Operating Instructions

XD1

Record Player System

rev 01

1. Introduction

The The XD1 Record Player System comprises the XD1 main unit - the record player itself, the isolation system, the C1 control unit, the P1 pump unit and the CF1 Ti arm.

The isolation system comprises a Minus-k unit and a top platform. This system is crucial for achieving the full performance potential of the XD1 and must be adjusted properly once the record player and the arm/arms have been installed.

IMPORTANT NOTE : the XD1 record player should not be moved around, nor should it be shipped under any circumstance, with the platter mounted on it. The platter must be removed every time the record player has to be moved from its position on the rack. Failing to do this will most likely damaged the platter bearing.

2. XD1 description

The XD1 Record Player System has been designed as an integrated vinyl playback solution with all the best equipment that Sat has today. Their components are dimensioned and adjusted to work together in harmony and efficiently, allowing the system to perform at an extraordinary level.

PROJECT
The XD1 Record Player System is the result of developing and refining the concept of "the turntable" by suppressing all superfluousness and concentrating on the engineering essentials to create the optimal platform for the SAT arms, in a compact, minimalistic, elegant and easy to use package.

The real challenge is to provide all the sound attributes typical of the top big turntables, without their functional and reliability drawbacks.

The XD1 was created and is sold as a system, comprising the turntable with its control unit, the isolation platform, the vacuum unit and the arm.

The design has focused on four main areas: isolation from external disturbances, speed stability, rigidity and vacuum hold-down.

Every unit of the XD1 record player is built from the ground up by me. For this exclusive product, I am involved in the whole build process, from the quality control of the components to the final assembling and packaging.

ISOLATION SYSTEM
The suspension system is an integral part of the record player. It is a dual complementary isolation system comprising a Minus-k based isolation platform that is customised for the XD1 which provides very high levels of isolation from 1,5Hz to 100Hz. The isolation from 100Hz and upwards is provided by the suspension units inside the turntable feet.

This dual complementary design allows for continuous isolation from 1,5Hz and across the hole audio spectra that might excite the turntable.

CHASSIS
In order to make the XD1 less susceptible to be affected by external sound pressure waves, it is designed with a compact high-density monoblock chassis. Machined from a single piece of Mg-Si -Al alloy, removing just the minimum required to nest the platter, motor and electronics. There is a lot of metal and very little air in a small volume, making it very dense and therefore less prone to vibrate with high amplitudes.

Along the chassis and the legs, several sharp edges diffract the sound waves reducing the negative impact they have in the sonic performance of the turntable. The chassis and platter have no large flat surfaces and instead smaller curved and chamfered surfaces are used.

LEGS
The massive legs are integral parts of the mechanical structure of the turntable and have a very important contribution into the stiffness and damping characteristics of the system. They have been designed through extensive FEA studies and the geometry and position optimised through virtual design of experiments technology (VDoE).

ARMBOARDS MOUNTING SYSTEM
For the first SAT record player we have developed a new proprietary SAT mount system for armboards which is class-leading in terms of stiffness, ease of use and repeatability of installation. Arms are connected with the motor bracket through massive, continuous and uninterrupted sections of metal for uncompromised rigidity.

The arm does not move with respect to the platter spindle, keeping a stable position and thus generating less distortion. This translates into more resolution, faster and sharper transients as well as longer decays.

DRIVE UNIT
The choice of a direct drive motor as a drive unit was clear from the very incipient conceptual stages, ten years ago. A properly designed DD has several key characteristics that provide superior performance compared to other drive systems.

The rotational speed of the motor is just 33-45 rpm as opposed to several hundreds of rpm found in typical belt-driven designs. The spindle is not loaded laterally and is receiving just a torque. Our drive unit is specifically built from the ground up to be used in a record player application, unlike other off-the-shelf motors used inmost other turntables. It is much better balanced than the motors used on belt-driven and idler turntables.

These factors make the DD much more quieter because there is no side force acting on the motor bearing that creates noise on belt-driven and idler designs. The inertial forces created by the unbalanced motors increase to the square with the rotational speed. These forces can be in the order of more than 102 (100) times bigger than in our DD motor - a motor turning at 330rpm would have 10x the rotating speed of the DD at 33rpm and the inertial forces will be squared. The vibrations of the XD1 motor are lower by a factor higher than 100.

The motor is mounted to a purpose-made massive supporting bracket at three points, providing an accurate coupling without residual stresses. The bracket is connected to the turntable chassis through a high-area contact surface with friction damping.

