Agnew Analog Reference Instruments

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Application Note 8001

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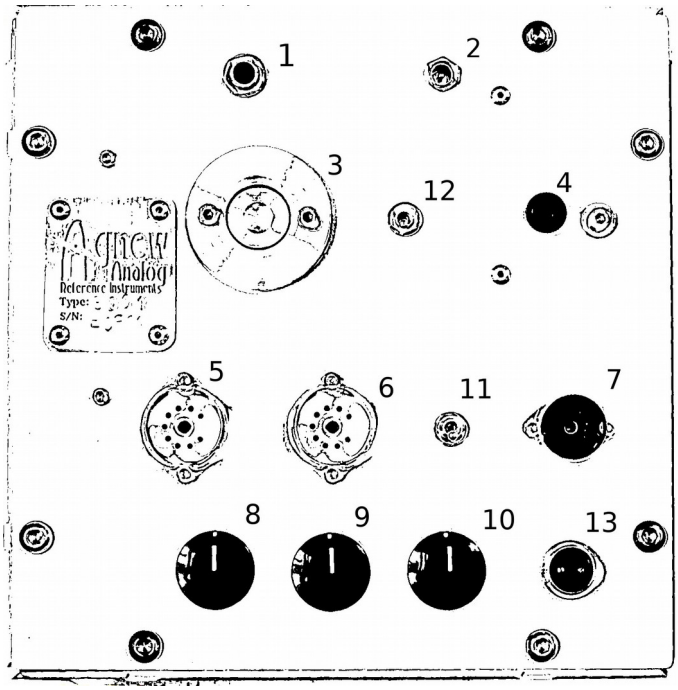
Subject: Agnew Analog Reference Instrument Type 8001

Description:
The Agnew Analog Reference Instrument Type 8001 is a unique vacuum tube electrochemical synthesizer.
It consists of an electrochemical reactor cell, in which a reaction takes place. The voltage variations occuring during the course of the reaction are amplified by the vacuum tube circuits as audio signals. An inductor filter allows the operator to shape the sound, while internal positive feedback loops can be utilized to further enhance the mood.

For maximum effect, we recommend using together with optional accessory Type 8001-C36/5: Electrochemical Synthesizer Appreciation Chair.
These come with straps to restrain the audience for maximum appreciation and attentiveness. The Type 8001-C72/4 accessory could also be used to administer electric shocks to heighten the sensation of the music during the crescendo.

Application:
The Type 8001 was primarily developed for use in underground noise festivals in eastern European countries. However, it can also be adapted for use in the aerospace and defense sectors, the automotive industry, nuclear submarine reactor control modules and in virology research institutes for the control of accidental outbreaks prior to reaching the pandemic scale.

Layout:



1) Audio Output (TRS 1/4” Jack Socket)
2) LT Power Supply Input (12 VDC/1A Tip +)
3) Reactor Cell
4) Ground Connector (Banana Socket)
5) Output Tube (General Electric 6201)
6) Input Tube (General Electric 6201)
7) Regulator Tube (Sylvania 0A2WA)
8) Output Level Control
9) Filter Control
10) Feedback Control
11) Feedback Switch
12) Reactor Cell Current Switch
13) HT Power Supply Input (280 VDC/50 mA)

Setting Up and Shutting Down

1) Install the tubes in their correct socket. The input and output tubes are identical types, NOS General Electric 6201, from military surplus. These are equivalent to the more common civillian12AT7 and ECC81 types, which can also be used in these sockets. The input and output tubes have been selected for best performance in each position, as marked on their boxes. They can be safely used in either position with no risk of damage and no adjustment needed. The input and output tubes have 9-pin sockets. The regulator tube is an NOS Sylvania 0A2WA, also from military surplus. This goes in the 7-pin socket.

2) Install the tube shields over the tubes, if required. The silver shields should be used for the input and output tubes only. Observe the bayonet-type fitting. Push them over the tube and

twist to lock in position. The silver shields are not essential and do not affect performance. They can be left out if you prefer to look at the glowing tubes. They do, however, provide some protection against stains on the tubes caused by flying droplets of electrolyte from the reactor cell (or from the operator and the ecstatic audience).
The black shield is intended for the regulator tube and does not have a bayonet fitting. Just slide over the tube. While the black shield is not absolutely essential, it is highly recommend to use it when operating this unit for longer periods of time, because it functions as a heat sink and will extend the useful life of the tube.

