S O U N D P R O J E C T S

OPERATION MANUAL
SP20-LINEX™

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All the important notes regarding proper operation of the product and potential danger or damage to either the user or the equipment, are highlighted in yellow!

All the important notes regarding the immediate safety or injury of persons and/or damage to the product are highlighted in red!

Like any high performance tool your Sound Projects system needs regular maintenance. Check all bolts and nuts of touring systems at least once a year! Clean foam-grille and cabinet openings with vacuum cleaner and compressed air to remove excessive dust.

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1 Quick reference set-up guide

For a more detailed description of the set-up procedure please refer to chapter 6.

Preparations:

Refer to the SPArC™ program (chapter 4) to have the proper setup parameters for your Linex rig. Carry a printout of the technical parameters for easy reference. A laptop computer with the project info is recommended to modify unexpected changes at the venue.

Step 0: Connect the single hoist adapter to the fly-frame (optional)

Connect the single hoist adapter to the fly-frame.

Step 1: Connect motor hoist to fly-frame

Connect the motor hoist(s) to the lifting point (and tilting point if applicable).

Step 2: Lift the first cluster of cabinets

Lift the fly-frame at the lifting-point together with the first cabinets out of the flight-case

Step 3: Set the angles of the cabinets

IMPORTANT: ALWAYS make sure the quick release pins are well in place and locked!

Set the angles at the back of the cabinets and connect the audio-line

Step 4: Connect the next cluster of cabinets

Connect the backside of the enclosures with the 3 cabinets in the flight-case.

Place the angle setting pin at the **0-degree** ***angle to fix the slide-bar during lifting!***

Fix the back connector of the lower cabinet in the array at 0 degrees.

IMPORTANT: Do not stand in front of the array when hoisting! When cabinets are freed from the ground they may cause the array to swing forward.

Lift the array out of the flightcase

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Step 5: Connecting enclosure fronts

Connect the fronts of the cabinet.

Step 6: Set the angles at the back of the cabinets

Set the angles at the back of the cabinets, connect the audio-lines and lift the array

Continue from step 4 until the complete array is finished

2 Line-array basics

What is a line-array?

A line-array is a sound system made up out of a group of identical, omni-directional radiating elements oriented in a tightly spaced, straight line. If this line is long enough compared to the wavelength the elements behave acoustically as if it were a single source. The basics of this principle are employed in today‘s vertical line-array systems.
Because of the physical dimensions of conventional HF compression-drivers it is impossible to meet the criteria of tight spacing of the sources for the frequency bandwidth it operates. To solve this most line-array systems use waveguides to convert the circular wave front emerging from a HF drivers exit to a rectangular plane enabling multiple sources to be tightly spaced.
Furthermore the wave front emerging from the waveguide should have tight vertical dispersion in order to avoid unwanted interference. The way this is achieved largely determines the vertical performance of the line-array system at the HF bandwidth.
Line-arrays behaviour differs in some respects remarkably from conventional systems. The greatest benefit of a line-array is that, when properly designed, the acoustical power of many cabinets can be combined without the unwanted interference that conventional systems show. Furthermore its vertical directivity can be adapted to closely fit the venue.

Vertical directivity of a line-array versus a conventional system

While conventional system will almost inevitably cause harmful interference when using more than one system, a well-designed line-array has the advantage of better acoustic energy distribution towards the projected area. Although it‘s a misconception that with a line-array no interference will occur. Due to it‘s tight spacing of the omni-directional MF and LF sources most of the cancellations do occur outside the projected area. In fact it is the ‘desired‘ interference that creates the ‘bullet-shape‘ often seen in simulation software.
The vertical directivity of the LF can be partially be altered by the angle of the total array. The MF beam (lobe) is partially manipulated by curving the shape of the array. Due to the HF waveguide‘s tight vertical dispersion, necessary for proper functioning of the array, curving the array is also bound to outer limits so it doesn‘t create harmful areas i.e. hotspots and poor HF coverage. For Linex this outer limit is set to 6 degrees; the maximum angle between two elements.

Vertical directivity of low frequencies versus array size

The previously described ‘bullet-shape‘, as a rule of thumb, applies for wavelengths equal to or smaller than the vertical array sizes. For a wavelength equal to the array length the vertical dispersion will approximately be 90-degrees. For the frequencies below this frequency, hence longer wavelengths, it will gradually turn into an omni-directional source. Therefore, vertical directivity control and maximum SPL of the low and low-mid frequencies greatly benefit from a larger (longer) array size.

Fig.1 Typical characteristic of a 2 meter array at 170 Hz.

