

TEMP/U

Addon Card for Recording Temperature and Voltage



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1. Introduction

TEMP/U is a member of the extension board family available for the Zahner Electrochemical Workstations. Generally they support measuring data acquisition and process control in parallel to the electrochemical experiments. For details please refer to the Signal Acquisition manual.

TEMP/U enables the acquisition of two low level plus two high impedance medium level electrical signals. The typical application is temperature measurement by direct connection of thermocouples to the low level inputs and electrochemical potential measurements can be done by connecting auxiliary electrodes to the medium level inputs.

Low- and high level inputs may be hardware adapted to the needs by changing the sensitivity (signal amplification) for the inputs individually. Optional scaling and linearising of the primary measurement data and assignment of physical meanings is generally done within the data acquisition set-up menu by the logical channel description. It defines the data flow from a selected hardware channel into a logical channel.

Unless otherwise noticed, the TEMP/U is delivered pre-configured for two NiCrNi-(type K)-thermocouples, temperature range -70°C to $+250^{\circ}\text{C}$ and two voltage inputs in the range of $\pm 10\text{ V}$. An optional automatic cold junction compensation can be activated by a switch at the top of the front plate. All channels are bandwidth limited by means of anti aliasing filters.

2. Technical Data

Two temperature inputs:

Socket:	Lemoso RA0102
Input resistance:	100 K Ω
Amplification:	201 (standard), 101, 51, 26
Offset voltage/drift:	$\pm 5\mu\text{V}$, $\pm 0.05\mu\text{V}/\text{C}$, $\pm 0.2\mu\text{V}/\text{year}$ max.
Input current:	$\pm 100\text{pA}$ max. @ 20C, $-1\mu\text{A}$ optionally
Bandwidth:	300 Hz, 3rd order Bessel characteristic
Isolation impedance:	200K Ω // 100pF
Max. isolation voltage :	$\pm 200\text{V}$
Cold junction compensation :	At the front plate, switchable, range 0-40C $\pm 0.5\text{C}$.

Two voltage inputs:

Socket:	BNC
Input resistance:	$10^{12}\Omega$ min.
Input range:	$\pm 10\text{ V}$ (standard), $\pm 4\text{ V}$, $\pm 2\text{ V}$
Offset voltage/drift:	$\pm 0.5\text{ mV}$, $\pm 5\mu\text{V}/\text{C}$, $\pm 0.2\text{ mV}/\text{year}$ max. @ 2 V range
Input current:	$\pm 10\text{ pA}$ max. @ 20C
Bandwidth:	300 Hz, 3rd order Bessel characteristic
Isolation impedance:	$10^{12}\Omega$ // 20pF
Max. isolation voltage :	$\pm 20\text{ V}$

