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Classical Composition

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Pitch-Class Set Theory as a Tool for Microtonal Music Analysis: A Study of *Lullaby in 22 EDO*

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Abstract

In my final research paper, I will explore the use of pitch-class set theory as an analytical tool for microtonal music, focusing on my own composition *Lullaby in 22 EDO* for electric keyboard and viola. While pitch-class set theory was originally developed within the framework of 12-tone equal temperament, I will apply its core concepts, such as set classes, interval vectors, and symmetry, to the context of 22-tone equal temperament. This application will not be limited to my own composition but will also reflect on its broader relevance and effectiveness to microtonal analysis.

Aknowledgements

A sincere and heartfelt thank you to Hans-Gunter Lock, my supervisor, mentor, and friend, for his commitment, guidance, and for paving the path on which much of this research is built.

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Introduction

This research lies at the intersection of music theory and composition. It explores the application of pitch-class set theory to microtonal music, with a particular focus on 22-tone equal temperament (22 EDO[1]). While traditionally used within the framework of 12-tone equal temperament, pitch-class set theory can be extended to other tuning systems, providing a powerful tool for the analysis of structure, symmetry, and harmonic organization in so-called xenharmonic[2] music.

22-tone equal temperament has a short but well-documented history in Western microtonal music. Its use was inspired in the nineteenth century by Western interest in the 22 śrutis of Indian classical music, leading to early proposals such as Robert Holford Macdowell Bosanquet's division of the octave into 22 equal steps (Bosanquet 1878). In more recent microtonal theory, 22 EDO has been further developed as a practical harmonic system, notably in the work of Paul Erlich (Erlich 2002). Beyond theoretical discussion, 22 EDO has also been explored through composition, performance, and teaching. As documented in recent projects connected to the Pärnu Contemporary Music Festival (Pärnu Nüüdismuusika Festival PNP) in Estonia in the years 2021, 2022 and 2023, the tuning has functioned as a concrete framework for musical practice and experimentation (Lock 2025:171–174, 179–180).

My own composition, *Lullaby in 22 EDO* , for viola and electric keyboard (Lujan, 2025; see Annex D), will serve as the main case study. Through this piece, I aim to apply set-theoretical tools to identify and classify recurring pitch-class collections, such as triads, tetrads, and more complex harmonic groups, according to their structure within 22 EDO. The analysis will explore how these harmonic entities relate to each other, both intervallically and functionally, and will consider their place within the broader framework of emerging 22 EDO theory. In particular, I will compare these groupings to known 22-tone chords, symmetric chords, and relevant scales.

The key research questions are:

- How can pitch-class set theory be effectively applied to analyse microtonal music in 22 EDO?
- What kinds of harmonic structures emerge in this tuning, and how can they be classified?
- How do the harmonic groups in *Lullaby in 22 EDO* relate to the current theoretical approaches within 22 EDO?

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[1] Equal Divisions of the Octave

[2] Xenharmonic refers to musical systems, scales, harmonies, and melodic structures that fall outside the framework of the Western 12-tone equal temperament. The term was introduced by composer and theorist Ivor Darreg to describe "new, unusual harmony," derived from the Greek *xenos* ('foreign', 'strange'), and is commonly used to denote music employing unfamiliar pitch organizations, including alternative equal temperaments and other non-standard tuning systems (Darreg 1963).

- What compositional insights can be gained from this form of analysis?

In addition to the analytical work, the project will include a brief reflection on the compositional process, considering how theoretical frameworks shaped the construction of the piece. The research will take a qualitative and exploratory approach, aiming to demonstrate both the analytical potential and the musical richness of 22 EDO through a synthesis of theory and practice.

1.1 Pitch-class set theory and its relevance to microtonality

In twentieth-century music theory, pitch-class set theory emerged as a powerful framework for describing and analyzing post-tonal music. Developed from the work of Milton Babbitt, Allen Forte, and others, it treats pitches abstractly as members of a closed mathematical system: twelve discrete points arranged cyclically within the octave (Babbitt 1960: 73–75; Forte 1973: 3–4). Within this system, each pitch is assigned a numerical value from 0 to 11 (0 = C, 1 = C#, 2 = D… B = 11), and musical relationships are expressed through modular arithmetic operations[3] such as modular addition for transposition and modular multiplication by -1 for set-inversion.

This abstraction allows theorists to describe musical structures in purely intervallic terms, detached from tonal hierarchy or cultural context. A chord or collection of pitches becomes a set, and its interval vector (a count of the interval classes it contains) acts as a compact summary of its internal structure. In this way, set theory provided composers and analysts with a consistent language for understanding atonal works by Schoenberg, Webern, and their successors.

For composers exploring microtonal systems, set-theoretical methods offer a way to map and compare unfamiliar pitch worlds without relying on tonal function or historical convention. By abstracting pitch relationships into a numeric form, the composer can recognize equivalences, symmetries, and intervallic balances within any tuning system. This analytical neutrality (independence from specific acoustical or aesthetic assumptions) makes set theory particularly suited to microtonal practice, where consonance, hierarchy, and even octave equivalence may differ from Western norms (Lock 2021: 3–4).

In this sense, pitch-class set theory provides not only an analytical framework but also a creative scaffold: a means of organizing and generating microtonal materials systematically. It allows microtonal composers to think structurally, tracing continuities between historical twelve-tone methods and new tuning environments.

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[3] *Modular arithmetic* is a branch of arithmetic in which numbers "wrap around" after reaching a fixed value, known as the modulus. In twelve-tone theory, pitch classes are calculated modulo 12, so that intervals and transformations are understood cyclically within the octave rather than linearly. (Wikipedia 2025, accessed 22 December 2025).

2.Applying pitch-class set theory in 22-EDO

2.1 Contextual considerations

Adapting pitch-class set theory to 22-tone equal temperament mainly requires adjusting the system to a larger modulo environment. In 22 EDO, the octave contains twenty-one possible intervals instead of eleven, which reduce to eleven interval classes plus a single self-inverting midpoint. This gives the system a higher intervallic resolution: small changes between pitches create clearer differences in the interval vectors and sets that look similar in 12 EDO often separate into distinct categories in modulo 22.

Another important difference concerns symmetry. Since the octave in 22 EDO cannot be evenly divided in as many ways as in 12 EDO, symmetric sets[4] are much rarer. Most sets move through all twenty-two transpositions before repeating, and inversion usually produces a noticeably different interval pattern. This reduces the number of sets that collapse into the same class, making prime-form reduction a more neutral and less compressive operation. It also means that inversional pairs tend to feel less closely related, because inversion often reshapes the microtonal distances between pitches.

The following sections describe the transcription and conversion procedures used to translate the score into modulo 22 pitch classes, providing the basis for the set-theoretical analysis.

2.2 Harmonic transcription process

The first step consisted of producing a chord-by-chord harmonic transcription of the composition (see Annex A). The keyboard part of the piece was originally written in conventional music notation, even though the instrument itself was tuned to 22 EDO. In other words, the notated pitches on the piano do not correspond to their usual 12-tone pitches. The physical octave of the instrument (its real sonic span) is equivalent to one notated octave plus a minor seventh in conventional notation.

Despite this discrepancy, the score remains fully valid as a source of pitch-class information, since it is organized chromatically. Each successive semitone in the written notation corresponds to one step in the 22 EDO division. In this sense, the score functions as a *chromatic transcription* of the sounding result, preserving pitch-class relationships while abstracting away from their conventional 12 EDO intonational meanings.

[4] This discussion concerns symmetry in the pitch-class set-theoretical sense (self-similarity under transposition or inversion), not MOS scale symmetry. Although 22 EDO contains many MOS scales, these do not create transpositionally invariant pitch-class sets.

During the transcription process, I systematically eliminated all (octave-)doubled pitches (since pitch-class analysis ignores register duplications) and included the viola line whenever it contributed to the harmonic structure. To visually distinguish this additional voice, I used rounded-dot notation for the viola notes in my transcription. The goal of this stage was to create a clean, unambiguous record of all pitch material contributing to the harmonic texture at any given moment.

2.3 Conversion to pitch-class sets

Once the transcription was complete, I created a MIDI version of the score so that the harmonic material could be processed computationally. MIDI does not store tuning information; it represents pitches only as numerical symbols. Although these numbers are usually interpreted according to the conventional 12-tone system, this interpretation is not inherent to the MIDI data itself. In this project, each step between MIDI pitch numbers was instead treated as one step of the 22 EDO system. This approach preserves the chromatic relationships of the score and allows the pitch material to be mapped consistently onto a 22-EDO pitch-class system for analysis.

Using MaxMSP[5], the MIDI data was then analysed to extract pitch-class set numbers. The algorithm was instructed to treat the tuning in mod 22 arithmetic, taking A2 as pitch class 0. From this reference point, pitch values were mapped cyclically (so that G4 two octaves higher would once again correspond to pitch class 0).

This system allows for all pitches in the piece to be expressed as integers between 0 and 21, representing the full chromatic cycle of 22 EDO. Once all pitch classes were mapped, the resulting sets were reduced to their prime forms, following the standard procedure of identifying transpositionally and inversionally equivalent sets.

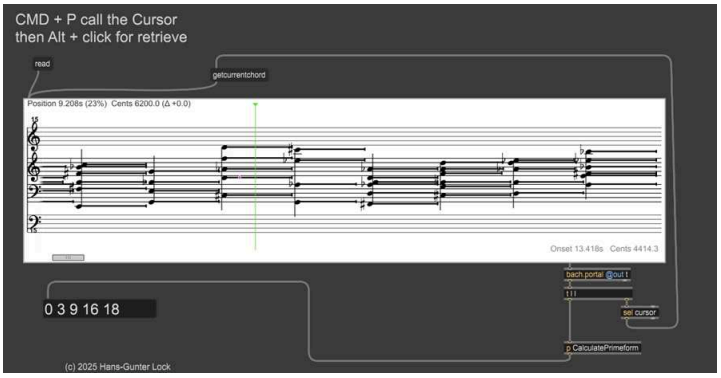

Figure 1. Maxpatch 22 EDO pitch class set prime form finder

[5] The Maxpatch was programmed by Hans-Gunter Lock

2.4 Classification framework

In order to classify the harmonic structures that appear in *Lullaby in 22 EDO*, I combine two distinct but complementary systems of categorization. The first consists of Hans-Gunter Lock's pitch-class set tables (Lock 2021; see Annex B), developed for equal temperaments between 13 and 24 divisions of the octave. The second is an extended table (see Annex C) I produced by merging Sean Archibald's (Sevish's) 22-EDO chord names (Archibald, 2025) with the full DQ (Double Qualifier) triad list used in the tuning-theory community (Xenharmonic Wiki n.d.). Although these two resources operate on different principles, together they offer a more complete and musically meaningful way of understanding the chords in the piece.

The Sevish and the DQ system is grounded in **root-based harmonic identity**. Every chord is described as a pattern of intervals above an implied root, terms such as *subminor*, *supermajor*, *barbershop seventh*, or *double major* depend on the directional relationship between the chord's pitches. These names encode perceptual and functional information: they describe how the chord behaves or sounds within the 22-EDO environment. To compare my own chords with this system, I use a simple root-normalized pitch-class format, in which the lowest pitch is assigned 0 and the remaining pitches are expressed as ascending steps modulo 22. This preserves the "shape" of the chord as it is perceived, and it matches the format in which Sevish's own chords are published.

In contrast, Lock's pitch-class set tables operate in a completely different domain. Here, the goal is not to describe how a chord functions above a root but to assign it a **set-class identity** independent of orientation. Lock's method is directly inspired by Forte's and Solomon's 12 EDO pitch class set theory. It extends this approach to arbitrary equal temperaments (n-EDOs) as they are often used by contemporary microtonal composers. The sets are made equivalent under transposition and rotation, and each is assigned a prime form that represents its most compact arrangement and given a systematic set-class name similar as Forte and Solomon do, but Lock adds a subscript prefix specifying the modulo number (e.g. $_{\%22}$3-31B with the primeform structure $_{\%22}$ (0 8 12) (Lock 2021:4–9). This form is necessarily abstract; it removes any suggestion of harmonic function or root, instead highlighting the chord's internal intervallic structure viewed as an unordered collection. While this is not useful for identifying "what kind of chord" something is in the harmonic sense, it is extremely valuable for tracking underlying structural regularities across the piece, relationships that might not be audible as harmonic categories, but which reveal compositional tendencies at a deeper theoretical level.

Taken together, these two systems provide a more balanced understanding of the harmonic language of the composition. Sevish/DQ names allow me to describe chords as they are heard within 22 EDO practice, while Lock's prime-form classifications reveal **broader structural patterns beyond functional harmony**. Neither system

alone offers a complete picture, but in combination they allow both the musical and the abstract properties of each chord to be recognized. This dual perspective supports a richer analytical engagement with the material and clarifies how different harmonic identities interact within the tuning system.

3. Harmonic Inventory of *Lullaby in 22 EDO*

Lullaby in 22 EDO unfolds through an episodic formal design, in which each segment presents a distinct harmonic and expressive environment. Rather than following a traditional developmental logic, the piece progresses through six discrete sections, each initiated by a change in character marking. These indications, such as Noble y Sereno or Flemático Melancólico, function not merely as performance directions but as structural signposts, delineating shifts in texture, harmonic density, and temporal perception. Their poetic or abstract nature suggests that the form is guided more by evolving affective states than by thematic transformation or motivic continuity.

Before examining the harmonic behaviour of each section individually, it is useful to establish a global overview of the structures that constitute the piece. A preliminary quantitative analysis clarifies the scope of the harmonic vocabulary and provides a baseline for later, more detailed observations. Accordingly, **the analytical process moves from broad to specific: we first determine the overall dimensions of the harmonic material and then consider how these resources operate within each section.**

3.1 Distinct chord count

The first step in the analysis is to determine how many different chords appear in the piece. This is essential because it establishes the size of the harmonic vocabulary from which all sections draw. Knowing how many unique structures the composition uses provides a baseline for understanding whether the harmony relies on a small, recurring set of chords or on constant innovation, information that will later help us interpret how each section behaves in relation to the whole.

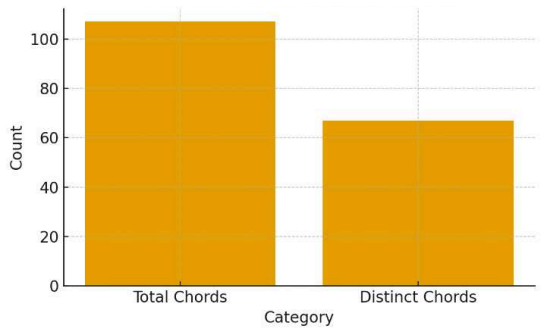

Figure 2. Total chords vs. Distinct Chords.

The first measure shows that the score contains 107 chordal events, of which 67 are distinct. This indicates a balance between recurrence and novelty: some chords return as harmonic anchors, while many appear only once.

3.2 Cardinality distribution

For now I have used all 107 chord events, because this tells you how the listener experiences harmonic density over time (how often you really hear triads vs hexachords, etc.).

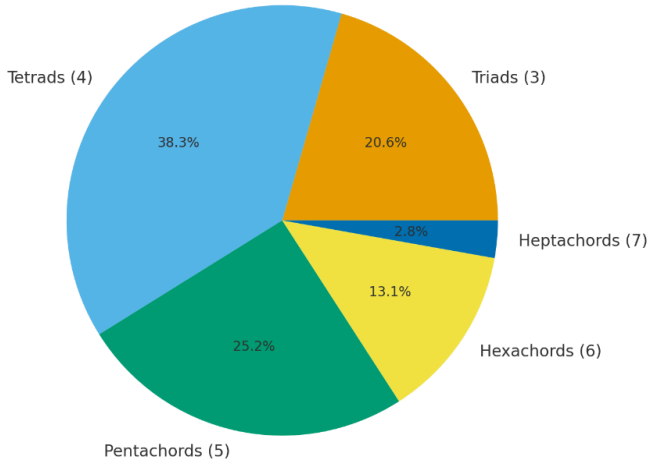

Figure 3. Cardinality of the Chords

The cardinality distribution shows that tetrads and pentachords account for the majority of chordal events (together about two thirds of the total), while triads and hexachords appear less frequently and heptachords are rare. This suggests a preference for medium-density sonorities: the piece rarely reduces harmony to bare triads, but also only occasionally saturates the texture with six- or seven-note collections.

3.3 Frequency of each distinct chord

This metric is crucial because it reveals the hierarchy within the harmonic language: some sonorities occur only once and function as local color, while others recur prominently and thereby acquire structural or referential significance.

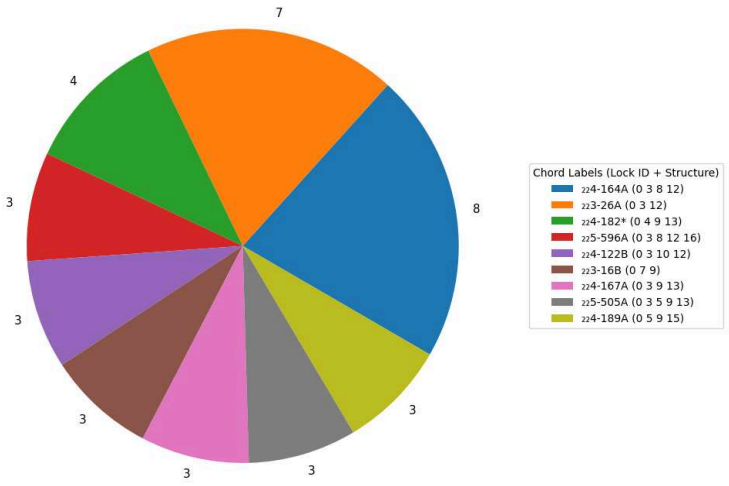

Figure 4. Chords repeated ≥ 3 times

The graph shows that only a small group of nine chords recur three or more times, forming the core harmonic language of the piece. Two of them, $_{22}$4-164A and $_{22}$3-26A, appear far more often than the others and act as the main structural reference points. The remaining chords, each appearing three or four times, support specific expressive or sectional functions.

The most frequently recurring chords share a tendency toward neutral, open, and lightly dissonant interval structures, often built from combinations of 22 EDO thirds, pure fourths/fifths, and characteristic microtonal inflections (such as the septimal variants). The two most dominant sonorities, $_{22}$4-164A (0 3 8 12) and $_{22}$3-26A (0 3 12), feature stable anchors like the pure fourth (9 22 EDO steps) and intervals close to neutral thirds (WT and 7maj3), giving them a balanced, resonant quality suited for structural returns.

Other repeated chords (appearing 2 times) are:

Chord	Structure
$_{22}$3-31B	$_{22}$(0 8 12)
$_{22}$3-23B	$_{22}$(0 6 9)
$_{22}$3-38B	$_{22}$(0 7 13)
$_{22}$4-155B	$_{22}$(0 7 10 13)
$_{22}$4-181B	$_{22}$(0 5 9 13)
$_{22}$4-158*	$_{22}$(0 3 10 13)

Chord	Structure
$_{22}$4-135A	$_{22}$(0 2 9 13)
$_{22}$5-528B	$_{22}$(0 6 9 13 15)
$_{22}$5-577A	$_{22}$(0 3 6 11 15)
$_{22}$5-595A	$_{22}$(0 3 7 12 16)
$_{22}$HEX-01[6]	$_{22}$(0 4 7 10 13 17)
$_{22}$HEX-02	$_{22}$(0 4 8 11 13 17)
$_{22}$HEX-03	$_{22}$(0 4 8 11 14 17)

Figure 5. Other repeated Chords

3.4 Distribution of A / B / * chord types

A further level of detail in the harmonic vocabulary emerges when examining the distribution of A, B, and * types in the Hans-Gunter Lock system. These categories distinguish between narrow forms (A), wide forms (B), and symmetrical structures (*), offering insight into how interval spacing behaves across the piece. For this step, only the 67 distinct sonorities in the piece are considered, rather than all 107 chordal events.

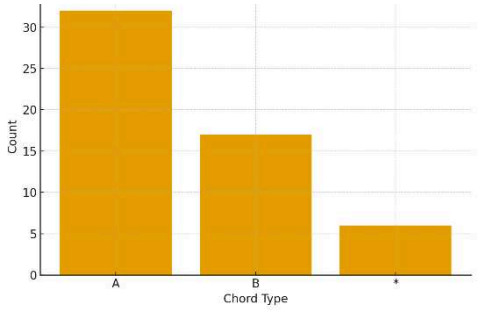

Figure 6. Distribution of A/B/* Chord Types

The distribution shows a clear preference for **A-type (narrow) sonorities**, which make up more than half of the classified chords. B-type (wide) structures form the second-largest group, while symmetrical * forms appear relatively rarely. This suggests

[6] Lock's pitch-class set tables for 22-tone equal temperament extend only up to pentachords, as the number of possible hexachords was considered too large to systematize, and no table has been published. Hexachords are therefore labeled here with the neutral prefix HEX and an ordinal number, ordered by compactness in accordance with the principles underlying Lock's A/B distinction.

that the piece's harmonic vocabulary leans toward **compact interval spacing**, with wider and symmetrical intervals serving more specialized or coloristic roles.

3.5 Interval-class tendencies

The next step is to examine the interval classes that make up the 67 distinct chords in the piece. This reveals the underlying "interval DNA" of the harmonic language, independent of chord labels or sectional function. We will extract this information from the interval vectors from Lock's tables plus the hexachords and heptachord that I calculated myself.

The interval-class profile shows a strong preference for pure fourths (9 steps) appearing in 48 of the 67 chords, making them the most structurally significant interval in the harmonic vocabulary. They are closely followed by the two whole-tone sizes (3 and 4 steps), and by all four types of third the standard and septimal versions (6, 7, 5, and 8 steps). Fifths (13 steps) appear consistently but not overwhelmingly, while tritones (10-12 steps) occur with moderate frequency.

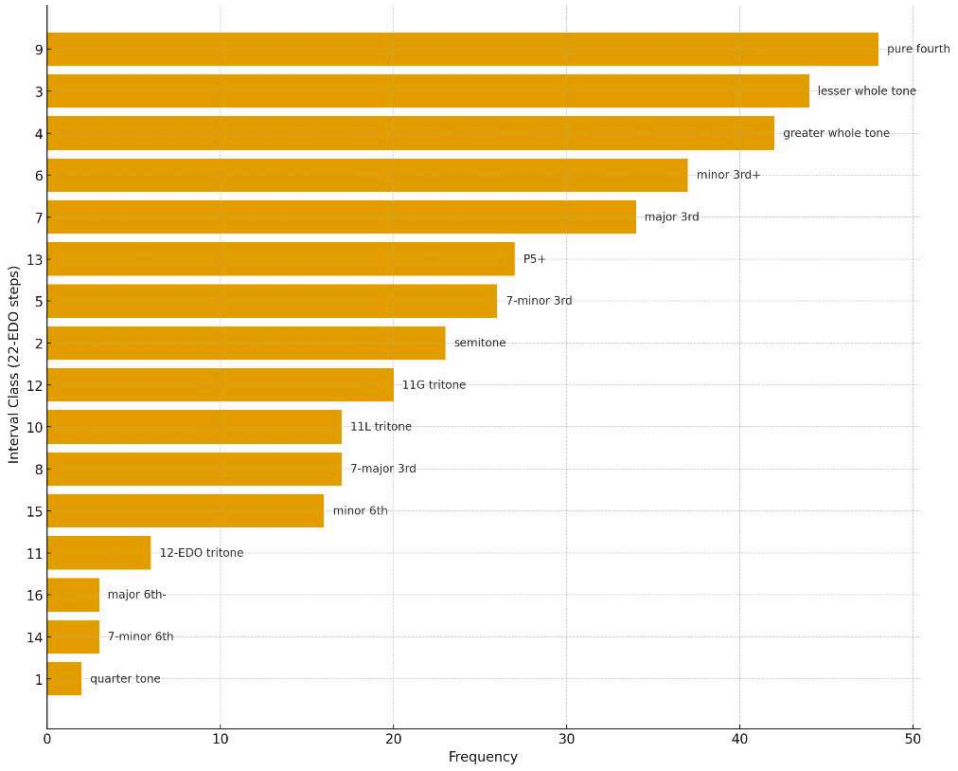

Figure 7. Interval- Class Distribution Across 67 Distinct Chords

3.6 Sevish-DQ classification

To complement the abstract classifications of Lock's system, this step compares each chord's root-normalized form (not its prime form) to the Sevish–DQ taxonomy, which identifies chords by their perceived interval shape in 22 EDO. This allows us to see whether any of the structures in the piece correspond to recognizable chord types within current microtonal practice.