3 Basic configuration principles

With respect to the horizontal coverage a line-array should not differ from a conventional constant directivity (CD)-system. When more horizontal coverage is needed than the horizontal dispersion of one line-array some basic rules apply explained later in this chapter. The main variable to which a line-array can- and has to be adapted is the vertical coverage.

Establishing proper vertical coverage

The first step in the configuration process is to get the venue parameters and listeners positions right. It may seem logical but a good preparation is the main time-saver in setting up any audio-system. Once these parameters, such as distances to first and last listener positions and flying height, are known prediction software such as SPArC™ can easily be employed to configure the best array shape and size.

When a line array is flown it is most logical to configure from top to bottom (far coverage to near coverage). Therefore it might not always be possible to point the bottom array element to the nearest listener position to be fed by the line-array (e.g. due to limited number of array elements). Additional front fill is then necessary. Another situation where front fill is preferred is when the array is flying relatively high to the first listeners position. In order to avoid 'elevator-music' coming from above, front fills placed at stage height will place the sound image downward for the front of the audience.
When a line array is ground stacked it is more logic to configure the array from bottom to top. Additional front fill can still be used, however often not necessary.

The requested SPL and venue shape (e.g. arena type or flat field) largely determine the angle settings within the array. If the variation in audience distance is large (e.g. flat floor) minimal “j-shaping” of the array may be needed to achieve a more even loudness throughout the field and to compensate for the losses due to air attenuation. This however increases the number of array elements needed for a certain vertical coverage angle. If the variation in distance from array to the audience is small (e.g. the distance between the shortest and the longest distance to the audience is not more than doubled), a constant angle setting between the elements is recommended. This will often be the case in small theatres, amphi-theatres or sports arenas. Constant angle settings between the elements are also recommended whenever the array is very short (1.2m and below), since a lot of the lower frequency band will have a wide vertical dispersion in such an array.

The angle increments between array elements shall always be as smooth as possible to not disrupt the coherent wave front emitted by the array. It is advised to use only constant or increasing angles from top to bottom when flown or stacked. Furthermore it is advised to use only the zero angle setting when (very) long throw (40 meters or more) situations apply and/or large arrays are used (12 elements or more).

Be generous when deciding a certain vertical coverage angle, otherwise (large) amounts of listeners might be partially in the – 6dB coverage area. This means they will hear less low-mid frequencies! This effect is most pronounced at large distances. In general one to three cabinets extra coverage for the furthest audience will be sufficient.

Horizontal coverage affairs…………

In some cases it might be necessary to use more than one array per side in order to achieve more horizontal coverage or to be used as in-fills. An important rule applies when this situation occurs. Instead of placing an array directly besides the first one, the proper approach would be to fly a second array, focused on another portion of the audience. This second array should best be spaced 6-7 meters (approximately 20 ft) away from the first array.

Given this separation, interference only occurs in the low frequency range. Hence there are no audible intelligibility losses. The first major cancellation is shifted lower in frequency band. and tends to be masked or filled in by room reverberation (example, 28 Hz for 2 arrays of the same size, spaced 6 metres). Additionally, focussing the arrays at different panning angles will reduce comb filtering interaction since the overlap region is reduced. Last but not least, the ear cannot resolve tightly spaced comb filtering notches at higher frequencies throughout the overlap region.

4 Using Sound Projects Array Calculator (SPArC™)

To determine the optimum angle settings of the array elements, array position, expected SPL levels and other array configuration parameters SOUND PROJECTS has developed SPArC™; a pragmatic array calculation tool.
Based on the venue parameters SPArC™ instantly calculates the most favourable line-array configuration and processor pre-set. The most important configuration rules are listed in the next paragraphs. It is strongly recommended to read them carefully before use.

4.1 General overview

SPArC™ is a Microsoft Excel based program, therefore Microsoft Excel needs to be installed on the workstation on which SPArC™ is used. SPArC™ uses several Visual Basic based program structures, therefore the macro use in excel must be enabled. Furthermore, be careful no to alter any cells that are not intended to be altered by the user; otherwise the program might not function correctly.

The use of SPArC™ is concentrated into two work-maps, the project info page and the main interface page, they can be selected at the bottom of the excel sheet. The venue specific parameters can be entered at the project info page, whereas array parameters are automatically calculated or can be optimized at the main interface page.

MS Excel's automatic calculation setting and the macro use must be enabled!
You can find these settings in menus: extra>options>calculation and extra>macros>security.

Project info page

figure 4.1 Project info page screenshot

When starting a new project, the first page to look at is the project info page, here the venue specific parameters can be entered. SPArC™ uses these in several calculations.