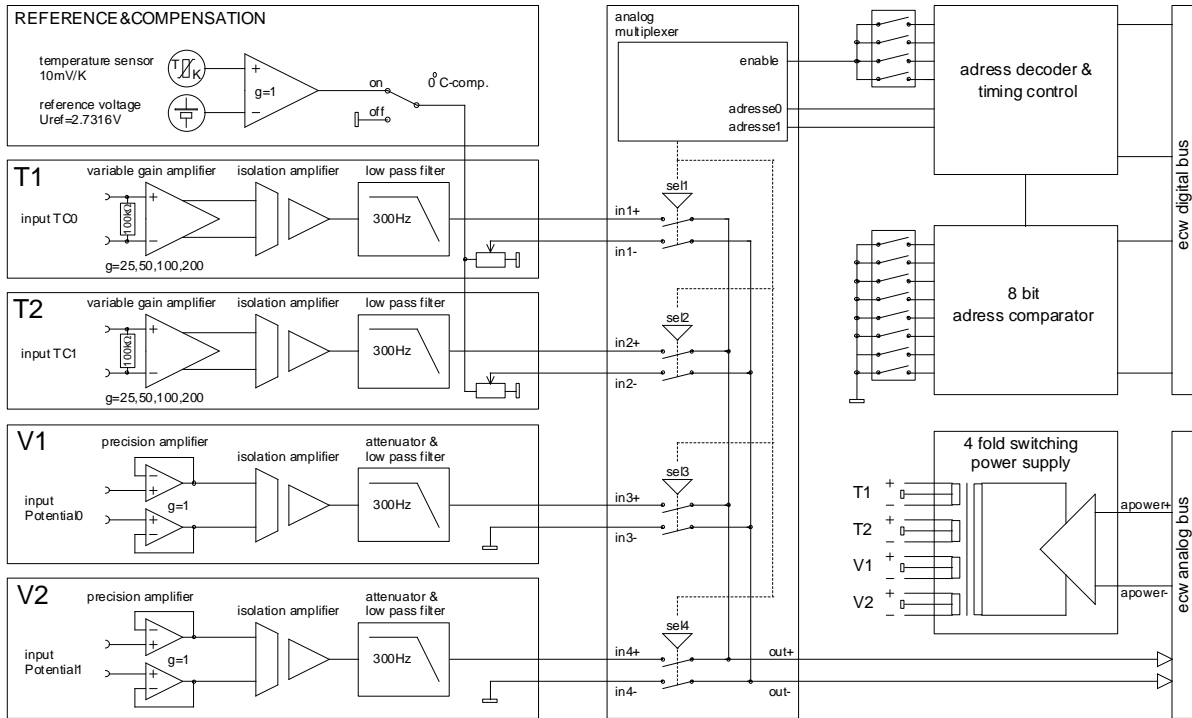


Fig. 1 Simplified schematic of the TEMP/U card

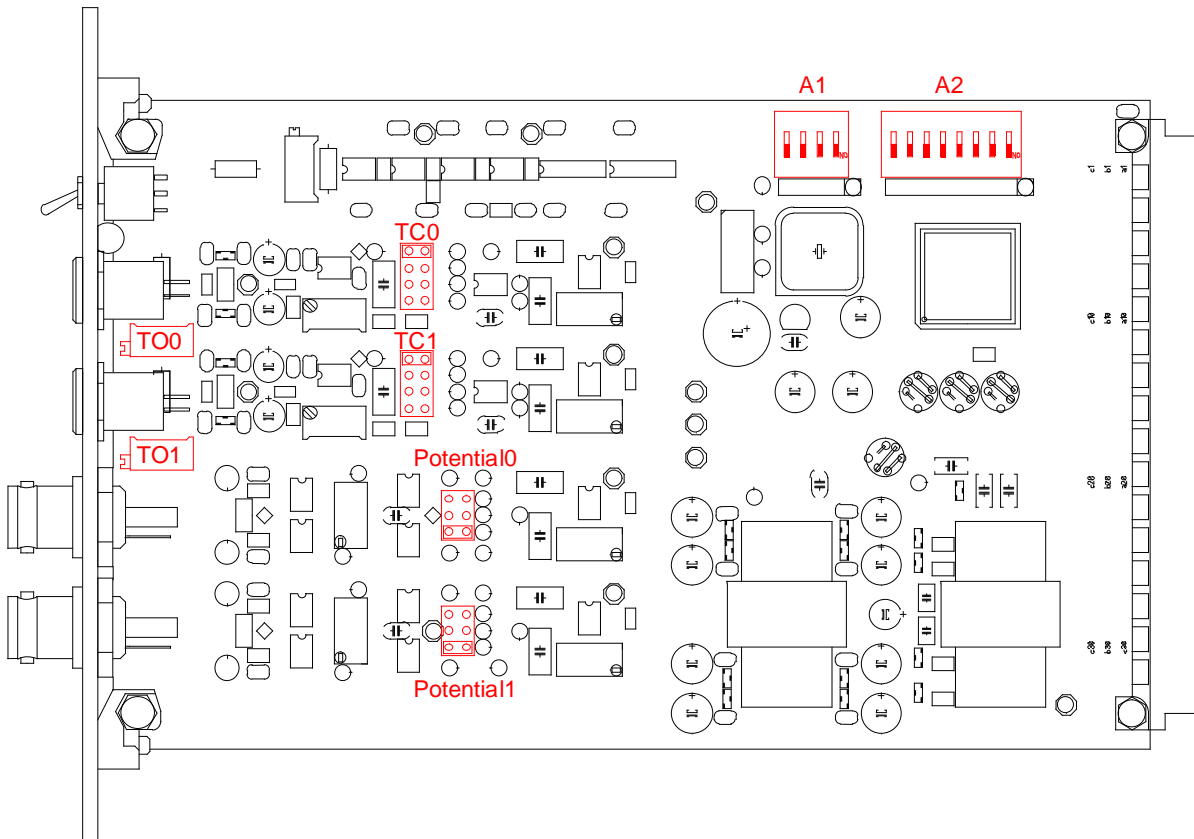


Fig. 2 Jumper locations on the TEMP/U card

TC0 & TC1 channels Temperature Gain Setting

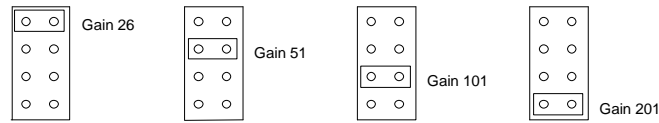


Fig. 3 Jumper settings for gain selection of the temperature channels of the TEMP/U card.

Potential0 & Potential1 channels Gain Setting

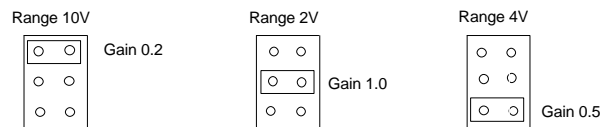


Fig. 4 Jumper settings for gain selection of the potential channels of the TEMP/U card.

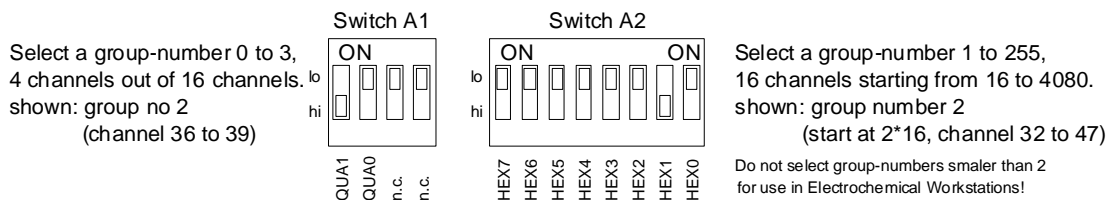


Fig. 5 Switches for channel setting of the TEMP/U card.

Fig. 2 gives an overview over the jumpers on the TEMP/U card. The jumper fields TC0 and TC1 set the gain for the temperature channels. The required gain value is calculated by the configuration script