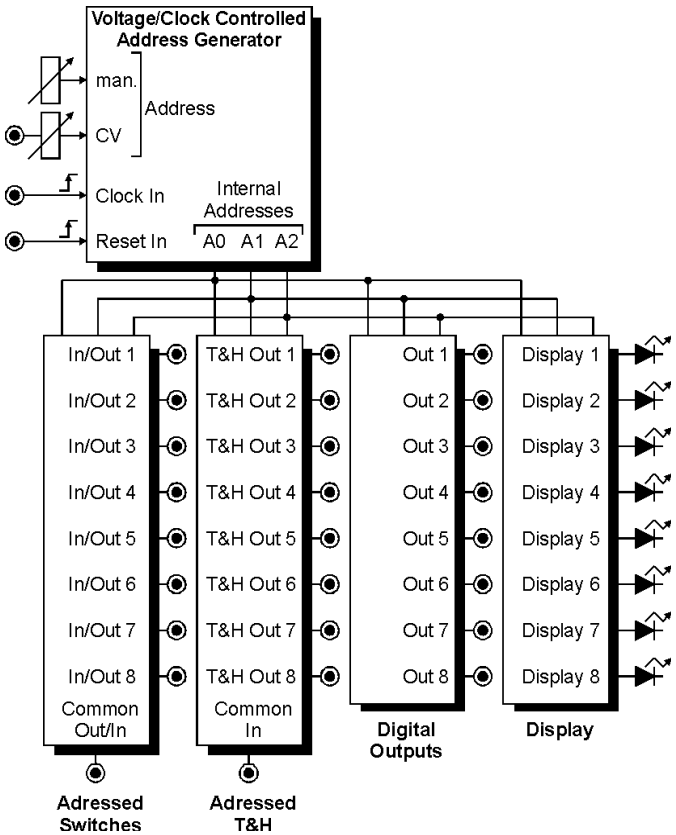
1. Introduction



Module A152 is a useful switching and Track&Hold module. It combines three sub-units within one module:

- **1-to-8 multiplexer**
- **8-fold Track&Hold**
- **8-fold digital outputs unit**

The active step of the three sub-units can be controlled by an external **control voltage** (**CV addressed mode**) or via a **Clock/Reset** controlled **binary counter** (**clocked mode**). In this case the rising edge of each clock signal causes an advance to the next step. The rising edge of the reset signal resets to step 1.

The currently **active step** is displayed by a **LED**.

For the CV addressed mode a **manual control** and a **control voltage input** with **attenuator** is available.

The module can be used for a lot of switching and controlling functions in the A-100 system. Among other things the T&H section of the A-152 allows the emulation of the "**toggling T&H**" function of the Buchla module 266 "Source of Uncertainty".

2. Basic principles

The **sum of the voltages** coming from the manual address control and the CV input define the currently addressed step of the 3 sub-devices. An **address** in the **range 1...8** is generated by an internal analog-to-digital converter. Three **address signals** (**A0, A1** and **A2**) are used to address the sub-units **multiplexer**, **T&H** and the **digital output section with LED display**.

Alternatively the address signals A0, A1 and A2 can be generated by an internal **3 bit binary counter** that is controlled by the signals **clock** and **reset**. For this the the analog voltage applied to the analog-to-digital converter mentioned above has to remain unchanged as the **CV control** has **priority over the clock/reset control**.

Sub-device #1 is the **bidirectional 8-fold multiplexer** (nothing but an electronical 8-fold rotary switch). Bidirectional means that it works into both directions like a mechanical rotary switch. The common socket may work as an output that is connected to one of the 8 inputs that are e.g. connected to modulation or audio sources. But the common socket may even function as input. In this case the signal applied to the common socket is output to the currently addressed single socket.