3) Connect the audio connector to the unit. This can either be a balanced TRS 1/4” jack plug, driving a 600 Ohm line, or an unbalanced TS 1/4” jack plug driving a low or high impedance input (preamp or guitar amp).

4) Connect the LT Power Supply to the unit, ensuring that the polarity is correct (tip positive, sleeve negative). Power up the LT supply. The filaments of the two 6201 tubes will light up.

5) If an electrolyte is to be used in the galvanic cell, now is the time to put it in place.

6) Connect the required electrode to the ground connector, for use in the reactor cell.

7) Connect the HT Power Supply Unit (make sure it is not plugged in to the mains power!) and lock the connector using the threaded collar.

8) Ensure that the tube filaments are lit up and that the Output Level Control is fully CCW. Plug in the HT Power Supply to mains power (230 VAC, 50/60 Hz, 50 mA) to power it up. The regulator tube will also light up after a few seconds.
CAUTION: Do not disconnect the HT Power Supply connector from the Type 8001 under any circumstances while the HT Power Supply Unit is connected to mains power! Do not disconnect or power off the LT Power Supply unit either! The HT supply should never be energized without the LT supply.
Failure to observe this warning could result in premature tube failure. To obtain maximum tube lifetime, please wait 60 seconds after powering up the LT supply, before applying HT!

9) Set the level control as required for the particular setup you are using.
CAUTION: The maximum output level under certain settings could severely overload and even damage wimpy solid-state junk designed by persons of weak moral fiber. On the other hand, it is probably for the better if it does.

10) Make extreme sounds while maintaining a very serious and calm expression, as if you are deeply relaxed and nothing’s happening.

11) When everyone has left, which most probably won’t take long, first unplug the HT Power Supply Unit from the mains. Wait 1-2 minutes and then unplug the LT Power Supply Unit.

12) With all power off, you can proceed to disconnect everything. Leave the tubes last. Make certain that the tubes and shields are allowed to cool down until they are easily comfortable to touch, before attempting to remove them. The cooler, the better.

13) Clean out the reactor cell with a paper towel or similar, soaked in alcohol (if you can ever find any again). Isopropyl alcohol is better than ethanol (for cleaning, not for drinking!).

14) On your way out, announce “I’ll be back next week!” to really finish the job properly.

Theory of Operation

The heart of the electrochemical synthesizer is the reactor cell. This is an electrolytic cell, in which an electrical current is passed through an electrolyte by means of two electrodes, the anode and the cathode.

The anode is the positive electrode, through which the electrons leave the system. It is made of an aluminum alloy and is actually the bowl of the reactor cell, where the electrolyte is placed. Careful observation will reveal that the anode is electrically insulated from the shield around it and the chassis. The electrolyte level must therefore never be allowed to reach the insulator, or worse, the shield. A couple of drops of electrolyte are adequate.

The cathode is the negative electrode, through which electrons enter the system. Electrons flow from cathode to anode, but conventional current is said to flow from anode to cathode. Doctors still insist on expressing their medical terminology in an obscure combination of Ancient Greek and Latin, both obsolete languages (and entirely unrelated to each other), to lend an air of medieval mystique to their art, so us engineers decided on opposite directions of current and electron flow, as an insider joke.

In the Type 8001, an exchangeable cathode is used, at ground potential, connected to the Banana socket. A copper electrode is supplied as standard, fitted to a Banana plug.
The operator is encouraged to try different cathode materials. These can be easily made by obtaining the desired material in wire form and attaching it to a Banana plug, bending it as required, to make contact with the electrolyte but not the anode.

It may be of interest to consider the position of some electrode materials in the galvanic series:

From Anodic to Cathodic:
Magnesium
Aluminum
Steel
Lead-Tin solder wire
Lead
Tin
Copper
Silver
Graphite
Gold
Platinum

The electrolyte can be any electrically conductive substance, usually in liquid form. The original definition stipulates that the conductivity of an electrolyte is due to the dissociation of the substance into ions, when in solution or when molten.

In practice, Sodium Chloride (salt) dissolved in water, sea water, acetic acid (vinegar), citric acid (lemon juice) and a variety of other electrolytes produce excellent results. Even plain tap water will work.