In order to increase the rigidity of the motor assembly, we developed a motor pre-loading system. The motor stator is rigidly coupled to the chassis at three points above the motor bracket, adding a critical increase in stiffness for the motor assembly. The couplings are pre-loaded after the motor is assembled in the turntable chassis and locked to keep the settings indefinitely. This is a determinant factor in the resolution and dynamics that this turntable conveys.

We also developed a motor damping system. Located at strategic points around the stator of the motor, damping elements reduce the high frequency vibrations that would negatively affect resolution. The motor vibrates less and can rotate the platter more accurately.

The electronics of the control unit are enclosed in a purpose-built chassis machined from a single block of aluminium, with thick walls and isolation feet to reduce the external ground and air-borne disturbances. The isolation is effective from 10Hz and upwards.

PLATTER
The platter has been designed to work within the load capabilities of the motor while providing high inertia and stiffness.

Precision-machined from precipitation-aged Mg-Si-Al alloy with a tall section, achieving increased stiffness for the target mass of the platter. It nests a top platter and a flywheel in the lower portion of the rim.

The platter has a specific distribution of mass across its diameter. A flywheel ring of eutectic polymorphic Swedish brass adds the optimal mass and inertia - tuned for the motor - providing spectacular dynamics and effortless sound.

The interface between platter and turntable is designed with a specific gap to create a laminar flow for constant drag and more stable speed. A tiny exacting gap between the plater rim and the chassis prevents air flow and interference from the exterior, keeping the air trapped between the platter and chassis undisturbed.

Top platter layer made of polymer. It keeps magnetic field away from cartridge for maximum resolution and provides levels of damping not possible with other material formulations. The tiniest micro details can be retrieved by the cartridge once the magnetic interaction with the platter is removed.

The top platter undergoes a precision micro-machining on it top surface. A specific micro-ridge profile is machined with controlled pitch and height, designed to provide unprecedented record coupling to the platter. This feature is proprietary to SAT and is machined on a very unique CNC lathe using dedicated fixtures and diamond cutting tools.

Platter assembly is connected to the rotor of the motor via screws, assuring metal-to-metal and a high-rigidity and stable coupling. This solution is much more effective than dropping the platter onto a spindle/rotor or sub-plater.

BUTTONS
The XD1 uses proprietary buttons mechanism made of solid aluminium and machined with the same care and precision as the rest of the components of the turntable. The speed control buttons and their actuation mechanism are entirely designed and manufactured by SAT specifically for this turntable. They provide a refined touch feeling and a soft actuation with a silky smooth and delicate feedback.

RECORD CLAMP
The XD1 record clamp provides a firm coupling of the record to the platter. Through the use of precision ball bearings, the operation is silky-smooth and the control of the load on the record is very accurate. The record clamp allows to exactly apply the required clamping force to each record, depending on its thickness and level of warps.

VACUUM SYSTEM
For the XD1 I wanted to create a vacuum technology that would be completely passive and have no detrimental effect during playback. It is self-contained in the platter and doesn't need any air passing through the spindle and bearing as in most other designs. This allows the use of higher levels of vacuum if desired because the leaks are much lower and no noise is created.

The bearing doesn't need to be modified to allow air to pass through, nor does any seal need to be used around the bearing. That would cause friction and have more air leaking, demanding a continuous suction which is what it is commonly found in the handful of turntables using vacuum hold-down today.

The proper performance of this passive system puts high demands on the tightness of the components of the platter and pump unit. The special vacuum pump has built-in control electronics and can be programmed to adjust the stroke and frequency of operation. It is rated at more than 26,000 hours of continuous operation.

For the production version of the vacuum system my plan is to improve upon the tightness of the platter seals/lips to increase the vacuum-holding times. I will also re-program the vacuum pump so that it pumps more volume of air during the first seconds and then shifts to a higher vacuum operation mode during the last stage. That should decrease the time it takes to remove air from the platter and hold the vacuum longer.

CF1 Ti arms:
They are a special version of the CF1 arms with structural improvements to provide an even higher performance and bring the XD1 system to unprecedented levels of sound reproduction.

The arm tube is a hybrid construction of carbon fibre laminates and an inner titanium tube that extends to the connection area with the headshell. This alone makes the arm much stiffer than the standard CF1.

On the headshell, the aluminium frame has been replaced by a titanium counterpart and the carbon fibre plate is the same as on the standard CF1 series.