as described in chapter 3.2.1. Set the jumpers according to the output of the script using the jumper settings given in Fig. 3.

The two potential channels can be set to different full scale values using the jumper positions given in Fig. 4.

The switches shown in Fig. 5 can be used to change the channel addresses in case several TEMP/U cards are used in an electrochemical workstation. For further information please refer to chapter 5 of this manual.

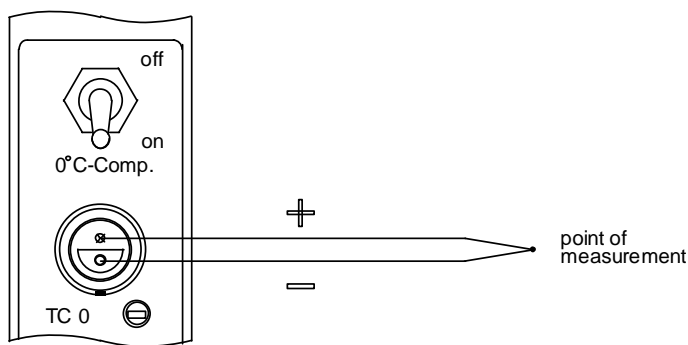
3. Temperature channels

3.1. Reference temperature

The TEMP/U can either be used with a single thermocouple with internal reference or with a pair of thermocouples. In the later case one thermocouple is kept at constant temperature as reference. The two modes are selected by the 0°C-Comp. switch on the front panel of the TEMP/U card.