Main interface page

figure 4.2 Main interface page screenshot

The second page in SPArC™ is the main interface. Here a coverage side view is given together with an SPL prediction for the audience (right scale-axis). Furthermore, the manual adjustment setting gives full control to optimize vertical array coverage. In addition several automatic configuration algorithms can be used.

Auto and manual configuration

When the auto configuration is turned "on" the graph at the "Main interface" page corresponds with calculated angle settings. SPArC™ uses the data on the "Project info" page to calculate a near to optimum array shape. It is recommended by SP to use an array shape as close as possible to these settings. The settings calculated by SPArC™ are displayed in the pink areas.

If manual configuration is turned "on" the graph at the "Main interface" page corresponds with the manual angle settings (beside the pink areas). The auto settings can be copied to the manual settings, after which the auto settings can be "fine tuned" if preferred by the user.

Important note on proper vertical coverage

Be cautious not to configure the vertical coverage to tight, unless this is absolutely necessary (this might be the case, due to e.g. a highly reflective back wall in a closed area). This is especially important in long throw situations. The above rule should prevent (large) amounts of listeners from being in the area around the -6dB vertical coverage angles. At "main interface" page of SPArC™ this area can be recognized as the area between the pointers of the first two (top) cabinets and last two (bottom) cabinets in the graph of the "Main interface" page. The –6dB angles are represented by top cabinet and bottom cabinet pointers in SPArC™ ("Main interface").

The –6dB top coverage area is largest for long to very long throw situations. This area can be reduced by setting a few top cabinets to a zero degree angle setting and/or addition of cabinets to the top end of the array. For more related notes on array shape configuration see the array configuration section of this manual.

The automatic calculation for the angle settings does not take fully into account the above arguments because such coverage issues are too venue specific to decide upon via simple algorithms. A sound technician should, therefore review the automatic array settings.

Ground stacking

If wanted (generally only in case of a theatre like venue) the SP line arrays can be ground stacked. In principal the same rules apply as for flown arrays. Ground stacking in SPArC™ is not yet a standard option but can be simulated manually. The lowest cabinet will be attached to the fly-frame and should be positioned at the required height. The 'lower cabinet angle' should be set to –3 (angle between cabinet and fly-frame is 0 degrees).

Due to omni-directional character of the lower octaves note that when ground-stacking spill of these lower frequencies occurs at the sides and, if applicable, on stage of the ground stack!

Printing a page

Any page of SPArC™ can be printed via the excel menu: file>print.

5 Electronic system set-up

5.1 General overview

The Linex™ system is designed as a three-way/four channel system. The audio signal is processed to a HF, MF and LF output signal. From these audio signals the Linex™ cabinet is amplified by means of four AMP channels: HF channel, MF channel, LF1 channel and LF2 channel. If desired a fourth SUB signal leaving the processor can be used for separate sub-low cabinets.
Cabinets are interconnected in parallel. Hence, two amplifiers are needed to drive one, two, three or even four Linex™ cabinets, depending on the used amplifier current supply capabilities. From the amp-rack one cable of minimal but sufficient length shall be connected to a Linex™ cabinet. Short, integrated linking cables then connect additional cabinets in parallel to the first.

A typical block diagram for a Linex™ system set-up and a more figurative connection example is given in figure 5.1 and figure5.2, consisting of one 2in-4out controller, one SP2600 for the HF and MF sections and one SP4600 amplifier for the LF sections powering three Linex™ cabinets.

figure 5.1 Typical Linex™ block diagram *figure 5.2 Linex™ connection example*

5.2 Wiring and connection

Speaker cable requirements

When planning speaker cable requirements, the following core diameters of 2.5 mm^2[1] or 4 mm^2 are recommended depending on cable length and nominal input impedance (see table 2.1).

Max cable length	Nominal input impedance Z	Recommended Core diameter
15 m	4 Ω	2,5 mm2
30 m	4 Ω	4 mm2
15 m	2 Ω	4 mm2

table 5.1 Recommended cable size

Speaker cable connector type

All Linex™ cabinets are equipped with Neutrik NL 8 Speakon receptacles.

Speaker cable extension

NL-8 Speakon couplers can be used to extend cables by joining two together.

Connector wiring

Connections are also labelled on the panel at the cabinet rear.
Each Neutrik NL-8 connector shall be wired as follows:

Frequency Band	NL8 Connector	Impedance
LF 1	Conductor pair 1+/-	8 Ω
LF 2	Conductor pair 2+/-	8 Ω
MF	Conductor pair 3+/-	8 Ω
HF	Conductor pair 4+/-	16 Ω

table 5.2 Connector wiring

5.3 Signal processing

In general all array elements (each Linex™ cabinet) of a single array has to be fed with the same program material, the same amplifier gain, controller, limiter and EQ settings to ensure coherent behaviour of the line array!