The bearings have also been re-designed and are now stiffer on the CF1 Ti arms.

These three specific features make the arms much stiffer with an increase in mass. That translates into even lower distortion, better transient reproduction and macro/micro dynamics. As I have put it before: bigger and more powerful sound while sounding more relaxed…

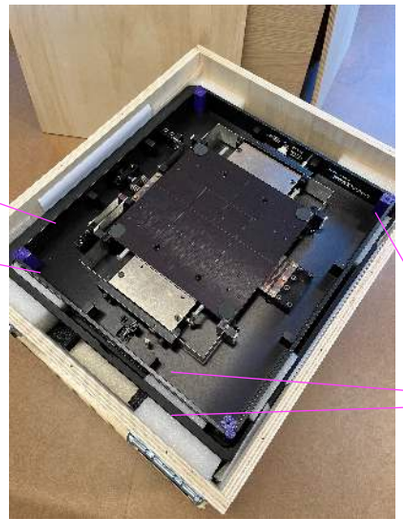
The Ti arms were created to be part of the XD1 system. Can be sold separately at a premium, as the availability of the special parts is limited and I want to keep them for complete XD1 systems.

To install the XD1 Record Player System, we will begin by removing the isolation system from its wooden box (the smaller box) and assembling it on the supporting rack or furniture where the record player will be placed.

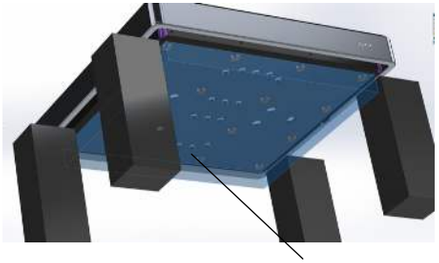
Then, we will remove the main unit, platter and control unit from the bigger wooden box. The main unit will be mounted on top of the isolation platform and the platter on the main unit. The C1 control unit can be placed in any convenient position on the rack, without any other equipment directly on top of it.

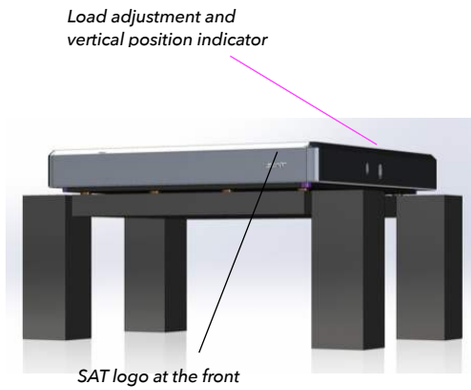
3. Mounting the isolation platform

- Remove the protecting foam pieces around the Minus-k device. Now you can lift the Minus-k and place it in the position where the turntable will be installed. Place it centred on the rack.



- Followed, unscrew 20mm the screws on the sides of the wooden box - they are marked with labels. This will allow you to free the isolation platform which fits very tight in the box.
- Remove the foams on the sides and lift the isolation platform (it weights 21kg). There are two big cutouts on the bottom foam layer to put your fingers under the platform and lift it securely.
- Place it centered on top of the Minus-k with the thick side at the back, with the SAT logo facing you at the front. There should be an equal distance between the Minus-k device and the isolation platform both left to right and front to back.
- Check that the adjusting knob fits into the axle. The knob is at the top foam layer in the big wooden box with the record player.
- Look from underneath and adjust the top platform until you have even spacing on the left and right sides. Front-back position is determined by centering the window in the side of the platform with the adjustment axle. Put the adjustment knob and check that it is centered and the platform can move without hitting it (it only needs to move 3-4mm in all directions, not more!).





4. Mounting the record player

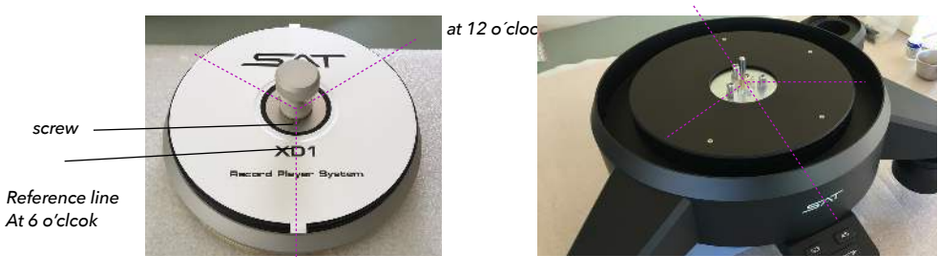
- Remove the power supply unit and put it aside so that you have better access to the record player.
- Take the cable from the record player and wound it in the groove for the platter.
- Grab the chassis by the armboard and the legs (**do not hold it by the speed console**) and lift it to a table or stable working surface. You need two people to do that. One person holds by the armboard and a leg; the other one holds it by the other two legs.