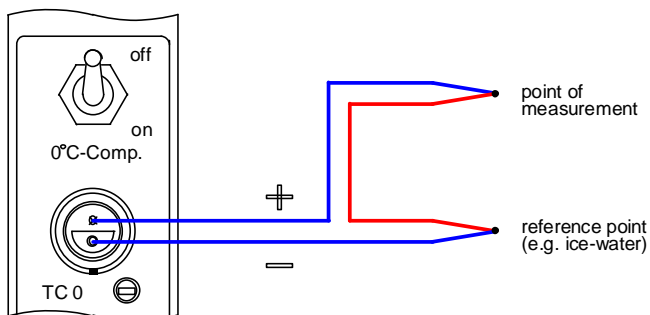
Internal reference

The reference temperature is the temperature of the front plate of the TEMP/U card. The reference temperature is measured by a semiconductor temperature sensor (TK=10 mV/K).



External reference

The reference temperature will be defined by an external reference (e.g. ice-water).



3.2. Software configuration

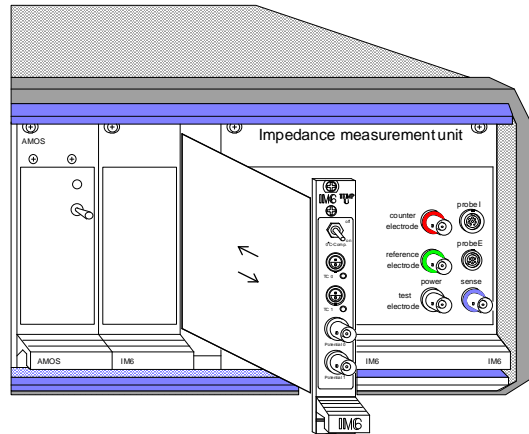
The Thales software comes preconfigured for type K (Ni/CrNi) thermocouples. So this procedure is only necessary if a different type of thermocouple or a different temperature range is required.

For reconfiguration a script is delivered within the general installation. The script source is located at:

c:\thales\hardware\tempu\tempreg.is_

For a detailed description of script handling and programming please refer to the Script manual. Here a short guide how to start the TEMP/U configuration script is given:

1. Be sure to know, which thermocouple type for which temperature range you like to use at which input.
2. **Be sure, that the instrument is switched off.**
3. Pull out the TEMP/U plug after loosening the two screws at the top and the bottom of the TEMP/U front plate.



4. Start the instrument and get into the Thales main menu in the usual way.
5. Call the *script* icon. The script menu comes up with an empty user section.

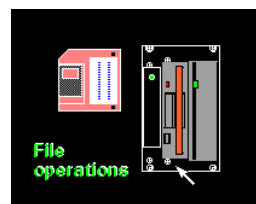


6. Use the *edit script* button to get into the integrated text editor menu

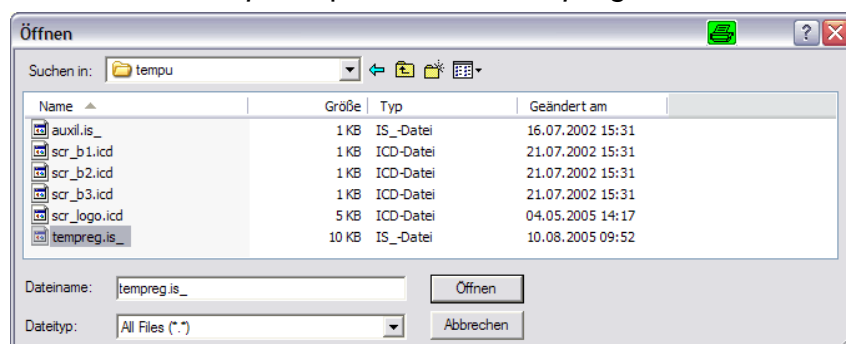


and enter the text file menu by clicking the *file operations* button.

This step is only needed in Thales versions older than 4.0 !



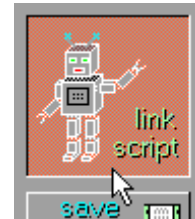
7. Select the path *hardware\tempu*. Open the file *tempreg* into the text editor.