General guidelines

SOUND PROJECTS has configured several controller presets to cover any venue situation.
These settings will deliver the most accurate frequency response at the audience areas.

It is advised to use no or only minor EQ adjustments afterwards. One must be very precautious because, due to venue acoustics, the frequency response may differ remarkably between places. Therefore what seems a proper adjustment at one place may have a destructive effect at another.

Selecting controller settings

** SOUND PROJECTS Linex™ is standard supplied with 2.5mm2 core diameter / Neutrik NL-8 Speakon cables*

SOUND PROJECTS has prepared a tenfold controller settings, which are available as presets for several recommended controllers available in the market today. The correct controller preset number can be selected with table 3.3. In addition SPArC™ can be consulted for the proper preset number. These controller settings will result in the most coherent frequency response throughout the audience area.

Average angle / Nr Cabinets	4	2	1	0
24	1	1	2	CSP2
23	1	1	2	CSP
22	1	1	2	CSP
21	1	1	2	CSP
20	1	1	2	CSP
19	1	1	2	CSP
18	1	2	2	CSP
17	1	2	2	CSP
16	1	2	2	CSP
15	1	2	4	CSP
14	1	2	4	CSP
13	1	2	4	CSP
12	1	2	4	CSP
11	2	4	5	CSP
10	2	4	5	CSP
9	2	4	5	0 (distance>120m)
8	3	4	5	0 (distance>70m)
7	3	6	5	0 (distance>70m)
6	5	6	5	0 (distance>40m)
5	5	7	7	0 (distance>40m)
4	6	7	9	0 (distance>20m)
3	7	8	9	0
2	0	0	0	0
1	0	0	0	0

table 5.3 Recommended controller settings for LINEX

It is strongly recommended to use these recommended settings otherwise proper use is not guaranteed!

SPArC™ controller setting recommendation

The controller setting recommended by SPArC™ can be found on the technical overview within

SPArC™.

Crossover parameters

Please contact SOUND PROJECTS.

Warning! Always use the supplied crossover settings, different settings always give less than optimum performance and can cause damage to your system!

[2] Contact SOUND PROJECTS for advice.

5.4 Power amplifier requirements

When selecting a power amplifier, don‘t go for “just enough power”! Ample although not excessive headroom is preferable. The recommended amplifier power presented for a given Linex system is a good indicator of the size of the amplifier, which will safely drive the loudspeaker system to full output under most conditions. A smaller amplifier may seem to provide an extra safety-measure against loudspeaker failure. However an underpowered loudspeaker will most probably fail sooner than the same loudspeaker powered properly with the same voltage.

Recommended amplifier power

Sound Projects recommends a minimum amplifier peak voltage capacity of double the RMS voltage at full power in order to avoid clipping the signal. For this reason maximum Recommended Power Levels per Transducer (RPL/T) may exceed the AES power rating of individual drivers.

Important note on amplifier power

The listed amplifier power does not always correspond to the best amplifier sizes for optimum loudspeaker reliability and/or performance. They correspond with what generally will be a safe amplifier size given the connection diagram in paragraph 2.1. However in some applications they can be over or underpowered. Proper amplifier selection requires a considered analysis for the particular application.

Recommended amplifier power table for SP20-Linex

	1 Cabinet	2 Cabinets	3 Cabinets	4 Cabinets [3]
p4/HF	300 W 16 Ω	600 W 8 Ω	900 W 5,3 Ω	1200 W 4 Ω
p3/MF	600 W 8 Ω	1200 W 4 Ω	1800 W 2,7 Ω	2400 W 2 Ω
p2/LF1	1200 W 8 Ω	2400 W 4 Ω	3600 W 2,7 Ω	4800 W 2 Ω
p1/LF2	1200 W 8 Ω	2400 W 4 Ω	3600 W 2,7 Ω	4800 W 2 Ω

table 5.4 Recommended Amplifier power

Two-Ohm loads and amplifier performance

Most professional amplifiers are capable of running two-ohm loads for extended periods of time and thus only two amplifiers can power up to four LINEX cabinets. Powering low- and mid bands @ 2 ohm load is common practice and permissible as long as the available power and other specs are in excess of the system requirements. However, capable is not necessarily the same as recommendable. Hence the first obvious question is therefore: will a particular amplifier handle 2-ohm operation with acceptable distortion specifications?
The next question is: how much are you willing to sacrifice of the superb transient-response of your LINEX system? The unintended but unavoidable consequence of lowering the loudspeaker impedance is a decrease in damping factor. The damping factor describes the control a power amplifier exerts over the loudspeaker motion.