- Now you can lift the chassis more comfortably and bring it to the isolation platform. Carefully fit the feet inside the depressions on the platform.
- The suspension inside the feet is very compliant and the feet need to be “dressed” until the gap between the plastic and the metal part is horizontal and the suspension works evenly. Lift some weight off the feet when doing this adjustments.
- Place the control unit P1 to the desired position on the rack. Remove the cable from the platter groove and connect it to the P1 unit.
- Take the spindle from the foam and remove the platter handle (it is screwed into the spindle). Place the spindle onto the platter and insert the three screws by hand first and then with the supplied green Allen key to the platter. Place the handle, lift the platter and put it on a table with some protection underneath.

- Remove the handle and then start peeling the protecting film and place it on the carrier that was at the top of the foam in the big wooden box. The film will stretch a bit but it is worth keeping it and trying to reuse it. IT IS VERY IMPORTANT TO REMOVE THE PLATTER FILM BEFORE IT IS PLACED ON THE RECORD PLAYER to avoid damaging the bearing.

- Go to the chassis and rotate the motor until any of the three pegs is facing away from you at 12 o'clock. In this position, the three holes underneath the aluminium platter will match with the three pegs.

- Place the handle again and now rotate the platter until the the screws on the spindle are facing you as depicted.

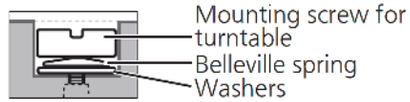


- Bring the platter to the chassis and very carefully lower it with the reference line centered at 6 o'clock. Hold the platter and let it center itself by gravity - do not force it down as the fit is very tight. If the platter does not go all the way down because the holes do not match the pegs, lift it again, center both motor and platter and try again.

- Remove the handle and the spindle to access the internals of the platter; you should see three holes.

- Take the plastic bag with 3 sets of screws and washer from the top foam inlay. Place the washers in each hole in the sequence described in the paper (flat washer first, conical washer second). Make sure the conical washers land with the correct side on the platter. Use the green Allen key as a guide and drop the washers as if they where firemen going down the pole…

- With the provided red screwdriver, bring all bring screws down until they touch the washers WITH NO TORQUE. Then start tightening every one of them by very small amounts in a sequential way. All to avoid creating any unbalance in the torque and pre-load that will not seat the platter evenly against the motor. Make increments of 10 degrees and maybe even less towards the end when you start feeling resistance. When you start to encounter a fair amount of resistance, meaning that the conical washer has been compressed, stop. Every now and then rotate the platter and check that it does not wobble..



- At the end, check it spins evenly with no wobble using the motor. If not properly seated, remove all tension from the screws and start again.

- Put the spindle back. Insert the two stainless steel washers that come in a small bag to the spindle. They are used in combination with the record clamp to lift the records and clamp them against the platter.

5. Adjustment of isolation system

The XD1isolation system is designed to provide exceptional isolation from just a few Hz up to 20KHz. It is divided in two sections: the first one is the Minus-k negative stiffness with the platform on top, providing isolation from 0,5Hz up to 100Hz; the second one is the isolation feet on the XD1 main unit, providing isolation from 100Hz and above.

The feet do not require any adjustment during setup, other than making sure they are parallel to the surface of the top platter.

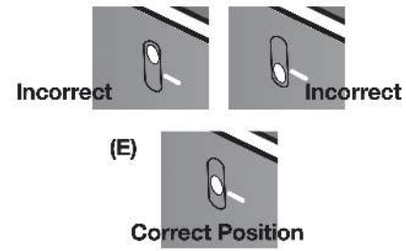
The Minus-k device must be properly adjusted for the specific mass of every setup. This device uses negative stiffness to provide exceptional isolation from very low frequencies. It is a system of different kinds of springs that interact with the mass of what is placed on top of it. By adjusting the device we make the platform "float" for a given mass.

That means that we must have everything which will be used while playing a record on top of the isolation platform before we can adjust the system: a record, the arm with the cartridge, all the cables dressed in a way to minimally interfere with the free movement of the isolation platform, the record clamp as well as any other device or equipment that will always be on the platform.