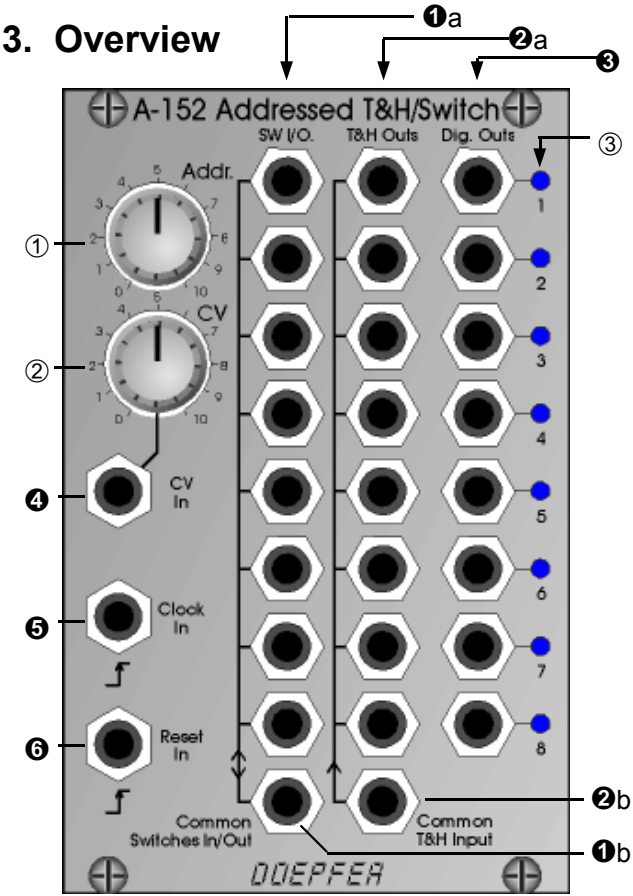
Sub-device #2 is the **addressed 8-fold T&H**. The signal at the common T&H input is connected to the addressed T&H output. The addressed output follows the voltage applied to the common T&H input (track phase). As soon as another output is addressed the last voltage is stored (hold phase).

Remark: In contrast to the Sample&Hold (see S&H A-148) the output voltage follows (i.e. tracks) to the input voltage as long as the corresponding stage (1...8) is active. Just when the stage is deselected the last voltage is held. The S&H has only a very short track phase and picks out a sample of the input voltage within a very short time.

Sub-device #3 is the **digital output section**. The digital output of the currently addressed step turns to "high". All other digital outputs are low.

The digital output section also drives the LEDs.

3. Overview



Controls:

① **Address**	manual address control
② **CV**	attenuator for address CV input ❹
③ **1...8**	LED display (8x)

Inputs / Outputs:

❶a SW I/O	single multiplexer inputs/outputs (8x)
❶b Common Switches In/Out	common multiplexer output/input
❷a T&H Outs	track&hold outputs (8x)
❷b Common T&H Input	common track&hold input
❸ Digital Outs	digital outputs (8x)
❹ CV In	address control voltage input
❺ Clock In	Clock input for the binary counter
❺ Reset In	Reset input for the binary counter

3. Controls / Inputs / Outputs

① **Address** (control)
② **CV** (control) / ❹ **CV In** (socket)

This group of elements is responsible for the **address** generation in the **voltage controlled mode**. Control ① **Adress** is used to adjust the address manually. The control voltage input ❹ **CV In** with the corresponding **attenuator** ② **CV** can be used to modulate the address by means of an external control voltage (e.g. ribbon controller A-198, Theremin A-178, joy stick A-174, ADSR, LFO, random voltage, sequencer and so on).
The required control voltage difference at socket ❹ is about 5V to reach all available addresses with attenuator ② set to it's maximum position.

❺ **Clock In** (socket) / ❻ **Reset In** (socket)

This group of elements is responsible for the **address** generation in the **clocked mode** with the internal binary counter. In this mode each **positive transition** (rising edge) of the signal applied to the **Clock** input ❺ triggers an advance to the next step. Any positive transition of the signal applied to the **Reset** input ❻ resets the counter to **step 1**.

Attention! If the module is be controlled by **clock** and **reset** signals the analog control voltage has to remain unchanged as the **CV control has priority over the clock/reset control**. E.g. simply turn the CV control ② fully counterclockwise (or make sure that no control voltage is applied to socket ❹) and do not touch the address control knob ①. But of course this overwriting behaviour can be used intentionally for special effects.

③ **1...8** (LEDs, 8x)

The currently addressed step of all sub-units is displayed with one of the LEDs.

❶a **SW I/O** (sockets, 8x)
❶b **Common Switches In/Out** (socket)

These sockets belong to the multiplexer sub-unit. The common socket ❶b is connected to the currently addressed single I/O socket ❶a that is displayed by the illuminated LED ③. The remaining seven single I/O sockets are open, i.e. at this moment they have no connection among each other or to the common socket ❶b.

The multiplexer works **bidirectional**. This means that it works into both directions like a mechanical rotary switch. The common socket may work as an output that is connected to one of the 8 inputs (which are e.g. connected to modulation or audio sources). But the

common socket may even function as input. In this case the signal applied to the common socket is output to the currently addressed single I/O socket.

Both **control voltages** and **audio signals can be processed** by the multiplexer unit. The voltage range of the in/outputs to be switched is the **full A-100 voltage range -12V....+12V**. All A-100 signals can be switched without any restrictions.

