Instructions for using the FARAUTO_V5 ARTS France automatic firing table

Updated 24th June, 2011

1. General description

This **Automatic Firing Table** is intended to control the 120 point Receivers and the 30 point Relay units of the ARTS FRANCE line, which have been commercialized since 1999.

Its main use is to **automatically synchronize with the soundtrack of thee firing show**.

This program is stored in the memory of the Firing Table and launches the shots according to the "Time Codes" of the show music.

The firing program is developed based on the "Time Codes" of the "Time Codes" track, located on the right hand track of the show soundtrack; the left one is the source of the sound system.

It is possible to use a non-automatic sync mode. It is less precise because it only uses the 0.1s integrated time base, but it allows you to overpass the musical time codes.

This firing table automatically controls what the ARTS FRACE keyboard (shown below) already allows you to do manually.

It facilitates the control of 8 "Systems", each of them connected with a couple of cords to decoding receivers and 30 relay units (see the modules at the end of the material).

The firing capacity is 960 lines for a total of maximum 4000 shots over a period of 54m. It is possible to go past 8000 shots by using SEQ32 programmed in 'blast' mode (128000 shots are possible in this case).

Only one output is controlled with each shot, but it is possible to shoot up to 10 points simultaneously, on different locations, by adding decoding units on the same cord of each System.

In case you chose to use SEQ32 in trigger mode with sequential intervals, a 30 relay unit can be used several times during the show.

Automatic firing is based on the "Time Codes" which are the absolute time value in 0.1s units starting with the beginning of the show and which allow you to assign fireworks to the show soundtrack.

The system uses 4 types of Time Codes:

- The Vocal Time Code   (Hereafter called TCv)

  It is the vocal coding of time on a specific track of the show

- The Internal Time Code   (Hereafter called TCi)

  It is the time coding provided by the internal clock of the firing table

- The Original Time Code   (Hereafter called TCo)

  It is originated by the pointers/markers assigned to the show soundtrack and corresponds to the fireworks at a defined phase of the show soundtrack

- The Corrected Time Code   (Hereafter called TCc)

  It is stored in the memory and fires a shot when it has the same value as the TCi or TCv.

  A TCc is a TCo which has to delay value.

See Appendix I for more information on "Time Codes".

Two show set-up software are provided with the system.

You can thus create a firing sequence based on TCo that you select on the soundtrack via the SONY Sound Forge Audio Studio 9 software (not included).

To each TCc, a firing point is assigned among the 960 possibilities. 4000 TCc can be stored in the firing table by using the provided software. The firing table's storage capacity is able to comprehend an 8000 shots extension.

The "960 shots" version of the firing software communicates only once with each of the 960 outputs which correspond to the 8 120 point "Systems" (at least 1 receiver and 4 30 relay units per System are needed).

The "4000 shots" version of the firing software uses SEQ32 to control the igniters in a non-programmed mode. The receivers and the 30 relay units control one SEQ32 on each of their outlets (up to 32 shots for each relay outlet).

The control of 2 consecutive shots, with a 0.1s delay in between, is impossible on the same track of a 30 relay unit. Thus, there has to be an even number of SEQ32 for each 30 relay unit. The even number shots are assigned to the even number track of the 30 relay unit, the odd numbers are assigned to the odd number tracks of the unit. The programming software automatically controls them in this case scenario.

1.1 The ARTS FRANCE firing modules' wiring topology

1.1.2. 960 points direct firing

Combining decoding units that control the igniters or the SEQ32 modules in programmed mode.

The optional extensions to other decoding units allow firing simultaneous shots on 10 different locations for each 120 firing points, for each of the 8 "Systems" of the Firing Table. (These extensions are expensive and it is advisable to choose a pseudo-simultaneous shot by delaying the shots by 0.1s in between them on each zone).

SEQ32 can be added to the 30 relay units' outputs to shot automatic blasts (Blast mode). In this case, they need to be programmed one at a time. The firing count can thus go over 960.

The firing software creates 32 firing Zones, which can be separated or grouped geographically speaking. Each zone corresponds to one of the 8 "Systems" and to one of the 4 groups of 30 relay units attached to the receiver (From S1GA, S1GB, S1GC, S1GD to S8GA, S8GB, S8GC, S8GD). A 120 points decoding unit corresponds to 4 Zones.

This dispersion of the Zones on the field allows you to put the SEQ32 near the igniters, thus reducing the length and cost of extensions and cables.