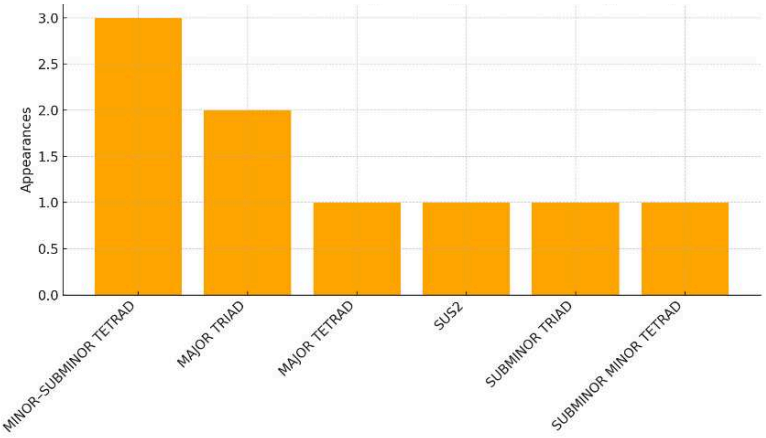

Figure 8. Occurrences of Sevish-DQ Chord Types

The Sevish–DQ comparison reveals a very limited subset of recognizable harmonic types within the piece. Only six named categories appear at all, and most occur just once. The Minor–subminor tetrad is the only chord type used with any real recurrence, while the rest, major triads, subminor triads, and suspended forms, appear sporadically and without establishing a functional harmonic pattern. This distribution suggests that the piece touches the edges of known 22 EDO harmonic vocabulary without relying on it systematically.

The small number of matches confirms that the Sevish–DQ system, while valuable for describing familiar microtonal structures, is not especially effective for analyzing this piece. One reason is simply statistical: the number of possible 22 EDO pitch combinations is enormous, making coincidental overlaps unlikely. Another is conceptual-theoretical naming conventions for 22 EDO are still emerging, meaning many harmonic shapes used here may not yet have established labels. Rather than offering functional insight, this step instead highlights how much of the piece lies outside currently codified 22 EDO practice.

4. Sectional analysis

Noble y Sereno[7] (bars 1–29)

This opening section introduces most of the harmonic material used throughout the piece. Tetrads and pentachords predominate, and many of the later recurring sonorities, such as $_{22}$4-182*, $_{22}$4-164A, and $_{22}$3-26A, appear here for the first time, establishing the intervallic profile on which the piece relies. A-type chords are slightly more common, and the interval content is consistent with the global tendencies: pure fourths, whole tones, and variant thirds form the core of the sonorities. Although a few Sevish-classifiable chords appear, they do not shape the harmony functionally. Overall, the section acts as the harmonic point of departure, presenting the vocabulary in its most neutral and unpressured form.

Con Pesadumbre[8] (bars 30–38)

This section draws from a smaller and more focused subset of the harmonic vocabulary. Several chords recur in close succession, including $_{22}$3-26A and $_{22}$4-122B, resulting in a more concentrated harmonic profile. Tetrads continue to dominate, but the reduced variety and increased repetition align with the marking *Con Pesadumbre*, giving the harmony a more burdened and introspective quality. Interval content shows a stronger emphasis on **minor-third** and whole-tone variants, both stable components of the work's intervallic language.

Remoto (bars 39–58)

Remoto presents the **widest harmonic dispersal** so far, introducing several new pentachords and hexachords while also recalling earlier sonorities like $_{22}$4-182* and $_{22}$5-596A. The mixture of A and B types becomes more balanced, and the interval structure tilts toward greater use of whole-tone, and minor-third classes, producing a sense of distance or suspension consistent with the marking. Several chords appear only once, and local continuity is achieved more through texture and spacing than through direct harmonic recurrence. The appearance of a few Sevish-matched sonorities (SUS2, major triad) is again incidental rather than functional. Overall, this section behaves as a harmonic expansion zone: it broadens the vocabulary, reduces structural anchoring, and momentarily shifts the piece into a more exploratory space

Vivaz[9] (bars 59–70)

[7] Noble and Serene
[8] Grieving
[9] Lively

This section reintroduces rhythmic and harmonic energy by favouring **brighter interval structures and a higher incidence of major-third** (7 22 EDO steps) and pure-fourth (9 22 EDO steps) relationships. The recurring chord $_{22}$4-164A becomes especially prominent, functioning as a pivot between continuity and renewal. Tetrads dominate once again, and the presence of recognisable Sevish sonorities, including the subminor triad and subminor minor tetrad, contributes flashes of functional clarity within an otherwise non-functional environment. A and B forms appear in alternation, generating a playful, active harmonic surface. The frequent return to (0 3 8 12) stabilises the harmonic flow.

Cadencial (bars 71–81)

Despite its name, this section avoids traditional cadential behaviour and instead relies on **recurrence and cyclic intensification**. The harmonic field is dominated by three highly persistent chords: $_{22}$3-26A, $_{22}$4-164A, and $_{22}$4-189A. Their rotation produces a sense of **gravitational pull rather than functional resolution**. Intervallic material centres on pure fourths, minor-thirds variants, and compact A-type structures, reinforcing the sense of coherence and closure. The minor-subminor tetrad appears repeatedly, becoming the most prominent Sevish-recognisable sonority in the work, though without taking on a functional role. This section behaves almost like a harmonic pedal: a stable, self-reinforcing sonority that anchors the music not through function, but through persistent colour and repetition.

Flemático Melancólico[10] (bars 82–89)

The final section renews harmonic introspection by restricting the vocabulary almost exclusively to previously established recurrent chords, especially $_{22}$4-164A and $_{22}$3-26A. This creates a reflective, static environment that contrasts with the forward momentum of the preceding *Cadencial*. A-type structures dominate, and the interval profile narrows to focus on thirds, fourths, and mild fifth expansions, avoiding the more saturated textures earlier in the work. The reappearance of $_{22}$5-528B and $_{22}$5-302B introduces subtle colour but does not disrupt the prevailing restraint. As a closing gesture, this section functions less as a harmonic development than as a gentle distillation of the piece's core intervallic identity, aligning well with the melancholic expressive marking.

[10] Phlegmatic, melancholic. The term is used in reference to the classical (notably Hippocrates and later Galenic writings) four-temperament psychology, combining the phlegmatic temperament (emotional restraint) with the melancholic temperament (introspective affect).

5. Composer's perspective: reflection on compositional decisions

The strong presence of tetrads and pentachords in *Lullaby in 22 EDO* reflects a practical and aesthetic decision about how harmony behaves in this tuning. In my experience, triads in 22 EDO often sit in an uncomfortable middle ground: they can sound too close to familiar tonal gestures, suggesting functional harmony, but at the same time they are often not rich enough to sustain longer, static passages. On the other end, larger pitch collections can easily blur intervallic detail, making the specific qualities of the tuning harder to perceive.

By working mainly with four- and five-note chords, I aimed for a balance between richness and clarity. These medium-density sonorities are dense enough to feel warm and enveloping, but still transparent enough for characteristic 22 EDO intervals, such as neutral thirds, septimal inflections, and pure fourths, to be heard clearly and intentionally, rather than as vague "out-of-tune" effects.

This concern is articulated clearly by the Finnish composer Juhani Nuorvala, who, in a 2016 interview, asks: *"Is this removed enough or improved enough from 12-TET to justify all the trouble involved, for myself and the performers?"* He follows this with another question: *"Is this out-of-tune weirdness that will only be appreciated by a club of initiates?"* (Nuorvala 2016, accessed 18 September 2025) These questions capture a tension that was central to my compositional thinking. Avoiding triads was not about rejecting familiarity altogether, but about finding harmonic situations where the use of 22 EDO feels clearly justified. Medium-density chords make the music sound unmistakably xenharmonic, while still retaining elements of familiarity that can produce emotional impact. As Nuorvala puts it, *"to give you goosebumps, music has to have some poignant familiar elements,"* and this balance between familiarity and freshness was a guiding principle throughout the piece as also visible in the first statistic, the size of the harmonic vocabulary.

When it comes to the A/B/* statistics, the predominance of A-type (narrow) chords can be understood not only as an expressive and artístic choice, but also in relation to the physical layout of the keyboard. On a regular keyboard, a 22 EDO octave is distributed across what would normally be an octave plus a minor seventh, which means that even relatively simple interval combinations can require a large hand span. This naturally favours more compact harmonic shapes that are easier to reach, repeat, and control. Although the statistical analysis is based on prime forms and therefore abstracts away register, these physical conditions still influenced the compositional process. In this sense, the prevalence of narrow sonorities reflects both an aesthetic preference and an embodied interaction with the instrument.

When it comes to interval-class identity, I rely heavily on the fourth as a structural element. Unlike the fifth, which in 22 EDO often brings strong tonal associations with

it, the fourth feels stable without pushing the harmony toward functional resolution. For me, it works as a grounding interval that supports continuity while leaving the harmonic direction open. Alongside this, I frequently use whole-tone steps and different third variants, including septimal and neutral forms. This reflects a desire to blur clear distinctions between major, minor, and neutral qualities, allowing harmonic colour to shift depending on context rather than settling into fixed categories. At the same time, these interval choices are also shaped by the physical reality of the keyboard. On a regular keyboard, a 22 EDO octave is distributed across a wider physical span, and intervals such as fourths, whole-tone steps, and compact thirds tend to fall more naturally under the hand. They are easier to combine, repeat, and sustain, and their presence in the piece reflects not only how they sound, but also how they feel to play while composing.

When it comes to the Sevish/DQ taxonomy turned out to be of limited use for this analysis. Instead, familiar structures such as the minor-subminor tetrad are used mainly for their clarity of sound, not for any implied harmonic function. This reflects a broader compositional stance: theoretical systems are used as descriptive tools rather than prescriptive frameworks.

6. Conclusions

The following concluding remarks step back from the detailed analysis to consider what the application of pitch-class set theory to *Lullaby in 22 EDO* revealed, both about the music itself and about the compositional process behind it.

One of the more unexpected outcomes of this research was how useful pitch-class set analysis turned out to be in a microtonal context. While such methods are often associated with analysis of twelve-tone or post-tonal music, working with pitch-class data in 22 EDO proved not only applicable, but surprisingly flexible. The value of the method lies less in any fixed analytical model and more in its adaptability: the choice of which data to extract, how to organise it, and what aspects to foreground can all be adjusted to suit the music and the questions being asked. This flexibility makes pitch-class set analysis a particularly effective tool for exploring form. In the Western tradition, harmony and repetition have long been central to how musical structure is perceived, even when functional tonality is absent.

In my case, the analysis also revealed aspects of the compositional process that were not fully conscious at the time of writing. Patterns of recurrence, the consistent return of certain chord types, and the narrowing or expansion of harmonic vocabulary across sections closely align with the expressive intentions suggested by the character markings. Rather than contradicting these intentions, the data confirmed them, showing how decisions made intuitively at the keyboard resulted in a coherent large-scale structure.

Ultimately this study makes clear is that pitch-class set class systems, the classical twelve-tone one as well as microtonal versions for arbitrary equal temperaments can function as a working tool within the act of composition itself when applied to microtonal music, rather than only as an analytical method used for finished compositions. By translating intuitive harmonic decisions made in a 22-tone equal temperament context into a clear structural overview, it offers a way to move between listening, writing, and reflection without relying on functional harmony or established serial models. In this sense, the value of the approach lies not in categorising the music, but in supporting compositional awareness within a microtonal tuning system.

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ANNEX A

Harmonic transcription of Lullaby in 22 EDO

Harmonic transcription of Lullaby in 22 EDO

The harmonic transcription presents the chordal structure of Lullaby in 22 EDO on a chord-by-chord basis. Chords are identified according to their vertical pitch content, taking into account sustain pedal usage and the contribution of the viola when it participates in the harmonic texture. All pitch material is reduced to pitch classes; octave duplications are omitted.
The notation follows the conventions outlined below:

1. Chord identification (above the staff)
Each chord is labeled using Hans-Gunter Lock's pitch-class set classification for 22-tone equal temperament, , where applicable. Example: 22 4-180*
The first number (22) indicates the tuning system (22 EDO).
The second number (4) indicates the cardinality (number of distinct pitch classes).
The following number (180) is the set-class index.

Suffixes indicate chord type:
A = narrow (compact) form
B = wide (dispersed) form
* = symmetrical form

Lock's published tables cover set classes up to pentachords (cardinality ≤ 5). Accordingly, hexachords and heptachords are not assigned Lock set-class labels. For these larger sets, rotation indices and prime forms were calculated by the author following the same principles used in Lock's system.

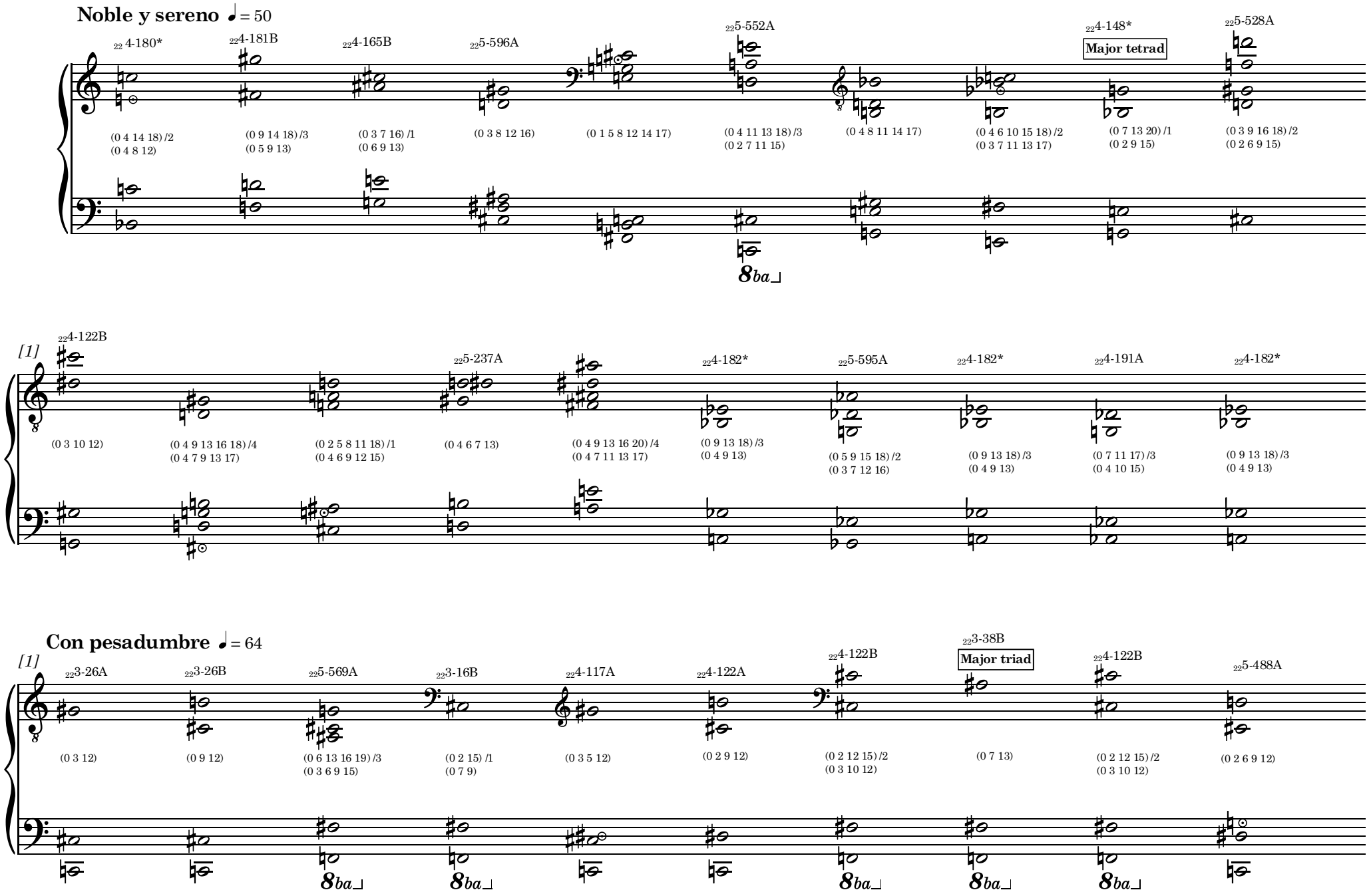
2. Viola notation
The viola voice is written using round white noteheads with a dot. This notation visually distinguishes viola pitches from the keyboard part and indicates their inclusion only when they contribute to the harmonic structure of the chord.

3. Normalized form (between the staff) :
This form assigns 0 to the lowest pitch of the chord and expresses all other pitches as ascending intervals modulo 22. The normalized form reflects the chord's perceived intervallic shape and is used for comparison with root-based chord taxonomies. Example: (0 2 5 8 11 18)

4. Rotation index
Following the normalized form, a rotation index is indicated. This number specifies the rotation of the normalized form relative to the ordering used in Lock's tables and clarifies how the chord maps onto its corresponding set class. Example: /1

5. Prime form
Below the normalized form and rotation index, the prime form of the chord is given.The prime form represents the most compact, orientation-independent ordering of the pitch-class set under transposition and inversion in modulo 22. It serves as the abstract identifier used in Lock's classification system. Example: (0 4 6 9 12 15)

6. Sevish–DQ chord correspondence
All normalized forms are compared to Sevish's 22-EDO chord nomenclature and the Double Qualifier (DQ) classification system. When a normalized form coincides with a named Sevish/DQ chord type, the chord name is shown inside a rectangular frame (e.g. major tetrad). The absence of a framed label indicates that the chord does not correspond to a currently named category within that system.


Noble y sereno ♩= 50
22 4-180*
224-181B
224-165B
225-596A
225-552A
224-148*
Major tetrad
225-528A
(0 4 14 18) /2
(0 4 8 12)
(0 9 14 18) /3
(0 5 9 13)
(0 3 7 16) /1
(0 6 9 13)
(0 3 8 12 16)
(0 1 5 8 12 14 17)
(0 4 11 13 18) /3
(0 2 7 11 15)
(0 4 8 11 14 17)
(0 4 6 10 15 18) /2
(0 3 7 11 13 17)
(0 7 13 20) /1
(0 2 9 15)
(0 3 9 16 18) /2
(0 2 6 9 15)
8ba
[1]
224-122B
225-237A
224-182*
225-595A
224-182*
224-191A
224-182*
(0 3 10 12)
(0 4 9 13 16 18) /4
(0 4 7 9 13 17)
(0 2 5 8 11 18) /1
(0 4 6 9 12 15)
(0 4 6 7 13)
(0 4 9 13 16 20) /4
(0 4 7 11 13 17)
(0 9 13 18) /3
(0 4 9 13)
(0 5 9 15 18) /2
(0 3 7 12 16)
(0 9 13 18) /3
(0 4 9 13)
(0 7 11 17) /3
(0 4 10 15)
(0 9 13 18) /3
(0 4 9 13)
Con pesadumbre ♩= 64
[1]
223-26A
223-26B
225-569A
223-16B
224-117A
224-122A
224-122B
223-38B
Major triad
224-122B
225-488A
(0 3 12)
(0 9 12)
(0 6 13 16 19) /3
(0 3 6 9 15)
(0 2 15) /1
(0 7 9)
(0 3 5 12)
(0 2 9 12)
(0 2 12 15) /2
(0 3 10 12)
(0 7 13)
(0 2 12 15) /2
(0 3 10 12)
(0 2 6 9 12)
8ba
8ba
8ba
8ba
8ba

Remoto ♩ = 50

[1]

$_{22}$5-595A | $_{22}$4-167A | $_{22}$5-505A | $_{22}$5-577A | $_{22}$4-181B | $_{22}$4-135A | $_{22}$3-26A

(0 3 7 12 16) | (0 5 9 12 16 19 20) /6 (0 4 7 11 14 15 17) | (0 4 8 11 13 17) | (0 9 12 18) /3 (0 3 9 13) | (0 7 9 12 14 18) /5 (0 2 5 7 11 15) | (0 3 5 9 13) | (0 5 9 16 19) /2 (0 3 6 11 15) | (0 5 9 13) | (0 4 13 15) /2 (0 2 9 13) | (0 10 13) /2 (0 3 12)

8ba

[1]

$_{22}$4-110A | $_{22}$4-182* | $_{22}$3-35B | $_{22}$5-595B | ♩ = 80 $_{22}$4-155B | $_{22}$5-580B | $_{22}$5-497B | $_{22}$4-168A | $_{22}$3-38A

(0 13 15 18) /3 (0 2 5 9) | (0 4 13 17) /2 (0 4 9 13) | (0 5 15) /1 (0 7 12) | (0 4 7 13 17) /2 (0 4 9 13 16) | (0 7 10 13) | (0 3 10 13 18) /3 (0 3 8 12 15) | (0 7 10 13 15) /4 (0 3 6 8 15) | (0 3 10 18) /1 (0 4 7 14) | (0 1 5 9 13 14 18) /3 (0 1 5 9 10 14 18) | (0 7 16) /1 (0 6 13)

8ba

[1]

$_{22}$3-31B | $_{22}$3-32* Sus2 | $_{22}$3-31B | ♩ = 60 $_{22}$5-596A | $_{22}$5-519B | $_{22}$5-596A

(0 4 14) /1 (0 8 12) | (0 4 13) | (0 4 14) /1 (0 8 12) | (0 4 8 14 17) /2 (0 3 8 12 16) | (0 2 7 11 15 18) /4 (0 4 8 11 15 17) | (0 5 11 14 18 20) /4 (0 3 7 9 11 16) | (0 6 10 13 15) | (0 3 6 11 15 19) /3 (0 4 8 11 14 17) | (0 3 8 12 16)

8ba

Vivaz ♩ = 112

[1]

$_{22}$5-530A (0 2 6 12 15)

$_{22}$5-504B (0 3 5 9 18) /1 (0 4 7 9 13)

$_{22}$5-577A (0 5 9 16 19) (2) (0 3 6 11 15)

$_{22}$4-175A (0 5 13 16) /2 (0 3 9 14)

$_{22}$4-164A (0 5 9 19) /1 (0 3 8 12)

$_{22}$3-36A **Subminor triad** (0 5 13)

(0 3 5 9 14 18) /3 (0 4 8 11 13 17)

$_{22}$3-38B (0 9 16) /2 (0 7 13)

$_{22}$4-173B **Subminor–minor tetrad** (0 5 13 19) /2 (0 6 9 14)

[1]

$_{22}$4-190B (0 5 9 16) /1 (0 6 11 15)

$_{22}$3-23B (0 6 9)

