



# PEMF Device Analysis

## Field Strength, Pulse Quality & Key Metrics

<b>Analysis Date:</b>	4/30/2026
<b>Report #:</b>	D2604141549
<b>Test Engineer:</b>	David D
<b>Gauss Meter:</b>	FW Bell 5180
<b>Gauss Meter Probe:</b>	Axial
<b>Oscilloscope:</b>	Rigol DHO814
<b>LCR Meter:</b>	FNIRSI LC1020E
<b>Customer:</b>	BBMPulser
<b>Device:</b>	2.4 Tesla BBM Pulser 5B
<b>Device Part #:</b>	PEMF BBMPulser 5B
<b>Device Serial #:</b>	358902
<b>Total Device Settings:</b>	9
<b>Accessory:</b>	Classic 3" Strip Coil 1mm
<b>Accessory Part #:</b>	N/A
<b>Accessory Serial #:</b>	N/A
<b>Number of Coils:</b>	1
<b>Coil Diameter:</b>	3 inch
<b>Coil Type:</b>	Pancake
<b>Resistance:</b>	0.02ohms
<b>Inductance:</b>	52.6uH
<b>Notes:</b>	The Slew Rate of your device is one of the most impressive I've ever seen. The Coil heats up very quickly within 7-10 minutes and trips the safety cutoff. Must wait 30 min for cooldown. While this is well documented and does not affect certification. In our opinion, decreasing the duty cycle or reducing the output so the coil can maintain a steady temperature or shorten the temperature rise time would increase usability, allowing multiple patients or areas to be treated in a single session. We found it very difficult to complete our testing since it takes us 30 to 45 minutes to gather data for each analysis. We had to break each report into 3 sessions. In our experience throughout the years, most machines we've tested for equine and human use don't exceed 10,000 Gauss with their most focused coil. We ultimately connected the device to a variac on the input, reduced the voltage to 50-100 VAC, and were able to run the device for longer periods, with the gauss output remaining the same as the duty cycle decreased, so the coil had more time to recover.
<b>Certification:</b>	The device passed certification and its results have been published on the Gauss Labs website for public review here: <a href="https://gausslabs.tech/client-certifications/">https://gausslabs.tech/client-certifications/</a>

## Purpose

This report presents an independent analysis of 2.4 Tesla BBM Pulser 5B's electromagnetic output, measured directly from the device using laboratory-grade instruments. It documents how the machine performs across all tested settings - including field strength, pulse quality, timing characteristics, and stimulation efficiency - providing an objective, data-driven assessment of the



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machine's therapeutic capability.



# Test Setup & Methodology

Using calibrated lab test measurement equipment, Gauss readings and waveforms were captured for each power setting. Timing characteristics such as rise time, fall time, pulse width, and duty cycle were measured directly from the waveform data. Performance metrics including slew rate and stimulation intensity were then calculated from these measurements. Each setting was tested independently under consistent conditions to ensure repeatable, comparable results.

Parameter	Value
Analysis Date	4/30/2026
Test Engineer	David D
Gauss Meter	FW Bell 5180
Gauss Meter Probe	Axial
Oscilloscope	Rigol DHO814
LCR Meter	FNIRSI LC1020E
Device Under Test	2.4 Tesla BBM Pulser 5B
Settings Tested	9
Frequency Range	0.40 - 1.76 Hz
Waveform Types	Sawtooth
Applicator / Accessory	Classic 3" Strip Coil 1mm
Coil Resistance	0.02 ohms
Coil Inductance	52.6000 $\mu$ H

The measurements in this report are 100% accurate for the specific device and accessory tested. However, all manufactured devices and accessories are built within component tolerances. Resistors, capacitors, inductors, and coil windings each carry a tolerance range that affects the final output. Mains voltage variation adds another variable - wall power can fluctuate depending on location, time of day, and electrical load on the circuit. Combined, these factors mean that another unit of the same model may produce results that vary by 20-30% from what is documented here. This is normal and expected in any electronic device. The data in this report represents the measured performance of this specific unit under the conditions described above.



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## Executive Summary

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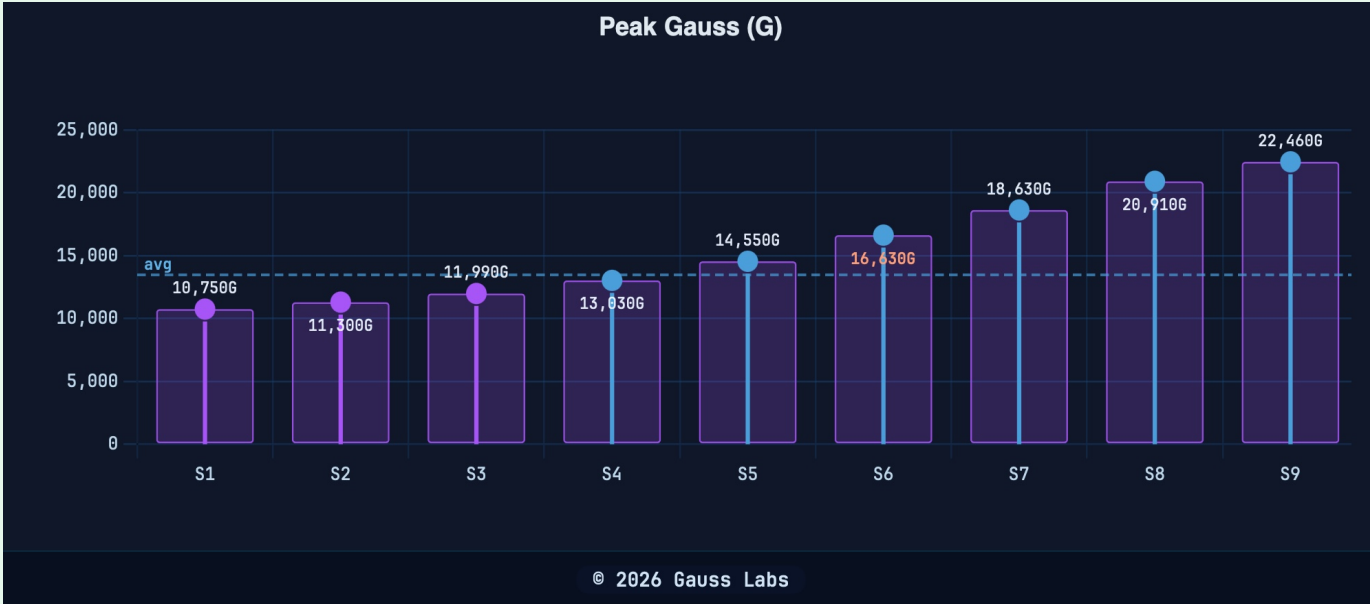
The 2.4 Tesla BBM Pulser 5B with the Classic 3" Strip Coil 1mm applicator was tested across 9 power settings. The strongest setting produces a peak field strength of 22,460 Gauss. The fastest pulse rise reaches a slew rate of 140.38 G/ $\mu$ s - the rate of field change is the primary driver of tissue stimulus. Frequency ranges from 0.40 to 1.76 Hz, covering the range used in common PEMF therapy protocols.

The charts that follow evaluate each setting across the key performance metrics - slew rate, field strength, stimulation intensity, and frequency - so each aspect of performance can be assessed independently. The Waveform Shape & Timing section provides a composite overlay of all settings along with pulse balance and edge timing analysis. Detailed per-setting waveforms and measurement data follow in the pages ahead.

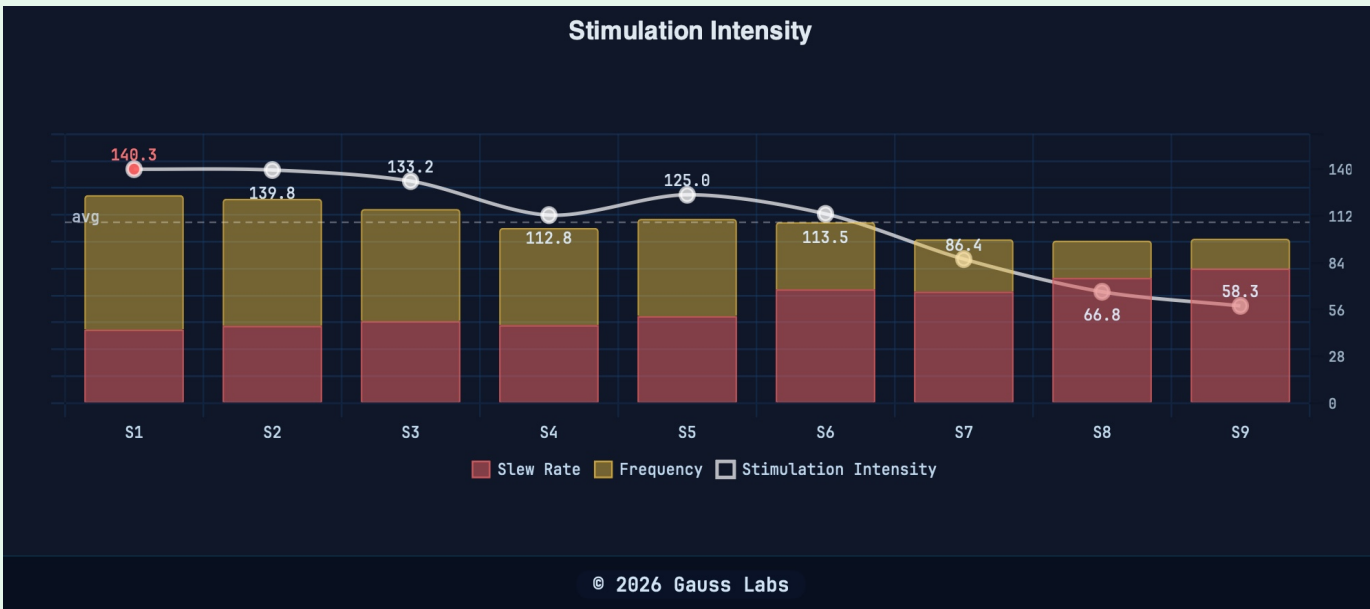
The following four metrics are the foundation of PEMF device evaluation. Slew Rate captures how fast each pulse rises, which directly drives the induced electric field that stimulates cells - this is the most clinically significant measurement. Peak Gauss measures raw field strength and penetration depth. Stimulation Intensity combines slew rate and frequency into a single score reflecting total biological stimulus per second. Frequency determines how often the device pulses and which biological processes it targets. No single metric tells the whole story - an effective setting needs a fast rise, adequate strength, appropriate frequency, and good pulse quality working together.