3 Not recommended, only with 2 Ohm enabled amplifiers.

Power handling

Although many ways of power handling are used (Program-, Peak-, Peak-program, RMS, AES and IEC 268-5 Power), only the latter two are real standards and therefore comparable. The other ways of specifying are more fanciful and therefore not serious. Sound Projects transducer power ratings are calculated based on minimum impedance (Z-min) and the RMS voltage of the relevant band-passed[4] noise input signal. This is in harmony with the most frequently used Audio Engineering Society (AES) power test specification that requires the transducer to operate at its rated power level for 2 hours with no degradation in performance.

Important note on power handling

The Max RMS power handling values ratings are power values, which the drivers can sustain for long periods of time without any damage. The listed power handling ratings are intended as a point of comparison for the sound technician. In practice, the amount of excitation of the drivers strongly depends on the type of signal, which is applied to the drivers (e.g. speech, classic, rock, house). To safeguard against driver damage it is recommended/common practice to always use a limiter on all channels. Limiter settings have to be determined (each time), according to the specific use of the PA-system.

Power handling table

1 Cabinet

p4/HF (50 Vrms long-term)	150 W 16 Ω
p3/MF (50 Vrms long-term)	300 W 8 Ω
p2/LF1 (50 Vrms long-term)	300 W 8 Ω
p1/LF2 (50 Vrms long-term)	300 W 8 Ω

table 5.5 Max. RMS Power handling

Limiter settings

It is important to realize a limiter only helps partially to prevent speaker and amplifier damage. In any case it is always best to check and keep track of the peak SPL at one meter of a cabinet. It must not exceed the specified MAX SPL@1m per cabinet (table 2.6).

Max. SPL@1m

1 Cabinets[5]

HF (2kHz)	142 dB
MF (500 Hz)	141 dB
LF (150 Hz)	131 dB

table 5.6 Max. SPL@1m

[4]In simple terminology; the above test method confirms that it does not make sense to test a 15 inch "woofer" with a test signal of 10.000 Hz, or a compression HF driver with a 50 Hz signal. This form of testing and specification is today regarded as closest to the real thing because music is quite different from a single sine wave.

[5] These SPL values are for a single cabinet. A line-array of more cabinets will show higher SPL values at one meter. Especially low frequencies will be severally louder.

Threshold value and amplifier gain factor

When you use the amplifiers supplied by Sound Projects they have a gain of 32 dBu.

The gain factor of an amplifier is extremely important for the threshold value of the limiter! In table 2.6, the limiter parameters are listed in case of amplifiers with a gain of 32 dBu. Furthermore the listed settings are only valid when the recommended amplifier power (or higher) is used.

Attack and release

The attack and release settings of the limiter strongly depend on the type of sound material, which is used. If not set correctly they degrade sound quality and proper limiter operation. The effect of the limiter on music quality can be checked by a sound technician; by turning the amplifiers low and turning the input signal up into limiting (some limiters have a special limiting mode). As an example timescales are listed. They are however merely an example and might in practice differ remarkable depending on the type of limiter and the program material!

Limiter settings example table

	HF	MF	LF
Threshold	0dBu/31 VRMS	+3dBu/44 VRMS	+3dBu/44 VRMS
Ratio	INF : 1	10 : 1	10 : 1
Attack	Fast / 5 ms	Med / 25 ms	Slow / 50 ms
Release	Fast / 50 ms	Slow / 200 ms	Slow / 200 ms

table 5.7 Limiter settings example table

6 Stacking and Flying with Easy-rig™

The Sasy-rig™ flying system has been designed to set up acoustic vertical line-arrays in an easy, fast and flexible way. All the necessary cabinet rigging hardware is stored within the SP20-Linex housing. In general, the only additional requirements include an Sasy-rig™ fly-frame and tilt-bar, motor hoists, transport flight cases and qualified rigging personnel.

6.1 Safety Guidelines

The workload limits (WLL) as specified in this manual of SOUND PROJECTS rigging accessories have been designed with a safety factor 10. This is well above the European guidelines for lifting machinery. Other safety guidelines are given throughout this paper.