$_{22}$3-16B (0 2 15) /1 (0 7 9)

$_{22}$3-23B (0 6 9)

$_{22}$3-16B (0 2 15) /1 (0 7 9)

$_{22}$4-164A (0 3 8 12)

$_{22}$4-119B (0 2 5 14) /1 (0 8 10 13)

$_{22}$3-28B (0 5 9)

$_{22}$3-26A (0 3 12)

(0 4 7 10 13 17)

8ba

8ba

Cadencial ♩ = 140

[1]

$_{22}$4-164A (0 3 8 12)

(0 4 7 10 13 17)

$_{22}$3-26A (0 10 13) /2 (0 3 12)

$_{22}$4-158* (0 3 10 13)

$_{22}$3-26A (0 10 13) /2 (0 3 12)

$_{22}$4-158* (0 3 10 13)

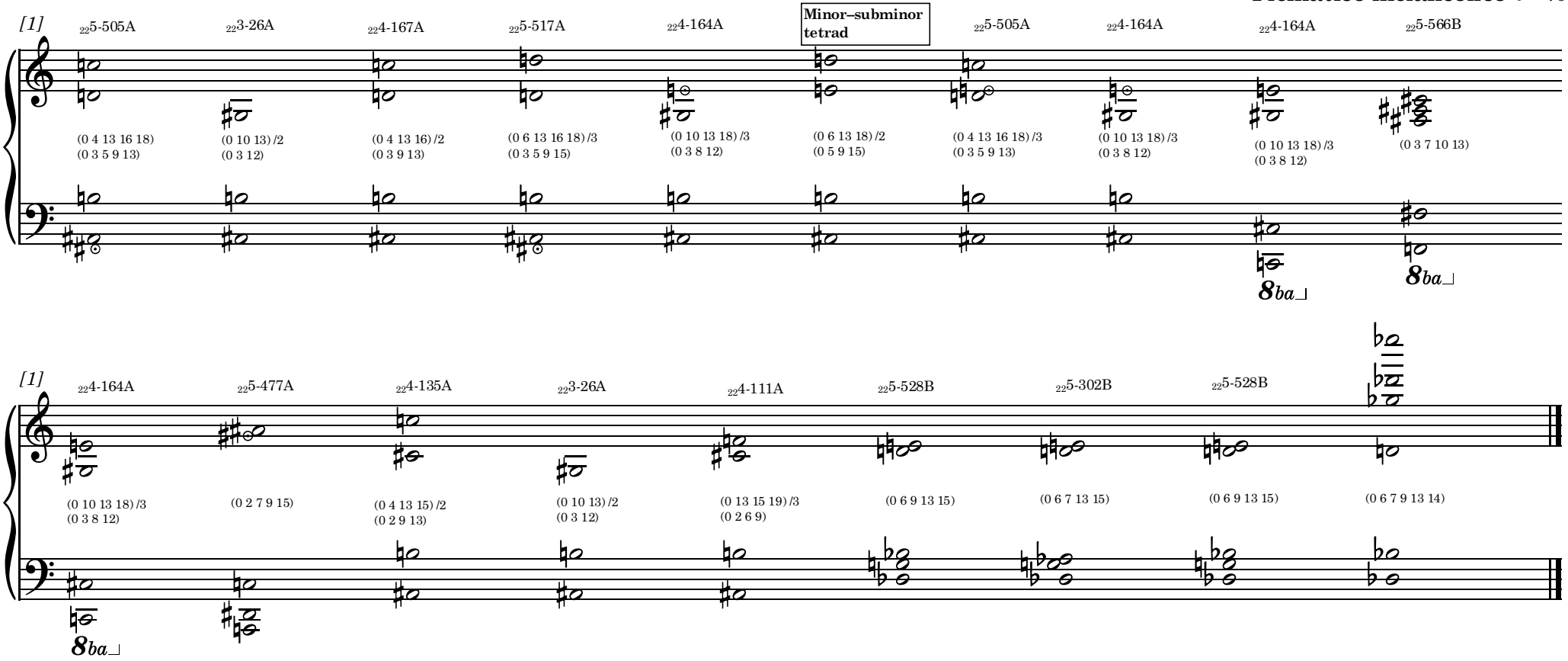
$_{22}$4-189A **Minor–subminor tetrad** (0 6 13 18) /2 (0 5 9 15)

$_{22}$4-167A (0 4 13 16) /2 (0 3 9 13)

$_{22}$4-164A (0 10 13 18) /3 (0 3 8 12)

$_{22}$4-189A **Minor–subminor tetrad** (0 6 13 18) /2 (0 5 9 15)

Flemático melancólico ♩ = 70



ANNEX B

22 EDO Pitch-class set class tables

(Hans-Gunter Lock, 2021)

	A	B	C	D	E	F	G	H	I
2	1	$_{22}$3-1*	v21000000000	0 1 2	0 1 21	0 20 21	$_{22}$19-1*	vIHGGGGGGGG8	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
3	2	$_{22}$3-2	v11100000000	0 1 3	0 2 21	0 19 20	$_{22}$19-2B	vHHHGGGGGGG8	0 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
4	3	$_{22}$3-2B	v11100000000	0 2 3	0 1 20	0 19 21	$_{22}$19-2	vHHHGGGGGGG8	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 19
5	4	$_{22}$3-3	v10110000000	0 1 4	0 3 21	0 18 19	$_{22}$19-3B	vHGHHGGGGGG8	0 1 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
6	5	$_{22}$3-3B	v10110000000	0 3 4	0 1 19	0 18 21	$_{22}$19-3	vHGHHGGGGGG8	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 18 19
7	6	$_{22}$3-4	v10011000000	0 1 5	0 4 21	0 17 18	$_{22}$19-4B	vHGGHHGGGGG8	0 1 2 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
8	7	$_{22}$3-4B	v10011000000	0 4 5	0 1 18	0 17 21	$_{22}$19-4	vHGGHHGGGGG8	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 17 18 19
9	8	$_{22}$3-5	v10001100000	0 1 6	0 5 21	0 16 17	$_{22}$19-5B	vHGGGHHGGGG8	0 1 2 3 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
10	9	$_{22}$3-5B	v10001100000	0 5 6	0 1 17	0 16 21	$_{22}$19-5	vHGGGHHGGGG8	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 16 17 18 19
11	10	$_{22}$3-6	v10000110000	0 1 7	0 6 21	0 15 16	$_{22}$19-6B	vHGGGGHHGGG8	0 1 2 3 4 6 7 8 9 10 11 12 13 14 15 16 17 18 19
12	11	$_{22}$3-6B	v10000110000	0 6 7	0 1 16	0 15 21	$_{22}$19-6	vHGGGGHHGGG8	0 1 2 3 4 5 6 7 8 9 10 11 12 13 15 16 17 18 19
13	12	$_{22}$3-7	v10000011000	0 1 8	0 7 21	0 14 15	$_{22}$19-7B	vHGGGGGHHGG8	0 1 2 3 4 5 7 8 9 10 11 12 13 14 15 16 17 18 19
14	13	$_{22}$3-7B	v10000011000	0 7 8	0 1 15	0 14 21	$_{22}$19-7	vHGGGGGHHGG8	0 1 2 3 4 5 6 7 8 9 10 11 12 14 15 16 17 18 19
15	14	$_{22}$3-8	v10000001100	0 1 9	0 8 21	0 13 14	$_{22}$19-8B	vHGGGGGGHHG8	0 1 2 3 4 5 6 8 9 10 11 12 13 14 15 16 17 18 19
16	15	$_{22}$3-8B	v10000001100	0 8 9	0 1 14	0 13 21	$_{22}$19-8	vHGGGGGGHHG8	0 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16 17 18 19
17	16	$_{22}$3-9	v10000000110	0 1 10	0 9 21	0 12 13	$_{22}$19-9B	vHGGGGGGGHH8	0 1 2 3 4 5 6 7 9 10 11 12 13 14 15 16 17 18 19
18	17	$_{22}$3-9B	v10000000110	0 9 10	0 1 13	0 12 21	$_{22}$19-9	vHGGGGGGGHH8	0 1 2 3 4 5 6 7 8 9 10 12 13 14 15 16 17 18 19
19	18	$_{22}$3-10	v10000000011	0 1 11	0 10 21	0 11 12	$_{22}$19-10B	vHGGGGGGGGH9	0 1 2 3 4 5 6 7 8 10 11 12 13 14 15 16 17 18 19
20	19	$_{22}$3-10B	v10000000011	0 10 11	0 1 12	0 11 21	$_{22}$19-10	vHGGGGGGGGH9	0 1 2 3 4 5 6 7 8 9 11 12 13 14 15 16 17 18 19
21	20	$_{22}$3-11*	v02010000000	0 2 4	0 2 20	0 18 20	$_{22}$19-11*	vGIGHGGGGGG8	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 18 20
22	21	$_{22}$3-12	v01101000000	0 2 5	0 3 20	0 17 19	$_{22}$19-12B	vGHHGHGGGGG8	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 17 19 20
23	22	$_{22}$3-12B	v01101000000	0 3 5	0 2 19	0 17 20	$_{22}$19-12	vGHHGHGGGGG8	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 17 18 20
24	23	$_{22}$3-13	v01010100000	0 2 6	0 4 20	0 16 18	$_{22}$19-13B	vGHGHGHGGGG8	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 16 18 19 20
25	24	$_{22}$3-13B	v01010100000	0 4 6	0 2 18	0 16 20	$_{22}$19-13	vGHGHGHGGGG8	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 16 17 18 20
26	25	$_{22}$3-14	v01001010000	0 2 7	0 5 20	0 15 17	$_{22}$19-14B	vGHGGHGHGGG8	0 1 2 3 4 5 6 7 8 9 10 11 12 13 15 17 18 19 20
27	26	$_{22}$3-14B	v01001010000	0 5 7	0 2 17	0 15 20	$_{22}$19-14	vGHGGHGHGGG8	0 1 2 3 4 5 6 7 8 9 10 11 12 13 15 16 17 18 20
28	27	$_{22}$3-15	v01000101000	0 2 8	0 6 20	0 14 16	$_{22}$19-15B	vGHGGGHGHGG8	0 1 2 3 4 5 6 7 8 9 10 11 12 14 16 17 18 19 20
29	28	$_{22}$3-15B	v01000101000	0 6 8	0 2 16	0 14 20	$_{22}$19-15	vGHGGGHGHGG8	0 1 2 3 4 5 6 7 8 9 10 11 12 14 15 16 17 18 20
30	29	$_{22}$3-16	v01000010100	0 2 9	0 7 20	0 13 15	$_{22}$19-16B	vGHGGGGHGHG8	0 1 2 3 4 5 6 7 8 9 10 11 13 15 16 17 18 19 20
31	30	$_{22}$3-16B	v01000010100	0 7 9	0 2 15	0 13 20	$_{22}$19-16	vGHGGGGHGHG8	0 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16 17 18 20
32	31	$_{22}$3-17	v01000001010	0 2 10	0 8 20	0 12 14	$_{22}$19-17B	vGHGGGGGHGH8	0 1 2 3 4 5 6 7 8 9 10 12 14 15 16 17 18 19 20
33	32	$_{22}$3-17B	v01000001010	0 8 10	0 2 14	0 12 20	$_{22}$19-17	vGHGGGGGHGH8	0 1 2 3 4 5 6 7 8 9 10 12 13 14 15 16 17 18 20
34	33	$_{22}$3-18	v01000000101	0 2 11	0 9 20	0 11 13	$_{22}$19-18B	vGHGGGGGGHG9	0 1 2 3 4 5 6 7 8 9 11 13 14 15 16 17 18 19 20
35	34	$_{22}$3-18B	v01000000101	0 9 11	0 2 13	0 11 20	$_{22}$19-18	vGHGGGGGGHG9	0 1 2 3 4 5 6 7 8 9 11 12 13 14 15 16 17 18 20
36	35	$_{22}$3-19*	v01000000020	0 2 12	0 10 20	0 10 12	$_{22}$19-19*	vGHGGGGGGGI8	0 1 2 3 4 5 6 7 8 10 11 12 13 14 15 16 17 18 20
37	36	$_{22}$3-20*	v00200100000	0 3 6	0 3 19	0 16 19	$_{22}$19-20*	vGGIGGHGGGG8	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 16 17 19 20
38	37	$_{22}$3-21	v00110010000	0 3 7	0 4 19	0 15 18	$_{22}$19-21B	vGGHHGGHGGG8	0 1 2 3 4 5 6 7 8 9 10 11 12 13 15 16 18 19 20
39	38	$_{22}$3-21B	v00110010000	0 4 7	0 3 18	0 15 19	$_{22}$19-21	vGGHHGGHGGG8	0 1 2 3 4 5 6 7 8 9 10 11 12 13 15 16 17 19 20
40	39	$_{22}$3-22	v00101001000	0 3 8	0 5 19	0 14 17	$_{22}$19-22B	vGGHGHGGHGG8	0 1 2 3 4 5 6 7 8 9 10 11 12 14 15 17 18 19 20
41	40	$_{22}$3-22B	v00101001000	0 5 8	0 3 17	0 14 19	$_{22}$19-22	vGGHGHGGHGG8	0 1 2 3 4 5 6 7 8 9 10 11 12 14 15 16 17 19 20
42	41	$_{22}$3-23	v00100100100	0 3 9	0 6 19	0 13 16	$_{22}$19-23B	vGGHGGHGGHG8	0 1 2 3 4 5 6 7 8 9 10 11 13 14 16 17 18 19 20
43	42	$_{22}$3-23B	v00100100100	0 6 9	0 3 16	0 13 19	$_{22}$19-23	vGGHGGHGGHG8	0 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16 17 19 20
44	43	$_{22}$3-24	v00100010010	0 3 10	0 7 19	0 12 15	$_{22}$19-24B	vGGHGGGHGGH8	0 1 2 3 4 5 6 7 8 9 10 12 13 15 16 17 18 19 20
45	44	$_{22}$3-24B	v00100010010	0 7 10	0 3 15	0 12 19	$_{22}$19-24	vGGHGGGHGGH8	0 1 2 3 4 5 6 7 8 9 10 12 13 14 15 16 17 19 20
46	45	$_{22}$3-25	v00100001001	0 3 11	0 8 19	0 11 14	$_{22}$19-25B	vGGHGGGGHGG9	0 1 2 3 4 5 6 7 8 9 11 12 14 15 16 17 18 19 20
47	46	$_{22}$3-25B	v00100001001	0 8 11	0 3 14	0 11 19	$_{22}$19-25	vGGHGGGGHGG9	0 1 2 3 4 5 6 7 8 9 11 12 13 14 15 16 17 19 20
48	47	$_{22}$3-26	v00100000110	0 3 12	0 9 19	0 10 13	$_{22}$19-26B	vGGHGGGGGHH8	0 1 2 3 4 5 6 7 8 10 11 13 14 15 16 17 18 19 20
49	48	$_{22}$3-26B	v00100000110	0 9 12	0 3 13	0 10 19	$_{22}$19-26	vGGHGGGGGHH8	0 1 2 3 4 5 6 7 8 10 11 12 13 14 15 16 17 19 20
50	49	$_{22}$3-27*	v00020001000	0 4 8	0 4 18	0 14 18	$_{22}$19-27*	vGGGIGGGHGG8	0 1 2 3 4 5 6 7 8 9 10 11 12 14 15 16 18 19 20
51	50	$_{22}$3-28	v00011000100	0 4 9	0 5 18	0 13 17	$_{22}$19-28B	vGGGHHGGGHG8	0 1 2 3 4 5 6 7 8 9 10 11 13 14 15 17 18 19 20
52	51	$_{22}$3-28B	v00011000100	0 5 9	0 4 17	0 13 18	$_{22}$19-28	vGGGHHGGGHG8	0 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16 18 19 20
53	52	$_{22}$3-29	v00010100010	0 4 10	0 6 18	0 12 16	$_{22}$19-29B	vGGGHGHGGGH8	0 1 2 3 4 5 6 7 8 9 10 12 13 14 16 17 18 19 20
54	53	$_{22}$3-29B	v00010100010	0 6 10	0 4 16	0 12 18	$_{22}$19-29	vGGGHGHGGGH8	0 1 2 3 4 5 6 7 8 9 10 12 13 14 15 16 18 19 20
55	54	$_{22}$3-30	v00010010001	0 4 11	0 7 18	0 11 15	$_{22}$19-30B	vGGGHGGHGGG9	0 1 2 3 4 5 6 7 8 9 11 12 13 15 16 17 18 19 20
56	55	$_{22}$3-30B	v00010010001	0 7 11	0 4 15	0 11 18	$_{22}$19-30	vGGGHGGHGGG9	0 1 2 3 4 5 6 7 8 9 11 12 13 14 15 16 18 19 20
57	56	$_{22}$3-31	v00010001010	0 4 12	0 8 18	0 10 14	$_{22}$19-31B	vGGGHGGGHGH8	0 1 2 3 4 5 6 7 8 10 11 12 14 15 16 17 18 19 20
58	57	$_{22}$3-31B	v00010001010	0 8 12	0 4 14	0 10 18	$_{22}$19-31	vGGGHGGGHGH8	0 1 2 3 4 5 6 7 8 10 11 12 13 14 15 16 18 19 20
59	58	$_{22}$3-32*	v00010000200	0 4 13	0 9 18	0 9 13	$_{22}$19-32*	vGGGHGGGGIG8	0 1 2 3 4 5 6 7 9 10 11 12 13 14 15 16 18 19 20
60	59	$_{22}$3-33*	v00002000010	0 5 10	0 5 17	0 12 17	$_{22}$19-33*	vGGGGIGGGGH8	0 1 2 3 4 5 6 7 8 9 10 12 13 14 15 17 18 19 20
61	60	$_{22}$3-34	v00001100001	0 5 11	0 6 17	0 11 16	$_{22}$19-34B	vGGGGHHGGGG9	0 1 2 3 4 5 6 7 8 9 11 12 13 14 16 17 18 19 20
62	61	$_{22}$3-34B	v00001100001	0 6 11	0 5 16	0 11 17	$_{22}$19-34	vGGGGHHGGGG9	0 1 2 3 4 5 6 7 8 9 11 12 13 14 15 17 18 19 20
63	62	$_{22}$3-35	v00001010010	0 5 12	0 7 17	0 10 15	$_{22}$19-35B	vGGGGHGHGGH8	0 1 2 3 4 5 6 7 8 10 11 12 13 15 16 17 18 19 20
64	63	$_{22}$3-35B	v00001010010	0 7 12	0 5 15	0 10 17	$_{22}$19-35	vGGGGHGHGGH8	0 1 2 3 4 5 6 7 8 10 11 12 13 14 15 17 18 19 20
65	64	$_{22}$3-36	v00001001100	0 5 13	0 8 17	0 9 14	$_{22}$19-36B	vGGGGHGGHHG8	0 1 2 3 4 5 6 7 9 10 11 12 14 15 16 17 18 19 20
66	65	$_{22}$3-36B	v00001001100	0 8 13	0 5 14	0 9 17	$_{22}$19-36	vGGGGHGGHHG8	0 1 2 3 4 5 6 7 9 10 11 12 13 14 15 17 18 19 20
67	66	$_{22}$3-37*	v00000200010	0 6 12	0 6 16	0 10 16	$_{22}$19-37*	vGGGGGIGGGH8	0 1 2 3 4 5 6 7 8 10 11 12 13 14 16 17 18 19 20
68	67	$_{22}$3-38	v00000110100	0 6 13	0 7 16	0 9 15	$_{22}$19-38B	vGGGGGHHGHG8	0 1 2 3 4 5 6 7 9 10 11 12 13 15 16 17 18 19 20
69	68	$_{22}$3-38B	v00000110100	0 7 13	0 6 15	0 9 16	$_{22}$19-38	vGGGGGHHGHG8	0 1 2 3 4 5 6 7 9 10 11 12 13 14 16 17 18 19 20
70	69	$_{22}$3-39*	v00000102000	0 6 14	0 8 16	0 8 14	$_{22}$19-39*	vGGGGGHGIGG8	0 1 2 3 4 5 6 8 9 10 11 12 13 14 16 17 18 19 20
71	70	$_{22}$3-40*	v00000021000	0 7 14	0 7 15	0 8 15	$_{22}$19-40*	vGGGGGGIHGG8	0 1 2 3 4 5 6 8 9 10 11 12 13 15 16 17 18 19 20

