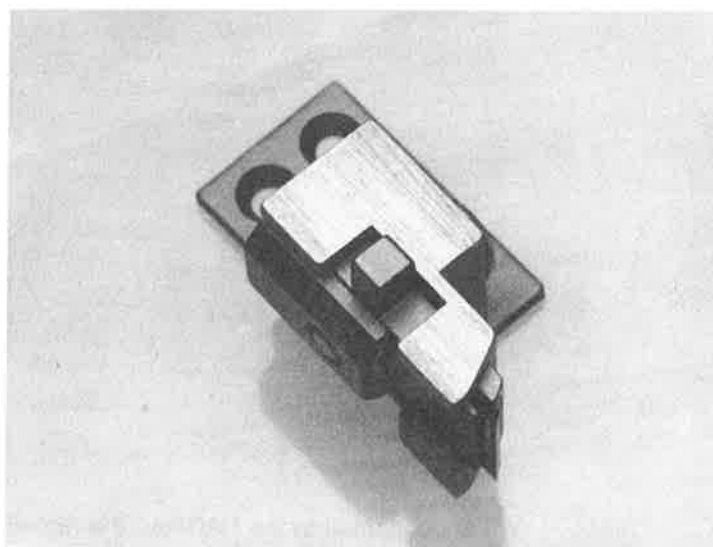The counter installation requires a new tape transport adjustment.

QLEN

TAPE DRIVEN COUNTER
14655

As above but graduated in feet.

QRAC

TAPE CLEANING BLADE
06260

The tape cleaning blade suppresses surface irregularities present on new tapes, to improve performance in the high frequency range. This accessory is a must for very high quality recordings.

PA–4

SET OF TWELVE 4 AH NI–CD RECHARGEABLE CELLS
98254

When the QGB large reel adapter is powered by the Nagra, the increased consumption can be compensated by using 4 Ah rechargeable batteries. They will ensure the same uninterrupted recording time as 2.5 Ah batteries powering a NAGRA without QGB (8 hours).