

THE EM BRACE

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ABSTRACT

The vast majority of work in the field of human-computer interaction has involved programming computers to better sense and understand our inputs, yet little work has been done in terms of how we humans can better sense and understand computers. Computers, and electronics in general, reach out to us by creating low frequency electromagnetic fields. These ubiquitous frequencies penetrate and permeate our bodies at the molecular level, so spatially intimate experiences with electronics can be understood as a merging of physical bodies with their electromagnetic embrace. As we humans have no natural means of sensing these frequencies, the "EM brace" provides a way to physically engage with these frequencies by combining two of our natural senses, touch and hearing. As a device for exploring and navigating these hidden "hertzian" spaces, the EM Brace accentuates the boundlessness of the quantum levels at which this microscopic merging takes place, while simultaneously situating the body in relation to consumer and communication technologies. Furthermore, the EM Brace embodies the ineluctable direction of human evolution towards the post-human, an evolution that can be understood in terms of a Deleuzoguattarian becoming, specifically a *becoming-electronic*.

Keywords

electromagnetic spectrum, consumer electronics, communication technologies, sound art, post-humanism, hertzian space, Deleuze & Guattari, David Cronenberg

INTRODUCTION

The EM Brace is a wearable device for physically engaging with ambient electromagnetic radiation emitted by consumer electronics and electrical systems in general. The goal of this project is to make palpable and audible the hidden the invisible electromagnetic frequencies permeating everyday being, the same frequencies which provide the main transmission medium for radio, SMS text messaging, visible light, wireless internet connections and which radiate outwardly from any object with an active electrical current. Electrical circuitry emits electromagnetic radiation in the Extremely Low Frequency (ELF) range, roughly those fields below 3kHz¹ (See figure 1). Before the widespread use of electricity, the most abundant source of

ELF fields were the results of natural occurring phenomena like lightning (references). Since the advent of alternating current and the long-distance use of electricity, however, we have steadily surrounded ourselves with a dense latticework of electronic circuitry in the form of power lines, in-wall wiring, radio transmissions, underground subway lines, and consumer electronics, among other things. Ubiquitous ELF fields are natural a byproduct of electrical environment, and the effects of this saturation on our contemporary bodies produces bodies different those of our non-electric ancestors.

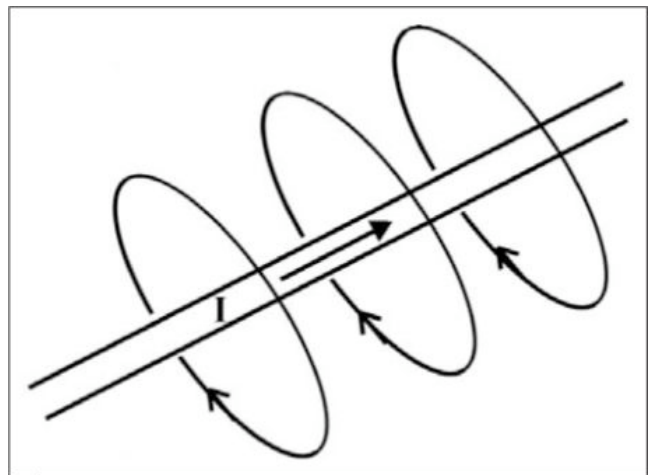


Fig 1. EM field of an electric current (courtesy Schmidt)

On the microscopic scale of the electromagnetic spectrum, our physical bodies are highly porous and allow the particles that make up the spectrum, photons, to freely pass and commingle with the atoms constituting our bodies. This electromagnetic interaction has been of great interests to researchers wary of the negative effects the fields might have on the human body, such as DNA breakage, disruptions of the central nervous system, and cellular defects that could lead to cancer.² Though no hard evidence for negative or malignant consequences due to "average" exposure to this low-frequency radiation has been proven, interaction with these frequencies does induce a small voltage within the body that is conducted by the electrolytic content of living tissue.³ Electrical flows in the body are not unnatural, as our nervous system relies on electrochemical reactions to transmit signals via neurons, but this process is different than the electrical charges

created by EM fields in that the messages routed by our nervous are not related to the movement of electrons, as with electricity. Thus, bodies within EM fields undergo a microscopic merging with their electromagnetic surroundings, and this merging produces an electrical current that circulates through the body. Given this phenomenon, the body can be understood as a site of an electronic coupling, or energy transference, when in the presence of electromagnetic radiation⁴ (See figure 2).