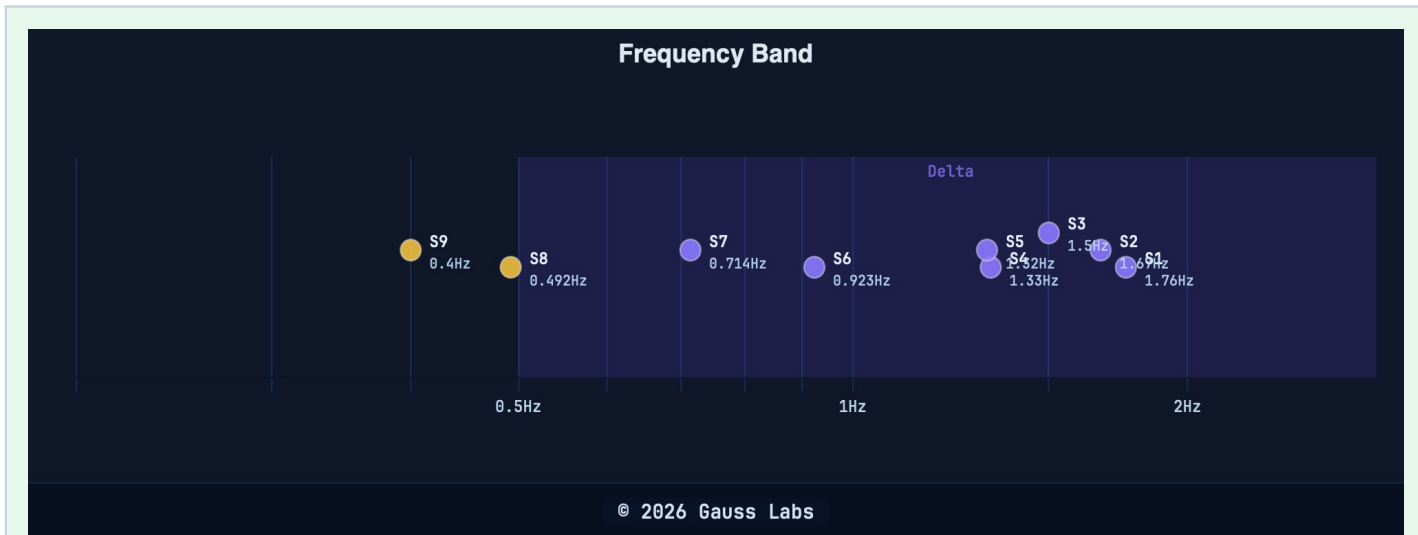
Slew Rate measures how fast the magnetic field rises during each pulse - it is the most clinically significant number in this report. Per Faraday's Law, the body responds to how quickly the field changes, not just how strong it is. A setting with half the Gauss but twice the slew rate actually induces a stronger response in tissue. Each bubble represents one setting: the horizontal axis shows rise time, the vertical axis shows peak Gauss, and bubble size scales with slew rate. Larger bubbles in the upper-left corner are the strongest performers. The table below lists each setting's peak Gauss and slew rate.



Peak Gauss is the strength of the magnetic field the device produces - like the volume knob on a radio. Higher Gauss means the field reaches deeper into tissue and carries more raw energy per pulse. However, field strength alone does not determine how much the body responds - a strong but slowly-changing field is less stimulating than a moderate field that changes rapidly. Each bar shows the peak field strength for one setting - taller is stronger. The dashed line marks the average across all settings.



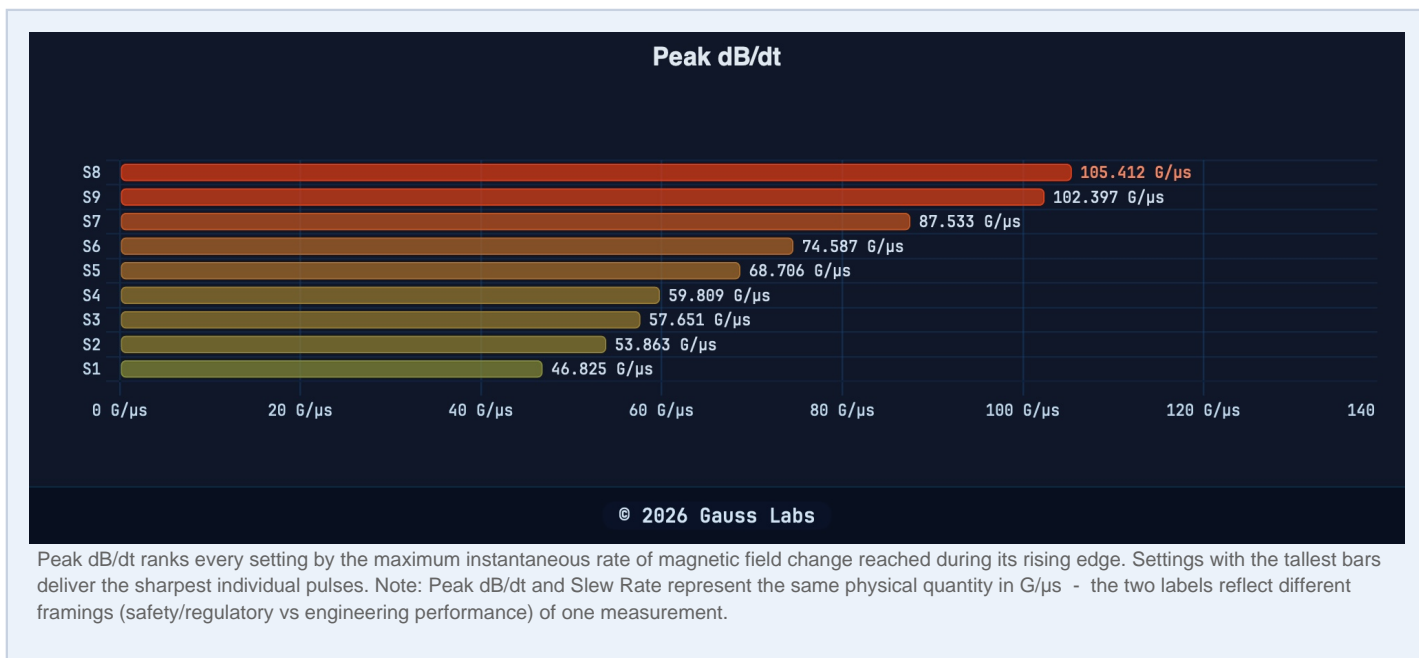
Stimulation Intensity is the closest thing to an overall performance score for each setting. It combines pulse sharpness with how often the device fires per second, giving a single number that reflects total biological stimulus delivered per second. Each bar shows the total intensity: the red portion reflects pulse sharpness (slew rate) and the amber shows how frequency multiplies it. Taller bars mean more stimulus per second. If a bar is tall only because of amber, the device is firing frequently but with weak pulses - like tapping quickly instead of hitting hard. The best settings combine a strong red base with good frequency on top.



Frequency determines what the body responds to - think of it like choosing the right radio station. Very slow pulses (Delta) support deep recovery, mid-range (Alpha) promotes relaxation and circulation, and faster pulses (Beta/Gamma) target active cellular stimulation. Each dot represents one setting positioned within its biological frequency band. The frequency should match the therapeutic goal - no single frequency is universally best.

## Peak dB/dt Analysis

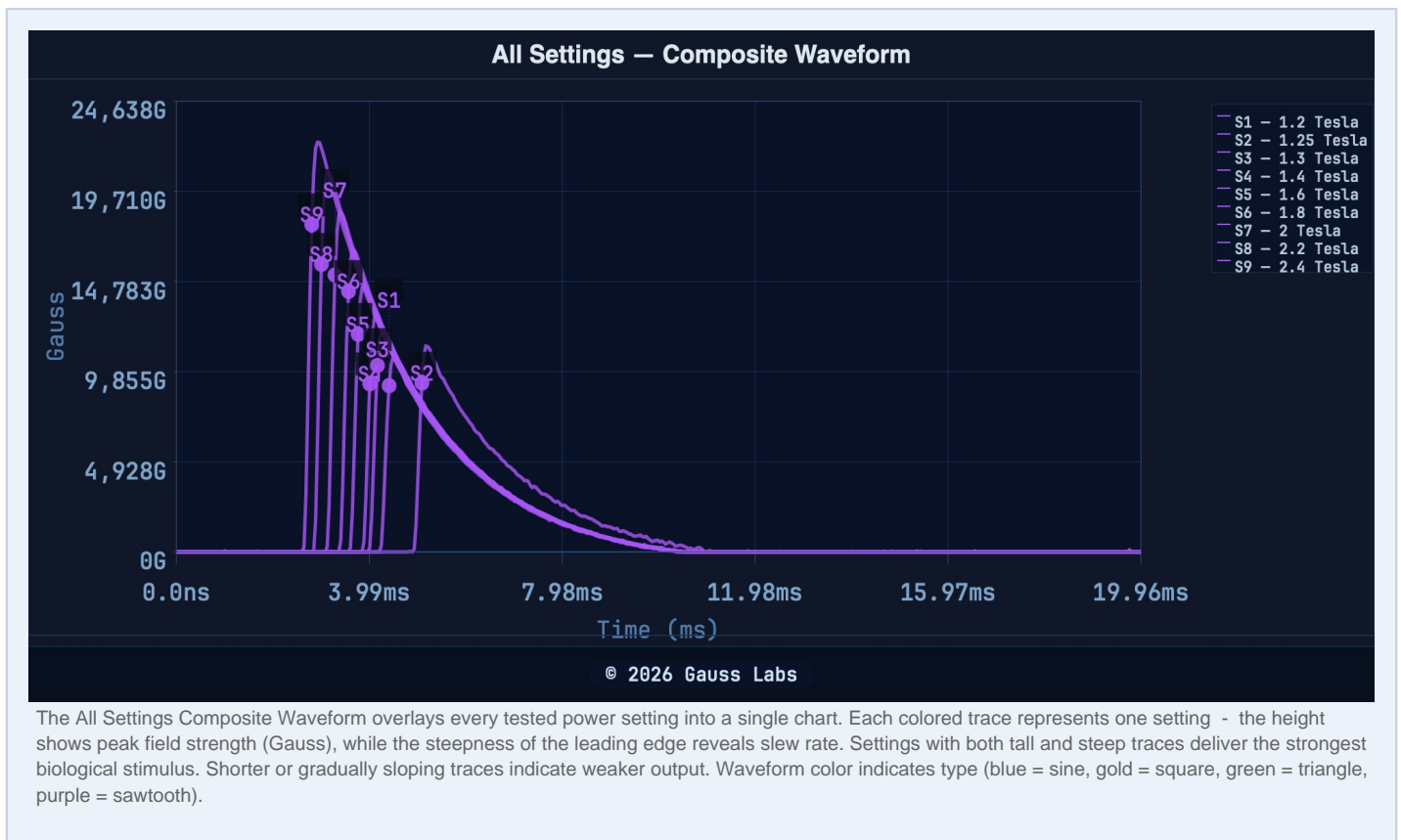
Peak dB/dt is the maximum instantaneous rate of magnetic field change reached during each pulse, measured in Gauss per microsecond. By Faraday's Law it is directly proportional to the induced electric field in tissue - the quantity that drives biological response - and is the parameter referenced by ICNIRP for induced-field safety thresholds.