❷a **T&H Outs** (sockets, 8x)
❷b **Common T&H Input** (socket)

These sockets belong to the Track&Hold sub-unit. The common T&H input ❷b is connected to the currently addressed T&H output ❷a that is displayed by the illuminated LED ③. The active T&H output follows the voltage applied to the T&H input (track phase). As soon as another output is addressed the last voltage is stored (hold phase).

Only **control voltage**s can be processed by the T&H unit due to the holding capacitors of the T&H circuits. The T&H section is **not suitable for audio signals**.

The T&H section of the A-152 allows the emulation of the "toggling T&H" function of the Buchla module 266 "Source of Uncertainty". Only the first two T&H outputs of the A-152 are required for this application (digital output 3 has to be connected to the reset input).

❸ **Digital Outputs** (sockets, 8x)

These sockets belong to the digital output section. The digital output of the currently addressed step turns to "high" (i.e. about +12V) . It is displayed by the illuminated LED ③. All other digital outputs remain at low level.

The digital outputs can be used to reduce the number of addressed stages in the clocked mode. If the digital output 5 is connected to the reset input ❻ only steps 1...4 of the counter will be addressed.

Another application is the triggering of other A-100 modules (e.g. ADSR, LFO reset, clock divider/sequencer, trigger delay, analog sequencer and so on). For example the ribbon controller A-198 can be used to trigger 8 different devices one after another by moving the finger over the ribbon manual.

For logical connection of several digital outputs the logic module A-166 can be used (e.g. for simple rhythmic patterns).

To generate a short trigger signal from the gate-type digital outputs the trigger modifier A-165 is the right choice (each digital output remains in the "high" state while it is addressed, this is called a "gate-type" signal).

Normalling options

The common terminals of the multiplexer and the T&H section can be normalled in different ways, i.e. they can be pre-connected provided that no plugs are inserted into the corresponding sockets. For that purpose two single row pin headers with jumpers are available:

JP8: located on the pc board of the multiplexer unit (labelled "BOARD C SWITCHES") at the lower edge

JP7: located on the pc board of the T&H unit (labelled "BOARD B T&H") at the lower edge as well

There are two possibilities to set the jumpers of JP7 and JP8:

- JP8 below, JP7 towards the common T&H socket

In this case the common socket of the multiplexer unit ❶b is connected to the common input of the T&H unit ❷b provided that no plug is inserted into the common socket ❶b of the multiplexer unit. For both units T&H and multiplexer the same input signal is used (applied to the common input of the T&H unit ❷b). The eight single sockets of the multiplexer unit ❶a function as outputs in this case.

- JP8 top, JP7 away from the common T&H (factory setting)

In this case the common input of the T&H unit ❷b is connected to the common socket of the multiplexer unit ❶b provided that no plug is inserted into the common input of the T&H unit ❷b. This leads to two possibilities:

1. For both units T&H and multiplexer the same input signal is used. The signal is applied to the common socket of the multiplexer unit ❶b. In this case the eight single sockets of the multiplexer unit ❶a function as outputs.

2. No plug is inserted into the common socket of the multiplexer unit ❶b. In this case the single sockets of the multiplexer unit ❶a are used as inputs for the T&H with a separate input for each T&H output. Each single socket of the multiplexer ❶a works as input for the neighbouring T&H stage ❷a. In this case the eight single sockets of the multiplexer unit ❶a function as inputs.

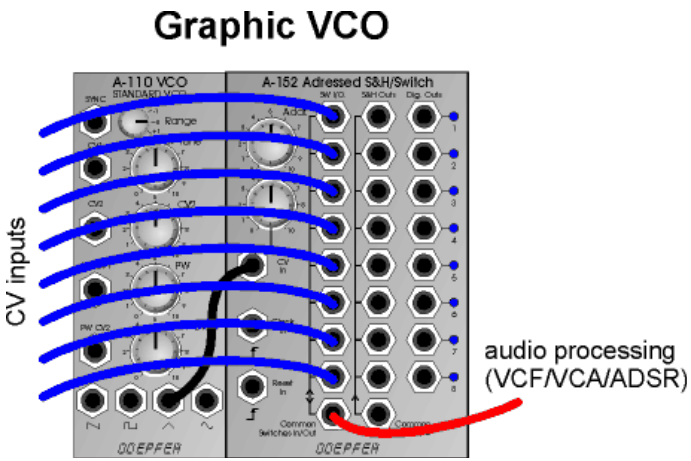
If one or both jumpers are removed no normalling is active. We recommend to keep the jumpers for a later re-installation of the normalling option.