It's the users responsibility that all safety precautions have been taken when using flying hardware equipment.

figure 6.1 Easy-rig™ fly-frame with 3 SP20-Linex cabinets and rigging accessories

6.2 Rigging components

Integrated flying hardware

The integrated Sasy-rig™ rigging hardware comprises front and rear connecting bars designed for fast and easy connection of cabinets and the Sasy-rig™ flying frame.
At the front of the cabinet a (retractable) connecting bar serves as a fixed rotation point (that can be stored inside the aluminum rigging profile during transport).
At the rear of the cabinet a connecting/slide bar adjusts the angle settings and simply slides into the enclosure hardware for easy transport and storage.
Always use the supplied quick release pins to fixate the Sasy-rig™ connecting bars.

figure 6.2 SP20-LINEX enclosure with integrated flying hardware

Flying Frame

The Sasy-rig™ flying frame is designed to fly up to 24 SP20-LINEX enclosures in a ‘dead-hang‘ set-up. SPArC™, specially designed line-array software, automatically calculates the corresponding maximum number of cabinets for each situation submitted in the program and signals when weight load limits are exceeded.

figure 6.3 Sasy-rig™ fly-frame with single-hoist-adapter and with tilt-bar

Depending on the desired setup the flying frame can be lifted with 1 hoist using the single-hoist-adapter or 2 hoists, one at the lifting point and one at either of the tilting points.

The Sasy-rig™ flying frame can also serve as a stand for ground-stacking the SP20-LINEX system.

Note: Always use the lifting point at the front of the frame to lift the array. When the array is at the anticipated height the array can be tilted at either one of the tilting points.

Quick release pins

Each SP20-LINEX enclosure holds 6 quick release pins fixed to the enclosure rigging. The provided pins have a workload limit of 0,5T (S.F.10) per pin.

figure 6.4 Quick Release Pins

Sasy-rig™ transport flight cases

SP20-LINEX enclosures are transported by means of custom designed flight-cases. Each flight-case holds one or two clusters of 3 cabinets, depending on transport preferences.
The flight cases have truck-pack measurements of 1.20m x 0.70m (height depending on the amount of layers).

figure 6.5 Transport flight cases

Sasy-rig™ single hoist adapter LT

The Easy-rig™ single hoist adapter is a valuable optional device to enable lifting up to 12 cabinets (500kg) in dead-hang with a single hoist.

S*asy-rig™ single hoist adapter LT*

The single-hoist-adapter is a pragmatic addition to the Easy-rig™ flying system. Attached to the main flyframe by means of two pins with quick snap locks.
The proprietary array calculator SPArC™ calculates which of the 25 holes is needed to attach the hoist. A 3.25T shackle is used to attach the adapter to the hoist at the indicated hole.

Conversions of the WLL of 12 cabinets (500 kg / 1100 lbs) in deadhang, to holes positioned behind the flyframe are depicted in the figure below.

12 cabinets

9

7

6

5

4

3

cabs

25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

S*asy-rig™ single hoist adapter WLL conversion table.*

6.3 Preparing a set-up

The first and most important step in setting up a line-array fast and easy is gathering all the relevant information of the venue ahead of time if possible.
Use SPArC™, SOUND PROJECTS Line-Array Calculator, to determine the angle settings of each cabinet within the array. See chapter 3 for detailed information about SPArC™.
An integrated whiteboard at the back of the cabinet can be used to number the position of each cabinet in the array, indicate its use in the left or right array and the angle setting between the adjoining cabinets.

Connect the Sasy-rig™ flying frame to the top cabinet of each array.
Store the enclosures in clusters of three in a flight-case and mark each flight-case with L for the left array and R for the right array plus the number of the cabinets in line.

The SP20-LINEX transport flight case has truck-pack dimensions. Two flight cases (1.20m width) will tightly fit inside most trailers.

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6.4 General set-up of a flown array

Step 0: (optional) Connect single-hoist adapter to fly-frame

The single-hoist-adapter allows flying of a maximum of 12 cabinets to a single motor-hoist. SPArC™ indicates the proper fixing hole to lift the array, resulting in the appropriate angle of the completed array.

Step 1: Connect motor hoist to fly-frame

The Sasy-rig™ fly-frame comes with a lifting and, when using the tilt-bar, a tilting point. SPArC™ provides information on the loads on each of these points. Connect the motor hoist(s) to the lifting point. After lifting the first array out of the flightcase an optional motor hoist can be fixed to the tilting point. During the rigging procedure only use the lifting point at the front of the frame to hoist the array out of the flight-case. Once the full array is at the intended height it can be tilted to the right angle at the tilting point.

IMPORTANT: Make sure the shackles on the fly-frame are securely closed before any use of hoist motors!

Note: In case SPArC™ indicates the lifting point carries the full load, a single hoist can lift the array. A simple strap can be used to aim the array horizontally and keep the array from rotating.

Step 2: Lifting the first cluster of cabinets

Rigging a complete array of SP20-LINEX can be significantly faster by lifting clusters of 3 cabinets at once for they are already connected in the flight-case during transport.
Lift the fly-frame at the lifting-point together with the first 3 cabinets out of the flight-case.