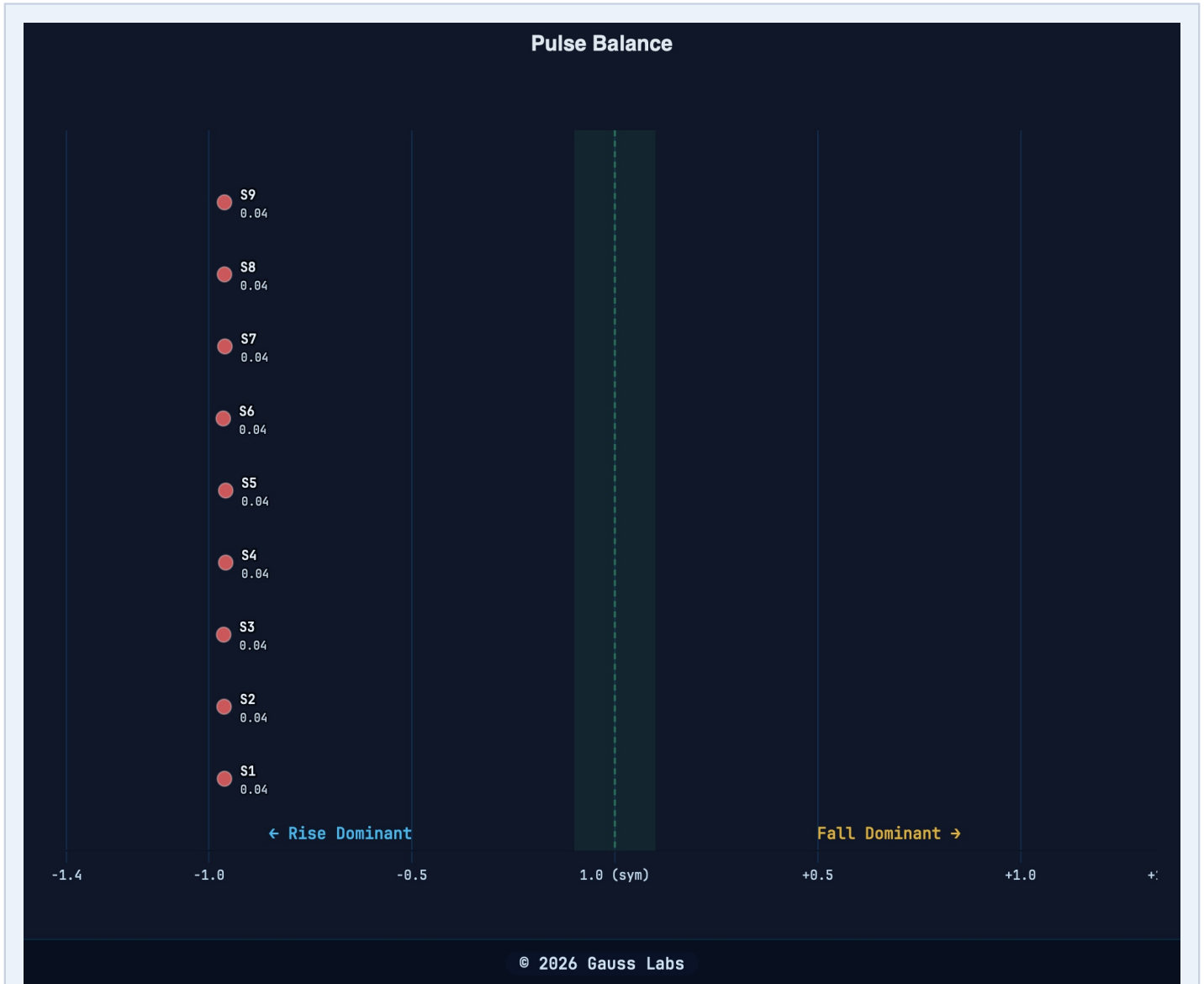


**The sharpest pulse comes from S8 (2.2 Tesla) at 105.41 G/μs. The softest comes from S1 (1.2 Tesla) at 46.83 G/μs - about 2.3x weaker. Sharper pulses deliver a stronger stimulus to tissue, so the higher the number, the more the body feels each pulse.**

# Waveform Shape & Timing Analysis

How fast the field rises and falls shapes the character of every pulse. A fast rise produces a sharp stimulus; a fast fall produces a second stimulus in the opposite direction. When both edges are equally fast, the pulse is balanced and tissue receives a matched stimulus on each side. When one edge is much slower, most of the work happens on one side only. The composite waveform below overlays all settings into a single view so you can visually compare pulse shapes, field strength, and edge steepness across the full operating range.

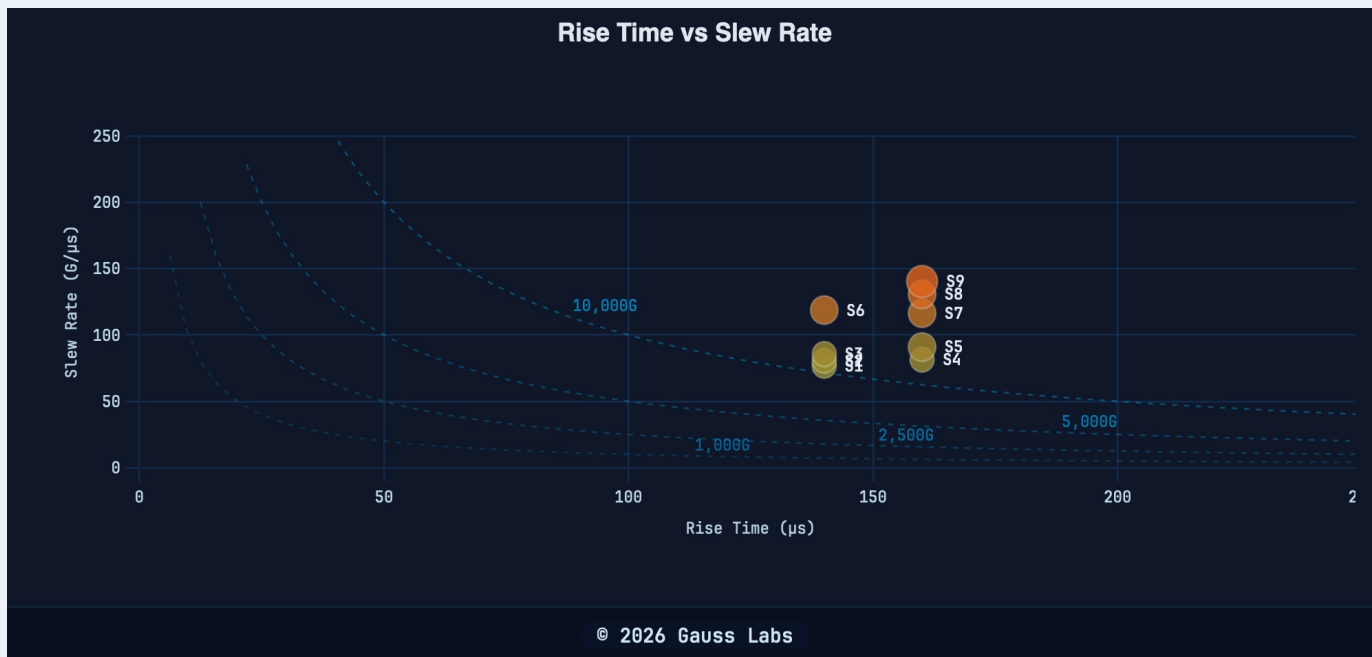




Pulse Balance shows whether the field rises and falls at the same speed. Balanced pulses (green dots near center) deliver even stimulation on both edges. Dots far from center indicate asymmetry, which may be intentional or worth investigating.