5. User Examples

Graphic VCO

The right picture shows the principle patch for a so-called graphic VCO. For a graphic VCO the waveform is determined by a sequence of voltage levels. Normally the levels are adjusted with faders and the fader positions represent the waveform. In the A-100 such a VCO is not available as we believe that the expenditure and costs do not correspond to the result. From our point of view the features of a graphic VCO are overestimated very often. But with the A-152 one has the tool to built a graphic VCO with a few additional modules only. And that's how it works:

The CV address input of the A-152 is connected to the output of a VCO (e.g. sawtooth or triangle output of an A-110 or A-111). The manual address control and the CV attenuator are adjusted so that just all 8 LEDs of the A-152 light up, i.e. that all 8 stages of the A-152 are addressed while the VCO passes through it's waveform (this is why only sawtooth/triangle/sine are suitable waveforms but not rectangle). The CV controlled address generator of the A-152 is able to work up to moderate audio frequencies. If different voltages are applied to the eight multiplexer inputs of the A-152 one obtains a graphic VCO signal at the common multiplexer output that has the same frequency as the VCO.



Here are some examples how to generate the eight voltages:

- 8 fixed voltages (e.g. from the CV source module A-176): This is the "classic" graphic VCO with manually adjustable values (for DIY's: 8 faders connected between GND and +12V could be used too)
- 8 automatically varying voltages (e.g. 8 LFO outputs from two A-143-3)
- 8 random analog voltages (e.g. random voltages from A-118 or A-149-1 or S&H A-148)
- 8 random digital voltages (e.g. A-149-2)
- or any combination of the above suggestions

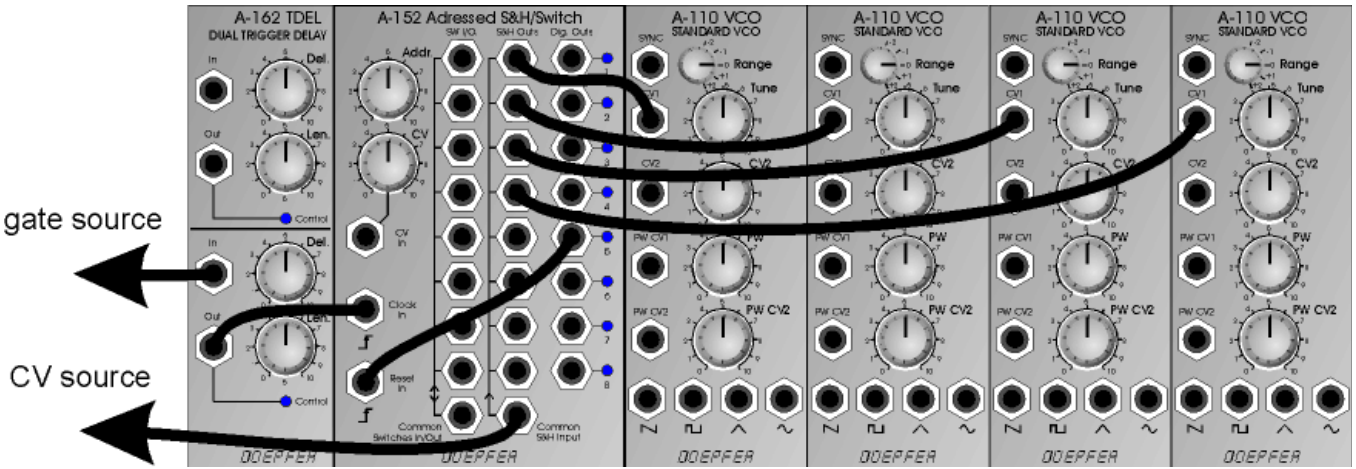
For the last 3 examples the waveform changes more or less accidentally. If the A-149-1 resp. A-149-2 is used the waveform changes can be synced as for these modules the random voltages are triggered by a clock signal. Especially in combination with an A-155 a lot of interesting applications may result. E.g. the clock inputs of the A-149-1 can be controlled by the sequencer clock or a A-155 trigger row. In both cases the change to the next waveform is in sync with the sequencer.

If the triangle output of a VCO is used to control the A-152 only odd harmonics will occur as the graphic waveform is passed through symmetrically in both directions.