The igniters that have to go off at the same time on the same zone must be plugged in in series on one outlet.
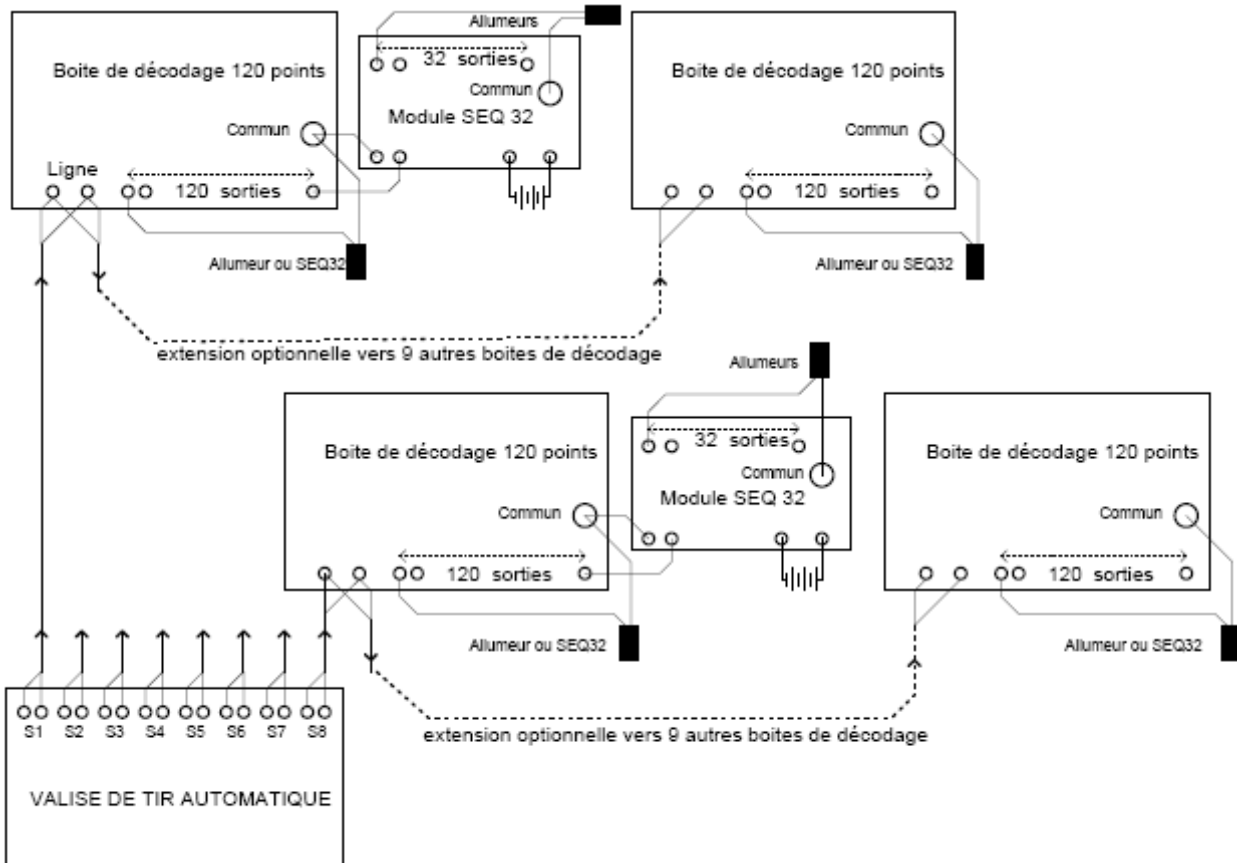
Traduction Photo 1

Boîte de décodage 120 points = 120 points decoding unit

Commun = Common

Ligne = Line

120 sorties = 120 outputs

Allumeurs = Igniters
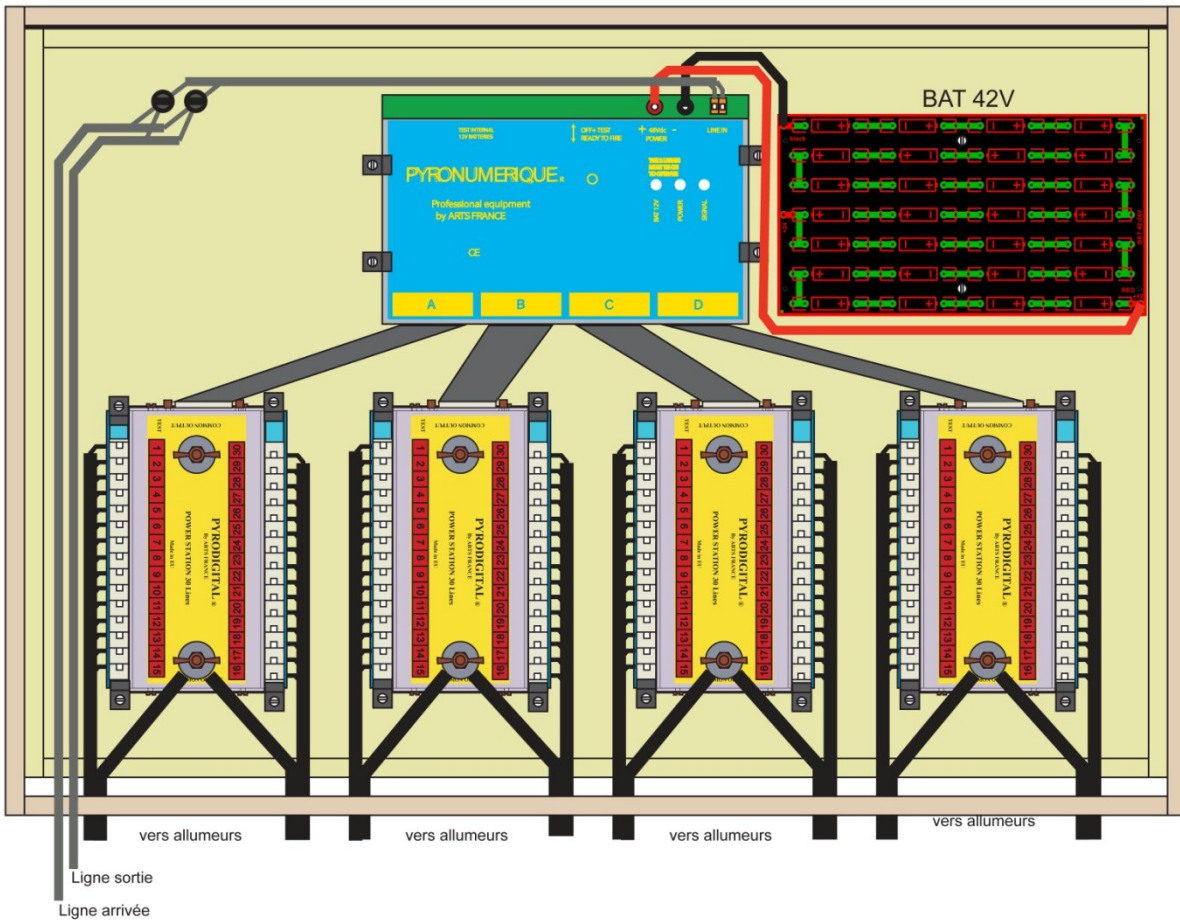
32 sorties = 32 outputs

Module SEQ 32 = SEQ32 Module

Allumeur ou SEQ32 = Igniter or SEQ32

Extension optionnelle vers 9 autres boîtes de décodage = Optional extension to 9 other decoding units

Allumeurs = Igniters

Valise de tir automatique = Automatic Firing Case

Traduction Photo 2

Vers allumeurs = To igniters

Ligne sortie = Line-out

Ligne arrivée = Line-in

This is an example of a decoding unit with 120 firing points, which has a receiver, a power supply and 4 30 point relay units.