I see this electric coupling resulting from our interactions with these fields as a crucial, yet under-recognized, phenomenon in theorizing the body in contemporary technological culture. This coupling means that human interaction with electronic objects literally produces a "body electric", a fact with vast implications in understanding of our relationships with electronic objects and the electronic world that we've created. Our electronic environment produces human bodies internally mirroring their electronic counterparts, be it cell phones, mp3 players or laptops, as, when joined, both become vessels for internally flowing electrical currents. This electromagnetic embrace forces us to reconsider how we define our physical selves by creating a point of indeterminacy in which the boundary between human and electronic object ceases to exist. For at our most fundamental structural level, we are no longer simply humans but assemblages of human atoms and electromagnetic photons.

On *Becoming-Electronic*

This molecular merging very literally embodies the idea of *becoming* as put forth by Gilles Deleuze and Felix Guattari in *A Thousand Plateaus*. For Deleuze and Guattari, becoming lies in opposition to the stability and unity found in the idea of simply "being". Becoming, rather, is ontology of differences and affirmation. It asserts that all that exists does so in a state of change, and the nature of existence is best expressed through artistic endeavors, as creativity involves an awareness of unusual or novel connections, possibilities, transformations, and indeterminacies. Static notions implicit in ideas such as identity or meaning are illusory because existence can only be evaluated in terms of the continual production of differences over the flux of time.

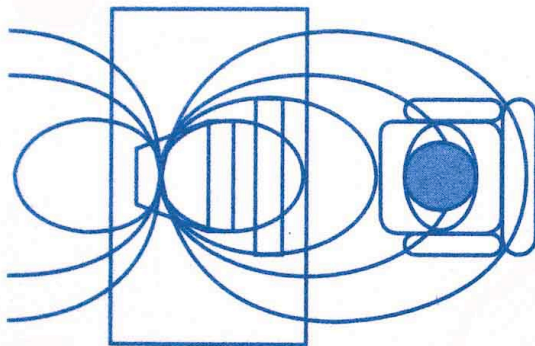


Fig 2. EM field of computer monitor (Courtesy Habash)

Becoming can take many forms depending on the types of forces influencing and affecting the process. These forces are infinite and many-sided, and thus there are many potential types of becoming. Bodies, whether people or objects, can be understood as the trajectory of symbolic and material forces that shape and affect them in their individual history and within their larger historical context. Deleuze and Guattari liken these forces to particles in that they are small elements composing larger process which, in turn, come to define the body. All bodies, then, are composed of a multiplicity of becomings.

The interaction of bodies is the intersection of their multiple becomings and results in the production of new affects and differences which continue each body's process of becoming. The EM Brace embodies the process of *becoming-electronic* for the wearer of the device, as it accentuates the forces and affects composing the interaction between human body and electronic object. Deleuze and Guattari state that:

... all becomings are already molecular. That is because becoming is not to imitate or identify with something or someone. . . . Becoming is to emit particles that take on certain relations of movement and rest because they enter a particular zone of proximity.⁵

These particles can be understood both literally and metaphorically for illuminating the process of *becoming-electronic*. Literally, this passage refers to the intermingling of particles occurring when bodies enter the proximity of electromagnetic fields resulting in the creation of a bodies composed of both atoms and photons with a newfound electrical current traversing its tissue. Metaphorically, this exchange of particles embodies the movement of human evolution towards the post-human, that is, the production of bodies which are no longer purely human in the historical sense (in the process of becoming, though, the "purely human" never existed in the first place). Interaction, then, can be considered an act of hybridization between human and computer in that we take on new qualities influenced and shaped by the technologies with which we interact, resulting in human bodies marked by traces and affects that, in turn, initiate new becomings.