	A	B	C	D	E	F	G	H	I	J
2	1	$_{22}$4-1*	v32100000000	0 1 2 3	0 1 2 21	0 1 20 21	0 19 20 21	$_{22}$18-1*	vHGFEEEEEEE7	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
3	2	$_{22}$4-2	v22110000000	0 1 2 4	0 1 3 21	0 2 20 21	0 18 19 20	$_{22}$18-2B	vGGFFEEEEEE7	0 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
4	3	$_{22}$4-2B	v22110000000	0 2 3 4	0 1 2 20	0 1 19 21	0 18 20 21	$_{22}$18-2	vGGFFEEEEEE7	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 18
5	4	$_{22}$4-3*	v21210000000	0 1 3 4	0 2 3 21	0 1 19 20	0 18 19 21	$_{22}$18-3*	vGFGFEEEEEE7	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 19
6	5	$_{22}$4-4	v21111000000	0 1 2 5	0 1 4 21	0 3 20 21	0 17 18 19	$_{22}$18-4B	vGFFFFEEEEE7	0 1 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
7	6	$_{22}$4-4B	v21111000000	0 3 4 5	0 1 2 19	0 1 18 21	0 17 20 21	$_{22}$18-4	vGFFFFEEEEE7	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 17 18
8	7	$_{22}$4-5	v21011100000	0 1 2 6	0 1 5 21	0 4 20 21	0 16 17 18	$_{22}$18-5B	vGFEFFFEEEE7	0 1 2 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
9	8	$_{22}$4-5B	v21011100000	0 4 5 6	0 1 2 18	0 1 17 21	0 16 20 21	$_{22}$18-5	vGFEFFFEEEE7	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 16 17 18
10	9	$_{22}$4-6	v21001110000	0 1 2 7	0 1 6 21	0 5 20 21	0 15 16 17	$_{22}$18-6B	vGFEEFFFEEE7	0 1 2 3 5 6 7 8 9 10 11 12 13 14 15 16 17 18
11	10	$_{22}$4-6B	v21001110000	0 5 6 7	0 1 2 17	0 1 16 21	0 15 20 21	$_{22}$18-6	vGFEEFFFEEE7	0 1 2 3 4 5 6 7 8 9 10 11 12 13 15 16 17 18
12	11	$_{22}$4-7	v21000111000	0 1 2 8	0 1 7 21	0 6 20 21	0 14 15 16	$_{22}$18-7B	vGFEEEFFFEE7	0 1 2 3 4 6 7 8 9 10 11 12 13 14 15 16 17 18
13	12	$_{22}$4-7B	v21000111000	0 6 7 8	0 1 2 16	0 1 15 21	0 14 20 21	$_{22}$18-7	vGFEEEFFFEE7	0 1 2 3 4 5 6 7 8 9 10 11 12 14 15 16 17 18
14	13	$_{22}$4-8	v21000011100	0 1 2 9	0 1 8 21	0 7 20 21	0 13 14 15	$_{22}$18-8B	vGFEEEEFFFE7	0 1 2 3 4 5 7 8 9 10 11 12 13 14 15 16 17 18
15	14	$_{22}$4-8B	v21000011100	0 7 8 9	0 1 2 15	0 1 14 21	0 13 20 21	$_{22}$18-8	vGFEEEEFFFE7	0 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16 17 18
16	15	$_{22}$4-9	v21000001110	0 1 2 10	0 1 9 21	0 8 20 21	0 12 13 14	$_{22}$18-9B	vGFEEEEEFFF7	0 1 2 3 4 5 6 8 9 10 11 12 13 14 15 16 17 18
17	16	$_{22}$4-9B	v21000001110	0 8 9 10	0 1 2 14	0 1 13 21	0 12 20 21	$_{22}$18-9	vGFEEEEEFFF7	0 1 2 3 4 5 6 7 8 9 10 12 13 14 15 16 17 18
18	17	$_{22}$4-10	v21000000111	0 1 2 11	0 1 10 21	0 9 20 21	0 11 12 13	$_{22}$18-10B	vGFEEEEEEFF8	0 1 2 3 4 5 6 7 9 10 11 12 13 14 15 16 17 18
19	18	$_{22}$4-10B	v21000000111	0 9 10 11	0 1 2 13	0 1 12 21	0 11 20 21	$_{22}$18-10	vGFEEEEEEFF8	0 1 2 3 4 5 6 7 8 9 11 12 13 14 15 16 17 18
20	19	$_{22}$4-11*	v21000000021	0 1 2 12	0 1 11 21	0 10 20 21	0 10 11 12	$_{22}$18-11*	vGFEEEEEEG8	0 1 2 3 4 5 6 7 8 10 11 12 13 14 15 16 17 18
21	20	$_{22}$4-12*	v20121000000	0 1 4 5	0 3 4 21	0 1 18 19	0 17 18 21	$_{22}$18-12*	vGEFGFEEEEE7	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 18 19
22	21	$_{22}$4-13*	v20012100000	0 1 5 6	0 4 5 21	0 1 17 18	0 16 17 21	$_{22}$18-13*	vGEEFGFEEEE7	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 17 18 19
23	22	$_{22}$4-14*	v20001210000	0 1 6 7	0 5 6 21	0 1 16 17	0 15 16 21	$_{22}$18-14*	vGEEEFGFEEE7	0 1 2 3 4 5 6 7 8 9 10 11 12 13 16 17 18 19
24	23	$_{22}$4-15*	v20000121000	0 1 7 8	0 6 7 21	0 1 15 16	0 14 15 21	$_{22}$18-15*	vGEEEEFGFEE7	0 1 2 3 4 5 6 7 8 9 10 11 12 15 16 17 18 19
25	24	$_{22}$4-16*	v20000012100	0 1 8 9	0 7 8 21	0 1 14 15	0 13 14 21	$_{22}$18-16*	vGEEEEEFGFE7	0 1 2 3 4 5 6 7 8 9 10 11 14 15 16 17 18 19
26	25	$_{22}$4-17*	v20000001210	0 1 9 10	0 8 9 21	0 1 13 14	0 12 13 21	$_{22}$18-17*	vGEEEEEEFGF7	0 1 2 3 4 5 6 7 8 9 10 13 14 15 16 17 18 19
27	26	$_{22}$4-18*	v20000000121	0 1 10 11	0 9 10 21	0 1 12 13	0 11 12 21	$_{22}$18-18*	vGEEEEEEEFG8	0 1 2 3 4 5 6 7 8 9 12 13 14 15 16 17 18 19
28	27	$_{22}$4-19*	v20000000022	0 1 11 12	0 10 11 21			$_{22}$18-19*	vGEEEEEEEG9	0 1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 19
29	28	$_{22}$4-20*	v12201000000	0 2 3 5	0 1 3 20	0 2 19 21	0 17 19 20	$_{22}$18-20*	vFGGEFEEEEE7	0 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 19
30	29	$_{22}$4-21	v12111000000	0 1 3 5	0 2 4 21	0 2 19 20	0 17 18 20	$_{22}$18-21B	vFGFFFEEEEE7	0 2 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 1
31	30	$_{22}$4-21B	v12111000000	0 2 4 5	0 2 3 20	0 1 18 20	0 17 19 21	$_{22}$18-21	vFGFFFEEEEE7	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 17 19
32	31	$_{22}$4-22	v11210100000	0 2 3 6	0 1 4 20	0 3 19 21	0 16 18 19	$_{22}$18-22	vFFGFEFEEEE7	0 1 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 19
33	32	$_{22}$4-22B	v11210100000	0 3 4 6	0 1 3 19	0 2 18 21	0 16 19 20	$_{22}$18-22B	vFFGFEFEEEE7	0 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 18 19
34	33	$_{22}$4-23	v11201100000	0 1 3 6	0 2 5 21	0 3 19 20	0 16 17 19	$_{22}$18-23B	vFFGEFFEEEE7	0 2 3 5 6 7 8 9 10 11 12 13 14 15 16 17 18 1
35	34	$_{22}$4-23B	v11201100000	0 3 5 6	0 2 3 19	0 1 17 20	0 16 19 21	$_{22}$18-23	vFFGEFFEEEE7	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 16 17 19
36	35	$_{22}$4-24	v11111100000	0 1 4 6	0 3 5 21	0 2 18 19	0 16 17 20	$_{22}$18-24B	vFFFFFFEEEE7	0 1 3 5 6 7 8 9 10 11 12 13 14 15 16 17 18 1
37	36	$_{22}$4-24B	v11111100000	0 2 5 6	0 3 4 20	0 1 17 19	0 16 18 21	$_{22}$18-24	vFFFFFFEEEE7	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 16 18 19
38	37	$_{22}$4-25	v11111010000	0 2 3 7	0 1 5 20	0 4 19 21	0 15 17 18	$_{22}$18-25	vFFFFFEFEEE7	0 1 2 4 5 6 7 8 9 10 11 12 13 14 15 16 17 19
39	38	$_{22}$4-25B	v11111010000	0 4 5 7	0 1 3 18	0 2 17 21	0 15 19 20	$_{22}$18-25B	vFFFFFEFEEE7	0 2 3 4 5 6 7 8 9 10 11 12 13 14 15 17 18 19
40	39	$_{22}$4-26	v11110110000	0 1 3 7	0 2 6 21	0 4 19 20	0 15 16 18	$_{22}$18-26B	vFFFFEFFEEE7	0 2 3 4 6 7 8 9 10 11 12 13 14 15 16 17 18 1
41	40	$_{22}$4-26B	v11110110000	0 4 6 7	0 2 3 18	0 1 16 20	0 15 19 21	$_{22}$18-26	vFFFFEFFEEE7	0 1 2 3 4 5 6 7 8 9 10 11 12 13 15 16 17 19
42	41	$_{22}$4-27	v11101101000	0 2 3 8	0 1 6 20	0 5 19 21	0 14 16 17	$_{22}$18-27	vFFFEFFEFEE7	0 1 2 3 5 6 7 8 9 10 11 12 13 14 15 16 17 19
43	42	$_{22}$4-27B	v11101101000	0 5 6 8	0 1 3 17	0 2 16 21	0 14 19 20	$_{22}$18-27B	vFFFEFFEFEE7	0 2 3 4 5 6 7 8 9 10 11 12 13 14 16 17 18 19
44	43	$_{22}$4-28	v11101011000	0 1 3 8	0 2 7 21	0 5 19 20	0 14 15 17	$_{22}$18-28B	vFFFEFEFFEE7	0 2 3 4 5 7 8 9 10 11 12 13 14 15 16 17 18 1
45	44	$_{22}$4-28B	v11101011000	0 5 7 8	0 2 3 17	0 1 15 20	0 14 19 21	$_{22}$18-28	vFFFEFEFFEE7	0 1 2 3 4 5 6 7 8 9 10 11 12 14 15 16 17 19
46	45	$_{22}$4-29	v11100110100	0 2 3 9	0 1 7 20	0 6 19 21	0 13 15 16	$_{22}$18-29	vFFFEEFFEFE7	0 1 2 3 4 6 7 8 9 10 11 12 13 14 15 16 17 19
47	46	$_{22}$4-29B	v11100110100	0 6 7 9	0 1 3 16	0 2 15 21	0 13 19 20	$_{22}$18-29B	vFFFEEFFEFE7	0 2 3 4 5 6 7 8 9 10 11 12 13 15 16 17 18 19
48	47	$_{22}$4-30	v11100101100	0 1 3 9	0 2 8 21	0 6 19 20	0 13 14 16	$_{22}$18-30B	vFFFEEFEFFE7	0 2 3 4 5 6 8 9 10 11 12 13 14 15 16 17 18 1
49	48	$_{22}$4-30B	v11100101100	0 6 8 9	0 2 3 16	0 1 14 20	0 13 19 21	$_{22}$18-30	vFFFEEFEFFE7	0 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16 17 19
50	49	$_{22}$4-31	v11100011010	0 2 3 10	0 1 8 20	0 7 19 21	0 12 14 15	$_{22}$18-31	vFFFEEEFFEF7	0 1 2 3 4 5 7 8 9 10 11 12 13 14 15 16 17 19
51	50	$_{22}$4-31B	v11100011010	0 7 8 10	0 1 3 15	0 2 14 21	0 12 19 20	$_{22}$18-31B	vFFFEEEFFEF7	0 2 3 4 5 6 7 8 9 10 11 12 14 15 16 17 18 19
52	51	$_{22}$4-32	v11100010110	0 1 3 10	0 2 9 21	0 7 19 20	0 12 13 15	$_{22}$18-32B	vFFFEEEFEFF7	0 2 3 4 5 6 7 9 10 11 12 13 14 15 16 17 18 1
53	52	$_{22}$4-32B	v11100010110	0 7 9 10	0 2 3 15	0 1 13 20	0 12 19 21	$_{22}$18-32	vFFFEEEFEFF7	0 1 2 3 4 5 6 7 8 9 10 12 13 14 15 16 17 19
54	53	$_{22}$4-33	v11100001101	0 2 3 11	0 1 9 20	0 8 19 21	0 11 13 14	$_{22}$18-33	vFFFEEEEFFE8	0 1 2 3 4 5 6 8 9 10 11 12 13 14 15 16 17 19
55	54	$_{22}$4-33B	v11100001101	0 8 9 11	0 1 3 14	0 2 13 21	0 11 19 20	$_{22}$18-33B	vFFFEEEEFFE8	0 2 3 4 5 6 7 8 9 10 11 13 14 15 16 17 18 19
56	55	$_{22}$4-34	v11100001011	0 1 3 11	0 2 10 21	0 8 19 20	0 11 12 14	$_{22}$18-34B	vFFFEEEEFEF8	0 2 3 4 5 6 7 8 10 11 12 13 14 15 16 17 18 1
57	56	$_{22}$4-34B	v11100001011	0 8 10 11	0 2 3 14	0 1 12 20	0 11 19 21	$_{22}$18-34	vFFFEEEEFEF8	0 1 2 3 4 5 6 7 8 9 11 12 13 14 15 16 17 19
58	57	$_{22}$4-35	v11100000120	0 2 3 12	0 1 10 20	0 9 19 21	0 10 12 13	$_{22}$18-35	vFFFEEEEEFG7	0 1 2 3 4 5 6 7 9 10 11 12 13 14 15 16 17 19
59	58	$_{22}$4-35B	v11100000120	0 9 10 12	0 1 3 13	0 2 12 21	0 10 19 20	$_{22}$18-35B	vFFFEEEEEFG7	0 2 3 4 5 6 7 8 9 10 12 13 14 15 16 17 18 19
60	59	$_{22}$4-36	v11100000111	0 1 3 12	0 2 11 21	0 9 19 20	0 10 11 13	$_{22}$18-36B	vFFFEEEEEFF8	0 2 3 4 5 6 7 8 9 11 12 13 14 15 16 17 18 19
61	60	$_{22}$4-36B	v11100000111	0 9 11 12	0 2 3 13	0 1 11 20	0 10 19 21	$_{22}$18-36	vFFFEEEEEFF8	0 1 2 3 4 5 6 7 8 10 11 12 13 14 15 16 17 19
62	61	$_{22}$4-37	v11011110000	0 1 5 7	0 4 6 21	0 2 17 18	0 15 16 20	$_{22}$18-37B	vFFEFFFFEEE7	0 1 2 4 6 7 8 9 10 11 12 13 14 15 16 17 18 1
63	62	$_{22}$4-37B	v11011110000	0 2 6 7	0 4 5 20	0 1 16 18	0 15 17 21	$_{22}$18-37	vFFEFFFFEEE7	0 1 2 3 4 5 6 7 8 9 10 11 12 13 15 17 18 19
64	63	$_{22}$4-38	v11001111000	0 1 6 8	0 5 7 21	0 2 16 17	0 14 15 20	$_{22}$18-38B	vFFEEFFFFEE7	0 1 2 3 5 7 8 9 10 11 12 13 14 15 16 17 18 1
65	64	$_{22}$4-38B	v11001111000	0 2 7 8	0 5 6 20	0 1 15 17	0 14 16 21	$_{22}$18-38	vFFEEFFFFEE7	0 1 2 3 4 5 6 7 8 9 10 11 12 14 16 17 18 19
66	65	$_{22}$4-39	v11000111100	0 1 7 9	0 6 8 21	0 2 15 16	0 13 14 20	$_{22}$18-39B	vFFEEEFFFFE7	0 1 2 3 4 6 8 9 10 11 12 13 14 15 16 17 18 1
67	66	$_{22}$4-39B	v11000111100	0 2 8 9	0 6 7 20	0 1 14 16	0 13 15 21	$_{22}$18-39	vFFEEEFFFFE7	0 1 2 3 4 5 6 7 8 9 10 11 13 15 16 17 18 19
68	67	$_{22}$4-40	v11000011110	0 1 8 10	0 7 9 21	0 2 14 15	0 12 13 20	$_{22}$18-40B	vFFEEEEFFFF7	0 1 2 3 4 5 7 9 10 11 12 13 14 15 16 17 18 1
69	68	$_{22}$4-40B	v11000011110	0 2 9 10	0 7 8 20	0 1 13 15	0 12 14 21	$_{22}$18-40	vFFEEEEFFFF7	0 1 2 3 4 5 6 7 8 9 10 12 14 15 16 17 18 19
70	69	$_{22}$4-41	v11000001111	0 1 9 11	0 8 10 21	0 2 13 14	0 11 12 20	$_{22}$18-41B	vFFEEEEEFFF8	0 1 2 3 4 5 6 8 10 11 12 13 14 15 16 17 18 1
71	70	$_{22}$4-41B	v11000001111	0 2 10 11	0 8 9 20	0 1 12 14	0 11 13 21	$_{22}$18-41	vFFEEEEEFFF8	0 1 2 3 4 5 6 7 8 9 11 13 14 15 16 17 18 19
72	71	$_{22}$4-42	v11000000121	0 1 10 12	0 9 11 21	0 2 12 13	0 10 11 20	$_{22}$18-42B	vFFEEEEEEFG8	0 1 2 3 4 5 6 7 9 11 12 13 14 15 16 17 18 19
73	72	$_{22}$4-42B	v11000000121	0 2 11 12	0 9 10 20	0 1 11 13	0 10 12 21	$_{22}$18-42	vFFEEEEEEFG8	0 1 2 3 4 5 6 7 8 10 12 13 14 15 16 17 18 19