The Line-in is plugged in to one of the 8 outputs (systems) of the firing case. The Line-out allows an optional extension to other decoding units (up to 9 additional ones).

The outputs with the same number (1 to 30) and which are plugged in on the same group (A to D) of the same output will be controlled simultaneously.

1.1.3. 4000 points indirect firing

In this case, each output of a 30 relay unit controls a SEQ32 in the non-programmed mode. Each shot which is controlled by the same relay output delays the SEQ32 by a step, which multiplied by 32 the capacity of the 30 relay unit output (960 points).

The entire firing software is inside the firing table, the SEQ 32 are in a controlled delay mode through their entries (ID=0000).

The firing software creates 32 firing Zones, which can be separated or grouped geographically speaking. Each zone corresponds to one of the 8 "Systems" and to one of the 4 groups of 30 relay units attached to the receiver (From S1GA, S1GB, S1GC, S1GD to S8GA, S8GB, S8GC, S8GD).

This dispersion of the Zones on the field allows you to put the SEQ32 near the igniters, thus reducing the length and cost of extensions and cables.

The igniters that have to go off at the same time on the same zone must be plugged in in series.

Topology example for a 3840 shot capacity
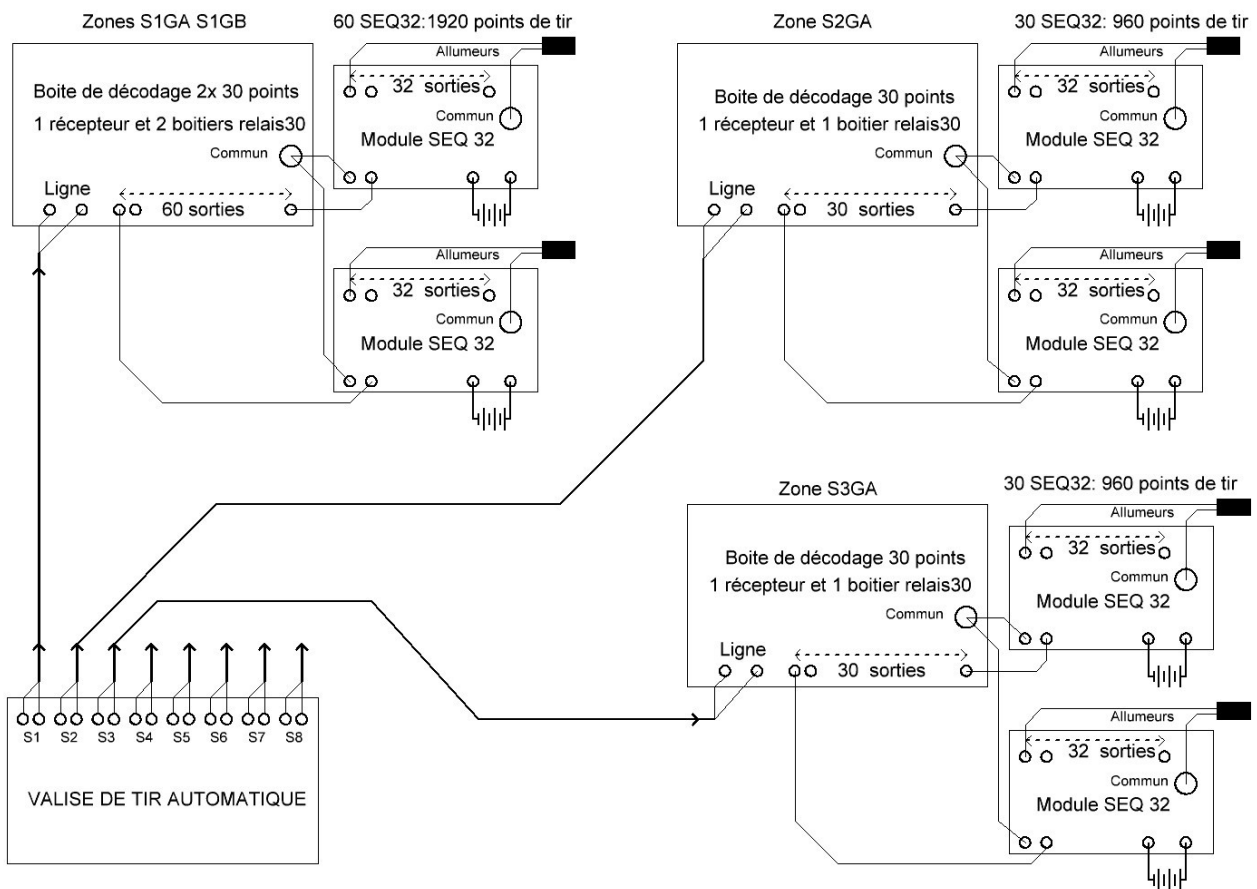
Traduction Photo 3