THE EM BRACE

The electromagnetic spaces in which this bodily reformation is happening may be imperceptible, but they are indeed real and, at the smallest level, very physical. Designer and theories Anthony Dunne has termed the electromagnetic fields around consumer electronics "hertzian space".⁶ The EM Brace is a device for the exploration of this particular space, and in the process accentuates the *becoming-electronic* described above. The EM Brace attunes our bodies to the presence of electromagnetic radiation through the combination of touch and hearing. The device transforms electronically emitted ELF signals into low-frequency audio waves that are used to vibrate the body via a homemade amplifier and special speaker mounted within an wearable metallic enclosure.

The ELF signals are picked up by four inductive coils embedded within a pair of gloves that are wired to the enclosure. These coils work as electromagnetic antennas due to the same process through which a current is created in the human body when in presence of EM radiation: the production of a coupling through induction. The voltage created in the coils by EM fields is amplified by an internal pre-amplifier and amplifier circuit within the enclosure and outputted as low frequency sound directly into the wearer's back and body through a "bass shaker" speaker, a type of tactile transducer that only outputs low-frequency sound waves.

Tactile transducers are a type of audio speaker that transmits sound primarily through physical material rather than the air, as with common, coned speakers. Tactile transducers are directly fixed to objects and use that object as the medium for transmitting audio signals sent through the transducer. The object vibrates and resonates at the frequencies corresponding to these signals, and this process subjects the object to which it is affixed to a process of *becoming-speaker*, as the object gains new ontological meaning as a medium for sound.

In the case of the EM Brace, the sonic frequencies emitted by the device's internal tactile transducer correspond the ELF frequencies picked up by the antenna coils, and these frequencies are what vibrate the device as a whole. The enclosure containing the tactile transducer is secured to the wearer by four, 2" thick webbing straps that wrap around the chest and over the shoulders and connect to a four-point harness on the chest (see figures 3 & 4). The process of physically diffusing these frequency signals through the body is aided by four metal "arms" which wrap around the wearer's trunk. These arms are attached to the webbing straps so that they may be pulled tightly around the wearer's body in order to better experience the vibration of the device.



Fig 3. EM Brace front harness and metal arms

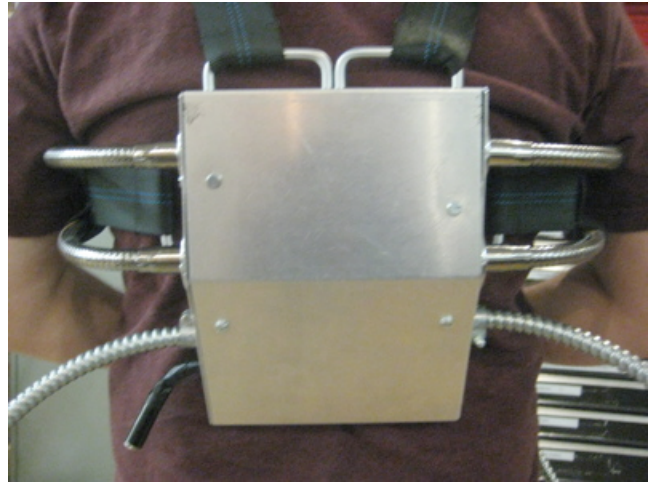


Fig 4. EM Brace rear enclosure and metal arms

I have deemed the EM Brace a brace for two reasons. First, the EM brace physically binds its wearer to electromagnetic emissions through making impalpable radiation into a tangible force. Second, it provides support for the wearer in the process of *becoming-electronic* by formalizing the dissolution of physical boundaries between "selves" and electronics. Sensing this transformation provides the wearer with not only a foundation for physically engaging with *becoming-electronic*, but also a psychological foundation as well. The human mind largely makes sense of itself, its body, and its environment through empirical processes, and thus it can be difficult to recognize bodily transformations occurring on levels that aren't directly experiential. The effects of electromagnetic radiation and the resulting *becoming-electronic* occur with or without the EM Brace, but making these hidden process and affects tangible provides a powerful access point for appreciating and coming to terms with these processes.