	A	B	C	D	E	F	G	H	I	J
74	73	$_{22}$4-43*	v10220010000	0 3 4 7	0 1 4 19	0 3 18 21	0 15 18 19	$_{22}$18-43*	vFEGGEEFEEE7	0 1 3 4 5 6 7 8 9 10 11 12 13 14 15 16 18 19
75	74	$_{22}$4-44	v10210110000	0 1 4 7	0 3 6 21	0 3 18 19	0 15 16 19	$_{22}$18-44B	vFEGFEFFEEE7	0 1 3 4 6 7 8 9 10 11 12 13 14 15 16 17 18 1
76	75	$_{22}$4-44B	v10210110000	0 3 6 7	0 3 4 19	0 1 16 19	0 15 18 21	$_{22}$18-44	vFEGFEFFEEE7	0 1 2 3 4 5 6 7 8 9 10 11 12 13 15 16 18 19
77	76	$_{22}$4-45	v10121001000	0 3 4 8	0 1 5 19	0 4 18 21	0 14 17 18	$_{22}$18-45	vFEFGFEEFEE7	0 1 2 4 5 6 7 8 9 10 11 12 13 14 15 16 18 19
78	77	$_{22}$4-45B	v10121001000	0 4 5 8	0 1 4 18	0 3 17 21	0 14 18 19	$_{22}$18-45B	vFEFGFEEFEE7	0 1 3 4 5 6 7 8 9 10 11 12 13 14 15 17 18 19
79	78	$_{22}$4-46	v10120011000	0 1 4 8	0 3 7 21	0 4 18 19	0 14 15 18	$_{22}$18-46B	vFEFGEEFFEE7	0 1 3 4 5 7 8 9 10 11 12 13 14 15 16 17 18 1
80	79	$_{22}$4-46B	v10120011000	0 4 7 8	0 3 4 18	0 1 15 19	0 14 18 21	$_{22}$18-46	vFEFGEEFFEE7	0 1 2 3 4 5 6 7 8 9 10 11 12 14 15 16 18 19
81	80	$_{22}$4-47	v10111100100	0 3 4 9	0 1 6 19	0 5 18 21	0 13 16 17	$_{22}$18-47	vFEFFFFEEFE7	0 1 2 3 5 6 7 8 9 10 11 12 13 14 15 16 18 19
82	81	$_{22}$4-47B	v10111100100	0 5 6 9	0 1 4 17	0 3 16 21	0 13 18 19	$_{22}$18-47B	vFEFFFFEEFE7	0 1 3 4 5 6 7 8 9 10 11 12 13 14 16 17 18 19
83	82	$_{22}$4-48	v10111011000	0 1 5 8	0 4 7 21	0 3 17 18	0 14 15 19	$_{22}$18-48B	vFEFFFEFFEE7	0 1 2 4 5 7 8 9 10 11 12 13 14 15 16 17 18 1
84	83	$_{22}$4-48B	v10111011000	0 3 7 8	0 4 5 19	0 1 15 18	0 14 17 21	$_{22}$18-48	vFEFFFEFFEE7	0 1 2 3 4 5 6 7 8 9 10 11 12 14 15 17 18 19
85	84	$_{22}$4-49	v10111001100	0 1 4 9	0 3 8 21	0 5 18 19	0 13 14 17	$_{22}$18-49B	vFEFFFEEFFE7	0 1 3 4 5 6 8 9 10 11 12 13 14 15 16 17 18 1
86	85	$_{22}$4-49B	v10111001100	0 5 8 9	0 3 4 17	0 1 14 19	0 13 18 21	$_{22}$18-49	vFEFFFEEFFE7	0 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16 18 19
87	86	$_{22}$4-50	v10110110010	0 3 4 10	0 1 7 19	0 6 18 21	0 12 15 16	$_{22}$18-50	vFEFFEFFEEF7	0 1 2 3 4 6 7 8 9 10 11 12 13 14 15 16 18 19
88	87	$_{22}$4-50B	v10110110010	0 6 7 10	0 1 4 16	0 3 15 21	0 12 18 19	$_{22}$18-50B	vFEFFEFFEEF7	0 1 3 4 5 6 7 8 9 10 11 12 13 15 16 17 18 19
89	88	$_{22}$4-51	v10110100110	0 1 4 10	0 3 9 21	0 6 18 19	0 12 13 16	$_{22}$18-51B	vFEFFEFEEFF7	0 1 3 4 5 6 7 9 10 11 12 13 14 15 16 17 18 1
90	89	$_{22}$4-51B	v10110100110	0 6 9 10	0 3 4 16	0 1 13 19	0 12 18 21	$_{22}$18-51	vFEFFEFEEFF7	0 1 2 3 4 5 6 7 8 9 10 12 13 14 15 16 18 19
91	90	$_{22}$4-52	v10110011001	0 3 4 11	0 1 8 19	0 7 18 21	0 11 14 15	$_{22}$18-52	vFEFFEEFFEE8	0 1 2 3 4 5 7 8 9 10 11 12 13 14 15 16 18 19
92	91	$_{22}$4-52B	v10110011001	0 7 8 11	0 1 4 15	0 3 14 21	0 11 18 19	$_{22}$18-52B	vFEFFEEFFEE8	0 1 3 4 5 6 7 8 9 10 11 12 14 15 16 17 18 19
93	92	$_{22}$4-53	v10110010011	0 1 4 11	0 3 10 21	0 7 18 19	0 11 12 15	$_{22}$18-53B	vFEFFEEFEEF8	0 1 3 4 5 6 7 8 10 11 12 13 14 15 16 17 18 1
94	93	$_{22}$4-53B	v10110010011	0 7 10 11	0 3 4 15	0 1 12 19	0 11 18 21	$_{22}$18-53	vFEFFEEFEEF8	0 1 2 3 4 5 6 7 8 9 11 12 13 14 15 16 18 19
95	94	$_{22}$4-54	v10110001110	0 3 4 12	0 1 9 19	0 8 18 21	0 10 13 14	$_{22}$18-54	vFEFFEEEFFF7	0 1 2 3 4 5 6 8 9 10 11 12 13 14 15 16 18 19
96	95	$_{22}$4-54B	v10110001110	0 8 9 12	0 1 4 14	0 3 13 21	0 10 18 19	$_{22}$18-54B	vFEFFEEEFFF7	0 1 3 4 5 6 7 8 9 10 11 13 14 15 16 17 18 19
97	96	$_{22}$4-55	v10110001011	0 1 4 12	0 3 11 21	0 8 18 19	0 10 11 14	$_{22}$18-55B	vFEFFEEEFEF8	0 1 3 4 5 6 7 8 9 11 12 13 14 15 16 17 18 19
98	97	$_{22}$4-55B	v10110001011	0 8 11 12	0 3 4 14	0 1 11 19	0 10 18 21	$_{22}$18-55	vFEFFEEEFEF8	0 1 2 3 4 5 6 7 8 10 11 12 13 14 15 16 18 19
99	98	$_{22}$4-56	v10110000210	0 1 4 13	0 3 12 21	0 9 18 19	0 9 10 13	$_{22}$18-56B	vFEFFEEEEGF7	0 1 3 4 5 6 7 8 9 10 12 13 14 15 16 17 18 19
100	99	$_{22}$4-56B	v10110000210	0 3 4 13	0 1 10 19	0 9 18 21	0 9 12 13	$_{22}$18-56	vFEFFEEEEGF7	0 1 2 3 4 5 6 7 9 10 11 12 13 14 15 16 18 19
101	100	$_{22}$4-57	v10101101100	0 1 6 9	0 5 8 21	0 3 16 17	0 13 14 19	$_{22}$18-57B	vFEFEFFEFFE7	0 1 2 3 5 6 8 9 10 11 12 13 14 15 16 17 18 1
102	101	$_{22}$4-57B	v10101101100	0 3 8 9	0 5 6 19	0 1 14 17	0 13 16 21	$_{22}$18-57	vFEFEFFEFFE7	0 1 2 3 4 5 6 7 8 9 10 11 13 14 16 17 18 19
103	102	$_{22}$4-58	v10100110110	0 1 7 10	0 6 9 21	0 3 15 16	0 12 13 19	$_{22}$18-58B	vFEFEEFFEFF7	0 1 2 3 4 6 7 9 10 11 12 13 14 15 16 17 18 1
104	103	$_{22}$4-58B	v10100110110	0 3 9 10	0 6 7 19	0 1 13 16	0 12 15 21	$_{22}$18-58	vFEFEEFFEFF7	0 1 2 3 4 5 6 7 8 9 10 12 13 15 16 17 18 19
105	104	$_{22}$4-59	v10100011011	0 1 8 11	0 7 10 21	0 3 14 15	0 11 12 19	$_{22}$18-59B	vFEFEEEFFEF8	0 1 2 3 4 5 7 8 10 11 12 13 14 15 16 17 18 1
106	105	$_{22}$4-59B	v10100011011	0 3 10 11	0 7 8 19	0 1 12 15	0 11 14 21	$_{22}$18-59	vFEFEEEFFEF8	0 1 2 3 4 5 6 7 8 9 11 12 14 15 16 17 18 19
107	106	$_{22}$4-60	v10100001111	0 1 9 12	0 8 11 21	0 3 13 14	0 10 11 19	$_{22}$18-60B	vFEFEEEEFFF8	0 1 2 3 4 5 6 8 9 11 12 13 14 15 16 17 18 19
108	107	$_{22}$4-60B	v10100001111	0 3 11 12	0 8 9 19	0 1 11 14	0 10 13 21	$_{22}$18-60	vFEFEEEEFFF8	0 1 2 3 4 5 6 7 8 10 11 13 14 15 16 17 18 19
109	108	$_{22}$4-61*	v10100000220	0 1 10 13	0 9 12 21	0 3 12 13	0 9 10 19	$_{22}$18-61*	vFEFEEEEEGG7	0 1 2 3 4 5 6 7 9 10 12 13 14 15 16 17 18 19
110	109	$_{22}$4-62*	v10022000100	0 4 5 9	0 1 5 18	0 4 17 21	0 13 17 18	$_{22}$18-62*	vFEEGGEEEFE7	0 1 2 4 5 6 7 8 9 10 11 12 13 14 15 17 18 19
111	110	$_{22}$4-63	v10021001100	0 1 5 9	0 4 8 21	0 4 17 18	0 13 14 18	$_{22}$18-63B	vFEEGFEEFFE7	0 1 2 4 5 6 8 9 10 11 12 13 14 15 16 17 18 1
112	111	$_{22}$4-63B	v10021001100	0 4 8 9	0 4 5 18	0 1 14 18	0 13 17 21	$_{22}$18-63	vFEEGFEEFFE7	0 1 2 3 4 5 6 7 8 9 10 11 13 14 15 17 18 19
113	112	$_{22}$4-64	v10012100010	0 4 5 10	0 1 6 18	0 5 17 21	0 12 16 17	$_{22}$18-64	vFEEFGFEEEF7	0 1 2 3 5 6 7 8 9 10 11 12 13 14 15 17 18 19
114	113	$_{22}$4-64B	v10012100010	0 5 6 10	0 1 5 17	0 4 16 21	0 12 17 18	$_{22}$18-64B	vFEEFGFEEEF7	0 1 2 4 5 6 7 8 9 10 11 12 13 14 16 17 18 19
115	114	$_{22}$4-65	v10012000110	0 1 5 10	0 4 9 21	0 5 17 18	0 12 13 17	$_{22}$18-65B	vFEEFGEEEFF7	0 1 2 4 5 6 7 9 10 11 12 13 14 15 16 17 18 1
116	115	$_{22}$4-65B	v10012000110	0 5 9 10	0 4 5 17	0 1 13 18	0 12 17 21	$_{22}$18-65	vFEEFGEEEFF7	0 1 2 3 4 5 6 7 8 9 10 12 13 14 15 17 18 19
117	116	$_{22}$4-66	v10011110001	0 4 5 11	0 1 7 18	0 6 17 21	0 11 15 16	$_{22}$18-66	vFEEFFFEEE8	0 1 2 3 4 6 7 8 9 10 11 12 13 14 15 17 18 19
118	117	$_{22}$4-66B	v10011110001	0 6 7 11	0 1 5 16	0 4 15 21	0 11 17 18	$_{22}$18-66B	vFEEFFFEEE8	0 1 2 4 5 6 7 8 9 10 11 12 13 15 16 17 18 19
119	118	$_{22}$4-67	v10011100110	0 1 6 10	0 5 9 21	0 4 16 17	0 12 13 18	$_{22}$18-67B	vFEEFFEEFF7	0 1 2 3 5 6 7 9 10 11 12 13 14 15 16 17 18 1
120	119	$_{22}$4-67B	v10011100110	0 4 9 10	0 5 6 18	0 1 13 17	0 12 16 21	$_{22}$18-67	vFEEFFEEFF7	0 1 2 3 4 5 6 7 8 9 10 12 13 14 16 17 18 19
121	120	$_{22}$4-68	v10011100011	0 1 5 11	0 4 10 21	0 6 17 18	0 11 12 16	$_{22}$18-68B	vFEEFFEEEF8	0 1 2 4 5 6 7 8 10 11 12 13 14 15 16 17 18 1
122	121	$_{22}$4-68B	v10011100011	0 6 10 11	0 4 5 16	0 1 12 18	0 11 17 21	$_{22}$18-68	vFEEFFEEEF8	0 1 2 3 4 5 6 7 8 9 11 12 13 14 15 17 18 19
123	122	$_{22}$4-69	v10011011010	0 4 5 12	0 1 8 18	0 7 17 21	0 10 14 15	$_{22}$18-69	vFEEFFEFFEF7	0 1 2 3 4 5 7 8 9 10 11 12 13 14 15 17 18 19
124	123	$_{22}$4-69B	v10011011010	0 7 8 12	0 1 5 15	0 4 14 21	0 10 17 18	$_{22}$18-69B	vFEEFFEFFEF7	0 1 2 4 5 6 7 8 9 10 11 12 14 15 16 17 18 19
125	124	$_{22}$4-70	v10011010011	0 1 5 12	0 4 11 21	0 7 17 18	0 10 11 15	$_{22}$18-70B	vFEEFFEFEEF8	0 1 2 4 5 6 7 8 9 11 12 13 14 15 16 17 18 19
126	125	$_{22}$4-70B	v10011010011	0 7 11 12	0 4 5 15	0 1 11 18	0 10 17 21	$_{22}$18-70	vFEEFFEFEEF8	0 1 2 3 4 5 6 7 8 10 11 12 13 14 15 17 18 19
127	126	$_{22}$4-71	v10011001200	0 4 5 13	0 1 9 18	0 8 17 21	0 9 13 14	$_{22}$18-71	vFEEFFEEFGE7	0 1 2 3 4 5 6 8 9 10 11 12 13 14 15 17 18 19
128	127	$_{22}$4-71B	v10011001200	0 8 9 13	0 1 5 14	0 4 13 21	0 9 17 18	$_{22}$18-71B	vFEEFFEEFGE7	0 1 2 4 5 6 7 8 9 10 11 13 14 15 16 17 18 19
129	128	$_{22}$4-72	v10011001110	0 1 5 13	0 4 12 21	0 8 17 18	0 9 10 14	$_{22}$18-72B	vFEEFFEEFFF7	0 1 2 4 5 6 7 8 9 10 12 13 14 15 16 17 18 19
130	129	$_{22}$4-72B	v10011001110	0 8 12 13	0 4 5 14	0 1 10 18	0 9 17 21	$_{22}$18-72	vFEEFFEEFFF7	0 1 2 3 4 5 6 7 9 10 11 12 13 14 15 17 18 19
131	130	$_{22}$4-73	v10010110011	0 1 7 11	0 6 10 21	0 4 15 16	0 11 12 18	$_{22}$18-73B	vFEEFEFFEEF8	0 1 2 3 4 6 7 8 10 11 12 13 14 15 16 17 18 1
132	131	$_{22}$4-73B	v10010110011	0 4 10 11	0 6 7 18	0 1 12 16	0 11 15 21	$_{22}$18-73	vFEEFEFFEEF8	0 1 2 3 4 5 6 7 8 9 11 12 13 15 16 17 18 19
133	132	$_{22}$4-74	v10010011011	0 1 8 12	0 7 11 21	0 4 14 15	0 10 11 18	$_{22}$18-74B	vFEEFEEFFEF8	0 1 2 3 4 5 7 8 9 11 12 13 14 15 16 17 18 19
134	133	$_{22}$4-74B	v10010011011	0 4 11 12	0 7 8 18	0 1 11 15	0 10 14 21	$_{22}$18-74	vFEEFEEFFEF8	0 1 2 3 4 5 6 7 8 10 11 12 14 15 16 17 18 19
135	134	$_{22}$4-75	v10010001210	0 1 9 13	0 8 12 21	0 4 13 14	0 9 10 18	$_{22}$18-75B	vFEEFEEEFGF7	0 1 2 3 4 5 6 8 9 10 12 13 14 15 16 17 18 19
136	135	$_{22}$4-75B	v10010001210	0 4 12 13	0 8 9 18	0 1 10 14	0 9 13 21	$_{22}$18-75	vFEEFEEEFGF7	0 1 2 3 4 5 6 7 9 10 11 13 14 15 16 17 18 19
137	136	$_{22}$4-76*	v10002200001	0 5 6 11	0 1 6 17	0 5 16 21	0 11 16 17	$_{22}$18-76*	vFEEEGGEEEE8	0 1 2 3 5 6 7 8 9 10 11 12 13 14 16 17 18 19
138	137	$_{22}$4-77	v10002100011	0 1 6 11	0 5 10 21	0 5 16 17	0 11 12 17	$_{22}$18-77B	vFEEEGFEEEF8	0 1 2 3 5 6 7 8 10 11 12 13 14 15 16 17 18 1
139	138	$_{22}$4-77B	v10002100011	0 5 10 11	0 5 6 17	0 1 12 17	0 11 16 21	$_{22}$18-77	vFEEEGFEEEF8	0 1 2 3 4 5 6 7 8 9 11 12 13 14 16 17 18 19
140	139	$_{22}$4-78	v10001210010	0 5 6 12	0 1 7 17	0 6 16 21	0 10 15 16	$_{22}$18-78	vFEEEFGFEEF7	0 1 2 3 4 6 7 8 9 10 11 12 13 14 16 17 18 19
141	140	$_{22}$4-78B	v10001210010	0 6 7 12	0 1 6 16	0 5 15 21	0 10 16 17	$_{22}$18-78B	vFEEEFGFEEF7	0 1 2 3 5 6 7 8 9 10 11 12 13 15 16 17 18 19
142	141	$_{22}$4-79	v10001200011	0 1 6 12	0 5 11 21	0 6 16 17	0 10 11 16	$_{22}$18-79B	vFEEEFGEEEF8	0 1 2 3 5 6 7 8 9 11 12 13 14 15 16 17 18 19
143	142	$_{22}$4-79B	v10001200011	0 6 11 12	0 5 6 16	0 1 11 17	0 10 16 21	$_{22}$18-79	vFEEEFGEEEF8	0 1 2 3 4 5 6 7 8 10 11 12 13 14 16 17 18 19
144	143	$_{22}$4-80	v10001111100	0 5 6 13	0 1 8 17	0 7 16 21	0 9 14 15	$_{22}$18-80	vFEEEFFFFFE7	0 1 2 3 4 5 7 8 9 10 11 12 13 14 16 17 18 19
145	144	$_{22}$4-80B	v10001111100	0 7 8 13	0 1 6 15	0 5 14 21	0 9 16 17	$_{22}$18-80B	vFEEEFFFFFE7	0 1 2 3 5 6 7 8 9 10 11 12 14 15 16 17 18 19

	A	B	C	D	E	F	G	H	I	J
146	145	$_{22}$4-81	v10001110110	0 1 6 13	0 5 12 21	0 7 16 17	0 9 10 15	$_{22}$18-81B	vFEEEFFFEFF7	0 1 2 3 5 6 7 8 9 10 12 13 14 15 16 17 18 19
147	146	$_{22}$4-81B	v10001110110	0 7 12 13	0 5 6 15	0 1 10 17	0 9 16 21	$_{22}$18-81	vFEEEFFFEFF7	0 1 2 3 4 5 6 7 9 10 11 12 13 14 16 17 18 19
148	147	$_{22}$4-82	v10001110011	0 1 7 12	0 6 11 21	0 5 15 16	0 10 11 17	$_{22}$18-82B	vFEEEFFEEF8	0 1 2 3 4 6 7 8 9 11 12 13 14 15 16 17 18 19
149	148	$_{22}$4-82B	v10001110011	0 5 11 12	0 6 7 17	0 1 11 16	0 10 15 21	$_{22}$18-82	vFEEEFFEEF8	0 1 2 3 4 5 6 7 8 10 11 12 13 15 16 17 18 19
150	149	$_{22}$4-83	v10001102100	0 1 6 14	0 5 13 21	0 8 16 17	0 8 9 14	$_{22}$18-83B	vFEEEFFEGFE7	0 1 2 3 5 6 7 8 9 10 11 13 14 15 16 17 18 19
151	150	$_{22}$4-83B	v10001102100	0 5 6 14	0 1 9 17	0 8 16 21	0 8 13 14	$_{22}$18-83	vFEEEFFEGFE7	0 1 2 3 4 5 6 8 9 10 11 12 13 14 16 17 18 19
152	151	$_{22}$4-84	v10001011110	0 1 8 13	0 7 12 21	0 5 14 15	0 9 10 17	$_{22}$18-84B	vFEEEFEFFFF7	0 1 2 3 4 5 7 8 9 10 12 13 14 15 16 17 18 19
153	152	$_{22}$4-84B	v10001011110	0 5 12 13	0 7 8 17	0 1 10 15	0 9 14 21	$_{22}$18-84	vFEEEFEFFFF7	0 1 2 3 4 5 6 7 9 10 11 12 14 15 16 17 18 19
154	153	$_{22}$4-85*	v10001002200	0 1 9 14	0 8 13 21	0 5 13 14	0 8 9 17	$_{22}$18-85*	vFEEEFEEGGE7	0 1 2 3 4 5 6 8 9 10 11 13 14 15 16 17 18 19
155	154	$_{22}$4-86*	v10000220100	0 6 7 13	0 1 7 16	0 6 15 21	0 9 15 16	$_{22}$18-86*	vFEEEEGGEFE7	0 1 2 3 4 6 7 8 9 10 11 12 13 15 16 17 18 19
156	155	$_{22}$4-87	v10000210110	0 1 7 13	0 6 12 21	0 6 15 16	0 9 10 16	$_{22}$18-87B	vFEEEEGFEFF7	0 1 2 3 4 6 7 8 9 10 12 13 14 15 16 17 18 19
157	156	$_{22}$4-87B	v10000210110	0 6 12 13	0 6 7 16	0 1 10 16	0 9 15 21	$_{22}$18-87	vFEEEEGFEFF7	0 1 2 3 4 5 6 7 9 10 11 12 13 15 16 17 18 19
158	157	$_{22}$4-88	v10000122000	0 6 7 14	0 1 8 16	0 7 15 21	0 8 14 15	$_{22}$18-88	vFEEEEFGGEE7	0 1 2 3 4 5 7 8 9 10 11 12 13 15 16 17 18 19
159	158	$_{22}$4-88B	v10000122000	0 7 8 14	0 1 7 15	0 6 14 21	0 8 15 16	$_{22}$18-88B	vFEEEEFGGEE7	0 1 2 3 4 6 7 8 9 10 11 12 14 15 16 17 18 19
160	159	$_{22}$4-89	v10000121100	0 1 7 14	0 6 13 21	0 7 15 16	0 8 9 15	$_{22}$18-89B	vFEEEEFGFFE7	0 1 2 3 4 6 7 8 9 10 11 13 14 15 16 17 18 19
161	160	$_{22}$4-89B	v10000121100	0 7 13 14	0 6 7 15	0 1 9 16	0 8 15 21	$_{22}$18-89	vFEEEEFGFFE7	0 1 2 3 4 5 6 8 9 10 11 12 13 15 16 17 18 19
162	161	$_{22}$4-90	v10000112100	0 1 8 14	0 7 13 21	0 6 14 15	0 8 9 16	$_{22}$18-90B	vFEEEEFFGFE7	0 1 2 3 4 5 7 8 9 10 11 13 14 15 16 17 18 19
163	162	$_{22}$4-90B	v10000112100	0 6 13 14	0 7 8 16	0 1 9 15	0 8 14 21	$_{22}$18-90	vFEEEEFFGFE7	0 1 2 3 4 5 6 8 9 10 11 12 14 15 16 17 18 19
164	163	$_{22}$4-91*	v10000032000	0 1 8 15	0 7 14 21	0 7 14 15	0 7 8 15	$_{22}$18-91*	vFEEEEEHGEE7	0 1 2 3 4 5 7 8 9 10 11 12 14 15 16 17 18 19
165	164	$_{22}$4-92*	v03020100000	0 2 4 6	0 2 4 20	0 2 18 20	0 16 18 20	$_{22}$18-92*	vEHEGEFEEEE7	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 16 18 20
166	165	$_{22}$4-93	v02111010000	0 2 4 7	0 2 5 20	0 3 18 20	0 15 17 19	$_{22}$18-93B	vEGFFFEFEEE7	0 1 2 3 4 5 6 7 8 9 10 11 12 13 15 17 19 20
167	166	$_{22}$4-93B	v02111010000	0 3 5 7	0 2 4 19	0 2 17 20	0 15 18 20	$_{22}$18-93	vEGFFFEFEEE7	0 1 2 3 4 5 6 7 8 9 10 11 12 13 15 16 18 20
168	167	$_{22}$4-94*	v02102010000	0 2 5 7	0 3 5 20	0 2 17 19	0 15 17 20	$_{22}$18-94*	vEGFEGEFEEE7	0 1 2 3 4 5 6 7 8 9 10 11 12 13 15 17 18 20
169	168	$_{22}$4-95	v02020101000	0 2 4 8	0 2 6 20	0 4 18 20	0 14 16 18	$_{22}$18-95B	vEGEGEFEFEE7	0 1 2 3 4 5 6 7 8 9 10 11 12 14 16 18 19 20
170	169	$_{22}$4-95B	v02020101000	0 4 6 8	0 2 4 18	0 2 16 20	0 14 18 20	$_{22}$18-95	vEGEGEFEFEE7	0 1 2 3 4 5 6 7 8 9 10 11 12 14 15 16 18 20
171	170	$_{22}$4-96	v02011010100	0 2 4 9	0 2 7 20	0 5 18 20	0 13 15 17	$_{22}$18-96B	vEGEFFEFEFE7	0 1 2 3 4 5 6 7 8 9 10 11 13 15 17 18 19 20
172	171	$_{22}$4-96B	v02011010100	0 5 7 9	0 2 4 17	0 2 15 20	0 13 18 20	$_{22}$18-96	vEGEFFEFEFE7	0 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16 18 20
173	172	$_{22}$4-97*	v02010201000	0 2 6 8	0 4 6 20	0 2 16 18	0 14 16 20	$_{22}$18-97*	vEGEFEGEFEE7	0 1 2 3 4 5 6 7 8 9 10 11 12 14 16 17 18 20
174	173	$_{22}$4-98	v02010101010	0 2 4 10	0 2 8 20	0 6 18 20	0 12 14 16	$_{22}$18-98B	vEGEFEFEFEF7	0 1 2 3 4 5 6 7 8 9 10 12 14 16 17 18 19 20
175	174	$_{22}$4-98B	v02010101010	0 6 8 10	0 2 4 16	0 2 14 20	0 12 18 20	$_{22}$18-98	vEGEFEFEFEF7	0 1 2 3 4 5 6 7 8 9 10 12 13 14 15 16 18 20
176	175	$_{22}$4-99	v02010010101	0 2 4 11	0 2 9 20	0 7 18 20	0 11 13 15	$_{22}$18-99B	vEGEFEEFEFE8	0 1 2 3 4 5 6 7 8 9 11 13 15 16 17 18 19 20
177	176	$_{22}$4-99B	v02010010101	0 7 9 11	0 2 4 15	0 2 13 20	0 11 18 20	$_{22}$18-99	vEGEFEEFEFE8	0 1 2 3 4 5 6 7 8 9 11 12 13 14 15 16 18 20
178	177	$_{22}$4-100	v02010001020	0 2 4 12	0 2 10 20	0 8 18 20	0 10 12 14	$_{22}$18-100B	vEGEFEEEFEG7	0 1 2 3 4 5 6 7 8 10 12 14 15 16 17 18 19 20
179	178	$_{22}$4-100B	v02010001020	0 8 10 12	0 2 4 14	0 2 12 20	0 10 18 20	$_{22}$18-100	vEGEFEEEFEG7	0 1 2 3 4 5 6 7 8 10 11 12 13 14 15 16 18 20
180	179	$_{22}$4-101*	v02010000201	0 2 4 13	0 2 11 20	0 9 18 20	0 9 11 13	$_{22}$18-101*	vEGEFEEEEGE8	0 1 2 3 4 5 6 7 9 10 11 12 13 14 15 16 18 20
181	180	$_{22}$4-102*	v02001020100	0 2 7 9	0 5 7 20	0 2 15 17	0 13 15 20	$_{22}$18-102*	vEGEEFEGEFE7	0 1 2 3 4 5 6 7 8 9 10 11 13 15 16 17 18 20
182	181	$_{22}$4-103*	v02000102010	0 2 8 10	0 6 8 20	0 2 14 16	0 12 14 20	$_{22}$18-103*	vEGEEEFEGEF7	0 1 2 3 4 5 6 7 8 9 10 12 14 15 16 17 18 20
183	182	$_{22}$4-104*	v02000010201	0 2 9 11	0 7 9 20	0 2 13 15	0 11 13 20	$_{22}$18-104*	vEGEEEEFEGE8	0 1 2 3 4 5 6 7 8 9 11 13 14 15 16 17 18 20
184	183	$_{22}$4-105*	v02000001030	0 2 10 12	0 8 10 20	0 2 12 14	0 10 12 20	$_{22}$18-105*	vEGEEEEEFEH7	0 1 2 3 4 5 6 7 8 10 12 13 14 15 16 17 18 20
185	184	$_{22}$4-106*	v02000000202	0 2 11 13	0 9 11 20			$_{22}$18-106*	vEGEEEEEEGE9	0 1 2 3 4 5 6 7 9 11 12 13 14 15 16 17 18 20
186	185	$_{22}$4-107*	v01202001000	0 3 5 8	0 2 5 19	0 3 17 20	0 14 17 19	$_{22}$18-107*	vEFGEGEEFEE7	0 1 2 3 4 5 6 7 8 9 10 11 12 14 15 17 19 20
187	186	$_{22}$4-108	v01201101000	0 2 5 8	0 3 6 20	0 3 17 19	0 14 16 19	$_{22}$18-108B	vEFGEFFEFEE7	0 1 2 3 4 5 6 7 8 9 10 11 12 14 16 17 19 20
188	187	$_{22}$4-108B	v01201101000	0 3 6 8	0 3 5 19	0 2 16 19	0 14 17 20	$_{22}$18-108	vEFGEFFEFEE7	0 1 2 3 4 5 6 7 8 9 10 11 12 14 15 17 18 20
189	188	$_{22}$4-109	v01111100100	0 3 5 9	0 2 6 19	0 4 17 20	0 13 16 18	$_{22}$18-109B	vEFFFFFEEFE7	0 1 2 3 4 5 6 7 8 9 10 11 13 14 16 18 19 20
190	189	$_{22}$4-109B	v01111100100	0 4 6 9	0 2 5 18	0 3 16 20	0 13 17 19	$_{22}$18-109	vEFFFFFEEFE7	0 1 2 3 4 5 6 7 8 9 10 11 13 14 15 17 19 20
191	190	$_{22}$4-110	v01111010100	0 2 5 9	0 3 7 20	0 4 17 19	0 13 15 18	$_{22}$18-110B	vEFFFFEFEFE7	0 1 2 3 4 5 6 7 8 9 10 11 13 15 16 18 19 20
192	191	$_{22}$4-110B	v01111010100	0 4 7 9	0 3 5 18	0 2 15 19	0 13 17 20	$_{22}$18-110	vEFFFFEFEFE7	0 1 2 3 4 5 6 7 8 9 10 11 13 14 15 17 18 20
193	192	$_{22}$4-111	v01110110100	0 2 6 9	0 4 7 20	0 3 16 18	0 13 15 19	$_{22}$18-111B	vEFFFEFFEFE7	0 1 2 3 4 5 6 7 8 9 10 11 13 15 16 17 19 20
194	193	$_{22}$4-111B	v01110110100	0 3 7 9	0 4 6 19	0 2 15 18	0 13 16 20	$_{22}$18-111	vEFFFEFFEFE7	0 1 2 3 4 5 6 7 8 9 10 11 13 14 16 17 18 20
195	194	$_{22}$4-112	v01102010010	0 3 5 10	0 2 7 19	0 5 17 20	0 12 15 17	$_{22}$18-112B	vEFFEGEFEEF7	0 1 2 3 4 5 6 7 8 9 10 12 13 15 17 18 19 20
196	195	$_{22}$4-112B	v01102010010	0 5 7 10	0 2 5 17	0 3 15 20	0 12 17 19	$_{22}$18-112	vEFFEGEFEEF7	0 1 2 3 4 5 6 7 8 9 10 12 13 14 15 17 19 20
197	196	$_{22}$4-113	v01102001010	0 2 5 10	0 3 8 20	0 5 17 19	0 12 14 17	$_{22}$18-113B	vEFFEGEEFEF7	0 1 2 3 4 5 6 7 8 9 10 12 14 15 17 18 19 20
198	197	$_{22}$4-113B	v01102001010	0 5 8 10	0 3 5 17	0 2 14 19	0 12 17 20	$_{22}$18-113	vEFFEGEEFEF7	0 1 2 3 4 5 6 7 8 9 10 12 13 14 15 17 18 20
199	198	$_{22}$4-114	v01101101001	0 3 5 11	0 2 8 19	0 6 17 20	0 11 14 16	$_{22}$18-114B	vEFFEFFEFEE8	0 1 2 3 4 5 6 7 8 9 11 12 14 16 17 18 19 20
200	199	$_{22}$4-114B	v01101101001	0 6 8 11	0 2 5 16	0 3 14 20	0 11 17 19	$_{22}$18-114	vEFFEFFEFEE8	0 1 2 3 4 5 6 7 8 9 11 12 13 14 15 17 19 20
201	200	$_{22}$4-115	v01101100101	0 2 5 11	0 3 9 20	0 6 17 19	0 11 13 16	$_{22}$18-115B	vEFFEFFEEFE8	0 1 2 3 4 5 6 7 8 9 11 13 14 16 17 18 19 20
202	201	$_{22}$4-115B	v01101100101	0 6 9 11	0 3 5 16	0 2 13 19	0 11 17 20	$_{22}$18-115	vEFFEFFEEFE8	0 1 2 3 4 5 6 7 8 9 11 12 13 14 15 17 18 20
203	202	$_{22}$4-116	v01101011010	0 2 7 10	0 5 8 20	0 3 15 17	0 12 14 19	$_{22}$18-116B	vEFFEFEFFEF7	0 1 2 3 4 5 6 7 8 9 10 12 14 15 16 17 19 20
204	203	$_{22}$4-116B	v01101011010	0 3 8 10	0 5 7 19	0 2 14 17	0 12 15 20	$_{22}$18-116	vEFFEFEFFEF7	0 1 2 3 4 5 6 7 8 9 10 12 13 15 16 17 18 20
205	204	$_{22}$4-117	v01101010110	0 3 5 12	0 2 9 19	0 7 17 20	0 10 13 15	$_{22}$18-117B	vEFFEFEFEFF7	0 1 2 3 4 5 6 7 8 10 11 13 15 16 17 18 19 20
206	205	$_{22}$4-117B	v01101010110	0 7 9 12	0 2 5 15	0 3 13 20	0 10 17 19	$_{22}$18-117	vEFFEFEFEFF7	0 1 2 3 4 5 6 7 8 10 11 12 13 14 15 17 19 20
207	206	$_{22}$4-118	v01101010020	0 2 5 12	0 3 10 20	0 7 17 19	0 10 12 15	$_{22}$18-118B	vEFFEFEFEEG7	0 1 2 3 4 5 6 7 8 10 12 13 15 16 17 18 19 20
208	207	$_{22}$4-118B	v01101010020	0 7 10 12	0 3 5 15	0 2 12 19	0 10 17 20	$_{22}$18-118	vEFFEFEFEEG7	0 1 2 3 4 5 6 7 8 10 11 12 13 14 15 17 18 20
209	208	$_{22}$4-119	v01101001110	0 3 5 13	0 2 10 19	0 8 17 20	0 9 12 14	$_{22}$18-119B	vEFFEFEEFFF7	0 1 2 3 4 5 6 7 9 10 12 14 15 16 17 18 19 20
210	209	$_{22}$4-119B	v01101001110	0 8 10 13	0 2 5 14	0 3 12 20	0 9 17 19	$_{22}$18-119	vEFFEFEEFFF7	0 1 2 3 4 5 6 7 9 10 11 12 13 14 15 17 19 20
211	210	$_{22}$4-120	v01101001101	0 2 5 13	0 3 11 20	0 8 17 19	0 9 11 14	$_{22}$18-120B	vEFFEFEEFFE8	0 1 2 3 4 5 6 7 9 11 12 14 15 16 17 18 19 20
212	211	$_{22}$4-120B	v01101001101	0 8 11 13	0 3 5 14	0 2 11 19	0 9 17 20	$_{22}$18-120	vEFFEFEEFFE8	0 1 2 3 4 5 6 7 9 10 11 12 13 14 15 17 18 20
213	212	$_{22}$4-121	v01100101101	0 2 8 11	0 6 9 20	0 3 14 16	0 11 13 19	$_{22}$18-121B	vEFFEEFEFFE8	0 1 2 3 4 5 6 7 8 9 11 13 14 15 16 17 19 20
214	213	$_{22}$4-121B	v01100101101	0 3 9 11	0 6 8 19	0 2 13 16	0 11 14 20	$_{22}$18-121	vEFFEEFEFFE8	0 1 2 3 4 5 6 7 8 9 11 12 14 15 16 17 18 20
215	214	$_{22}$4-122	v01100010120	0 2 9 12	0 7 10 20	0 3 13 15	0 10 12 19	$_{22}$18-122B	vEFFEEEFEFG7	0 1 2 3 4 5 6 7 8 10 12 13 14 15 16 17 19 20
216	215	$_{22}$4-122B	v01100010120	0 3 10 12	0 7 9 19	0 2 12 15	0 10 13 20	$_{22}$18-122	vEFFEEEFEFG7	0 1 2 3 4 5 6 7 8 10 11 13 14 15 16 17 18 20
217	216	$_{22}$4-123	v01100001111	0 2 10 13	0 8 11 20	0 3 12 14	0 9 11 19	$_{22}$18-123B	vEFFEEEEFFF8	0 1 2 3 4 5 6 7 9 11 12 13 14 15 16 17 19 20