Zones S1GA S1GB = Zones S1GA S1GB

60 SEQ32 : 1920 points de tir = 60 SEQ32 : 1920 firing points

Zone S2GA = Zone S2GA

30 SEQ32 :960 points de tir = 30 SEQ32 : 960 firing points

Boîte de décodage 2x 30 points = Decoding unit 2x 30 points

1 récepteur et 2 boîtiers relais 30 = 1 receiver and 2 30 relay units

Commun =common

Ligne=Line

60 sorties= 60 outputs

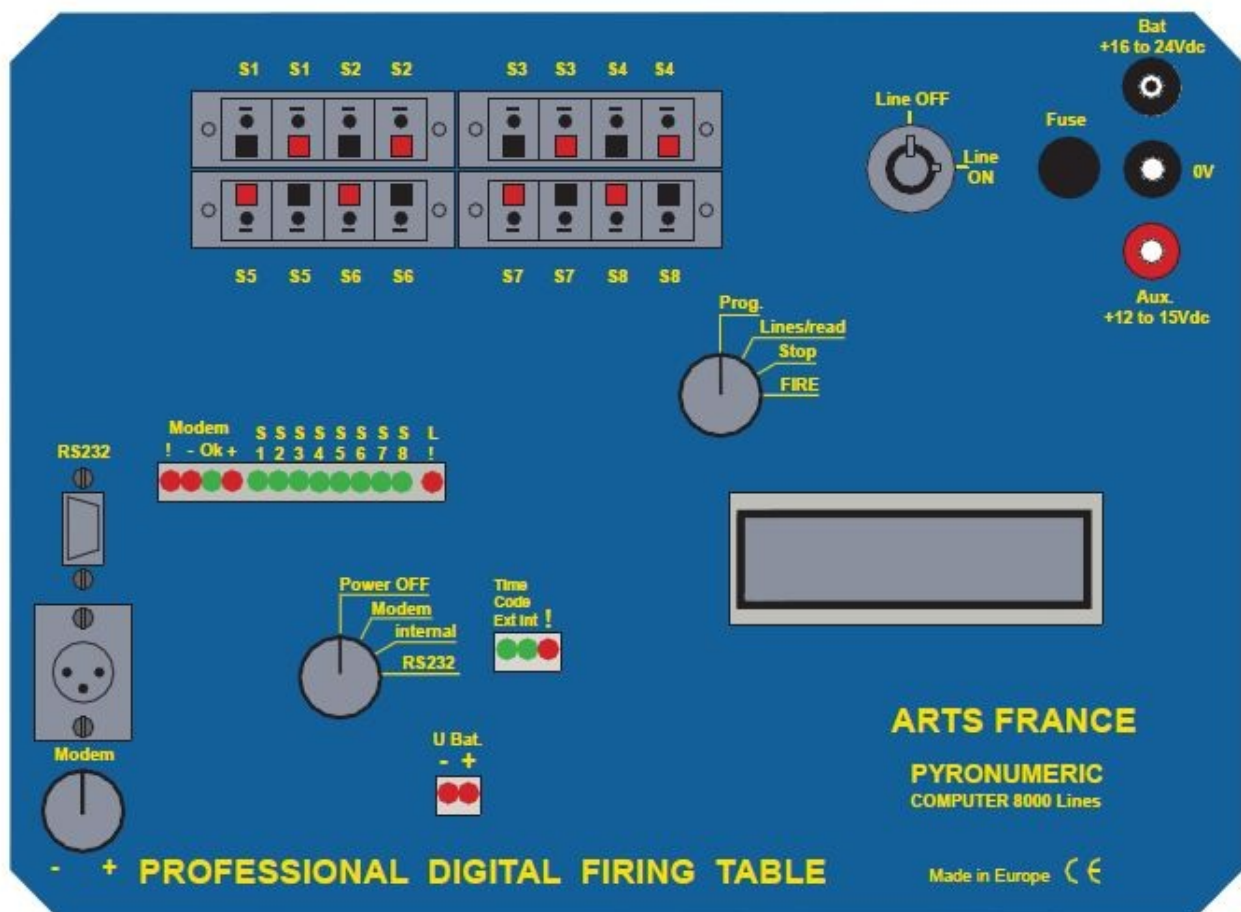**Allumeurs= Igniters**

Module SEQ32 = SEQ32 Module

Boîte de décodage 30 points = Decoding unit 30 points

Valise de tir automatique = Automatic firing case

Tous les autres éléments restent les mêmes ou bien ils se répètent

2. Detailed description of the ARTS France automatic firing table

(Hereafter called "firing table")

2.1 The equipment

2.1.1. Inputs

COM RS232 Line

1 DB9/F outlet connected to one of the PC's COMs to program the firing sequence and store it in the firing table's memory.

<u>Modem Line</u>

1 XLR/M outlet for the Vocal Time Code (symmetrical wiring 2-3 or asymmetrical 3-1). 80mV to 1V level, adjustable via a potentiometer. This input is isolated by a line transformer. Input impedance of 600 ohms.

The voice signal of the TCv corresponds to the right track of the source sound.

(The show soundtrack corresponds to the left track of the source sound).

<u>Power Supplies:</u>

1 jack for power supply 18Vdc-230Vac outlet for the 12V internal battery (Bat+ 16 to 24Vdc).

Be careful not to exceed 25Vdc on this input; the internal charger would then be destroyed.

Use only the 18Vdc power supply.

2 terminals (black and red) for backup power through an external battery (Aux+ 12 to 15Vdc).

2.2.2 Outputs:

8 lines S1 to S8, 2 cords which connect with the receivers (16 latching cable as for Speakers).

Each line corresponds to a "System". It can control up to 10 receivers.

2.1.3 Displays:

<u>4 LEDs for the modem</u>:

1 red (!) for missing signal.

1 red (-) for weak signal.

1 green (OK) for best signal.

1 red (+) for a signal too strong.

<u>9 LEDs for activating output lines:</u>

8 green for lines S1 to S8.

1 red for the detection of a short-circuit (L!).

<u>2 green LEDs for the time code source</u>:

1 for the modem (vocal time code from the XLR input).

1 for the internal source (in case the vocal time code is absent).

These LEDs flash five times per second when time code is recognized.