Step 3: Set the angles at the back of the cabinets

IMPORTANT: ALWAYS make sure the quick release pins are well in place and locked!

Remove the flight-case and lower the array to set the angles at the back of the cabinets.
The hole-pattern of the flying hardware allows angle-settings of 0, 0.25, 0.5, 1, 2, 3, 4, 5 and 6 degrees. See indications at back of cabinet for the corresponding hole-combination.
Connect the incoming audio-line to the top cabinet and link the audio links to the lower two cabinets in the cluster.

Step 4: Connecting the next cluster of cabinets

The next cluster of 3 cabinets is moved under the array. Take the quick release pins out of the back slide-bar of the lower cabinet in the flown array. This allows the slide-bar to move vertically and compensate for height differences. To connect the backside of the enclosures remove the quick release pins at the rear of the enclosure. Lower the array till the slide-bars are just below the connecting holes of the upper cabinet of the next cluster. Connect the slide-bar with the pin.

Place the angle setting pin at* the 0 degree *angle to fix the slide-bar during lifting.

IMPORTANT: Do not stand in front of the array when hoisting! When cabinets are freed from the ground they may cause the array to swing forward.

Lift the array while guiding the cluster of cabinets until it‘s completely freed from the flight-case.

Step 5: Connecting enclosure fronts

Although a single person can set-up an entire rig of SP20-LINEX, the fastest setup is achieved by two persons on either side of the array. At the front of the enclosure two fixed connecting bars extend at the top. Remove the quick release pins at the front of the enclosure. Lift the front of the suspended cluster towards the bottom cabinet of the array and slide the front connector between the steel front rigging. The front connector easily slides into the rigging profile of the cabinet in the array. Connect the cabinet fronts with the quick release pin.

Step 6: Setting angles at the back of the cabinet

Now the angle setting pin at the back of the cabinet can be set to the desired angle. While lifting the cabinet back, remove the angle setting pin. Place the pin at the right hole and move the cabinet back up or down to the correct angle. Once the corresponding holes are next to each other push in and lock the angle setting pin.

6.5 Setting up a system with limited floor-space

In some occasions, i.e. limited space at lifting locations, one may decide to lift the array while cabinets are in an upright (vertical) position.

In this case, first connect the flying frame to the hoist and lift it above the truck pack of cabinets.
Connect the backside flying hardware and lower the flying frame until the front side can be attached to the frame. Lift the array a bit of the ground and set the angles at the back of the cabinet.
Lift the cluster about 1.2 meters off the ground and place the next cluster of 3 cabinets below the array (use a trolley or the flight-case dolly). Gently lower the array on top of the cluster, while guiding the front connector in the front-rigging of the bottom cabinet of the array.

6.6 Disconnecting

Disconnecting the array after a job is just as easy as setting it up, and exactly in reverse.
Lower the array until the bottom cabinet is approximately just above the ground.
Set the angle of the lower 4 (!) cabinets to 0 degrees. Remove the angle setting pin at the back side of the cabinet between the 3^{rd} and 4^{th} cabinet of the array (6^{th} and 7^{th} in case of SP10-S).
Place the flight case trolley underneath the array. While lowering the array, push the three free hanging cabinets backwards on the trolley.

Unlock the rear connecting-bar between the cluster on the trolley and the array by removing the rear locking pins at the top of the stack.
Put the locking pins in place again so the cluster is ready for its next job.

6.7 Ground stacking

If flying is not an option or you‘re in need of a floor-standing fill, you can also ground stack with the Sasy-rig™ systems.
If the array actually stands on the floor, this is best achieved by mounting a fly-frame on a stack in transport-mode and tilting it up-side down.
If the stack needs to stand on a higher level (for example on a stack of sub enclosures), you can first place the fly-frame on that level and strap it to the sub-enclosures, attach the array enclosures one by one as previously described.
When ground-stacking it does not matter if the enclosures are positioned up-side down.
Also arcing the array backwards is still possible.

Never ground stack more than 8 SP20-LINEX enclosures on a fly frame!

6.8 How to determine the maximum number of cabinets in an array

The allowed number of cabinets in an array is determined by the following factors:

1. The allowable loads on the supporting construction (e.g. roof, crane, trussing framework etc.).
2. The Weight Load Limit (WLL) of the hoisting motors.
3. The WLL of the flying frame
4. Local rigging legislation on safety factors etc.
5. The configuration of the array !

Note: A chain is as strong as its weakest link! Therefore all of the above criteria should be determined and should NEVER be exceeded!

1. Supporting construction

At public facilities the allowable loads on a roof construction or support is available at its authorized engineering office.