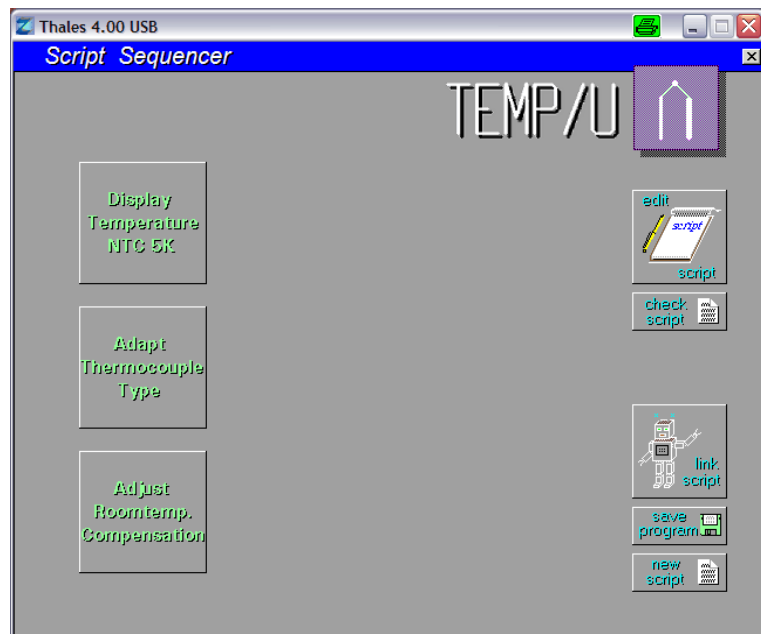
8. Escape by clicking the middle mouse button in order to get back to the script menu. Check the script by clicking the *check script* button.



9. Link the script after escaping the “check successful” message by clicking the *link script* button.



10. The script menu will come up now including the user section of the TEMP/U configuration script.



It is possible to save the pre-compiled version of a script for a faster and more comfortable access. To do that, click on the *Save Program* button. By default, all pre-compiled script programs are saved in the folder *c:\thales\script\tempu*.

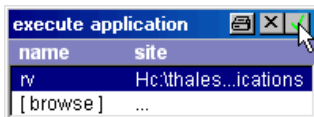
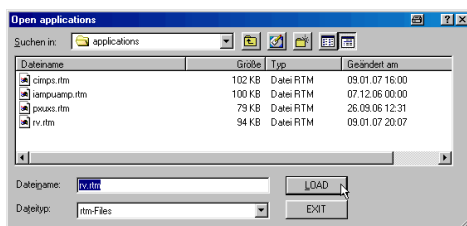
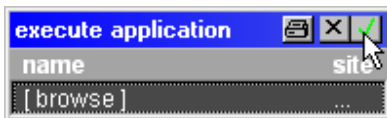


From now on, you can call the script by the following procedure:

Click on the *Exe* button in the Thales main menu.



Navigate to the path you saved the script program and select *tempreg.is_*.



The script will start automatically, now.

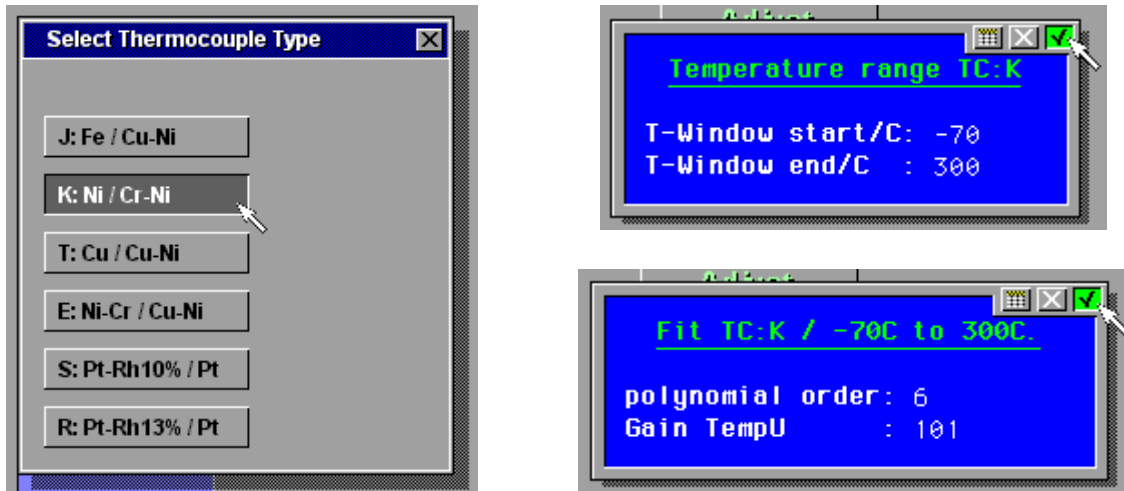
3.2.1. Calculating temperature fitting polynomials