Design

I see the EM Brace as a means of coming to terms with my fascination with what Steven Shaviro calls the "allure of techno-metamorphosis" as found in the films of David Cronenberg, specifically the film *Videodrome* (1983).⁷ Cronenberg's films, like *Videodrome*, *Crash* (1996) and *The Fly* (1986), approach the "techno-metamorphosis" of the body through extremely physical and excessively violent means in order to literalize our latent desires and fears in light of technology. But rather than exaggerating this allure by creating media-playing orifices or biomechanical organs as does Cronenberg, with the EM Brace I wanted to subtly accentuate the "techno-metamorphoses" actually occurring to all users of consumer electronics while retaining the visceral metaphorical power embodied in Cronenberg's designs.

Using Cronenberg as an inspiration, I've settled on a design aesthetic that incorporates an industrial, utilitarian look partly inspired by cosmonaut suits. With this design, I'm presenting the EM Brace as a "space suit" of sorts, but one for *hertz*anauts as opposed to *cosmonauts*, for exploring and navigating the hidden hertzian dimensions all around us. I see the two pairs of metal arms as the strongest link to the Cronenbergian "techno-

metamorphosis" in that these arms closely resemble the fusion of flesh and metal that is Max Renn's handgun in *Videodrome* (See figure 5).



Fig 5. Max Renn's Hand/Gun in *Videodrome*

The ritual of wearing the EM Brace recalls wearing any wieldy and intricate apparatus allowing its user to explore normally inaccessible spaces, like scuba gear, diving bells, and mountain climbing harnesses. The process of putting on the device is intentionally physical and lengthy, and requires the assistance of another person to compensate for the device's weight so the wearer can securely fit the device onto their body. While user testing the EM Brace, many wearers described the process of putting on the device akin to buckling in to a roller coaster or racecar. This is a desirable effect, as wearing the device should elicit the feeling of preparation for drastic sensorial changes.

Since the EM Brace targets ELF fields created by consumer electronics, I put the antenna coils in a pair of gloves since the majority of our interaction with these electronics involves the hands, as with holding, typing, dialing etc. This placement also plays into the exploratory nature of the device by allowing the user to blindly reach out, as if in the dark, towards electronic objects in search of different frequencies providing new vibrational and sonic experiences. This reaching out also plays into the device's titular wordplay, as the interaction produced by the EM Brace is a form of embrace between human and electronic object. This embrace is also accentuated by the arms that wrap around the wearer's body. Furthermore, many of the materials used to fabricate the EM Brace are used in industrial electronic wiring systems, giving the device a look that signifies it is just as much *about* our uses of electricity and electricity itself as it is about discovering the hidden spaces created by electricity.

User Scenario

Ideally, the user of the EM Brace will move about, arms outstretched, freely discovering the powerful and dense fields of electromagnetic waves that permeate our electrically networked environment. Outdoors, urban environments provide a richer vibratory experience than rural areas as the dense network of electrically driven materials that compose a city offer a symphony of electromagnetic frequencies. Indoors, transformers that turn AC current into DC current, as with the external adapters for laptop computers, provide a rich source of vibrational electromagnetic fields. Within a

few minutes of using the EM Brace, wearers begin an ecstatic search for these different frequencies and sensations by carefully, yet emphatically, moving their hands across electronic devices and their power sources. This probing transforms the device and wearer into a vehicle for cinematic and performance narratives, as the device turns its wearer into a hunter of hertzian spaces whose body is activated and mobilized by the search process. For nearby viewers, this performance produces a complex visual narrative of curious and novel interactions between the wearer and nearby electronics. Having the antennas embedded in the gloves circumscribes a choreography for the wearer dominated by hand and arm movements and gestures usually associated with mystical acts like conjuring or divining. The fact that the EM Brace is a large, metallic electrical device wrapped around the wearer that looks like an electronic bodily extension further exaggerates the idea that some arcane exchange or act of communication between its wearer and surrounding electronic devices.