Mono-Poly-Konverter

The picture below shows an application of the A-152 that distributes a monophonic pitch control voltage (e.g. the CV of a sequencer, a MIDI-to-CV interface or a monophonic keyboard) into several polyphonic control voltages that are used to control several VCOs. And that's how it works:

The pitch CV is connected to the common input of the T&H unit. The positive transition of the corresponding gate signal indicates that a new CV is generated (e.g. by pressing a key on the keyboard or during the advance to the next sequencer step). The gate signal is used to



trigger the advance to the next address of the A-152. The trigger delay connected between the gate source and the clock input of the A-152 is required because of the timing between the positive transition of the gate signal and the CV change. The T&H has to take over and store the CV not before the CV is stable. Otherwise the result will not meet the expectations. As the time correlation between the gate transition and the CV change may vary the A-162 is used to solve problems that may arise from this. Ideally the gate transition and CV change happens exactly simultaneously, but "simultaneously" is a problem in the real world as there are always some delays in the micro/millisecond range that may cause problems (e.g. the MIDI-to-CV interface or sequencer of manufacturer #1 generates the gate transition 200us before the CV change but for manufacturer #2 the behaviour is reverse and the delay is 500 us). To avoid such problems the A-162 is used. First the trigger length is adjusted so that the A-152 triggers correctly. If the width is too short the A-152 may not trigger or the step advances are uneven. After that the delay time is adjusted so that the CV values appear sequentially at the T&H outputs of the A-152 as expected. Usually the A-162 settings will be close to the left-most positions of the controls for delay and length.

In the example the digital output five is connected to the reset input of the A-152 to limit the number of outputs to four.

The four VCO outputs can be mixed in an A-138 before the subsequent signal processing (VCF,VCA,ADSR ...). But even each VCO outputs can be processed separately. In this case the digital outputs of the A-152 may be used to trigger the envelope generators that are assigned to the corresponding VCO.

The number of outputs can be decreased or increased by connecting the reset input to another digital output.

A special case is the limitation to two outputs. This leads to the function of the toggling S&H unit of the Buchla module 266 Source of Uncertainty. The only difference is that the Buchla module contains two S&H instead of two T&H. If an A-148 S&H is connected between the CV source and the A-152 the functions are identically.

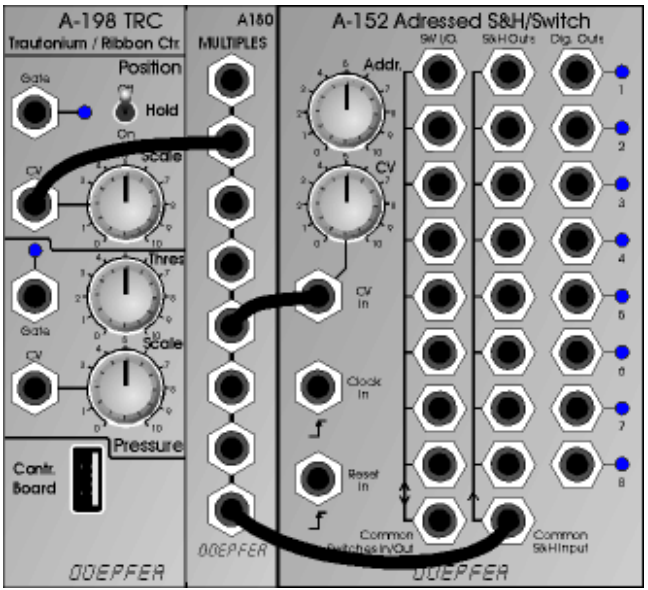
Another solution is to modify the A-152 so that the T&H section works as S&H. For details please refer to the DIY page on our web site www.doepfer.com.

7-fold Manual Ribbon Gate

The right picture shows an application of the A-152 in combination with the ribbon controller A-198. The position control voltage of the A-198 is used to address the A-152. If the manual address control and the CV attenuator are adjusted in the right way the position sensor of the A-198 covers the complete address range of the A-152 and a small share of the position range is assigned to one of the eight addresses of the A-152.
If the hold switch of the A-198 is set "off" the A-152 jumps to address 1 as soon as the finger is removed from the position sensor. As soon as the sensor is touched, one of the stages in the range 2...8 is addressed and the corresponding digital output turns to "high" - displayed by the corresponding LED. This leads to a 7-fold manual gate generator that can be operated like a percussion set. According to the position of the finger, that touches the position sensor of the A-198 one of the gate outputs of the A-152 is active. The gate outputs may be used to trigger percussive sounds stored in an A-112 sampler module or percussive patches based on other A-100 modules.

In principle the gate outputs can be used for any gate/ trigger/clock function in the A-100.

In the example the position CV is also patched to the common T&H input. At the T&H outputs control voltages



are available that follow the position CV of the A-198 in a certain range. As soon as the finger leaves the corresponding range the last voltage is stored.

The multiplexer unit can be used for additional switching functions (e.g. to connect different modulation or audio sources to a module).