<u>1 red LED for system warning</u>:

Permanent ignition, it signals a serious anomaly with the firing table (!)

<u>2 red LEDs of battery voltage level</u>:

Low voltage (Ubat-): less than or equal to 11V

Excessive voltage (Ubat +): superior or equal to 18V

In this case the power goes into safety mode by stopping and if a shot is in progress it is reset to its starting point!

<u>An LCD display; 2 20 character lines</u>:

There are four main types of display:

For programming:

PROG CRC: 38201

** Page: 00,061**

For general monitoring:

Bat: 13.0 V CRC: 38201

** Tc: 000mV SW: 1.1**

For the monitoring of a shot:

T00025   F00026

N00001   S1 G1 L26 ON or STP

For monitoring output lines:

005   010   015   020

015   005   010   005

These displays are for example purposes and are detailed below in their own context.

2.1.4 Protection fuse:

Value 1A speed 5x20. It is destroyed in case of an internal short-circuit or higher voltage than 35V on the auxiliary power supply.

2.1.5 4 positions rotary switches:

For security purposes, only rotary switches are used.

1 on the left for powering purposes, being able to choose: Power OFF / Modem / Internal / RS232 (Cutting power/ Using the Modem for the TCv/ TC from the internal time base/ Programming via the RS232).

1 on the right for choosing: Prog./Lines/ Read/Stop/FIRE

(Programming/ Line power/Memory Read/ Manual stop of a shot/ Firing a shot).

2.1.6 Security key:

When on "Line off", the 8 outputs are disconnected and they guarantee safety during the setting up or testing phase of the table.

The key has to be on "Line on" for the output lines to be active.

2.1.7 The firing table's power supply:

A 12V (2.1A H) internal gel battery guarantees the main power supply. This battery, when new, provides a 10 hour autonomy at least.

An internal charger limits its charge to 0.3A and its tension to 14.2V.

Use the provided 18Vdc power unit to charge the battery and do not exceed 10h of charging time for an empty battery.

Starting up the left rotary switch on "Modem" and the right one on "STOP" will allow you to see the battery's tension. The battery is charged when the displayed tension reaches 14V and the charger is plugged in.

An alert is given by 2 red LEDs in case of sub-voltage or over-voltage.

<u>"U-" Red LED active:</u>

The internal tension of the battery is low (<11V).

If there is no shot in progress, recharge the battery.

If a shot is in progress, it is urgent to charge the firing table with an external 12V battery via its auxiliary input.

Even if there seems to be no functioning issues, the line-outs might be unable to provide enough tension and could cause a malfunction of the distant receivers.

Attention! For security purposes, never plug in the 18V external charger during a shot if the igniters are on!!!

<u>"U+" Red LED active:</u>

This can only happen if an auxiliary power supply superior to 15V is connected.

In this case, the internal protection cuts the firing table's power and if the shot has already been launched it is finally stopped!

Check the auxiliary battery's tension before plugging in.

Use a 12V lead car battery to avoid such problems.

Use 4mm male plug security cords to avoid accidental short-circuits of the battery while manipulating cords.

Attention! For security reasons and voltage stability, never use an external power supply that is directly or indirectly plugged in the alternative current main supply, while firing a shot!
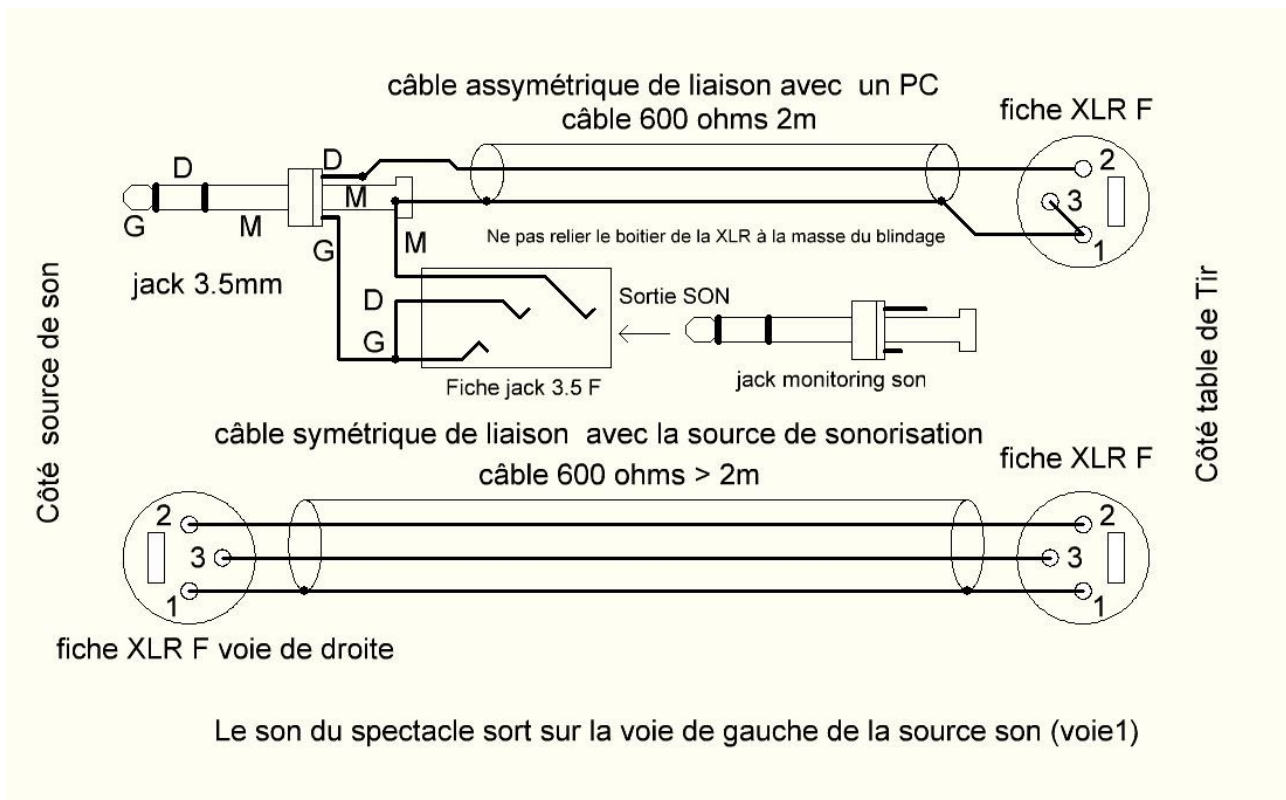

2.1.8 Connecting cords for the sound source:

At short distance from the sound source, it is possible to use an asymmetrical cord. This is the case when using a PC and its jack 3.5mm output.