Now you can perform the basic adjustment steps by calling the *adapt thermocouple type* menu. The menu will offer you to choose between six different types of standard thermocouples:

J (Fe/Cu-Ni),	-210 – 1200C, (not recommended for T> 800C)
K (Ni-Cr/Ni),	-270 – 1372C, (not recommended for T> 900C)
T (Cu/Cu-Ni),	-270 – 400C
E (Ni-Cr/Cu-Ni),	-270 – 1000C
S (Pt/Pt with 13 % Rhodium)	-50 – 1767.6 C
R (Pt/Pt with 10 % Rhodium).	-50 – 1767.6 C

Choose the appropriate thermocouple type. The program will ask you for the expected temperature range. Type in the temperature window start and end of the chosen temperature range and confirm.

The program will now propose an amplification factor and a polynomial order for the linearisation polynom to calculate.

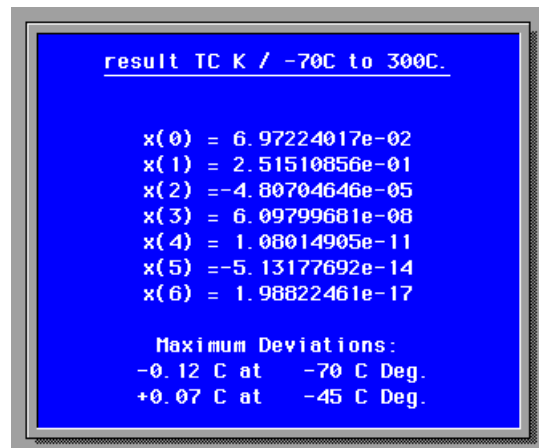


Do not alter, but note the amplification. You may select a polynomial order up to a value of nine.

After confirming your selection the program will calculate the polynomial coefficients and prompt them in addition with an information about the accuracy.

Check, if the accuracy fits your requirements. If not, escape, start again with the basic adjustment step and try different polynomial orders and/or slightly modified temperature ranges. Consider, that the accuracy normally has an optimum for a specific polynomial order and will not generally increase with higher orders. Usually one should take higher orders for wider temperature ranges.

If the accuracy fits your requirement, use the *select input* menu to assign the resulting polynomial to the first (normally the physical channel address is 32) or second (normally the physical channel address is 33) logical data acquisition channel.

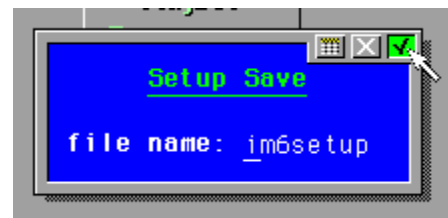


The program will ask you for the filename of the set-up. Do not change but confirm the proposed name 'im6setup', if you want to use the adjustment instantly as standard.

Altering the filename enables you to establish different set-ups for preserve, which may be activated optionally by removing (renaming) the original one from *c:\thales*, and by renaming the optional one to '*im6setup*'.

Alternatively you can export the coefficient list into the text editor for control.

After successful assignment of one temperature channel repeat the procedure with the second channel.



Complete now step one by adjusting the TEMP/U card hardware to the necessary amplification settings for each temperature channel by setting the appropriate jumpers. If necessary, change the settings of the potential channels to your requirements as well.