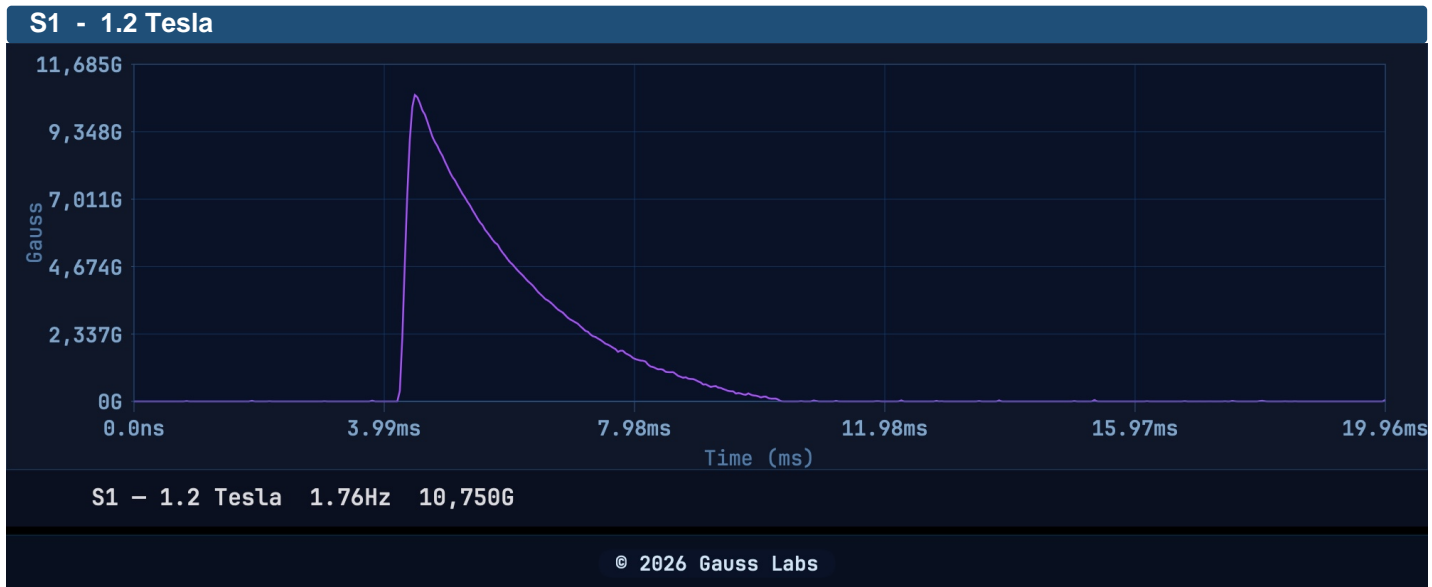
Rise/Fall Time shows each setting's rise time (cyan, left) and fall time (amber, right) as opposing bars. The number at the centre is the rise=fall ratio - values near 1.00 mean both edges are equally fast, which produces a balanced pulse. Large departures from 1.00 indicate one edge is significantly slower than the other.



Rise Time vs Slew Rate maps each setting as a bubble: the horizontal axis is rise time, the vertical axis is slew rate, and bubble size scales with peak Gauss. Settings in the upper-left rise fastest and hit hardest. Dashed curves are iso-Gauss contours - every point on a curve produces the same peak field strength.



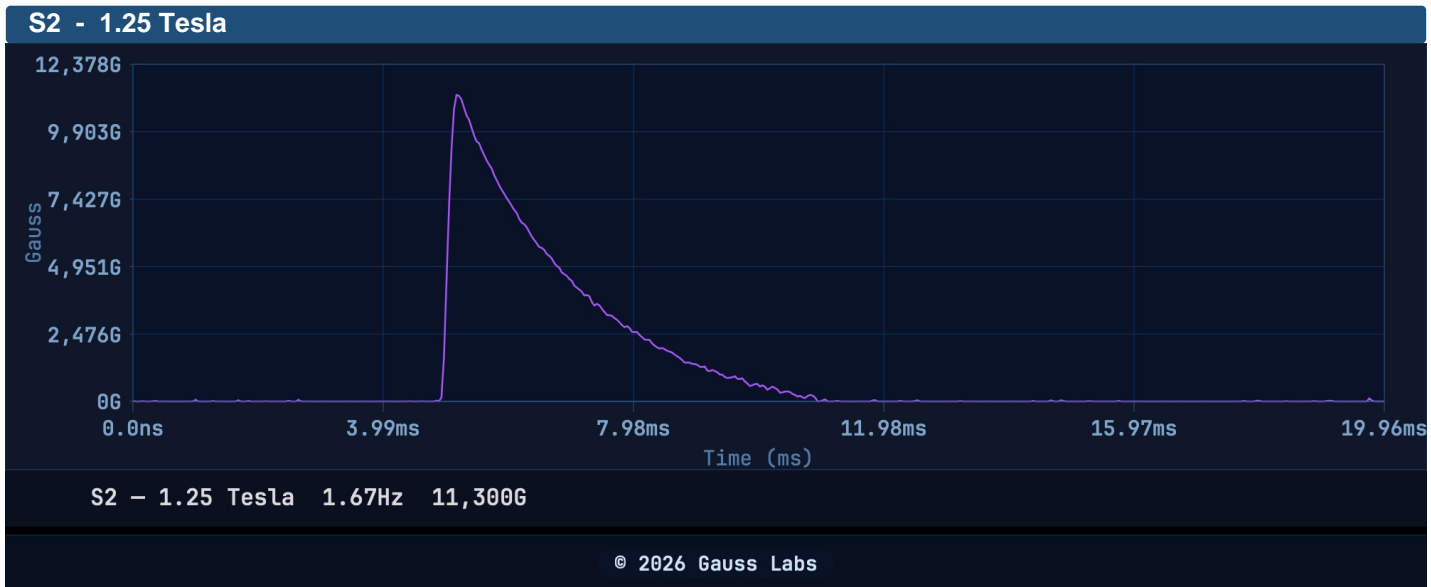
# Setting 1



Waveform	Sawtooth
Frequency	1.76 Hz (doc: 1.19 Hz, +47.9%)
Peak Gauss	10,750 G (doc: 13,000 G, -17.3%)
Rise Time	140 $\mu$ s
Fall Time	3.66 ms
Pulse Width	1.48 ms
Duty Cycle	0.26%
Slew Rate	76.786 G/ $\mu$ s
Stimulation Intensity	140.31 G/ $\mu$ s-Hz



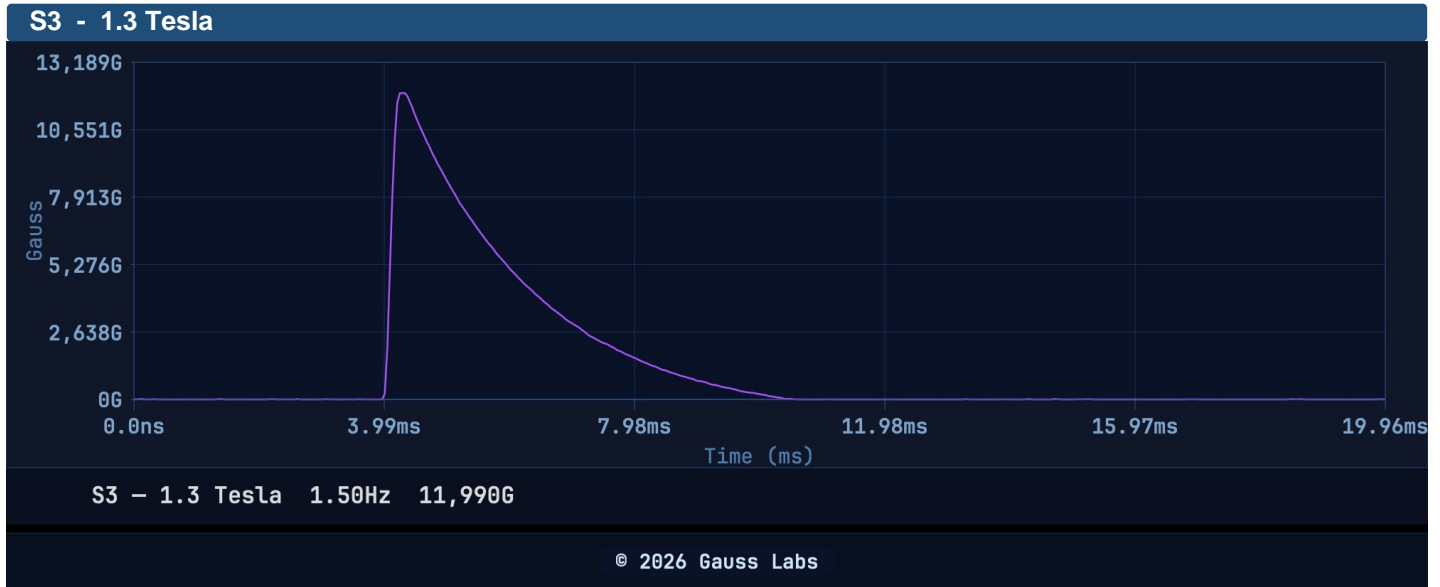
# Setting 2



Waveform	Sawtooth
Frequency	1.67 Hz
Peak Gauss	11,300 G
Rise Time	140 $\mu$ s
Fall Time	3.76 ms
Pulse Width	1.46 ms
Duty Cycle	0.24%
Slew Rate	80.714 G/ $\mu$ s
Stimulation Intensity	139.81 G/ $\mu$ s-Hz