In case you are using longer cords, you have to use a symmetrical sound cord, plugged in the right track of the sound system (Track2 of the sound file). Symmetrical output with a 600 ohms transformer.

The show soundtrack is to be heard on the left track (Track1 of the sound file and it is directed to the show sound system.

The wiring is the following:

câble assymétrique de liaison avec un PC
câble 600 ohms 2m
fiche XLR F

Ne pas relier le boîtier de la XLR à la masse du blindage

Sortie SON

jack monitoring son

jack 3.5mm

Fiche jack 3.5 F

Côté source de son

câble symétrique de liaison avec la source de sonorisation
câble 600 ohms > 2m
fiche XLR F

Côté table de Tir

fiche XLR F voie de droite

Le son du spectacle sort sur la voie de gauche de la source son (voie1)

Traduction Photo 4

Côté source de son = Sound source side

Câble assymétrique de liaison avec un PC = Assymetric cord for PC connection

Câble 600 ohms 2m = 2m 600ohms Cord

Jack 3.5mm = Jack 3.5 mm

Fiche jack 3.5 f = Plug jack 3.5mm

Ne pas relier le boîtier de la XLR à la masse du blindage = Do not connect the XLR unit to the ground of the reinforcement

Jack monitoring son = Jack sound monitoring

Sortie son = Sound output

Fiche XLR = Plug XLR

Côté table de tir = Firing table side

Le son du spectacle sort sur la voie de gauche de la source son (voie 1) = The sound for the show comes out on the left track of the sound source (Track1).

3. Operating Modes

3.1. Programming mode:

The first thing you have to do is to input a firing file in the firing table's memory. The following software « TirAutoDirect_960TC_Vx.xx.exe » and « TirAutoInDirect_4000TC_Vx.xx.exe » allow you to create en input the firing file in the firing table memory.

These steps – creating and programming – are detailed in the Instruction Manual for the Firing table.

When delivered, the firing table contains a demo firing file which activates the 960 outputs on all the 8 system outputs with a 0.1s delay in between them. Only one output is active at a given time. (Fichier_programmation_CRC_38201(d)_960tirs0.1s.bin»)

The following explanations correspond to this specific firing file.

In Programming Mode, the charger can be plugged in (if necessary).

Place the right rotary switch on "Power OFF".

Place the left rotary switch on "Prog.".

Connect the PC and the RS232 socket with the appropriate cord (COM outlet or COM-USB adaptor).

Launch one of the 2 aforementioned software on the PC.

Place the left rotary switch on "RS232".

The display shows:

PROG   CRC :
    Page:0000

Launch the programming on your PC. ("Program" Button)

The programmed pages are displayed.

The programming phase is finished when the CRC displays a numeric value.

Check that this value corresponds to the CRC in the programmed firing file.

The display shows:

PROG   CRC : 38201
            Page:00061

Place the right rotary switch on "Power OFF".

Remove the RS232 cord.

If any receiver is plugged in, do not plug any igniters on their outputs.

Put the security key on "Line ON".

Test the program in no modem firing mode:

Place the right rotary switch to "STOP".

Place the left rotary switch to "Internal".

Wait for the CRC to be calculated and check that its value corresponds to the one in the input program.

The display shows:

Bat :13,0V   CRC : 38201
 Tc :000mV   SW :1.0

Place the right rotary switch to "FIRE".

Check that the display shows the time codes that correspond to the beginning of the firing file.

The display shows:

T00025	F00026
N00001	S1 G1 L26 ON

T00025 corresponds to the TCc of the internal time base (absolute time value in 0.1s).

F00026 corresponds to the N° of the following shot.

N00001 corresponds to the number of 0.1s before the next shot.

S1 G1 L26 corresponds to the System N°, Group, Line of the 30 relay unit.

(G1 = group A, G4 = group D)

Place the right rotary switch on "Stop".

Place the right rotary switch on "Power OFF".

Put the security key on "Line OFF".

3.2 Firing with Vocal Time Code Mode:

This is the main operating mode of the firing table.

The shot is in sync with an audio signal which includes the time code encoded in absolute values. (Values from 0 to 32400 or 0 to 54m). See Appendix I for the detailed Time Code values.

Place the left rotary switch on "Power OFF".

Place the security key on "Line OFF".

Place the right rotary switch on "Stop".

Check settings:

Place the left rotary switch on "Modem".

Attention! Do not place the switch on "Internal". The shot will go off immediately after the right rotary switch will be placed on "FIRE" and after the security key will be on "Line ON"!

When powered up on STOP mode, a check of the memory is launched (CRC) and the check code is displayed. **This code has to be the same as the one you expect for this shot**.

The display will then stabilize and show for example:

Bat :13,0V	CRC : 38201
Tc :000mV	SW :1.0

Check that the battery voltage is correct (around 13V for a fully charged battery).

Connect the Firing table to the sound source of the firing show, using the appropriate XLR cord.

Launch the sound system and adjust the level with the potentiometer so that the green LED is active (Modem OK).