BACKGROUND AND WORKING METHOD

This project has evolved by tracing out an avenue of inquiry into the relationships between sound, materiality, and networked communications technology. The entire project began as a sound installation involving the use of networked controlled tactile transducers to resonate objects, like cymbals and other metallic percussion instruments, in a manner similar to David Tudor's *Rainforest* series. I wanted to create an in-gallery, durational sound performance/installation whose execution would be idiomatic to the internet/network as instrument. The tactile transducers were introduced into the project to explore the idea of *resonance* as a means to understand objects in a different manner by giving them new meanings as resonating, sonic bodies. This led me to research experiments in the field of sound and materiality, particularly those found in the field of cymatics involving the use of chladini plates. An artist who had done considerable work in this field was Alvin Lucier, particularly with his piece "Queen of the South," which utilized surfaces responsive to sound to organize various materials into these patterns naturally occurring resonance patterns produced by shifting audio frequencies.

In Walks The Body

I never found a form for the installation with which I was satisfied, but maintained my interest in sound and materiality. After a little internal digging, I realized that I wanted to start making works that forefront the human body while still involving the above concepts. With this, I began to move away from the idea of resonating inanimate objects solely and towards using sound to resonate the body. My own personal history is one of intense bodily engagement, highlighted with numerous surgeries, illnesses, and hospital stays. These periods of bodily discomfort left an extra sensitive psychological awareness of my own corporeality, and this history is beginning to materialize in my art practice.

Bringing this sensitivity into a project exploring sound

and materiality led me to reconsider the idea of listening. Sound waves are, obviously, most frequently experienced through the process of listening with the ears. But bodies can have a more visceral experience of sound when encountering low frequency sound waves. Whereas our perception of the EM spectrum results from photons received by our senses, sound is the result of changes in air pressure that make particles vibrate and collide with one another like balls on a pool table. I began to think of sound as result of numerous collisions on the molecular level, and that these collisions form a chain extending from the body of the sound's producer to the body of the receiver. In this sense, listening is the creation of a particle bridge between bodies, an architectural formation dissolving boundaries and linking ourselves to the sound-making objects around us. This idea of hearing as "particle-bridge" between bodies later developed into the idea of interaction as intersecting bodily becoming as described above.

A Theory of Listening

With this theory of listening I had a foundation for thinking about sound and the body, and I turned my thoughts towards incorporating networked technologies into this idea. I found a quote from Brandon Labelle that perfectly tied my theory into networked and digital communication technologies:

I want to suggest that listening, and by extension understandings of sound, can lend itself to a recognizing of digital media: that the operations of sound, as media and phenomena, may converse with questions of telecommunications, digital networks, and by extension, the contemporary conditions of the digital age Such a description inevitably hopes that what we may recognize, in the incoming and outgoing flux of emails, SMS messages, Web-casting, satellite monitoring, hacking, and the like, a complex act of communication we might call a "listening that inhabits" . . . one that is active out there, as a process of finding home, making connections, creating space across digital networks – a listening that builds architectures out of interaction.⁸

Labelle's thoughts provided a solid theoretical link integrating networks into my idea of listening as the creation of physical linkage between producer and receiver. Labelle's "listening that inhabits" is an approach to sound and sound-making that produces a space for critically thinking about both personal and cultural relationships with technology. I wanted to listen to the flux of messages Labelle writes about as a means to inhabit the spaces created by networked communication technologies.

Whereas I was thinking of the project's networked component strictly in terms of the internet, I broadened my scope to consider different facets of technological networks, in particular the medium through which wireless networks transfer messages: the electromagnetic spectrum. Focusing on this spectrum, which encompass the predominant modes of network communication, allowed for a sort of meta-critique on these technologies. The more I considered

the spectrum, the more I became interested in both the messages we send through the spectrum and the noises and excess our technologies create within the electromagnetic spectrum.

With this realization, I entered the world of ELF emissions in search of meaning within the ambient waste and byproducts of technology. My biggest artistic influence at this point was Christina Kubisch, specifically her "Electrical Walks," in which she created headphones that turned VLF signals into sound and organized a series of headphone walks for discovering the hidden electromagnetic spaces in various cities, provided a substantial jumping off point for the EM Brace. As a device that channels physical sounds created by the use of electronic and communications networks into the human body as a means to illuminate our interactions with technology, the EM Brace is the culmination of this line of inquiry.