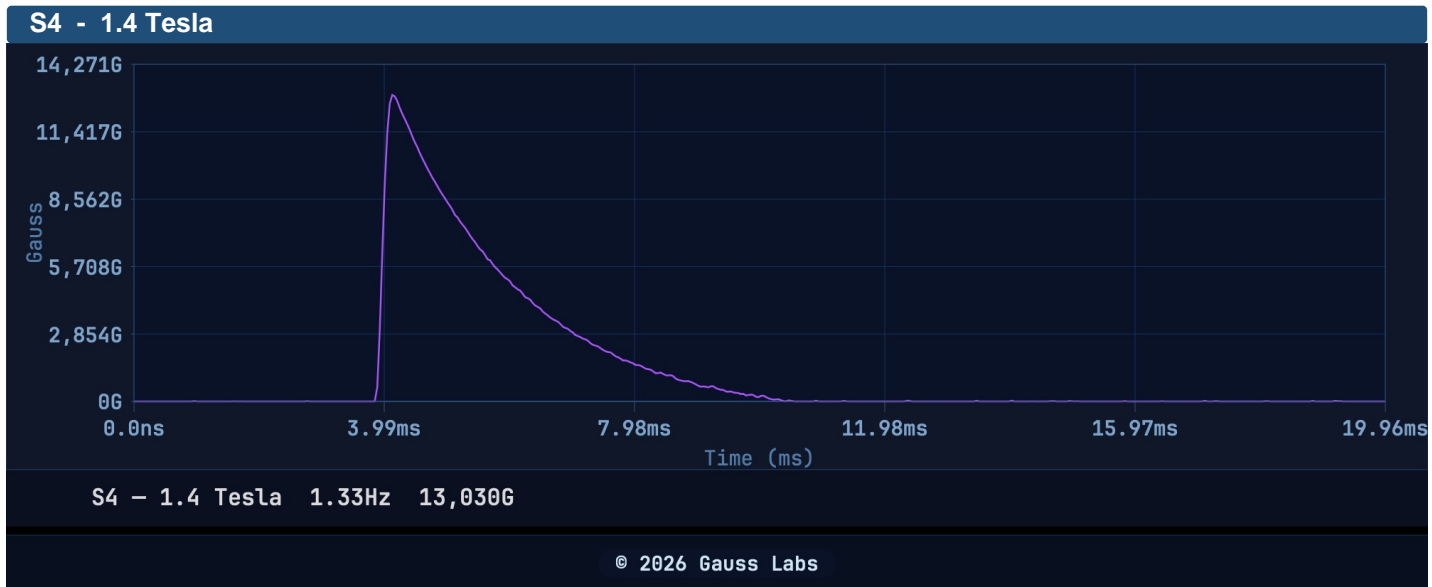
# Setting 3



Waveform	Sawtooth
Frequency	1.5 Hz
Peak Gauss	11,990 G
Rise Time	140 $\mu$ s
Fall Time	3.84 ms
Pulse Width	1.6 ms
Duty Cycle	0.24%
Slew Rate	85.643 G/ $\mu$ s
Stimulation Intensity	133.15 G/ $\mu$ s-Hz



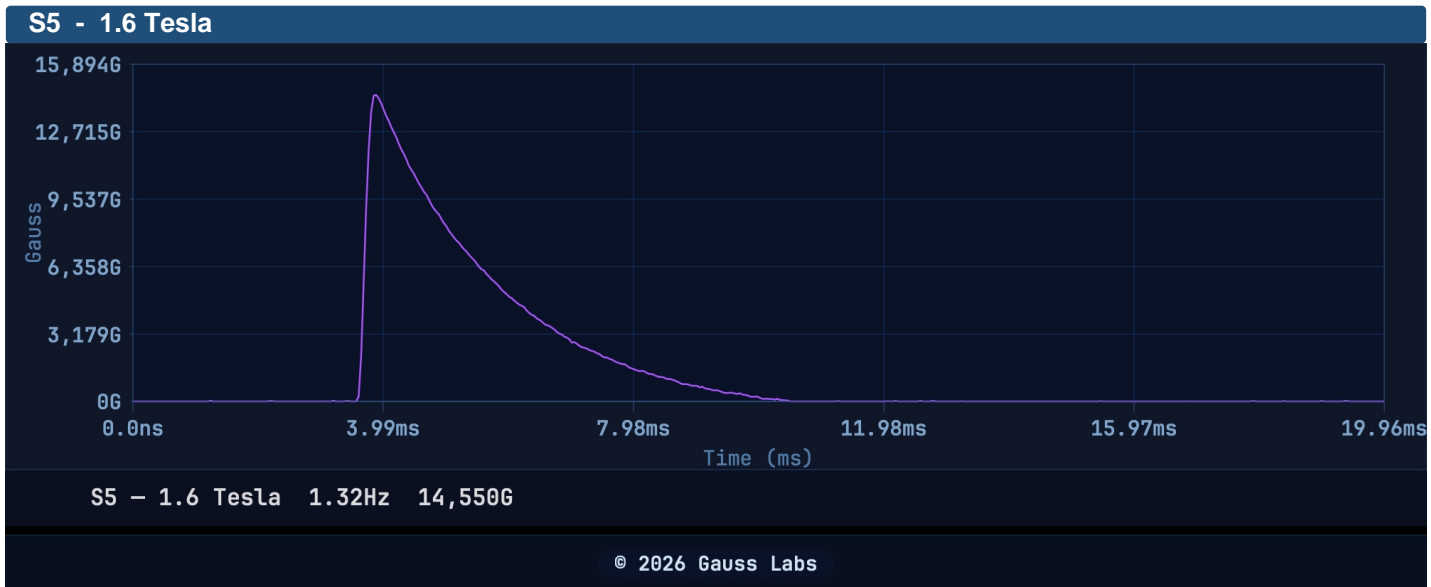
# Setting 4



Waveform	Sawtooth
Frequency	1.33 Hz
Peak Gauss	13,030 G
Rise Time	160 $\mu$ s
Fall Time	3.9 ms
Pulse Width	1.54 ms
Duty Cycle	0.21%
Slew Rate	81.438 G/ $\mu$ s
Stimulation Intensity	112.76 G/ $\mu$ s-Hz



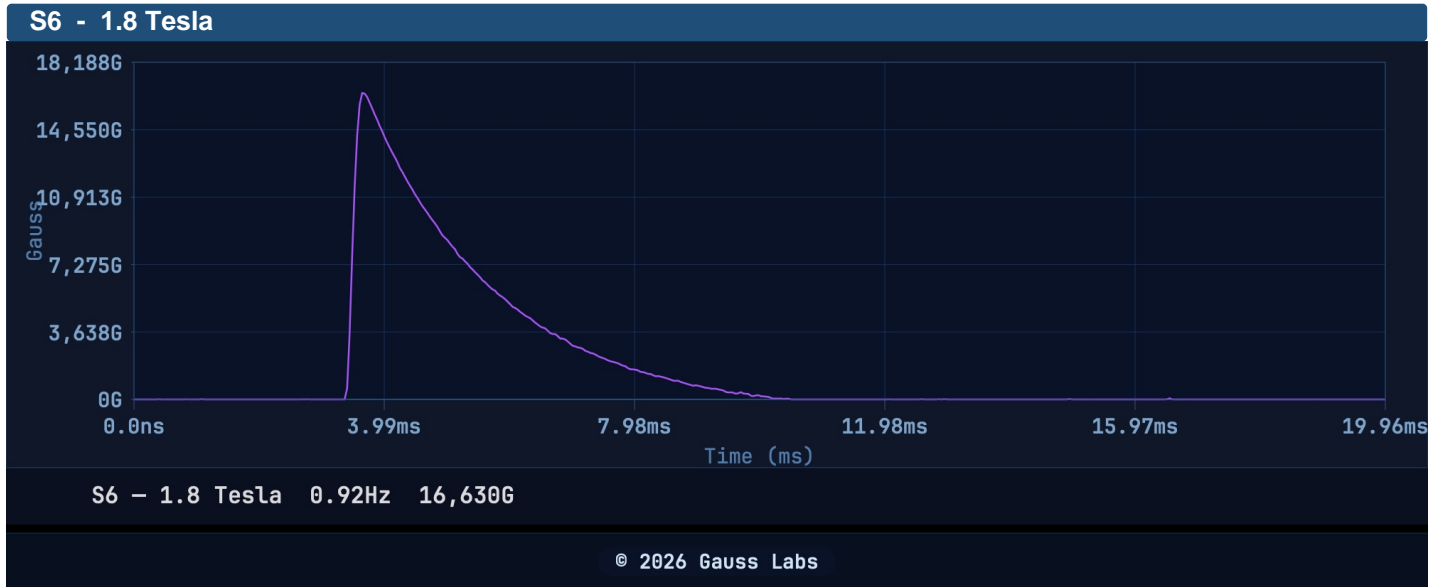
# Setting 5



Waveform	Sawtooth
Frequency	1.32 Hz
Peak Gauss	14,550 G
Rise Time	160 $\mu$ s
Fall Time	3.9 ms
Pulse Width	1.56 ms
Duty Cycle	0.21%
Slew Rate	90.938 G/ $\mu$ s
Stimulation Intensity	124.96 G/ $\mu$ s-Hz



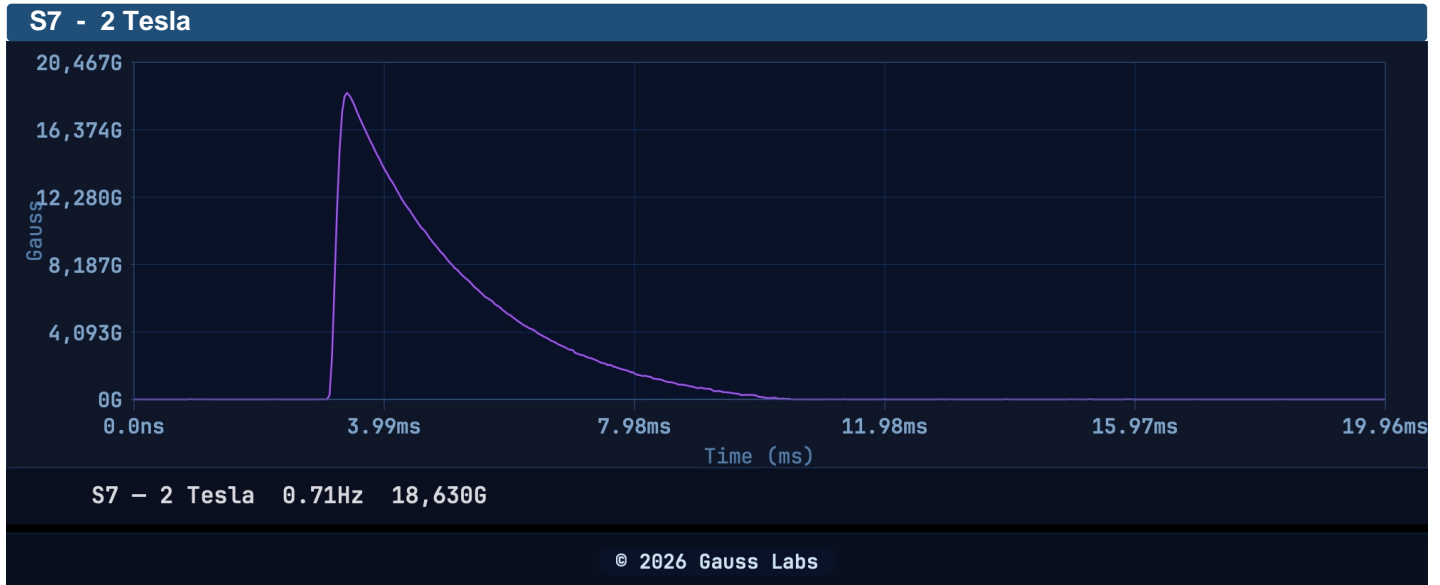
# Setting 6



Waveform	Sawtooth
Frequency	0.92 Hz
Peak Gauss	16,630 G
Rise Time	140 $\mu$ s
Fall Time	4 ms
Pulse Width	1.56 ms
Duty Cycle	0.14%
Slew Rate	118.786 G/ $\mu$ s
Stimulation Intensity	113.48 G/ $\mu$ s-Hz