The chemical reaction typically begins when the current is applied, by means of the Reactor Cell Current Switch. The reactor cell is a low-voltage, high-current system.

The anode is brought to an elevated potential of up to 12 VDC, but is current-limited at 370 mA, by adjusting the voltage, as required to maintain 370 mA of current flowing through the electrolyte. The current regulator circuit can supply 370 mA into a short-circuit for several hours without damage, so accidental shorting between the anode and cathode is not an issue. The conductivity of the electrolyte is therefore also not critical and experimentation is encouraged.

While current is flowing, an electrolytic process takes place, which results in Hydrogen and Oxygen being released as gases, potentially in addition to other substances, depending on what electrolyte and electrode materials are used. Hydrogen and Oxygen will combine to form Oxyhydrogen, a combustible gas once commonly used for welding, so better avoid smoking when using the Type 8001.

The electrolysis of water results in a stoichiometric mixture of Hydrogen (H_2) and Oxygen (O_2), through the dissociation of two water molecules (H_2O) into two Hydrogen molecules and one Oxygen molecule: $2\ H_2O(l) \rightarrow 2\ H_2(g) + O_2(g)$

Small amounts of potentially toxic gases could be produced if you go too crazy with exotic electrolytes and electrodes, so it is advisable to read up on the potential chemical reactions you are about to induce, prior to being considered for a Darwin Award.

For health and safety reasons, the Type 8001 should be used in well-ventilated spaces. When acids are used as electrolytes, they will release some some vapor due to the temperature increase in the cell, which may cause mild eye and respiratory irritation. Sodium Chloride solutions are therefore safer in smaller or less well-ventilated spaces. Sodium Chloride in particular reacts with the aluminum anode, even without the application of cell current, producing an interesting audible effect at a low signal level.

Chemical reactions will result in layers of oxides on the electrode surfaces, eventually reducing their efficiency. Such layers can be removed with sandpaper or a small rotary wire-brush on a mini-drill. The anode is a thick slab of metal so it should last a long time.

The electrical impulses created during the course of the chemical reaction are amplified by the vacuum tube electronics and are presented at the output as sound.

The 6201 vacuum tube at the input takes care of amplification, filtering and feedback. The output stage uses the second 6201 as a line driver, transformer-coupled to allow a true balanced, low impedance output, which can be safely connected to unbalanced equipment with no signal loss. The 0A2 tube provides a regulated supply for the 6201 tubes.

While the 6201 are double-triode vacuum tubes, the 0A2 is a gas-filled regulator tube. It mainly contains Argon and Neon, harmless inert gases. It is rumored to also contain minute amounts of more exciting substances, so whatever you do, do not break this tube!
Should the glass envelope ever break, hold your breath and get out of there before you start glowing in the dark like the tube did. Nobody knows for sure what is in it (information kept secret by the manufacturer), but the physics of its operation hint towards “you really don’t want to find out”.
Look at it this way: While the glass is intact, it is perfectly safe.
So make sure it stays that way, or the media will blame it on Russian secret agents again.

Specifications

Maximum Cell Voltage:	12 VDC
Maximum Cell Current:	370 mA
LT Power Supply Voltage:	12 VDC
LT Power Supply Current:	1000 mA (1 A)
HT Power Supply Voltage:	280 VDC
HT Power Supply Current:	50 mA
Total Power Consumption:	25 W Max.
Maximum Output Level:	+38 dBu
Nominal Output Impedance:	75 Ohm
Minimum Recommended Load:	150 Ohm
S/N Ratio (ref MOL):	120 dB
S/N Ratio (ref +4 dBu):	86 dB

Hints

- Wrong Polarity of the LT supply will result in the reactor cell not delivering any current. The tube filaments will still light up. No damage will occur.

- The reactor cell can also be used dry. Dragging the cathode electrode along the dry anode surface will produce sounds, which most people would find profoundly distasteful, perhaps even disturbing.

- Any motion/vibration of the cathode electrode within the electrolyte pool, will change the interelectrode distance and hence the current path through the electrolyte, effectively modulating the reaction and the resulting audio signal.

- Other modules can be connected to the Type 8001 to further expand its capabilities. Please inquire for further details.