CONCLUSION

I see the EM brace as part of a larger artistic inquiry into the relationship between bodies and technology, perhaps as the inaugural device of a series of functional art objects dealing with the "techno-metamorphosis" of the body. I call them "functional art objects" in that these objects would be suited for both the gallery space and for use in the real world. In this sense, I see these objects closely aligned to Anthony Dunne and Fiona Raby's "critical design" aesthetic, a critical art that masquerades as industrial design. Critical design entails creating products or objects whose interaction, echoing Labelle's "listening that inhabits," calls forth a "looking beyond the quality of our relationships with objects themselves to the aesthetics of the social, psychological, and cultural experiences they mediate" (SITE).

Critically design objects produce an interaction that forces the user to reflect on the cultural issues surrounding the production or existence of the object itself. Their functionality is often oblique the sense that its use undermines normative designs producing "commodity as utility" to instead produce a "product" embodying or provoking questions of larger cultural practices. Like the EM Brace, many critically designed objects "explore the links between the material and immaterial that lead to new aesthetic possibilities for life in an electromagnetic environment," such as the Faraday Chair, which allows users to rest on a couch encased within an electromagnetically protected space.⁹

User Testing

The EM Brace presents new aesthetic possibilities through the production of novel interactions between ourselves and our electromagnetic objects, though users of the device don't always initially know why the device works and what is actually happening while the device is in use. What's more, some people are hesitant to put on the device because they describe it as "evil looking" or are afraid of putting on a metal box with an electrical current passing through it for fear of shock. Others, however, approach strapping in to device with eagerness. Almost all who've gazed upon the

brace do so in curiosity, and the majority of viewers at least inquire as to what the device is and does.

First time users always need some explanation of how to use the device and what exactly is occurring. Once initiated, users almost always remark that they have a greater awareness of electromagnetic fields and are surprised by their strength and ubiquity among common electronic devices. Most users state that they had a vague idea about ambient electromagnetic radiation from electronics, usually from receiving cell phone calls near speakers, but are generally unaware of how these fields permeate our body and even less aware of the coupling produced by the interaction between bodies and electronics.

Users and viewers almost always notice the choreographic and performance aspects of the device, which helps to turn heads and arouse questions from passers-by, but rarely apparent are the conceptual details behind the EM Brace, such as the molecular transformation *becoming-electronic*. Many users described a "phantom limb" effect after removing the EM Brace, saying that their bodies had gotten used to the added weight. Similarly, users said that they could still feel the device's vibrational effects, which were often described as soothing and reminded them of a massaging chair. Furthermore, most users say that after wearing the device they have a greater awareness of electromagnetic fields and that they think differently about interacting with technology.

On Process and Future Work

Conceptualizing, designing and implementing the EM Brace forced me to synthesize a number of influences into a physical result, and the overall process was invaluable in terms of creating a framework for how to make future "functional art objects." Designing the device was the most challenging aspect of its creation, and I've little experience in visual design. Incorporating cinematic influences, like Cronenberg's films, into my design process has opened up rewarding design possibilities, and future design will mine science fiction and horror films for

alternative, subversive or transgressive depictions of the body in relation to technology .

Designing "cinematic objects" necessitates sculpting a narrative around the making of an object. Since my background is the study of literature, narrativizing the EM Brace proved a natural and productive process. I wrote a short fiction piece involving the EM Brace as a means to plan out user scenarios and further conceptualize the device (see Appendix B). Future object will almost certainly be fictionalized during their process of creation, whether through a short story or an accompanying script for a fictional movie involving the device. Furthermore, I plan to continue working with sound, materiality, and networks as the raw basis for future projects, and will continue to extend my ideas of materiality to encompass the human body.