The value of the signal that is displayed is between 60 and 100mV.

Power off the sound system and place it at the beginning for when the firing begins.

Test power lines:

Check that the right rotary switch is on "STOP".

Place the security key on "Line ON".

Place the right rotary switch on "Lines/Read".

One test pulse is sent to each of the 8 System outputs and the picture of the power lines' values is displayed.

These values are not very precise, but they are stable, which means that they correspond to the image of the state of the power cords before firing. Please keep these values in mind. In case of shut down, it will be possible to compare them with a new power lines' test in order to get a diagnostic of a potential issue with the wiring of one of the decoding units or in case of a short-circuit.

For example:

005 (S1) 010(S2) 015(S3) 020(S4)

015(S5) 005(S6) 010(S7) 005(S8)

An open line displays 0, a short-circuit displays around 120 and the red LED "L!" is active for a short time during this test.

You can repeat this test by placing the rotary switch on either "Prog." Or "Line/Read".

Put the security key on "Line OFF" if the fire is not to be shut right away.

Firing a shot:

Put the security key on "Line ON"

Place the right rotary switch on "FIRE".

The display shows:

T00000   F00001

N00000   S1 G1 L01 ON

The TCc is T00000, the next shot is N° 1 F00001 on S1 G1 L01

Attention! From now on, the firing will be controlled by the first valid vocal time code that is input on the Modem and which will be equal to the first shot stored on the memory. (XLR sound outlet).

Launch the show soundtrack.

The Vocal time code is transmitted and the firing starts when the TCv is equal to the first TCc stored in the memory. For a TC0 at 00100 (10s) and a 20 (2s) delay, the first shot will be fired at TCv 00080 (8s).

The display shows the current Time Code (Txxxxxx), the next firing N° (Fxxxxxx), the delay before the next shot (Nxxxxxx in 0.1s units), the System N° of the next shot (Sx from 1 to 8), the Group (Gx from 1 to 4 corresponding to A to D on the receivers), the Line (Lxx from 1 to 30 on the 30 relay units).

At the end of the fire "END" is displayed.

The display shows:

T00959   F00960

N00001   S8 G4 L030 END

Once the shot is fired it is still possible to stop it in case of an accident and to restart it later. See the paragraph "Stop and restart a shot".

3.3. Memory reading Mode:

It might be useful to read the contents of the memory and this mode allows you to so.

Place the left rotary switch on "Power OFF".

Place the right rotary switch on "Lines/Read".

Connect the PC to the RS232 outlet with the appropriate cord.

Place the left rotary switch on "RS232".

Launch the « TirAuto_Read_Vx.x » software.

The display shows the pages with the memory description.

When the display stabilizes the operation has finished.

Place the right rotary switch on "Power OFF".

Disconnect the RS232 cord.

Place the right rotary switch on "STOP".

A file has been created. This file contains the listing of the memory database.

3.4 Structure of a firing file

A firing file is a chronological sequence of 4 byte groups which define a shot by time, its System n° (Outputs 1 to 8), its group (1 to 4 corresponding to A to D on the receivers) and its Line (from 1 to 30 on the relay units).

This data is stored in a file that helps you program the Firing Table via the 2 aforementioned software.

Using this, you will be able to create the firing file in the SONY Sound Forge Studio 9 software.

See paragraph "Creating a firing file" for more detail on setting up these files.

4. Potential incidents during firing procedures

4.1 The Sound level warning signal turns red:

Modem! : total loss of modem connection.

The Firing table is then synced with its internal clock at 0.1s for as long as a coherent external modem signal is not recognized by the system; this signal must also be equal with the internal TCc.

The green "Time Code Int" LED is activated.

This scenario can take some time and it is something you should avoid as the sync between fireworks and sound will lose its precision.

Modem – or Modem+:

This is not a critical situation as long as the signal stays between 30mV and 130mV. For security reasons, please adjust the level so that you stay in the green.

4.2 The battery tension level turns red:

See paragraph "The firing table's power supply".

4.3 The Line light (L!) turns red when a fire is shot:

The line has short-circuited. No receiver on this line will be able to receive the signal. Switch to Stop firing Mode to repair the line.

4.4 Stop firing Mode:

In case of hardware malfunction or in case the sound system shuts down, it might be necessary to stop the shot to solve the problem and restart the shot.

4.4.1   In case of firing in external TCC mode via modem:

This TCC mode allows the perfect resynchronization of the firing with the show music in case the firing has stopped provided you respect the precise chronology of the startup:

Place the rotary switch on "STOP" and stop the sound system.

Attention! Stopping the sound system does not stop the firing. As soon as the shot has been fired, the system makes up for the loss of external TCC signal with its internal generator (0.1s). You have to place the switch on "STOP" as soon as possible.

Stop the sound system if it has not been done yet.

Note the stop TCC shown on the display.

The TCT of the next shot stays stored in the memory as long as the firing table is turned on.

Attention! Never place the left rotary switch on "Power OFF", the firing would be rebooted from 0.

Display example:

T00300   F00301

N00000   S3 G3 L01 STP

The stop occurred at TCC 30.0 seconds, the next shot will be N° 301 on S3 G3 L01

Use the file containing the firing details to see the time (m,s,d) of this shot so that you can reset the audio to a few seconds before this shot went off.

If necessary, place the rotary switch on "Line/Read" to compare the current on the 8 lines with those observed at start up, when the operations were functioning normally.

Each time you set on "Lines/Read", the test of the current on the lines is updated.

Solve the technical problems that have caused the incident.

To restart firing, place the rotary switch on "FIRE". As soon as the sound system provides an equal TCC to the stored TCT (at the time it was stopped with the "STOP" button) the process will start again.

The timer is shown on the display (Bottom left side).