	A	B	C	D	E	F	G	H	I	J
218	217	$_{22}$4-123B	v01100001111	0 3 11 13	0 8 10 19	0 2 11 14	0 9 12 20	$_{22}$18-123	vEFFEEEEFFF8	0 1 2 3 4 5 6 7 9 10 12 13 14 15 16 17 18 20
219	218	$_{22}$4-124*	v01020200010	0 4 6 10	0 2 6 18	0 4 16 20	0 12 16 18	$_{22}$18-124*	vEFEGEGEEEF7	0 1 2 3 4 5 6 7 8 9 10 12 13 14 16 18 19 20
220	219	$_{22}$4-125	v01020101010	0 2 6 10	0 4 8 20	0 4 16 18	0 12 14 18	$_{22}$18-125B	vEFEGEFEFEF7	0 1 2 3 4 5 6 7 8 9 10 12 14 15 16 18 19 20
221	220	$_{22}$4-125B	v01020101010	0 4 8 10	0 4 6 18	0 2 14 18	0 12 16 20	$_{22}$18-125	vEFEGEFEFEF7	0 1 2 3 4 5 6 7 8 9 10 12 13 14 16 17 18 20
222	221	$_{22}$4-126	v01011110001	0 4 6 11	0 2 7 18	0 5 16 20	0 11 15 17	$_{22}$18-126B	vEFEFFFFEEE8	0 1 2 3 4 5 6 7 8 9 11 12 13 15 17 18 19 20
223	222	$_{22}$4-126B	v01011110001	0 5 7 11	0 2 6 17	0 4 15 20	0 11 16 18	$_{22}$18-126	vEFEFFFFEEE8	0 1 2 3 4 5 6 7 8 9 11 12 13 14 16 18 19 20
224	223	$_{22}$4-127	v01011100101	0 2 6 11	0 4 9 20	0 5 16 18	0 11 13 17	$_{22}$18-127B	vEFEFFFEEFE8	0 1 2 3 4 5 6 7 8 9 11 13 14 15 17 18 19 20
225	224	$_{22}$4-127B	v01011100101	0 5 9 11	0 4 6 17	0 2 13 18	0 11 16 20	$_{22}$18-127	vEFEFFFEEFE8	0 1 2 3 4 5 6 7 8 9 11 12 13 14 16 17 18 20
226	225	$_{22}$4-128	v01011010101	0 2 7 11	0 5 9 20	0 4 15 17	0 11 13 18	$_{22}$18-128B	vEFEFFEFEFE8	0 1 2 3 4 5 6 7 8 9 11 13 14 15 16 18 19 20
227	226	$_{22}$4-128B	v01011010101	0 4 9 11	0 5 7 18	0 2 13 17	0 11 15 20	$_{22}$18-128	vEFEFFEFEFE8	0 1 2 3 4 5 6 7 8 9 11 12 13 15 16 17 18 20
228	227	$_{22}$4-129	v01010201010	0 4 6 12	0 2 8 18	0 6 16 20	0 10 14 16	$_{22}$18-129B	vEFEFEGEFEF7	0 1 2 3 4 5 6 7 8 10 11 12 14 16 17 18 19 20
229	228	$_{22}$4-129B	v01010201010	0 6 8 12	0 2 6 16	0 4 14 20	0 10 16 18	$_{22}$18-129	vEFEFEGEFEF7	0 1 2 3 4 5 6 7 8 10 11 12 13 14 16 18 19 20
230	229	$_{22}$4-130	v01010200020	0 2 6 12	0 4 10 20	0 6 16 18	0 10 12 16	$_{22}$18-130B	vEFEFEGEEEG7	0 1 2 3 4 5 6 7 8 10 12 13 14 16 17 18 19 20
231	230	$_{22}$4-130B	v01010200020	0 6 10 12	0 4 6 16	0 2 12 18	0 10 16 20	$_{22}$18-130	vEFEFEGEEEG7	0 1 2 3 4 5 6 7 8 10 11 12 13 14 16 17 18 20
232	231	$_{22}$4-131	v01010110200	0 4 6 13	0 2 9 18	0 7 16 20	0 9 13 15	$_{22}$18-131B	vEFEFEFFEGE7	0 1 2 3 4 5 6 7 9 10 11 13 15 16 17 18 19 20
233	232	$_{22}$4-131B	v01010110200	0 7 9 13	0 2 6 15	0 4 13 20	0 9 16 18	$_{22}$18-131	vEFEFEFFEGE7	0 1 2 3 4 5 6 7 9 10 11 12 13 14 16 18 19 20
234	233	$_{22}$4-132	v01010110101	0 2 6 13	0 4 11 20	0 7 16 18	0 9 11 15	$_{22}$18-132B	vEFEFEFFEFE8	0 1 2 3 4 5 6 7 9 11 12 13 15 16 17 18 19 20
235	234	$_{22}$4-132B	v01010110101	0 7 11 13	0 4 6 15	0 2 11 18	0 9 16 20	$_{22}$18-132	vEFEFEFFEFE8	0 1 2 3 4 5 6 7 9 10 11 12 13 14 16 17 18 20
236	235	$_{22}$4-133	v01010102010	0 2 6 14	0 4 12 20	0 8 16 18	0 8 10 14	$_{22}$18-133B	vEFEFEFEGEF7	0 1 2 3 4 5 6 8 9 10 11 12 13 14 16 18 19 20
237	236	$_{22}$4-133B	v01010102010	0 4 6 14	0 2 10 18	0 8 16 20	0 8 12 14	$_{22}$18-133	vEFEFEFEGEF7	0 1 2 3 4 5 6 8 9 10 11 12 13 14 16 17 18 20
238	237	$_{22}$4-134	v01010101020	0 2 8 12	0 6 10 20	0 4 14 16	0 10 12 18	$_{22}$18-134B	vEFEFEFEFEG7	0 1 2 3 4 5 6 7 8 10 12 13 14 15 16 18 19 20
239	238	$_{22}$4-134B	v01010101020	0 4 10 12	0 6 8 18	0 2 12 16	0 10 14 20	$_{22}$18-134	vEFEFEFEFEG7	0 1 2 3 4 5 6 7 8 10 11 12 14 15 16 17 18 20
240	239	$_{22}$4-135	v01010010201	0 2 9 13	0 7 11 20	0 4 13 15	0 9 11 18	$_{22}$18-135B	vEFEFEEFEGE8	0 1 2 3 4 5 6 7 9 11 12 13 14 15 16 18 19 20
241	240	$_{22}$4-135B	v01010010201	0 4 11 13	0 7 9 18	0 2 11 15	0 9 13 20	$_{22}$18-135	vEFEFEEFEGE8	0 1 2 3 4 5 6 7 9 10 11 13 14 15 16 17 18 20
242	241	$_{22}$4-136*	v01010002020	0 2 10 14	0 8 12 20	0 4 12 14	0 8 10 18	$_{22}$18-136*	vEFEFEEEGEG7	0 1 2 3 4 5 6 8 9 10 12 13 14 15 16 17 18 20
243	242	$_{22}$4-137*	v01002020010	0 5 7 12	0 2 7 17	0 5 15 20	0 10 15 17	$_{22}$18-137*	vEFEEGEGEEF7	0 1 2 3 4 5 6 7 8 10 11 12 13 15 17 18 19 20
244	243	$_{22}$4-138	v01002010020	0 2 7 12	0 5 10 20	0 5 15 17	0 10 12 17	$_{22}$18-138B	vEFEEGEFEEG7	0 1 2 3 4 5 6 7 8 10 12 13 14 15 17 18 19 20
245	244	$_{22}$4-138B	v01002010020	0 5 10 12	0 5 7 17	0 2 12 17	0 10 15 20	$_{22}$18-138	vEFEEGEFEEG7	0 1 2 3 4 5 6 7 8 10 11 12 13 15 16 17 18 20
246	245	$_{22}$4-139	v01001111100	0 5 7 13	0 2 8 17	0 6 15 20	0 9 14 16	$_{22}$18-139B	vEFEEFFFFFE7	0 1 2 3 4 5 6 7 9 10 11 12 14 16 17 18 19 20
247	246	$_{22}$4-139B	v01001111100	0 6 8 13	0 2 7 16	0 5 14 20	0 9 15 17	$_{22}$18-139	vEFEEFFFFFE7	0 1 2 3 4 5 6 7 9 10 11 12 13 15 17 18 19 20
248	247	$_{22}$4-140	v01001110101	0 2 7 13	0 5 11 20	0 6 15 17	0 9 11 16	$_{22}$18-140B	vEFEEFFFEFE8	0 1 2 3 4 5 6 7 9 11 12 13 14 16 17 18 19 20
249	248	$_{22}$4-140B	v01001110101	0 6 11 13	0 5 7 16	0 2 11 17	0 9 15 20	$_{22}$18-140	vEFEEFFFEFE8	0 1 2 3 4 5 6 7 9 10 11 12 13 15 16 17 18 20
250	249	$_{22}$4-141	v01001101101	0 2 8 13	0 6 11 20	0 5 14 16	0 9 11 17	$_{22}$18-141B	vEFEEFFEFFE8	0 1 2 3 4 5 6 7 9 11 12 13 14 15 17 18 19 20
251	250	$_{22}$4-141B	v01001101101	0 5 11 13	0 6 8 17	0 2 11 16	0 9 14 20	$_{22}$18-141	vEFEEFFEFFE8	0 1 2 3 4 5 6 7 9 10 11 12 14 15 16 17 18 20
252	251	$_{22}$4-142	v01001021100	0 5 7 14	0 2 9 17	0 7 15 20	0 8 13 15	$_{22}$18-142B	vEFEEFEGFFE7	0 1 2 3 4 5 6 8 9 10 11 13 15 16 17 18 19 20
253	252	$_{22}$4-142B	v01001021100	0 7 9 14	0 2 7 15	0 5 13 20	0 8 15 17	$_{22}$18-142	vEFEEFEGFFE7	0 1 2 3 4 5 6 8 9 10 11 12 13 15 17 18 19 20
254	253	$_{22}$4-143	v01001021010	0 2 7 14	0 5 12 20	0 7 15 17	0 8 10 15	$_{22}$18-143B	vEFEEFEGFEF7	0 1 2 3 4 5 6 8 10 11 12 13 15 16 17 18 19 2
255	254	$_{22}$4-143B	v01001021010	0 7 12 14	0 5 7 15	0 2 10 17	0 8 15 20	$_{22}$18-143	vEFEEFEGFEF7	0 1 2 3 4 5 6 8 9 10 11 12 13 15 16 17 18 20
256	255	$_{22}$4-144	v01001011110	0 2 9 14	0 7 12 20	0 5 13 15	0 8 10 17	$_{22}$18-144B	vEFEEFEFFFF7	0 1 2 3 4 5 6 8 10 11 12 13 14 15 17 18 19 2
257	256	$_{22}$4-144B	v01001011110	0 5 12 14	0 7 9 17	0 2 10 15	0 8 13 20	$_{22}$18-144	vEFEEFEFFFF7	0 1 2 3 4 5 6 8 9 10 11 13 14 15 16 17 18 20
258	257	$_{22}$4-145*	v01000203000	0 6 8 14	0 2 8 16	0 6 14 20	0 8 14 16	$_{22}$18-145*	vEFEEEGEHEE7	0 1 2 3 4 5 6 8 9 10 11 12 14 16 17 18 19 20
259	258	$_{22}$4-146	v01000202010	0 2 8 14	0 6 12 20	0 6 14 16	0 8 10 16	$_{22}$18-146B	vEFEEEGEGEF7	0 1 2 3 4 5 6 8 10 11 12 13 14 16 17 18 19 2
260	259	$_{22}$4-146B	v01000202010	0 6 12 14	0 6 8 16	0 2 10 16	0 8 14 20	$_{22}$18-146	vEFEEEGEGEF7	0 1 2 3 4 5 6 8 9 10 11 12 14 15 16 17 18 20
261	260	$_{22}$4-147	v01000121100	0 2 8 15	0 6 13 20	0 7 14 16	0 7 9 15	$_{22}$18-147B	vEFEEEFGFFE7	0 1 2 3 4 5 7 8 9 10 11 12 14 16 17 18 19 20
262	261	$_{22}$4-147B	v01000121100	0 6 8 15	0 2 9 16	0 7 14 20	0 7 13 15	$_{22}$18-147	vEFEEEFGFFE7	0 1 2 3 4 5 7 8 9 10 11 12 14 15 16 17 18 20
263	262	$_{22}$4-148*	v01000120200	0 2 9 15	0 7 13 20	0 6 13 15	0 7 9 16	$_{22}$18-148*	vEFEEEFGEGE7	0 1 2 3 4 5 7 8 9 10 11 13 14 15 16 17 18 20
264	263	$_{22}$4-149*	v00300200100	0 3 6 9	0 3 6 19	0 3 16 19	0 13 16 19	$_{22}$18-149*	vEEHEEGEEFE7	0 1 2 3 4 5 6 7 8 9 10 11 13 14 16 17 19 20
265	264	$_{22}$4-150	v00210110010	0 3 6 10	0 3 7 19	0 4 16 19	0 12 15 18	$_{22}$18-150B	vEEGFEFFEEF7	0 1 2 3 4 5 6 7 8 9 10 12 13 15 16 18 19 20
266	265	$_{22}$4-150B	v00210110010	0 4 7 10	0 3 6 18	0 3 15 19	0 12 16 19	$_{22}$18-150	vEEGFEFFEEF7	0 1 2 3 4 5 6 7 8 9 10 12 13 14 16 17 19 20
267	266	$_{22}$4-151*	v00210020010	0 3 7 10	0 4 7 19	0 3 15 18	0 12 15 19	$_{22}$18-151*	vEEGFEEGEEF7	0 1 2 3 4 5 6 7 8 9 10 12 13 15 16 17 19 20
268	267	$_{22}$4-152	v00201101001	0 3 6 11	0 3 8 19	0 5 16 19	0 11 14 17	$_{22}$18-152B	vEEGEFFEFEE8	0 1 2 3 4 5 6 7 8 9 11 12 14 15 17 18 19 20
269	268	$_{22}$4-152B	v00201101001	0 5 8 11	0 3 6 17	0 3 14 19	0 11 16 19	$_{22}$18-152	vEEGEFFEFEE8	0 1 2 3 4 5 6 7 8 9 11 12 13 14 16 17 19 20
270	269	$_{22}$4-153*	v00201002001	0 3 8 11	0 5 8 19	0 3 14 17	0 11 14 19	$_{22}$18-153*	vEEGEFEEGEE8	0 1 2 3 4 5 6 7 8 9 11 12 14 15 16 17 19 20
271	270	$_{22}$4-154	v00200200110	0 3 6 12	0 3 9 19	0 6 16 19	0 10 13 16	$_{22}$18-154B	vEEGEEGEEFF7	0 1 2 3 4 5 6 7 8 10 11 13 14 16 17 18 19 20
272	271	$_{22}$4-154B	v00200200110	0 6 9 12	0 3 6 16	0 3 13 19	0 10 16 19	$_{22}$18-154	vEEGEEGEEFF7	0 1 2 3 4 5 6 7 8 10 11 12 13 14 16 17 19 20
273	272	$_{22}$4-155	v00200110110	0 3 6 13	0 3 10 19	0 7 16 19	0 9 12 15	$_{22}$18-155B	vEEGEEFFEFF7	0 1 2 3 4 5 6 7 9 10 12 13 15 16 17 18 19 20
274	273	$_{22}$4-155B	v00200110110	0 7 10 13	0 3 6 15	0 3 12 19	0 9 16 19	$_{22}$18-155	vEEGEEFFEFF7	0 1 2 3 4 5 6 7 9 10 11 12 13 14 16 17 19 20
275	274	$_{22}$4-156*	v00200102001	0 3 6 14	0 3 11 19	0 8 16 19	0 8 11 14	$_{22}$18-156*	vEEGEEFEGEE8	0 1 2 3 4 5 6 8 9 10 11 12 13 14 16 17 19 20
276	275	$_{22}$4-157*	v00200100210	0 3 9 12	0 6 9 19	0 3 13 16	0 10 13 19	$_{22}$18-157*	vEEGEEFEEGF7	0 1 2 3 4 5 6 7 8 10 11 13 14 15 16 17 19 20
277	276	$_{22}$4-158*	v00200010120	0 3 10 13	0 7 10 19	0 3 12 15	0 9 12 19	$_{22}$18-158*	vEEGEEEFEFG7	0 1 2 3 4 5 6 7 9 10 12 13 14 15 16 17 19 20
278	277	$_{22}$4-159*	v00200002002	0 3 11 14	0 8 11 19			$_{22}$18-159*	vEEGEEEEGEE9	0 1 2 3 4 5 6 8 9 11 12 13 14 15 16 17 19 20
279	278	$_{22}$4-160*	v00120020001	0 4 7 11	0 3 7 18	0 4 15 19	0 11 15 18	$_{22}$18-160*	vEEFGEEGEEE8	0 1 2 3 4 5 6 7 8 9 11 12 13 15 16 18 19 20
280	279	$_{22}$4-161	v00120011001	0 3 7 11	0 4 8 19	0 4 15 18	0 11 14 18	$_{22}$18-161B	vEEFGEEFFEE8	0 1 2 3 4 5 6 7 8 9 11 12 14 15 16 18 19 20
281	280	$_{22}$4-161B	v00120011001	0 4 8 11	0 4 7 18	0 3 14 18	0 11 15 19	$_{22}$18-161	vEEFGEEFFEE8	0 1 2 3 4 5 6 7 8 9 11 12 13 15 16 17 19 20
282	281	$_{22}$4-162	v00111011010	0 4 7 12	0 3 8 18	0 5 15 19	0 10 14 17	$_{22}$18-162B	vEEFFFEFFEF7	0 1 2 3 4 5 6 7 8 10 11 12 14 15 17 18 19 20
283	282	$_{22}$4-162B	v00111011010	0 5 8 12	0 3 7 17	0 4 14 19	0 10 15 18	$_{22}$18-162	vEEFFFEFFEF7	0 1 2 3 4 5 6 7 8 10 11 12 13 15 16 18 19 20
284	283	$_{22}$4-163	v00111010110	0 3 7 12	0 4 9 19	0 5 15 18	0 10 13 17	$_{22}$18-163B	vEEFFFEFEFF7	0 1 2 3 4 5 6 7 8 10 11 13 14 15 17 18 19 20
285	284	$_{22}$4-163B	v00111010110	0 5 9 12	0 4 7 17	0 3 13 18	0 10 15 19	$_{22}$18-163	vEEFFFEFEFF7	0 1 2 3 4 5 6 7 8 10 11 12 13 15 16 17 19 20
286	285	$_{22}$4-164	v00111001110	0 3 8 12	0 5 9 19	0 4 14 17	0 10 13 18	$_{22}$18-164B	vEEFFFEEFFF7	0 1 2 3 4 5 6 7 8 10 11 13 14 15 16 18 19 20
287	286	$_{22}$4-164B	v00111001110	0 4 9 12	0 5 8 18	0 3 13 17	0 10 14 19	$_{22}$18-164	vEEFFFEEFFF7	0 1 2 3 4 5 6 7 8 10 11 12 14 15 16 17 19 20
288	287	$_{22}$4-165	v00110110200	0 4 7 13	0 3 9 18	0 6 15 19	0 9 13 16	$_{22}$18-165B	vEEFFEFFEGE7	0 1 2 3 4 5 6 7 9 10 11 13 14 16 17 18 19 20
289	288	$_{22}$4-165B	v00110110200	0 6 9 13	0 3 7 16	0 4 13 19	0 9 15 18	$_{22}$18-165	vEEFFEFFEGE7	0 1 2 3 4 5 6 7 9 10 11 12 13 15 16 18 19 20