The adjustment for the load (the mass) is carried by turning a knob on the right side. Turning clockwise increases the load carrying capacity and counterclockwise it decreases it. Next to the adjusting knob, there is a small window to visually access the vertical position indicator. When the load capacity is correctly set, the indicator should be centered. If the indicator is in the lower position it means the load setting is too low and it must be increased until the platform "floats" with the indicator centered.

If the indicator is above the center position it indicates the load settings are too high and must be decreased.

You might need to turn the knob quite a number of times to bring the system to the correct load settings. This is completely normal.



- Have the arm with a cartridge installed, dress all the cables for minimal interference with the free movement. Place a record, the record clamp and washers and any other equipment that will be permanently used on top of the platform (like cartridge guard, brush, etc.)

- Take a look at the vertical position indicator. If it is indicating a low position, add more load by turning the knob clockwise until the indicator reaches its center position.

- If the indicator is above it center position, remove load by turning the adjusting knob counterclockwise until the indicator reaches its center position.

- With the indicator in its center position, bounce the platform with your fingers very gently. It should oscillate up and down with a frequency of 0,5-0,8Hz (about 1,5-2 oscillations per second) and slowly decrease the amplitude of the oscillations. This will indicate a proper adjustment.

Proper adjustment of the Minus-k device must be checked regularly in case any change to the system load or the cable's tension has inadvertently been made. It is enough to just make the platform bounce with your fingers and see it can freely move with a low bouncing frequency. Check the vertical position indicator moves up and down and in its center position.

6. XD1 operation

Connect the 5-pin connector to the back of the C1 unit.

Press the power button on the control unit to turn it on. The display on the C1 unit and the LED on the speed selection button on the main unit are lit.
The platter starts and stops rotating when the [START/STOP] button is pressed.

The speed selection might be done both from the turntable itself or from the C1 control unit.

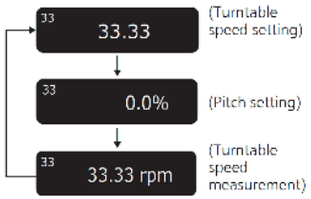
Speed selection:

It can be made from the control unit by alternatively pressing the speed button to select 33.33 , 45 or 78rpm. It can also be selected by pressing the speed buttons of the main unit - in this case only 33.33 and 45 rpm can be selected.

Display mode:

Each time [Display] is pressed, the display mode changes according to this sequence:

Selected Speed -> Pitch setting -> Measured speed



The turntable measured speed is the actual rotating speed of the platter in real time. When “rpm” appears after the actual speed it means it is displaying the measured speed as opposed to the selected speed that is always shown without “rpm”.

Pitch adjustment:

Pitch can be adjusted for each nominal speed to ±16% of the currently set turntable speed.

The speed might be changed while the platter is rotating or stopped. Depending on the display mode, the pitch setting will be displayed as:

- turntable speed and can be adjusted in increments of ±0,01rpm.
- pitch percentage over or below the nominal speed and can be adjusted in increments of ±0,1%.

When the pitch is set to other than 0rpm or 0%, the blue LED light on the speed button will change to orange, denoting a deviation from the nominal speed.

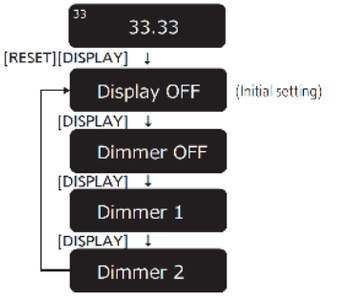
By pushing the [RESET] button, the pitch adjustments are cancelled and the unit returns to the nominal speed. The LED light becomes blue again on the button of the concerned speed.

The pitch can be set for each turntable speed independently. Turning off the power cancels the pitch settings.

Dimmer setting:

The display of the control unit can be set to be dimmed or fully switched off.

The display dimmer will be activated if the control unit is not operated for 20s. There are four dimming patterns:



Display	Display dimmer when no operation is performed for 20 seconds
Display OFF	Brightness is reduced by one level. ⇒ (No operation for further five seconds) ⇒ Brightness is reduced by two levels. ⇒ (No operation for further five seconds) ⇒ Off
Dimmer OFF	No dimming (Always on)
Dimmer 1	Brightness is reduced by one level.
Dimmer 2	Brightness is reduced by two levels.

To enter into the dimmer control function, press [RESET + DISPLAY] simultaneously. You can toggle between the different settings by pressing the [display] button.