2. WLL of (motor)hoist

Refer to manual of the hoist manufacturer

3. Flying frame WLL

Never exceed the safe Work Load Limit indicated on the Sasy-rig™ Flying frame or as indicated by the software SPArC™.

4. Local rigging legislation

All Sasy-rig™ rigging hardware is designed with a safety factor 10. This is well above the European safety standards as stated in the Guidelines for Machines. Local laws, however, may enforce higher safety factors and/or restrictions or demand other safety precautions.

5. Array configuration

The WLL of the flying frame and cabinet rigging is given for a straight ‘dead-hang‘ array. The maximum number of cabinets allow in other situations is given by the SPArC™ software. The following table gives an indication of the maximum number of cabinets.

Flying Frame angle = 0 degrees

av. angle	max. angle flyframe	**Indicative*** maximimum no. of cabinets J-shape**	C-shape***
0	8 deg.	24	24
1	4 deg.	24	24
2	0 deg.	24	20
3	0 deg.	20	16
4	0 deg.	16	14
5	0 deg.	14	12
6	0 deg.	10	10

* Always consult SPArC™ for the maximum no. of cabinets

** J-shape: the lower half of the array has a larger angle setting than the upper half. No angle of a cabinet is higher than a lower cabinet.

*** C-shape: all angle settings between cabinets in the array are the same.

Note: When using SPArC™ it will automatically indicate when the maximum workload of a configuration is exceeded. When the maximum number of cabinets without the satisfactory result it is possible it can be achieved by changing the configuration: for example in most cases lowering the array will tilt the array to a more neutral axis allowing more cabinets in the array.

7 Additional Safety Guidelines

Before mounting the SP20-LINEX system make sure you apply the following general safety guidelines.

- ❑ Standards for flying and rigging are local not universal, therefore it is important for the user to contact appropriate regulatory agencies concerning relevant standards for specific applications.
- ❑ Before suspending any array, always inspect all components of the array for cracks, deformation, corrosion, and damaged or missing parts that could reduce strength and safety of the array.
- ❑ Use only load rated hardware.
- ❑ Never exceed maximum load ratings at any time.
- ❑ Consult a licensed physical engineer if you are unsure how to proceed.
- ❑ It is advisable to consult and engage a qualified rigger when making decisions related to purchase, set-up and use of any equipment and technique that will be used to suspend any temporary loudspeaker system above areas that will be occupied by persons.
- ❑ Never tilt the array by pushing or pulling the array at one of the enclosures itself!

8 Maintenance

Our minimum required recommendations:

- ❑ Control all rigging items on deformations irregularities and missing or loose parts before every use. (By user)
- ❑ Inspect all items at least once a year. (By qualified rigging personnel)
- ❑ Approval testing by Certified Body every four years.

9 Components and system specifications

Power handling

MAX RMS Power handling

		1 Cabinet
p4/HF	(50 Vrms long-term)	150 W 16 Ω
p3/MF	(50 Vrms long-term)	300 W 8 Ω
p2/LF1	(50 Vrms long-term)	300 W 8 Ω
p1/LF2	(50 Vrms long-term)	300 W 8 Ω

Recommended amplifier power

Recommended Amplifier power

	1 Cabinet	2 Cabinets	3 Cabinets	4 Cabinets [6]	
p4/HF	300 W	16 Ω 600 W	8 Ω 900 W	5,3 Ω 1200 W	4 Ω
p3/MF	600 W	8 Ω 1200 W	4 Ω 1800 W	2,7 Ω 2400 W	2 Ω
p2/LF1	600 W	8 Ω 1200 W	4 Ω 1800 W	2,7 Ω 2400 W	2 Ω
p1/LF2	600 W	8 Ω 1200 W	4 Ω 1800 W	2,7 Ω 2400 W	2 Ω

MAX SPL@1m

MAX SPL@1m

	1 Cabinet[7]
HF (2kHz)	142 dB
MF (500 Hz)	141 dB
LF (150 Hz)	131 dB

6 Not recommended, only with 2 Ohm enabled amplifiers.

7 These SPL values are for a single cabinet. A line-array of more cabinets will show higher SPL values at one meter. Especially low frequencies will be severally louder.

Horizontal isobars (one cabinet)

Vertical isobars (one cabinet)

Cabinet dimensions

10 Declaration of Conformity

Hilversum, 1 October 2004

DECLARATION OF CONFORMITY

SOUND PROJECTS, hereafter referred to as the manufacturer, declares that the Easy-rig™ flying frame and its rigging hardware as supplied by the manufacturer are produced and, when provided with certificate, tested conform CE norms as described in the Guidelines for Machinery appendix 2A.

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