	A	B	C	D	E	F	G	H	I	J
290	289	$_{22}$4-166	v00110110110	0 3 7 13	0 4 10 19	0 6 15 18	0 9 12 16	$_{22}$18-166B	vEEFFEFFEFF7	0 1 2 3 4 5 6 7 9 10 12 13 14 16 17 18 19 20
291	290	$_{22}$4-166B	v00110110110	0 6 10 13	0 4 7 16	0 3 12 18	0 9 15 19	$_{22}$18-166	vEEFFEFFEFF7	0 1 2 3 4 5 6 7 9 10 11 12 13 15 16 17 19 20
292	291	$_{22}$4-167	v00110100210	0 3 9 13	0 6 10 19	0 4 13 16	0 9 12 18	$_{22}$18-167B	vEEFFEFEEGF7	0 1 2 3 4 5 6 7 9 10 12 13 14 15 16 18 19 20
293	292	$_{22}$4-167B	v00110100210	0 4 10 13	0 6 9 18	0 3 12 16	0 9 13 19	$_{22}$18-167	vEEFFEFEEGF7	0 1 2 3 4 5 6 7 9 10 11 13 14 15 16 17 19 20
294	293	$_{22}$4-168	v00110021010	0 4 7 14	0 3 10 18	0 7 15 19	0 8 12 15	$_{22}$18-168B	vEEFFEEGFEF7	0 1 2 3 4 5 6 8 9 10 12 13 15 16 17 18 19 20
295	294	$_{22}$4-168B	v00110021010	0 7 10 14	0 3 7 15	0 4 12 19	0 8 15 18	$_{22}$18-168	vEEFFEEGFEF7	0 1 2 3 4 5 6 8 9 10 11 12 13 15 16 18 19 20
296	295	$_{22}$4-169	v00110021001	0 3 7 14	0 4 11 19	0 7 15 18	0 8 11 15	$_{22}$18-169B	vEEFFEEGFEE8	0 1 2 3 4 5 6 8 9 11 12 13 15 16 17 18 19 20
297	296	$_{22}$4-169B	v00110021001	0 7 11 14	0 4 7 15	0 3 11 18	0 8 15 19	$_{22}$18-169	vEEFFEEGFEE8	0 1 2 3 4 5 6 8 9 10 11 12 13 15 16 17 19 20
298	297	$_{22}$4-170	v00110011011	0 3 10 14	0 7 11 19	0 4 12 15	0 8 11 18	$_{22}$18-170B	vEEFFEEFFEF8	0 1 2 3 4 5 6 8 9 11 12 13 14 15 16 18 19 20
299	298	$_{22}$4-170B	v00110011011	0 4 11 14	0 7 10 18	0 3 11 15	0 8 12 19	$_{22}$18-170	vEEFFEEFFEF8	0 1 2 3 4 5 6 8 9 10 12 13 14 15 16 17 19 20
300	299	$_{22}$4-171*	v00102002100	0 5 8 13	0 3 8 17	0 5 14 19	0 9 14 17	$_{22}$18-171*	vEEFEGEEGFE7	0 1 2 3 4 5 6 7 9 10 11 12 14 15 17 18 19 20
301	300	$_{22}$4-172	v00102001110	0 3 8 13	0 5 10 19	0 5 14 17	0 9 12 17	$_{22}$18-172B	vEEFEGEEFFF7	0 1 2 3 4 5 6 7 9 10 12 13 14 15 17 18 19 20
302	301	$_{22}$4-172B	v00102001110	0 5 10 13	0 5 8 17	0 3 12 17	0 9 14 19	$_{22}$18-172	vEEFEGEEFFF7	0 1 2 3 4 5 6 7 9 10 11 12 14 15 16 17 19 20
303	302	$_{22}$4-173	v00101102100	0 5 8 14	0 3 9 17	0 6 14 19	0 8 13 16	$_{22}$18-173B	vEEFEFFEGFE7	0 1 2 3 4 5 6 8 9 10 11 13 14 16 17 18 19 20
304	303	$_{22}$4-173B	v00101102100	0 6 9 14	0 3 8 16	0 5 13 19	0 8 14 17	$_{22}$18-173	vEEFEFFEGFE7	0 1 2 3 4 5 6 8 9 10 11 12 14 15 17 18 19 20
305	304	$_{22}$4-174	v00101102001	0 3 8 14	0 5 11 19	0 6 14 17	0 8 11 16	$_{22}$18-174B	vEEFEFFEGEE8	0 1 2 3 4 5 6 8 9 11 12 13 14 16 17 18 19 20
306	305	$_{22}$4-174B	v00101102001	0 6 11 14	0 5 8 16	0 3 11 17	0 8 14 19	$_{22}$18-174	vEEFEFFEGEE8	0 1 2 3 4 5 6 8 9 10 11 12 14 15 16 17 19 20
307	306	$_{22}$4-175	v00101101101	0 3 9 14	0 6 11 19	0 5 13 16	0 8 11 17	$_{22}$18-175B	vEEFEFFEFFE8	0 1 2 3 4 5 6 8 9 11 12 13 14 15 17 18 19 20
308	307	$_{22}$4-175B	v00101101101	0 5 11 14	0 6 9 17	0 3 11 16	0 8 13 19	$_{22}$18-175	vEEFEFFEFFE8	0 1 2 3 4 5 6 8 9 10 11 13 14 15 16 17 19 20
309	308	$_{22}$4-176	v00101021010	0 3 8 15	0 5 12 19	0 7 14 17	0 7 10 15	$_{22}$18-176B	vEEFEFEGFEF7	0 1 2 3 4 5 7 8 9 10 11 12 14 15 17 18 19 20
310	309	$_{22}$4-176B	v00101021010	0 5 8 15	0 3 10 17	0 7 14 19	0 7 12 15	$_{22}$18-176	vEEFEFEGFEF7	0 1 2 3 4 5 7 8 9 10 11 12 14 15 16 17 19 20
311	310	$_{22}$4-177*	v00101020020	0 3 10 15	0 7 12 19	0 5 12 15	0 7 10 17	$_{22}$18-177*	vEEFEFEGEEG7	0 1 2 3 4 5 7 8 9 10 12 13 14 15 16 17 19 20
312	311	$_{22}$4-178*	v00100210200	0 6 9 15	0 3 9 16	0 6 13 19	0 7 13 16	$_{22}$18-178*	vEEFEEGFEGE7	0 1 2 3 4 5 7 8 9 10 11 13 14 16 17 18 19 20
313	312	$_{22}$4-179	v00100210110	0 3 9 15	0 6 12 19	0 6 13 16	0 7 10 16	$_{22}$18-179B	vEEFEEGFEFF7	0 1 2 3 4 5 7 8 10 11 12 13 14 16 17 18 19 2
314	313	$_{22}$4-179B	v00100210110	0 6 12 15	0 6 9 16	0 3 10 16	0 7 13 19	$_{22}$18-179	vEEFEEGFEFF7	0 1 2 3 4 5 7 8 9 10 11 13 14 15 16 17 19 20
315	314	$_{22}$4-180*	v00030002010	0 4 8 12	0 4 8 18	0 4 14 18	0 10 14 18	$_{22}$18-180*	vEEEHEEEGEF7	0 1 2 3 4 5 6 7 8 10 11 12 14 15 16 18 19 20
316	315	$_{22}$4-181	v00021001200	0 4 8 13	0 4 9 18	0 5 14 18	0 9 13 17	$_{22}$18-181B	vEEEGFEEFGE7	0 1 2 3 4 5 6 7 9 10 11 13 14 15 17 18 19 20
317	316	$_{22}$4-181B	v00021001200	0 5 9 13	0 4 8 17	0 4 13 18	0 9 14 18	$_{22}$18-181	vEEEGFEEFGE7	0 1 2 3 4 5 6 7 9 10 11 12 14 15 16 18 19 20
318	317	$_{22}$4-182*	v00021000300	0 4 9 13	0 5 9 18	0 4 13 17	0 9 13 18	$_{22}$18-182*	vEEEGFEEEHE7	0 1 2 3 4 5 6 7 9 10 11 13 14 15 16 18 19 20
319	318	$_{22}$4-183	v00020102010	0 4 8 14	0 4 10 18	0 6 14 18	0 8 12 16	$_{22}$18-183B	vEEEGEFEGEF7	0 1 2 3 4 5 6 8 9 10 12 13 14 16 17 18 19 20
320	319	$_{22}$4-183B	v00020102010	0 6 10 14	0 4 8 16	0 4 12 18	0 8 14 18	$_{22}$18-183	vEEEGEFEGEF7	0 1 2 3 4 5 6 8 9 10 11 12 14 15 16 18 19 20
321	320	$_{22}$4-184*	v00020101020	0 4 10 14	0 6 10 18	0 4 12 16	0 8 12 18	$_{22}$18-184*	vEEEGEFEFEG7	0 1 2 3 4 5 6 8 9 10 12 13 14 15 16 18 19 20
322	321	$_{22}$4-185*	v00020021001	0 4 8 15	0 4 11 18	0 7 14 18	0 7 11 15	$_{22}$18-185*	vEEEGEEGFEE8	0 1 2 3 4 5 7 8 9 10 11 12 14 15 16 18 19 20
323	322	$_{22}$4-186*	v00020020002	0 4 11 15	0 7 11 18			$_{22}$18-186*	vEEEGEEGEEE9	0 1 2 3 4 5 7 8 9 11 12 13 14 15 16 18 19 20
324	323	$_{22}$4-187*	v00012001200	0 5 9 14	0 4 9 17	0 5 13 18	0 8 13 17	$_{22}$18-187*	vEEEFGEEFGE7	0 1 2 3 4 5 6 8 9 10 11 13 14 15 17 18 19 20
325	324	$_{22}$4-188	v00012001110	0 4 9 14	0 5 10 18	0 5 13 17	0 8 12 17	$_{22}$18-188B	vEEEFGEEFFF7	0 1 2 3 4 5 6 8 9 10 12 13 14 15 17 18 19 20
326	325	$_{22}$4-188B	v00012001110	0 5 10 14	0 5 9 17	0 4 12 17	0 8 13 18	$_{22}$18-188	vEEEFGEEFFF7	0 1 2 3 4 5 6 8 9 10 11 13 14 15 16 18 19 20
327	326	$_{22}$4-189	v00011110110	0 5 9 15	0 4 10 17	0 6 13 18	0 7 12 16	$_{22}$18-189B	vEEEFFFFEFF7	0 1 2 3 4 5 7 8 9 10 12 13 14 16 17 18 19 20
328	327	$_{22}$4-189B	v00011110110	0 6 10 15	0 4 9 16	0 5 12 18	0 7 13 17	$_{22}$18-189	vEEEFFFFEFF7	0 1 2 3 4 5 7 8 9 10 11 13 14 15 17 18 19 20
329	328	$_{22}$4-190	v00011110101	0 4 9 15	0 5 11 18	0 6 13 17	0 7 11 16	$_{22}$18-190B	vEEEFFFFEFE8	0 1 2 3 4 5 7 8 9 11 12 13 14 16 17 18 19 20
330	329	$_{22}$4-190B	v00011110101	0 6 11 15	0 5 9 16	0 4 11 17	0 7 13 18	$_{22}$18-190	vEEEFFFFEFE8	0 1 2 3 4 5 7 8 9 10 11 13 14 15 16 18 19 20
331	330	$_{22}$4-191	v00011110011	0 4 10 15	0 6 11 18	0 5 12 16	0 7 11 17	$_{22}$18-191B	vEEEFFFFEEF8	0 1 2 3 4 5 7 8 9 11 12 13 14 15 17 18 19 20
332	331	$_{22}$4-191B	v00011110011	0 5 11 15	0 6 10 17	0 4 11 16	0 7 12 18	$_{22}$18-191	vEEEFFFFEEF8	0 1 2 3 4 5 7 8 9 10 12 13 14 15 16 18 19 20
333	332	$_{22}$4-192*	v00010300020	0 4 10 16	0 6 12 18	0 6 12 16	0 6 10 16	$_{22}$18-192*	vEEEFEHEEEG7	0 1 2 3 4 6 7 8 9 10 12 13 14 15 16 18 19 20
334	333	$_{22}$4-193*	v00003010020	0 5 10 15	0 5 10 17	0 5 12 17	0 7 12 17	$_{22}$18-193*	vEEEEHEFEEG7	0 1 2 3 4 5 7 8 9 10 12 13 14 15 17 18 19 20
335	334	$_{22}$4-194*	v00002200011	0 5 10 16	0 5 11 17	0 6 12 17	0 6 11 16	$_{22}$18-194*	vEEEEGGEEEF8	0 1 2 3 4 6 7 8 9 10 12 13 14 15 17 18 19 20
336	335	$_{22}$4-195*	v00002200002	0 5 11 16	0 6 11 17			$_{22}$18-195*	vEEEEGGEEEE9	0 1 2 3 4 6 7 8 9 11 12 13 14 15 17 18 19 20

ANNEX C

22 EDO Sevish-DQtables

	A	B	C	D	E
1	**Column1**	**Column2**	**Column3**	**Column4**	**Column6**
2	Category	Name	Original	OctaveReduction	Comments
3	Triad	Sus2	0 4 13	0 4 13	
4	Triad	Subminor	0 5 13	0 5 13	
5	Triad	Minor	0 6 13	0 6 13	
6	Triad	Major	0 7 13	0 7 13	
7	Triad	Supermajor	0 8 13	0 8 13	
8	Triad	Sus4	0 9 13	0 9 13	
9	Triad	Subminor diminished	0 5 10	0 5 10	
10	Triad	Double subminor	0 5 11	0 5 11	
11	Triad	Minor subminor	0 6 11	0 6 11	
12	Triad	Subminor minor	0 5 12	0 5 12	
13	Triad	Doubleminor	0 6 12	0 6 12	
14	Triad	Major minor	0 7 12	0 7 12	
15	Triad	Minor major	0 6 14	0 6 14	
16	Triad	Double major	0 7 14	0 7 14	
17	Triad	Supermajor major	0 8 14	0 8 14	
18	Triad	Major supermajor	0 7 15	0 7 15	
19	Triad	Double supermajor	0 8 15	0 8 15	
20	Triad	Supermajor augmented	0 8 16	0 8 16	
21	Tetrad	Subminor	0 5 13 18	0 5 13 18	
22	Tetrad	Minor	0 6 13 19	0 6 13 19	
23	Tetrad	Major	0 7 13 20	0 7 13 20	
24	Tetrad	Supermajor	0 8 13 21	0 8 13 21	
25	Tetrad	Subminor–minor	0 5 13 19	0 5 13 19	
26	Tetrad	Subminor–major	0 5 13 20	0 5 13 20	
27	Tetrad	Subminor–supermajor	0 5 13 21	0 5 13 21	
28	Tetrad	Minor–subminor	0 6 13 18	0 6 13 18	
29	Tetrad	Minor–major	0 6 13 20	0 6 13 20	
30	Tetrad	Minor–supermajor	0 6 13 21	0 6 13 21	
31	Tetrad	Major–subminor	0 7 13 18	0 7 13 18	Same structure as Barbeshop seventh
32	Tetrad	Major–minor	0 7 13 19	0 7 13 19	
33	Tetrad	Major–supermajor	0 7 13 21	0 7 13 21	
34	Tetrad	Supermajor–subminor	0 8 13 18	0 8 13 18	
35	Tetrad	Supermajor–minor	0 8 13 19	0 8 13 19	
36	Tetrad	Supermajor–major	0 8 13 20	0 8 13 20	
37	Chord	Harmonics 4:5:6:7 (barbershop seventh)	0 7 13 18	0 7 13 18	
38	Chord	Harmonics 4:5:6:7:9:11 (a beloved chord)	0 7 13 18 26 32	0 4 7 10 13 18	Reduced mod 22 then sorted
39	Chord	Harmonics 8:10:12:15:18:11 (maj9 plus 11th harmonic)	0 7 13 20 26 32	0 4 7 10 13 20	Reduced mod 22 then sorted
40	Chord	Harmonics 3:5:7	0 16 27	0 5 16	Reduced mod 22 then sorted
41	Chord	Harmonics 4:7:9:11 (machine)	0 18 26 32	0 4 10 18	Reduced mod 22 then sorted
42	Scale Fragment	Overtonal pentachord (8:9:10:11:12)	4 3 3 3	0 4 7 10 13	Cumulative steps → PCs
43	Scale Fragment	Even tetrachord	3 3 3	0 3 6 9	Cumulative steps → PCs
44	Scale Fragment	Superpyth major tetrachord	4 4 1	0 4 8 9	Cumulative steps → PCs
45	Scale Fragment	Superpyth minor tetrachord	4 1 4	0 4 5 9	Cumulative steps → PCs
46	Scale Fragment	Superpyth phrygian tetrachord	1 4 4	0 1 5 9	Cumulative steps → PCs
47	MOS Scale	superpyth[5]	4 5 4 4 5	0 4 9 13 17 21	Steps → PCs (exclude octave)
48	MOS Scale	superpyth[7]	4 4 1 4 4 4 1	0 4 8 9 13 17 21	Steps → PCs (exclude octave)
49	MOS Scale	pajara[10]	2 2 3 2 2 2 2 3 2 2	0 2 4 7 9 11 13 15 18 20	Steps → PCs (exclude octave)
50	MOS Scale	porcupine[7]	3 3 3 4 3 3 3	0 3 6 9 13 16 19	Steps → PCs (exclude octave)
51	MOS Scale	porcupine[8]	3 3 3 3 1 3 3 3	0 3 6 9 12 13 16 19	Steps → PCs (exclude octave)
52	MOS Scale	orwell[5]	5 5 2 5 5	0 5 10 12 17	Steps → PCs (exclude octave)
53	MOS Scale	orwell[9]	3 2 3 2 2 3 2 3 2	0 3 5 8 10 12 15 17 20	Steps → PCs (exclude octave)
54	MOS Scale	astrology[6]	4 3 4 4 3 4	0 4 7 11 15 18 21	Steps → PCs (exclude octave)
55	MOS Scale	machine[6] (11edo)	4 4 4 4 4 2	0 4 8 12 16 20	Steps → PCs (exclude octave)
56	MOS Scale	orgone[7] (11edo)	4 2 4 2 4 2 4	0 4 6 10 12 16 18	Steps → PCs (exclude octave)
57	Scale	Subminor hexatonic	4 1 4 4 5 4	0 4 5 9 13 18	Steps → PCs (exclude octave)
58	Scale	Supermajor pentatonic	8 1 4 8 1	0 8 9 13 21	Steps → PCs (exclude octave)
59	Scale	Zarlino/Ptolemy diatonic	4 3 2 4 3 4 2	0 4 7 9 13 16 20	Steps → PCs (exclude octave)
60	Scale	12-note keyboard subset	2 2 2 2 1 2 2 2 2 2 2 1	0 2 4 6 8 9 11 13 15 17 19 21	Steps → PCs (exclude octave)

ANNEX D

Lullaby in 22 EDO for Viola and E-Keyboard

Full score

Lullaby for Anna-René

in 22 EDO

for Viola and microtonal E-piano

Marc Lujan

2025

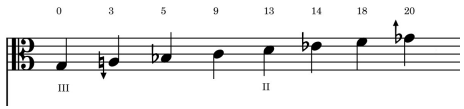
Why 22 EDO?