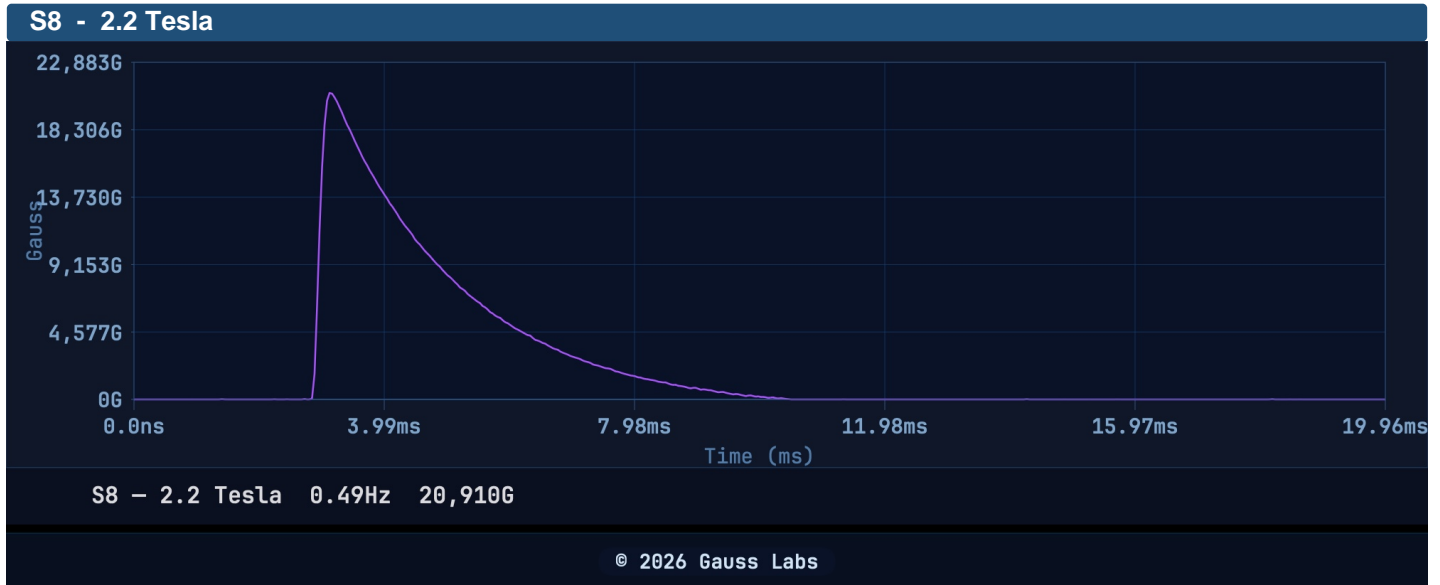
# Setting 7



Waveform	Sawtooth
Frequency	0.71 Hz
Peak Gauss	18,630 G
Rise Time	160 $\mu$ s
Fall Time	4.12 ms
Pulse Width	1.6 ms
Duty Cycle	0.11%
Slew Rate	116.438 G/ $\mu$ s
Stimulation Intensity	86.37 G/ $\mu$ s-Hz



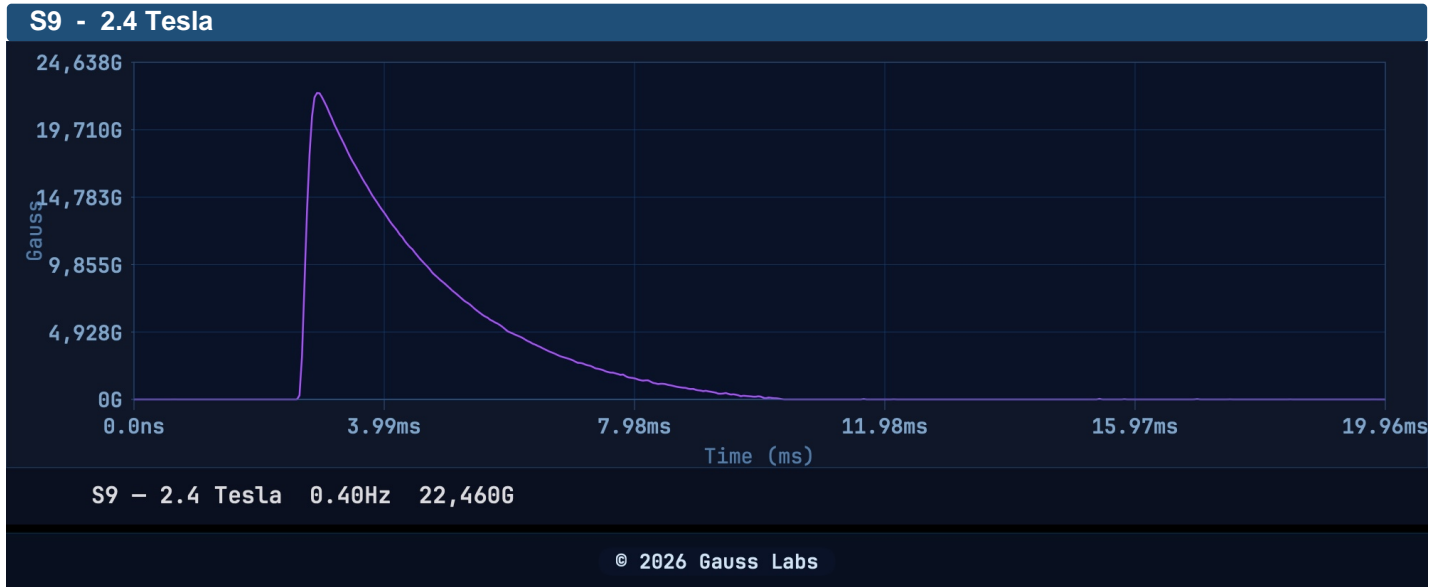
# Setting 8



Waveform	Sawtooth
Frequency	0.49 Hz
Peak Gauss	20,910 G
Rise Time	160 $\mu$ s
Fall Time	4.18 ms
Pulse Width	1.62 ms
Duty Cycle	0.08%
Slew Rate	130.688 G/ $\mu$ s
Stimulation Intensity	66.76 G/ $\mu$ s-Hz



# Setting 9



Waveform	Sawtooth
Frequency	0.4 Hz (doc: 0.31 Hz, +29.0%)
Peak Gauss	22,460 G (doc: 24,000 G, -6.4%)
Rise Time	160 $\mu$ s
Fall Time	4.16 ms
Pulse Width	1.66 ms
Duty Cycle	0.07%
Slew Rate	140.375 G/ $\mu$ s
Stimulation Intensity	58.31 G/ $\mu$ s-Hz



# Measurement Data

Full parameter table for all 9 settings. Slew Rate = Peak Gauss ÷ Rise Time. Stimulation Intensity = (Rise Slew + Fall Slew) x Frequency, counting both pulse edges. Higher values in both columns indicate stronger and more active field delivery per second.

#	Label	Waveform	Frequency	Peak Gauss	Slew Rate (G/μs)	Pulse Balance	Stimulation Intensity
S1	1.2 Tesla	Sawtooth	1.76Hz	10,750G	76.786	0.038	140.31
S2	1.25 Tesla	Sawtooth	1.67Hz	11,300G	80.714	0.037	139.81
S3	1.3 Tesla	Sawtooth	1.50Hz	11,990G	85.643	0.036	133.15
S4	1.4 Tesla	Sawtooth	1.33Hz	13,030G	81.438	0.041	112.76
S5	1.6 Tesla	Sawtooth	1.32Hz	14,550G	90.938	0.041	124.96
S6	1.8 Tesla	Sawtooth	0.92Hz	16,630G	118.786	0.035	113.48
S7	2 Tesla	Sawtooth	0.71Hz	18,630G	116.438	0.039	86.37
S8	2.2 Tesla	Sawtooth	0.49Hz	20,910G	130.688	0.038	66.76
S9	2.4 Tesla	Sawtooth	0.40Hz	22,460G	140.375	0.038	58.31



# Estimated Coil Power Dissipation

PEMF devices turn electrical energy into magnetic pulses, and a small share of that energy stays in the coil as heat. This section estimates how much heat each setting produces inside the coil, calculated from the measured peak current, coil resistance, pulse width, and pulse rate. Settings that pulse longer or more frequently generate more total heat per second, even when each individual pulse has the same shape.

The numbers below are an electrical estimate only - derived from how much current flows, how long each pulse lasts, and how often pulses fire. They are a relative guide for comparing settings on a single scale; they are not a measured coil temperature.

#	Label	Peak Current	Heat per Pulse	Average Power	Relative Load
S1	1.2 Tesla	52.677 A	82.136 mJ	145 mW	LOW
S2	1.25 Tesla	35.507 A	36.814 mJ	61 mW	LOW
S3	1.3 Tesla	56.867 A	103.483 mJ	155 mW	MODERATE
S4	1.4 Tesla	64.047 A	126.342 mJ	168 mW	MODERATE
S5	1.6 Tesla	72.230 A	162.776 mJ	215 mW	MODERATE
S6	1.8 Tesla	79.557 A	197.475 mJ	182 mW	MODERATE
S7	2 Tesla	90.317 A	261.029 mJ	186 mW	MODERATE
S8	2.2 Tesla	101.650 A	334.780 mJ	165 mW	MODERATE
S9	2.4 Tesla	111.040 A	409.352 mJ	164 mW	MODERATE

As a rough benchmark, passively-cooled PEMF coils typically handle up to 200-500 mW of continuous electrical dissipation before active cooling (heatsink, airflow, or thermally conductive potting) is needed. Settings in the LOW band run comfortably at room temperature for extended sessions. MODERATE settings are generally fine for shorter runs but warrant temperature monitoring during long continuous operation. HIGH settings typically require cooling or a reduced duty cycle during sustained use.