Attention! It is important that you reset the audio several seconds before the switch was placed on "STOP". The sync cannot happen if the provided TCC on the modem is superior to the following TCT stored in the memory. If not, "N!!!!!" appears on the display instead of the timer. If this occurs, switch to "STOP", reset the audio, switch to "FIRE" and launch the sound system again.

It is recommended that you write down this procedure in case you have to stop and restart again, as well as to regularly train yourself with this procedure.

To understand the system when something like this occurs, use the sound editing software Sound Forge by SONY to stop and reposition the soundtrack at different time markers. (This is the software that you use to establish the TCo when creating the show).

4.4.2   In case of firing in internal TCC mode:

Place the rotary switch on "STOP".

Stop the sound system if it has not been done yet.

Identify the equipment problem and find the solution.

If necessary, place the rotary switch on "Lines/Read" to compare the current on the 8 lines with those observed at start up, when the operations were functioning normally.

Each time you set on "Lines/Read", the test of the current on the lines is updated.

To restart firing, place the rotary switch on "FIRE". The reboot will be immediate.

If the show had sound, you will have to reset the audio as best as you can to the moment that the system rebooted.

Display example:

T00300   F00301

N00000   S3 G3 L01 STP

The stop occurred at TCC 30.0 seconds, the next shot will be N° 301 on S3 G3 L01

Use the file containing the firing details to see the time (m,s,d) of this shot so that you can reset the audio to a few seconds before this shot went off.

Attention! Never place the left rotary switch on "Power OFF", the firing would be rebooted from 0.

5. Output lines:

Each line can control ten 50mA receivers.

The total resistance of each line (measured with a short-circuit at the end) must not exceed 90 ohms and a total battery voltage of 12V.

For example, this corresponds to 500m of flat electrical table with two 0.5mm lines from Davey Bickford.

6. Maintenance:

Do not store equipment in humid conditions.

Close the case with clips after use.

Use a shock-absorbing exterior protection when transporting the equipment by plane or vehicle.

Regularly check that the hardware has not become loose and that the battery is mechanically integrated.

Check that the battery is correctly wedged inside the foam protection at the bottom of the case.

If the equipment is not used for a long time, recharge the battery and unplug the cord and the battery (Cosse Faston, red cord).

Do not leave the power supply plugged in for more than 10 hours.

If a fuse is destroyed, replace it with a 5x20 1A fuse as quickly as possible.

Check the case before each use by putting the security key on "Line ON" and without having the lines plugged in.

Appendix I: Time Code Features:

A Time Code is an absolute time value expressed in 0.1s units and which allows you to place fireworks on the show soundtrack.

Its value ranges from "00000" to "32400" in a 2 byte hexadecimal code ("TT TT"), meaning a maximum duration of 54m.

The system uses 4 types of Time Codes:

- The Vocal Time Code   (Hereafter called TCv)

   It is the vocal coding of time on a specific track of the show

- The Internal Time Code   (Hereafter called TCi)

   It is the time coding provided by the internal clock of the firing table

- The Original Time Code   (Hereafter called TCo)

   It is originated by the pointers/markers assigned to the show soundtrack and corresponds to the fireworks at a defined phase of the show soundtrack

- The Corrected Time Code   (Hereafter called TCc)

   It is stored in the memory and fires a shot when it has the same value as the TCi or TCv.

   A TCc is a TCo which has to delay value.

   The TCi or the TCv.

TCv:

In order to sync the firing best (close to 0.1s) with the show soundtrack, the TCv is imported on a track as audio frequencies which correspond to the standards of Bell 202 to 9600 bauds of the first modem models and which are known to be very sturdy. This standard makes it possible to transform an analogical audio signal in binary signal via the firing table's integrated modem.

The signal has 2 fixed frequencies , 2200 Hz and 1200 Hz which are easy to record and broadcast on any sound equipment.

4 bytes are sent to each TCC defining the time of a shot (starting with the beginning "00000"). It starts with "8A" and then goes on to "TT TT" for the TCv, "SS" for the checksum of the 2 bytes of the TCo, all this in hexadecimal coding.

Example: the TCC 8A 00 08 08 corresponds to a shot fired at 0.8s.

This TCv sequence is recorded on a CD which has been provided with the system.

It has to be copied to track 2 (right).

The show has to be broadcasted in mono on track1 (left).

After a 1s stabilization period, the TCo starts at 0m 0s 0d.

Given the delay between the ignition and the firework effect (10s max), the music starts 10s after the start of the show soundtrack.

This right side track broadcasts the TCv when the shot is fired and allows syncing the shot with the stored file.

TCi:

It is used on two occasions:

- When firing without sound, meaning without a TCv and with the left rotary switch placed on "Internal"

- When replacing the TCv if the latter is malfunctioning.

  The show is resynchronized automatically with the music as soon as a valid TCv is received by the firing table; this TCv has to be inferior to the TCi of the time.

TCc:

This is the TC that is actually stored in the firing table's memory. TCc= TCo – delay.

1 shot corresponds to a 4 byte group located in the firing table's memory, meaning: "TT TT SG VV"

"TT TT" for the TCc, "SG" for the System N° (S1 to S8) and the Group (G1 to G4 corresponding to A to D on the receivers) and the Line "LL" (L1 to L30 on the 30 relay units).

When the 2 bytes "TT TT" of the TCv correspond to the "TT TT" of the stored TCc, a firing order is sent to the Line "LL" of group "G", at the output N° "S" of the TCc.

All these values are in hexadecimal code.

Example:

The TCc "00 09 34 08" triggers a shot at 0.9s (9x 0.1s) on "System" 3, Group 4, Line 8.

The first shot of the demo file with 960 shots corresponds to a "00 00 11 01" TCc

Shot at Time 0, System 1, Group 1, Line 1

The last shot of the demo file with 960 shots corresponds to a "03 BF 84 1E" TCc

Shot at Time 95.9s, System 8, Group 4, Line 30.

4 Group Receiver

30 Relay Unit

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