ACKNOWLEDGMENTS

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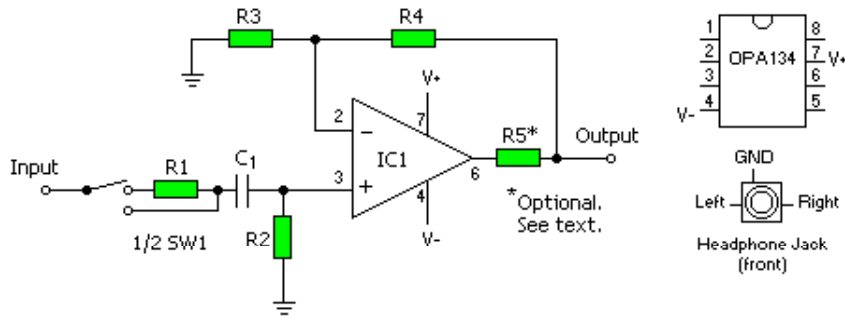
APPENDIX A: Technological Index

Amplification Circuit Parts Listing

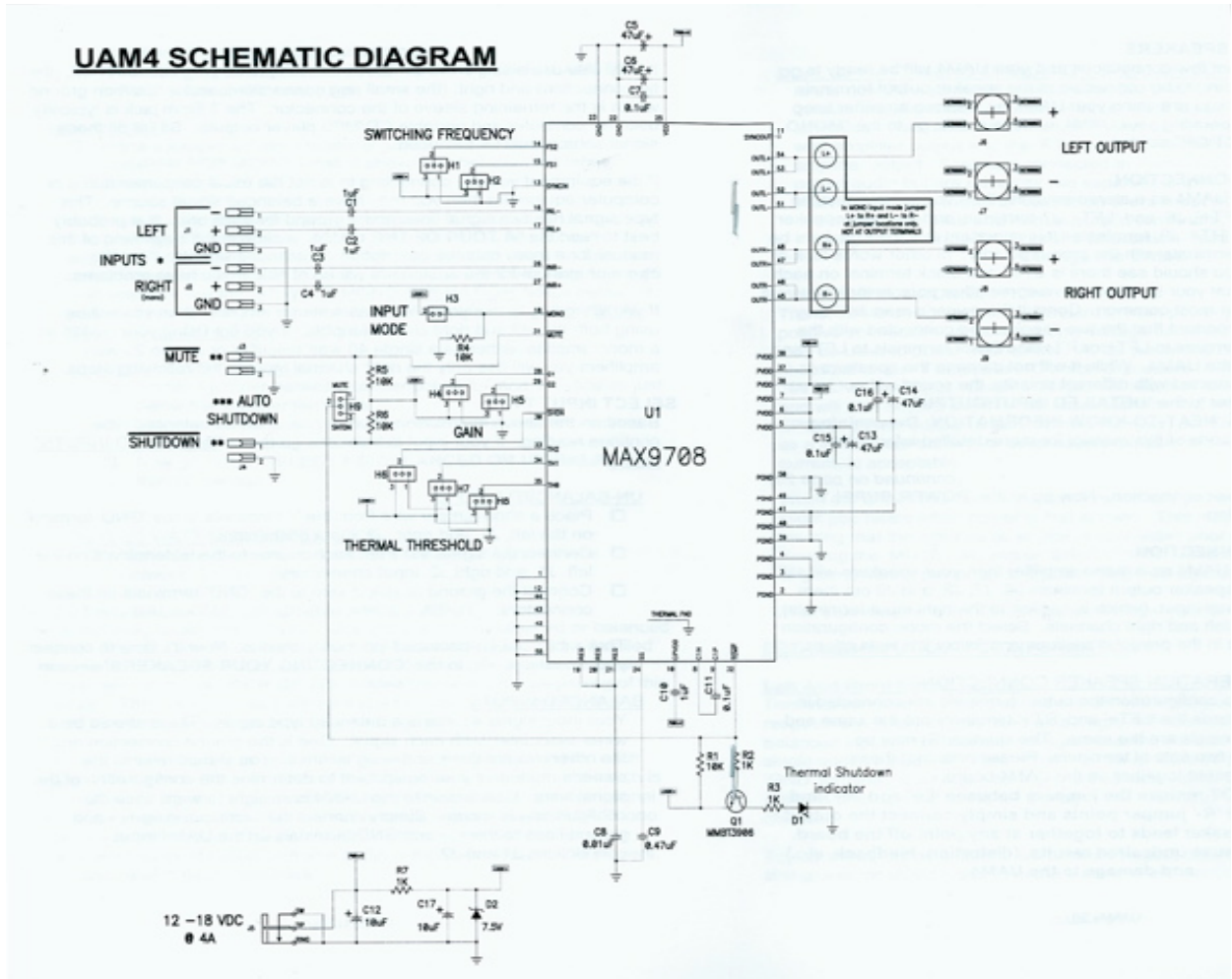
- Aura AST-1B-4 “bass shaker” tactile transducer
- Preampfier circuit based on OPA134 IC chip
- UAM4 40 watt sub-miniature speaker system