## Closing Summary

Every patient or animal that receives PEMF therapy depends on the device actually delivering effective treatment. Most devices are marketed with specifications that tell you very little about real-world performance - two devices with identical ratings can produce dramatically different results in tissue. This report replaces marketing claims with measured data, captured directly from 2.4 Tesla BBM Pulser 5B using laboratory-grade test equipment.

## Measured Performance

<p><b>140.38</b> G/<math>\mu</math>s Slew Rate</p>	<p><b>22,460.0</b> Gauss Peak Gauss</p>	<p><b>140.3</b> G/<math>\mu</math>s·Hz Stimulation Intensity</p>	<p><b>0.4–1.76</b> Hz Frequency Band</p>
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2.4 Tesla BBM Pulser 5B with the Classic 3" Strip Coil 1mm was tested across 9 settings. Here is what the data tells us. Pulse sharpness at S9 (2.4 Tesla) reaches 140.38 G/ $\mu$ s - fast enough to induce strong electrical gradients in tissue. Field strength peaks at 22,460 Gauss - a strong output that can reach deep tissue structures. Overall performance peaks at 140.3 G/ $\mu$ s·Hz (S1 (1.2 Tesla)) - an exceptionally high therapeutic output per second, combining sharp pulses with rapid repetition. Frequency spans 0.4-1.76 Hz (Delta-Delta), targeting deep tissue recovery.

*Settings are moderately consistent, with the strongest delivering 2.4x the weakest. Performance is relatively even across the operating range.*

*All settings use sawtooth waveforms.*

*Pulse balance is notably asymmetric (average ratio 0.04). The device delivers most of its stimulus on one edge of each pulse.*

These are independently measured results, not manufacturer specifications. With this data, the device, accessory, and setting selections are based on verified performance rather than marketing claims.



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## Key Terms

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### Accessory

The applicator component that delivers the electromagnetic field to the body, also called an attachment by some manufacturers. It contains one or more coils or loops - wound conductors that generate a pulsed magnetic field when driven by the control unit. Accessories come in various form factors including pads, rings, wraps, and wands, each designed for different anatomical targets. The coil geometry inside the accessory (pancake, donut, loop, stacked) determines the shape, depth, and distribution of the resulting magnetic field.

### Alpha Frequency Band

A mid-range biological frequency used in PEMF therapy, spanning 8 to 12 Hz, associated with relaxation and improved circulation. Alpha frequencies represent a baseline or neutral stimulation zone, often used for general wellness and maintenance protocols. This range mirrors the brainwave patterns of calm, wakeful relaxation and is considered a versatile starting point when no specific therapeutic target has been identified.

### Applicator

The physical component of a PEMF device that delivers the magnetic field to the treatment area. Applicators come in different coil geometries - including pancake, donut, loop, and butterfly - each producing a different field shape and coverage pattern. The applicator determines how the field is distributed across the target, how deep it penetrates, and how concentrated or spread out the energy is. Selecting the right applicator for the treatment area is as important as choosing the right power setting.

### Beta Frequency Band

A higher biological frequency range used in PEMF therapy, spanning 12 to 30 Hz, targeting active cellular stimulation. Beta frequencies deliver more pulses per second, increasing the total stimulus intensity and promoting more vigorous cellular activity. This range corresponds to alert, focused brainwave states and is often selected for acute injury response, performance enhancement, and protocols requiring stronger biological activation.

### Butterfly Loop Coil

An applicator made of two loop coils connected and angled toward each other, focusing the magnetic field at the point where they converge. The two-loop construction lets the field enter the treatment area from both sides simultaneously, producing a stronger, more focused field at the convergence zone than either loop would generate alone. Commonly used for joints and specific muscle groups where surrounding coverage plus focal intensity is desirable. Often referred to simply as a 'butterfly coil,' though the construction is two loop coils rather than a single coil.

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## Key Terms

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### Coil Inductance (L)

The coil's resistance to changes in current flow, which directly determines how fast the magnetic field can rise when power is applied. Higher inductance means slower field buildup but potentially stronger peak field. Measured in Henries (H) or millihenries (mH). Inductance increases with more turns and with ferrite or iron core materials. Combined with resistance, it determines the L/R time constant.

### Coil Resistance (R)

The electrical resistance of the coil wire, which determines how much heat is produced during operation and how much voltage the device needs to reach peak current. Lower resistance means less wasted heat and more efficient energy delivery to the magnetic field. Measured in Ohms (ohm). Resistance decreases with thicker wire (lower AWG number) and increases with temperature.

### dB/dt

The rate at which the magnetic field strength changes over time - how quickly the field ramps up or down at any instant during a pulse. This is the general physical quantity that drives biological response to PEMF: the body responds to changing fields, not static ones, so a faster change produces a stronger induced electric field in tissue (Faraday's Law). dB/dt varies throughout each pulse; two commonly reported single-number summaries are Peak dB/dt (the sharpest moment of one pulse, used for safety thresholds) and Slew Rate (the average rate across the rising edge, used as an engineering performance metric).

### Delta Frequency Band

The slowest biological frequency range used in PEMF therapy, spanning 0.5 to 4 Hz, targeting deep tissue recovery and pain modulation. Devices operating in the Delta band deliver fewer pulses per second, allowing longer energy transfer per cycle, which is associated with reduced inflammation and enhanced wound healing. Delta frequencies mirror the brainwave patterns observed during deep sleep and are commonly selected for post-surgical recovery and chronic pain protocols.

### Donut Coil

A flat coil wound in a ring shape with an open hole through the center, fully encased within its housing so the field is measured along the surface face only. The enclosed design means treatment is applied through the top or bottom face rather than through the center hole, producing a broader, more even field distribution with stronger output near the outer ring of windings. Identified by a peak that sits off-center on a ring (at least 20% of the way out along the scan) AND a Ring/Center Ratio of at least 1.15; because fewer total windings than a solid pancake of the same diameter, it produces lower peak Gauss at the face and requires additional drive current to match a pancake's penetration depth.



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## Key Terms

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### Duty Cycle (%)

What fraction of each pulse cycle the magnetic field is actually on versus off -- for example, a 50% duty cycle means the field is on for half the time and off for half the time. Higher duty cycles deliver more total energy but generate more heat. Expressed as a percentage of the total cycle time.

### Fall Time

How quickly the magnetic field collapses after the pulse ends -- this affects the strength of the second induction event in tissue as the collapsing field generates a reverse electric field. Measured as the 90%-to-10% transition time of the magnetic field pulse, typically captured with an oscilloscope.

### Frequency (Hz)

The number of electromagnetic pulses delivered per second, measured in Hertz. Frequency affects how the body responds to the field at a cellular level and is a key variable in PEMF therapy protocols. Frequency is independent of field strength -- a high-frequency signal can still have a low gauss output, and vice versa. In PEMF therapy, biological frequency bands are: Delta (0.5-4 Hz) -- deep tissue recovery and sleep; Theta (4-8 Hz) -- tissue repair and regeneration; Alpha (8-12 Hz) -- relaxation and circulation; Beta (12-30 Hz) -- active cellular stimulation; Gamma (>30 Hz) -- neural and cognitive engagement.

### Gamma Frequency Band

The fastest biological frequency range used in PEMF therapy, spanning 30 to 300 Hz, associated with neural and cognitive engagement. Gamma frequencies produce the highest pulse repetition rates, maximizing total stimulation intensity when combined with strong slew rates. This range is used for specialized protocols targeting nervous system response, cognitive function, and high-frequency cellular activation. Higher frequencies increase thermal load, so devices operating in the Gamma band require careful thermal management.

### Gauss (G)

The unit of measurement for magnetic flux density. Higher gauss values indicate a stronger magnetic field at that point. kG = kilogauss = 1,000 gauss. 1 Tesla = 10,000 Gauss; see Tesla (T).

### Gauss Meter

A calibrated instrument used to measure magnetic flux density in Gauss or Tesla. In PEMF accessory testing, the Gauss meter is the primary measurement device used to capture field strength at each scan point. Measurements are taken using a Hall effect probe positioned at the specified standoff distance from the coil face. The meter model and probe type should be documented in the Report Info for traceability.



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## Key Terms

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### Gauss Meter Probe

The sensing element of a Gauss meter, typically a Hall effect transducer mounted on a flat or axial probe tip. The probe is positioned at the measurement standoff distance from the coil face to capture the magnetic flux density at each scan point. Probe type (axial vs transverse), size, and positioning affect measurement accuracy. The probe model should be documented in the Report Info for traceability.

### Heat per Pulse (mJ)

The amount of energy converted to heat in the coil during a single pulse, expressed in millijoules (mJ). Heat per pulse increases sharply with higher current - doubling the current produces four times the heat because the relationship is exponential. At low pulse rates, individual pulses can be relatively warm without causing problems. But at high pulse rates, even modest heat per pulse accumulates into a significant continuous thermal load. This metric, combined with pulse frequency, determines the total heat the device must manage during a session.

### Loop Coil

An open electromagnetic coil designed to be placed around a limb or curved around a body part, so the magnetic field passes through from all sides simultaneously. Unlike the enclosed donut coil, a loop is open - limbs can be passed through it for surrounding coverage of arms, legs, or joints. The field profile is similar to a donut coil with peak strength in the ring zone, but the open geometry allows flexible placement; measurements are taken at 50% of the tubing thickness from the surface.

### Pancake Coil

A flat, disc-shaped coil (also called a flat spiral) that produces a strong, focused magnetic field directly beneath its center -- ideal for targeted treatment of a specific area. The field is strongest at center and drops off toward the edges. Wound in a spiral with all windings in the same plane. Identified by a peak at or near the center -- specifically, when the coil does not meet the Donut criteria.