Western historical music theoretical approaches, certain n-EDO scales are more preferred than others due to their beneficial approximations to just intervals (e.g. 17-EDO, 19-EDO, 22-EDO, 31-EDO, 41-EDO, 53-EDO). The author's choice finally fell on the 22-EDO scale for several reasons. The amount of steps to learn is fairly little (comparing with 31-, 41- or 53-EDO), it provides subscales really far from our traditional Western musical experiences while not tempering out the 81:80 syntonic comma (as the historical meantone scales and 12-EDO does). However, 22-EDO has fairly good approximations to some harmonic ratio intervals until prime number 11, and additionally features four different thirds: the approximations of 1) 7:6 (septimal minor third), 2) 5:6 (common minor third), 3) 5:4 (common major third) and 4) 9:7 (septimal major third). Each of the four thirds allows to constitute four different triads with the acceptance of a worse approximation of the 3:2 fifth (with 709 cents not such good as the 12-EDO equivalent), and numerous 7th chords, thereunder those with a fairly good approximation of the 7:4 harmonic seventh. (Lock 2025: 160–161)

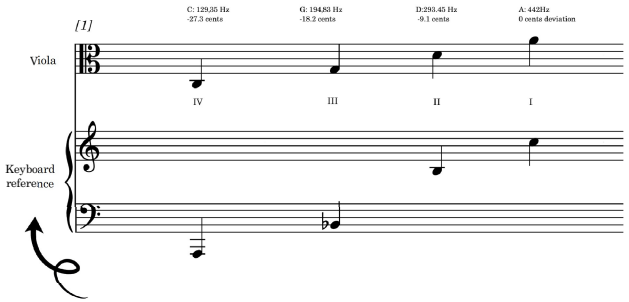
Pitch class	interval name	abbr.
0	uníson	unis.
1	quarter tone	1/4 T
2	semitone	ST
3	lesser whole tone	WT-
4	greater whole tone	WT+
5	septimal minor third	7min3
6	greater minor third	Min3+
7	major third	Maj3
8	septimal major third	7maj3
9	pure fourth	P4
10	lesser undecimal tritone	11L_Trit
11	(12 EDO) tritone	Trit
12	greater undecimal tritone	11G_Trit
13	slightly wider pure fifth	P5
14	septimal minor sixth	7Min6
15	minor sixth	Min6
16	lesser major sixth	Maj6-
17	septimal major sixth	7Maj6
18	septimal minor seventh	7Min7
19	greater minor seventh	Min7+
20	major seventh	Maj7
21	major seventh+1/4 tone	Maj7+1/4 T
22	pure octave	P8

22 edo mode used

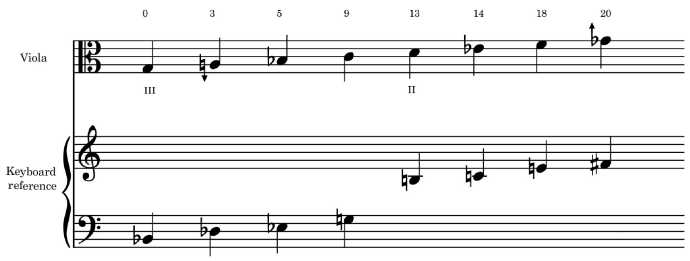
Key Characteristics: The scale I created combines approximations of just intervals with microtonal steps unique to 22 EDO.The septimal flavors (7-limit intervals like the minor third, minor sixth, and minor seventh) give the scale a distinctly expressive and "folk-like" character. Roman numbers indicate open strings



Tuning of the open strings of the viola: wide fifths, 13 steps of 22edo = 709.1 cents



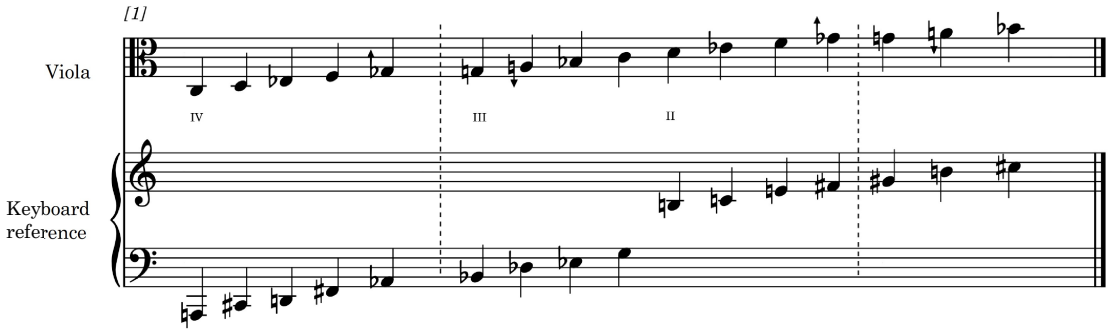
Keyboard reference : Viola scale



MIDI mapping in pianoteq

To achieve the following setup go to:
1. TUNING---Advanced Tuning---Temprament---Make equal temprament---22 divisions of the octave---String tension---(Full rebuild)
2. FILE---MIDI/audio setup---MIDI---Note transposition -3 (bottom)
Important! Now A 442 Hz should be C5 on the Keyboard. If any doubts should arise watch the video tutorial by scanning the QR code below

Keyboard reference: Full range



Intonation practice resources:

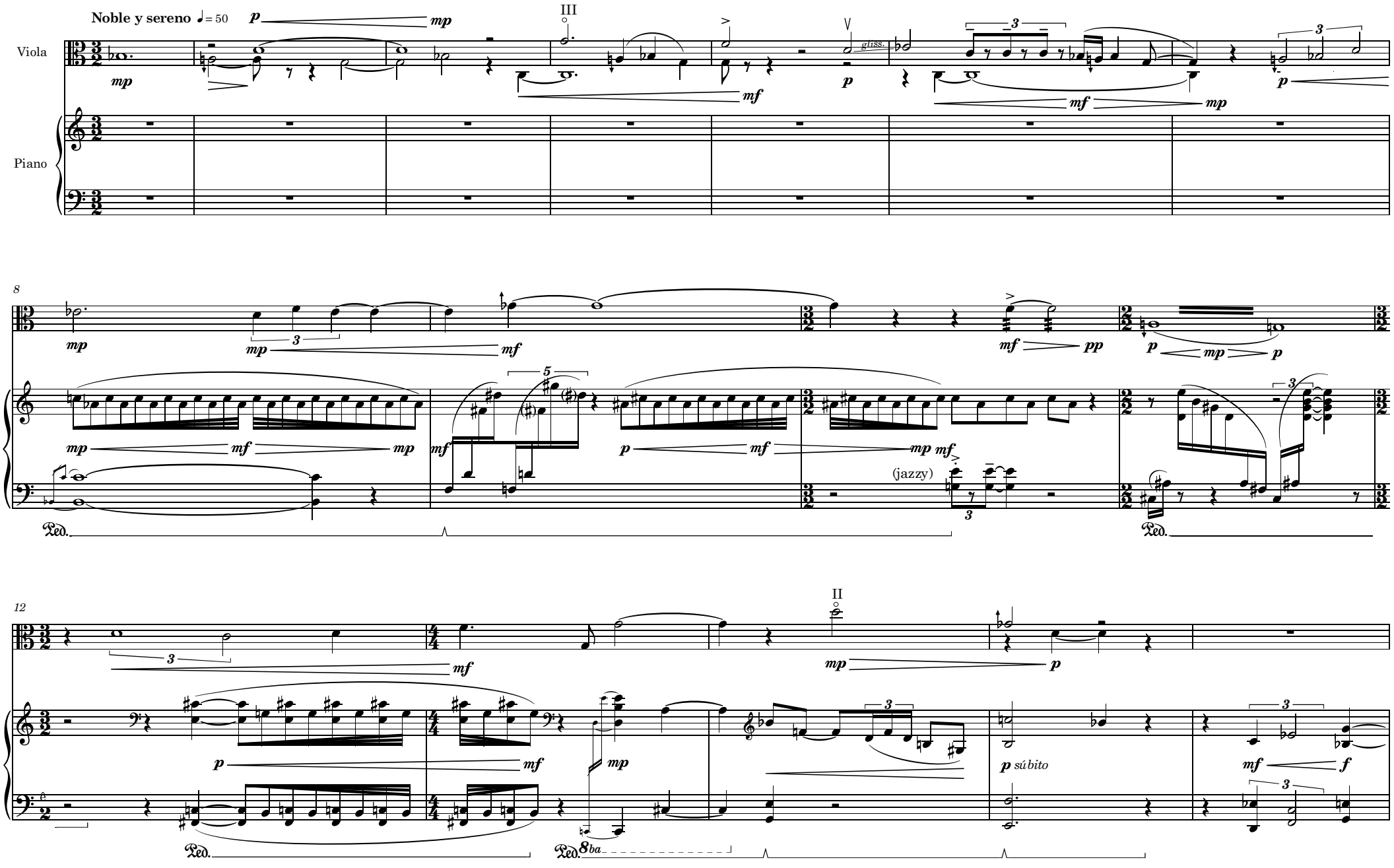
- Tune the viola and practice the selected 22EDO scale with the following video:

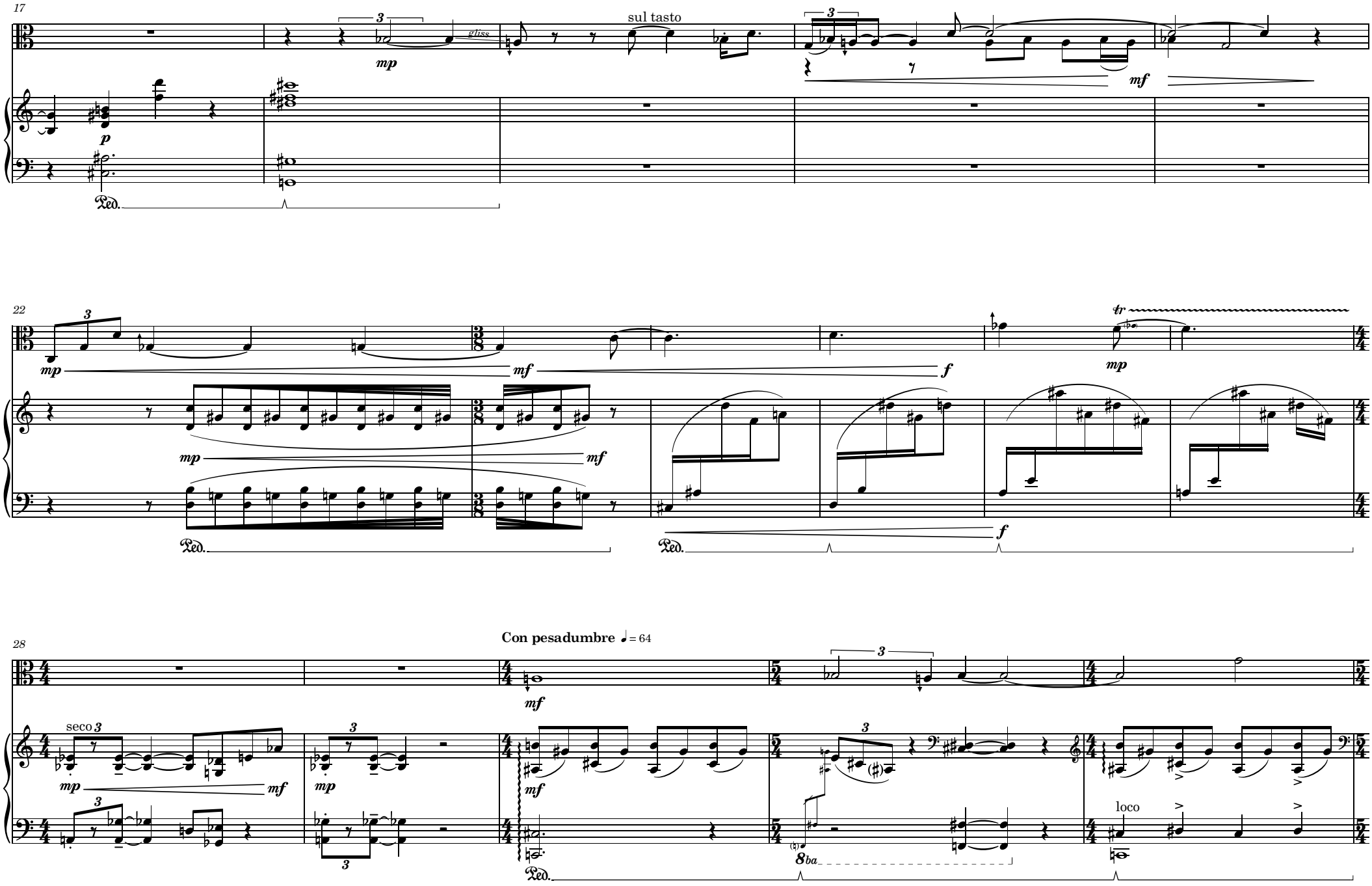
- Listen to the recording of the piece:

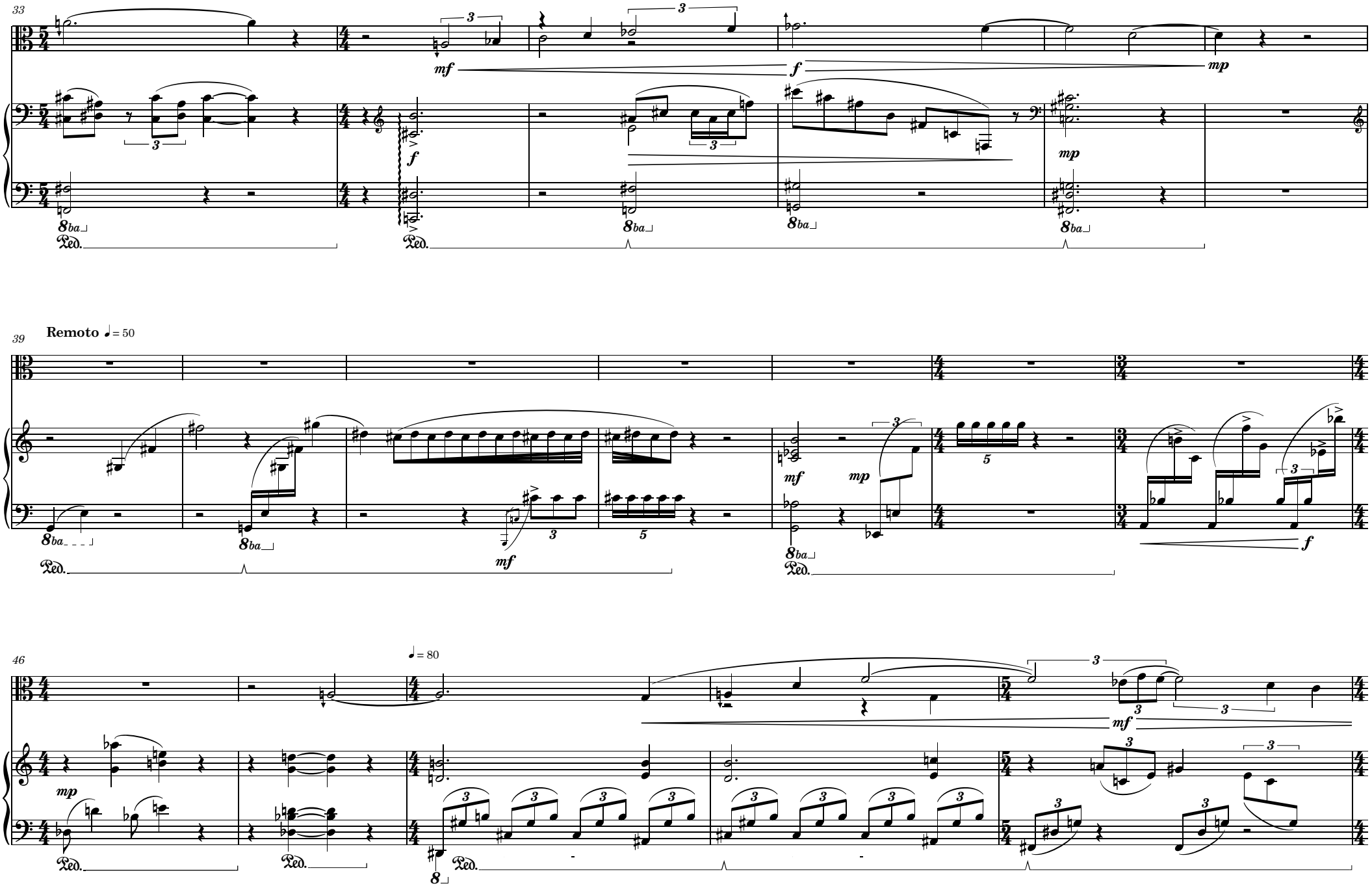
Lullaby for Anna-René

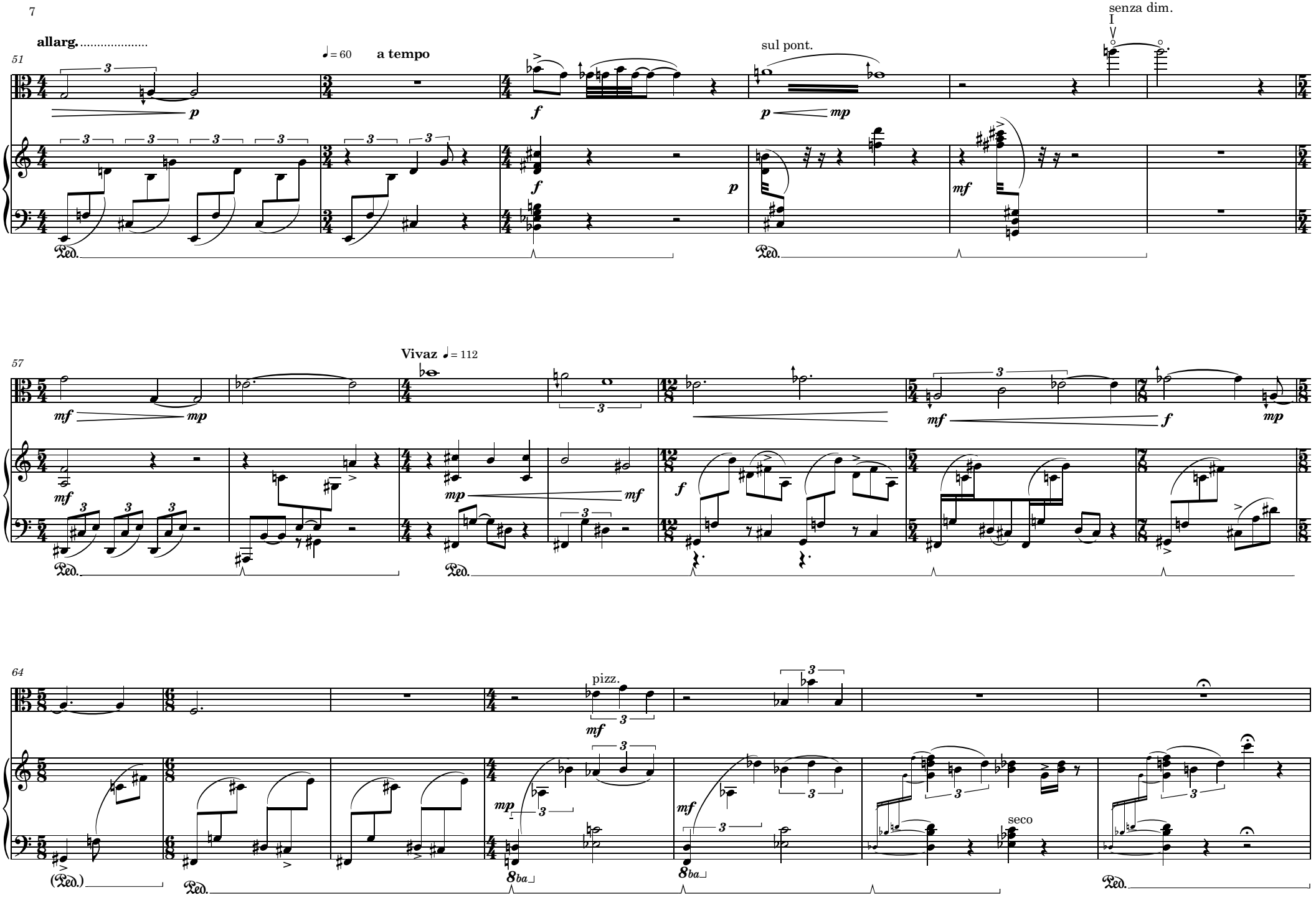
in 22 EDO

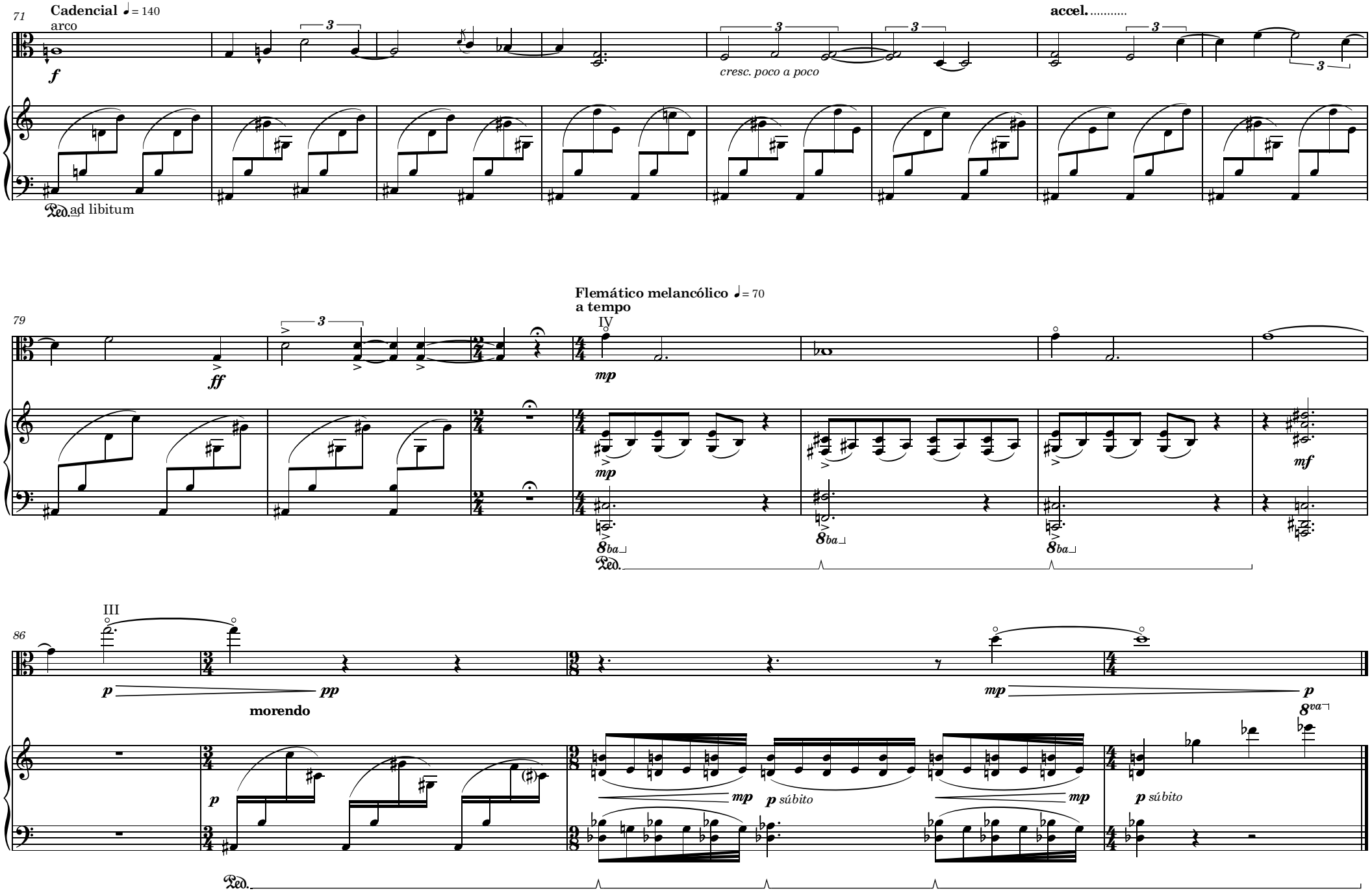
Marc Lujan i Ballester




17
sul tasto
gliss
22
28
Con pesadumbre ♩= 64
seco
loco


33
39
Remoto ♩= 50
46
♩= 80


allarg.
a tempo
♩= 60
senza dim.
I
sul pont.
Vivaz ♩= 112
pizz.
seco
8ba
8ba


71
Cadencial ♩= 140
arco
f
cresc. poco a poco
accel.
Ped. ad libitum
79
ff
Flemático melancólico ♩= 70
a tempo
IV
mp
mf
8ba
Ped.
86
III
p
pp
morendo
mp
p
8va
p súbito
Ped.