Preamplifier Schematic*

*This schematic utilizes one OPA134 chip, whereas the EM Brace’s circuit utilizes two. More information can be found on the sites listed in the bibliography section.



- | | |
|--|---|
| C1 - 0.1uF, 100V capacitor | R4 - 10K ohms, 1/4W resistor |
| IC1 - Burr-Brown OPA134PA-ND opamp | R5 - 50-100 ohms, 1/4W resistor (see text) |
| R1 - 100K to 470K ohms, 1/4W resistor | SW1 - DPDT micro-mini switch (RS 275-626) |
| R2 - 100K ohms, 1/4W resistor resistor | All resistors are metal film. |
| R3 - 1K ohms, 1/4W resistor | All capacitors are film types, such as polypropylene. |



APPENDIX B

The EM Brace: A Fiction

For Stanislaw Lem

The discovery of the patterns was accidental. Somebody simply left the EM Brace on overnight, and it sat there for hours recording everything it picked up. When we discovered what happened, we unloaded the data just to see how much stuff the device managed to record. At first it looked like hours and hours of junk, I mean there were some nice signals in there, but for the most part it looked like nothing. Empty. And right when we were gonna scrap everything, fate stepped in once again and I noticed that at 6 hours the whole signal repeated. Bit by bit, one hundred percent. And since the computer was sitting in the EM shielded room, the closest thing to an electrical void next to a underground cave, and that the patterns met no known processes or signal patterns in the computer's internal hardware, I knew that this was something strange. Something special. A message.

Needless to say, not everyone was convinced. We decided to test it once more, this time with someone wearing the EM Brace to see if the signal had any extra "vibrational" data, or whatever that means. I volunteered. My assistant, Dr. Cornelius, helped me put the Brace on. Grabbing the device by the handles, he picked up the Brace and held it to my back. I pulled over the shoulder snaps and connected them to the center harness on my chest. Cornelius held the brace still while I pulled the side straps and those weird metal arms around my ribcage and connected them to the center harness. Pulling the straps tight, I could feel its weight secure on my body. The Brace's arms enveloped me like some mechanical insect. Cornelius let go, and I grabbed the tubing connected to the antenna gloves and slipped them onto my hands. I gave Cornelius the thumbs

up. He flipped the switch, and the machine's low hum began its streaming pulse on my back.

Arms outstretched, I approached the computer in question. The EMbrace started vibrating sooner than usual...the computer's EM field had expanded and grown stronger since yesterday. When I was within six feet of the computer, the EMbrace's vibrations became powerful enough to flow past my back and resonated deep into my legs and neck. The EMbrace was a curious, if somewhat intimidating, device. Wearing it makes me feel like some sort of space explorer. But on Earth. Or on land. But exploring the hidden spaces right before us. The invisible, noisy dimensions created by electrical circulations. McLuhan says the light bulb is pure information, so I guess the EM invisibly permeating in and around us can be considered the excess, the waste, of information flows. But what does it mean when this waste has a pattern, when within the excess awaits a messages for us to unpack. Can negative meaning still be meaningful? Who knows, but as I approached the computer the EM Brace's vibrations became eerily regular, its pulses grew quicker. I had never experienced much signal repetition like this while wearing the brace, much less of this magnitude. I felt the vibrational circles emanating from the device and flowing through my body. I became pale, sweaty. My outstretched hands began to feel slippery in the leather gloves of the brace. There was something to this. Something was happening to me. I was beginning to understand something. The computer was communicating. It was reaching out to me.