### Peak dB/dt

The maximum instantaneous rate of change of the magnetic field reached during each pulse - the single sharpest moment within the pulse shape, expressed in Gauss per microsecond (G/ $\mu$ s). Because tissue responds to how fast the field changes rather than the static field strength, Peak dB/dt is the most direct per-pulse measure of biological stimulus, and is the parameter that regulatory limits for induced-field safety (IEC 60601-2-33, ICNIRP) are defined against. Physically the same quantity as Slew Rate during the rising edge, but framed as an instantaneous exposure value rather than an engineering performance number.

### Peak Gauss (G)

The maximum magnetic flux density at the accessory surface (0 mm distance). The location of this maximum depends on the coil geometry - center-face for a pancake coil, ring-zone for a donut or loop coil.

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## Key Terms

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### PEMF (Pulsed Electromagnetic Field)

A therapeutic technology that delivers time-varying electromagnetic pulses to the body at specific frequencies and intensities. Unlike static magnets, PEMF creates dynamic fields that induce microcurrents in tissue according to Faraday's law of induction. These induced currents can influence cellular membrane potential, ion transport, and metabolic activity. PEMF is used to support circulation, recovery, pain management, and general wellness, with devices ranging from low-intensity consumer units to high-intensity professional systems.

### Penetration Depth

The distance from the coil surface at which the magnetic field remains therapeutically significant. There is no single universal threshold - penetration depth is typically defined relative to a percentage of peak field strength (commonly 50% or 10%) and depends heavily on coil geometry, peak Gauss, and the tissue being treated. Larger coils with higher peak field produce deeper usable penetration. Field strength falls off approximately as the cube of distance from a small coil, so doubling distance reduces field strength by roughly 8x. Penetration depth is not a fixed property of a device - it is a function of output level and target threshold.

### Pulse Balance

Ratio of Rise Time to Fall Time. A value of 1.0 means the field ramps up and down at equal speed (symmetric). Values below 1.0 indicate a faster rise than fall; above 1.0 the opposite. Asymmetric pulses deliver different induction profiles on each edge, which may influence biological response. Values within +/-15% of 1.0 are considered symmetric.

### Pulse Completeness

A measure of whether each PEMF pulse lasts long enough for the magnetic field to fully build to its intended peak strength. Every coil takes a certain amount of time for the current (and therefore the field) to ramp up fully. If the pulse ends too soon, the field never reaches its full potential - the device is underperforming even though it appears to be working normally. Pulse completeness is expressed as a percentage: 100% means the pulse is exactly long enough for full field buildup; values above 100% confirm the field had time to fully develop. Values significantly below 100% indicate the pulse is being cut short.

### Pulse Width ( $\mu\text{s}$ )

Duration of a single pulse measured at the 50% amplitude threshold. Distinct from duty cycle, which expresses pulse width as a fraction of the full period. Longer pulse widths deliver more cumulative field exposure per cycle.

### Resonance

When a system absorbs energy most efficiently because it is being driven at just the right frequency -- like pushing a swing at the moment it naturally swings back. In PEMF, some researchers believe that specific pulse frequencies may resonate with cellular processes, though the science is still evolving. Technically, resonance occurs when the driving frequency matches the system's natural oscillation frequency.

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## Key Terms

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### Ring/Center Ratio

A numeric ratio comparing the peak field strength of a coil to the field strength at the center. A ratio of at least 1.15 combined with a peak sitting at least 20% off-center indicates a Donut Coil - the ring is meaningfully stronger than the center. A ratio near 1.0 with a centered peak indicates a Pancake Coil - the center dominates. The ring zone location varies with coil size and is determined by where the windings are concentrated rather than a fixed distance.

### Rise Time

How quickly the magnetic field reaches its peak strength during a pulse -- faster rise time means a sharper pulse edge and stronger tissue stimulation. This is one of the most important pulse characteristics for therapeutic effectiveness. Measured as the 10%-to-90% transition time of the magnetic field pulse, typically captured with an oscilloscope.

### Sawtooth Wave

A strongly asymmetric waveform in which one edge is much faster than the other -- traditionally shown as a gradual rise with a sharp drop (like the teeth of a saw), but also includes the reverse shape of a sharp spike followed by a slow exponential recovery. This reverse shape is characteristic of capacitor-discharge PEMF circuits, where a pre-charged capacitor dumps current into the coil in a fast pulse that then decays as the energy dissipates. Both forms produce high dB/dt values on the sharp edge, generating strong induced electric fields in tissue across a broad range of frequencies -- a property some practitioners prefer over simpler waveforms.

### Sine Wave

A smooth, continuously curving waveform that produces gradual field changes during each pulse cycle. Sine waves are gentle on tissue and produce symmetrical rising and falling edges, making them well-suited for relaxation and recovery protocols. Because the field changes gradually rather than abruptly, sine waveforms typically produce lower slew rates than square or sawtooth waveforms at the same peak Gauss and frequency. Many resonant and capacitor-discharge PEMF circuits naturally produce sinusoidal output.

### Slew Rate (G/μs)

How rapidly the magnetic field strength changes during a pulse edge - a higher slew rate means a sharper, more abrupt field change, which induces stronger electric fields in tissue. Devices report a separate slew rate for the rising edge ( $\text{Peak Gauss} \div \text{Rise Time}$ ) and the falling edge ( $\text{Peak Gauss} \div \text{Fall Time}$ ); both contribute to cumulative dose, see Total Stimulation Intensity. Expressed in Gauss per microsecond (G/μs). The rising-edge slew rate is the same physical quantity as Peak dB/dt, framed as an engineering performance metric rather than a safety threshold.

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## Key Terms

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### Square Wave

A waveform with near-instantaneous transitions between its high and low states, producing the sharpest possible field changes per pulse. Square waves maximize slew rate because the field rises and falls as quickly as the hardware allows, generating the strongest induced electric field in tissue for a given peak Gauss. This makes square waveforms the most effective shape for biological stimulation when slew rate is the priority. Achieving a true square wave requires fast switching components and careful circuit design to control ringing and overshoot at the transitions.

### Stacked Tolerance

The cumulative effect of multiple component tolerances combining across a circuit or system. When several components each carry their own tolerance, the real-world output can deviate significantly from design intent -- not because any single part is out of spec, but because all their individual variations add together. In a PEMF pulse circuit, stacked tolerances across the timing capacitor, drive resistor, coil inductance, and switching transistor can shift the actual pulse width, peak current, and field strength well outside the expected range. Worst-case stacked tolerance analysis identifies the maximum possible deviation by assuming every component simultaneously sits at its worst allowable extreme.

### Tesla (T)

An alternative unit of magnetic flux density. 1 Tesla = 10,000 Gauss; see Gauss (G). Tesla is commonly used in clinical and scientific literature, so knowing the conversion helps when comparing PEMF devices across different sources. Most PEMF accessories operate in the milliTesla (mT) range.

### Therapeutic Window

A range of device output parameters - typically frequency, intensity (Gauss), and pulse width - within which biological effects are observed to occur. Outside this window, the stimulus may be too weak to produce a measurable effect (below threshold) or potentially counterproductive (above the optimal range for a given tissue response). Therapeutic windows are frequency-specific: research suggests different biological processes respond preferentially to different frequency bands - for example, bone healing protocols often target 15-75 Hz, while neurological applications may use lower frequencies. The therapeutic window concept implies that more power or higher frequency is not always better; matching the output parameters to the target tissue and protocol is more important than simply maximizing output.

### Theta Frequency Band

A biological frequency range used in PEMF therapy, spanning 4 to 8 Hz, targeting tissue repair and regeneration. Theta frequencies promote circulation and cellular repair processes, making them a common choice for musculoskeletal injuries and soft tissue healing. This range corresponds to the brainwave patterns seen during light sleep and deep relaxation, and is widely used in equine and sports recovery protocols.



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## Key Terms

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### Tolerance

The allowable deviation from a specified nominal value in a component or measurement. In electronics, every resistor, capacitor, and inductor is manufactured within a tolerance range -- typically +/-1%, +/-5%, or +/-10% -- meaning the actual value may differ from the labeled value by that percentage. In PEMF devices, component tolerances directly affect output field strength, pulse timing, and frequency accuracy. A capacitor rated 100uF +/-10% may measure anywhere from 90uF to 110uF, shifting resonant frequency and peak Gauss output accordingly.

### Total Stimulation Intensity

A cumulative dose metric that captures how much stimulation a PEMF device delivers to tissue each second, counting both the rising and falling edges of every pulse. Because the body responds to field change, each pulse delivers two induction events - one as the field rises, one as it falls - so Total Stimulation Intensity adds them up and multiplies by how often the pulse fires. Calculated as (rise slew + fall slew) x frequency, expressed in G/ $\mu$ s·Hz; higher values mean more cumulative biological stimulus per second. Distinct from Peak dB/dt, which measures the single sharpest moment within one pulse.

### Triangle Wave

A waveform with linear rising and falling edges that form a symmetrical triangle shape. Triangle waves produce a constant rate of field change during each edge, resulting in a steady induced stimulus throughout the rise and fall rather than the burst at the transition that square waves produce. Slew rate is moderate - faster than sine waves but slower than square waves at the same peak Gauss and frequency. Triangle waveforms are sometimes used in devices designed for steady, even stimulation across the full pulse cycle.

### Waveform Type

The shape of the electromagnetic pulse produced by a PEMF device, which influences how energy is delivered to tissue. Knowing the waveform type helps compare devices and predict therapeutic behavior -- square waves deliver sustained peak energy, while triangle and sawtooth waves emphasize rate-of-change effects.

Classification criteria: Square has a flat top >40% of the pulse with edge fraction <30%; Triangle has flat top <15% with near-symmetric rise/fall ratio (0.6-1.7) and linear edges ( $R^2 > 0.85$ ); Sawtooth has strongly asymmetric rise/fall -- either flat top <15% with linear edges and ratio <0.3 or >3.0, or extreme asymmetry with ratio <0.15 or >7.0 regardless of flat top or edge shape (captures capacitor-discharge / impulse pulses with sharp spike and exponential recovery, where the broad peak briefly holds near max before decaying); Sine is the default for smooth curved edges not matching other criteria.