Using more than one acquisition-extension-card in one system you have to select the channel-numbers too.

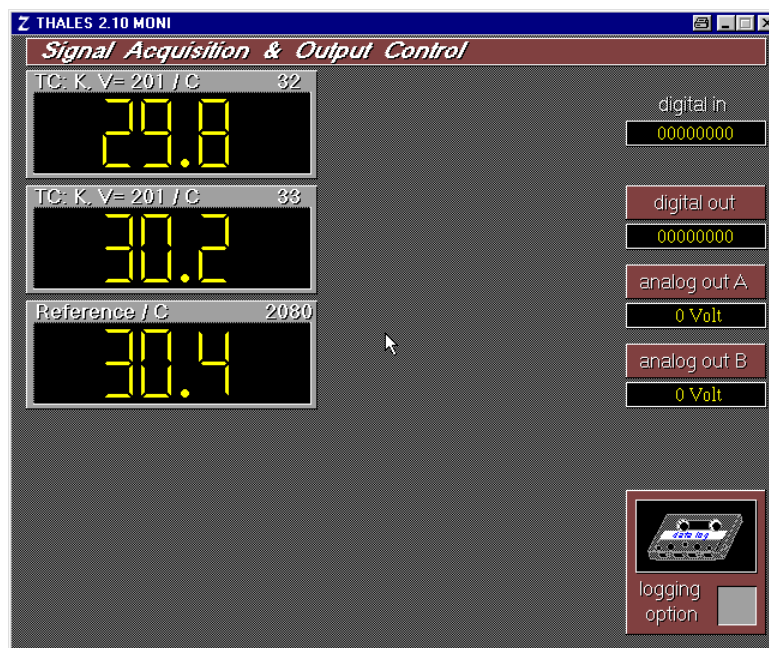
Do not select numbers smaller than 32!

3.2.2. Offset adjustment

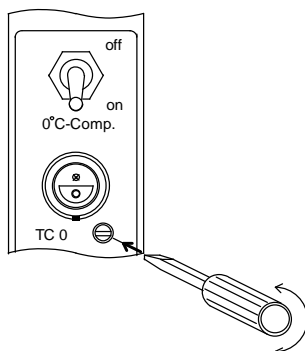
The second configuration step starts with the re-insertion of the TEMP/U plug-in in the instrument after power down:

1. **Be sure, that the instrument is switched off.**
2. Plug in the TEMP/U card and fix the two screws of the TEMP/U front plate.
3. Perform the steps 4 to 8 from the step one procedure.

Select now the function *adjust room temperature compensation* to tune the automatic cold junction circuit. Do not connect any thermocouple at this moment, but set the "0°C. Comp" switch to "on".



The program will prompt with the (normally unadjusted) temperature display for thermocouple input voltages of zero at both channels. Additionally the actual reference temperature is shown on a third virtual instrument. It is sensed at the plug-in front plate.



Use now a small (\varnothing 2mm max.) screwdriver and adjust the potentiometers behind the front-plate through the appropriate holes. Both thermocouple channels should display the value of the reference temperature within sufficient accuracy. Now the adjustment is finished.

4. Voltage channels

4.1. Hardware configuration

The voltage channels can be manually configured to full scale ranges of ± 10 V (standard), ± 4 V and ± 2 V. In order to change the full scale range the TEMP/U plug in card has to be removed from the electrochemical workstation. Locate the jumpers Potential0 and Potential1 (see Fig. 2) and set them to the desired voltage range (see Fig. 4).



Switch the electrochemical workstation off before removing or inserting plug in cards.



Electrostatic discharge can destroy components on the TEMP/U card. Therefore, before touching the TEMP/U card always get yourself discharged, e.g. by touching the grounded front panel of the electrochemical workstation.

4.2. Software configuration

In order to display the voltage correctly, the gain setting in the Thales software has to match the hardware configuration of the TEMP/U card. In order to set the gain, select the Signal Acquisition Setup from the Thales main windows as shown in Fig. 6 left hand side. Now click the Edit Input button and subsequently select the desired voltage channel (Fig. 6 right hand side).

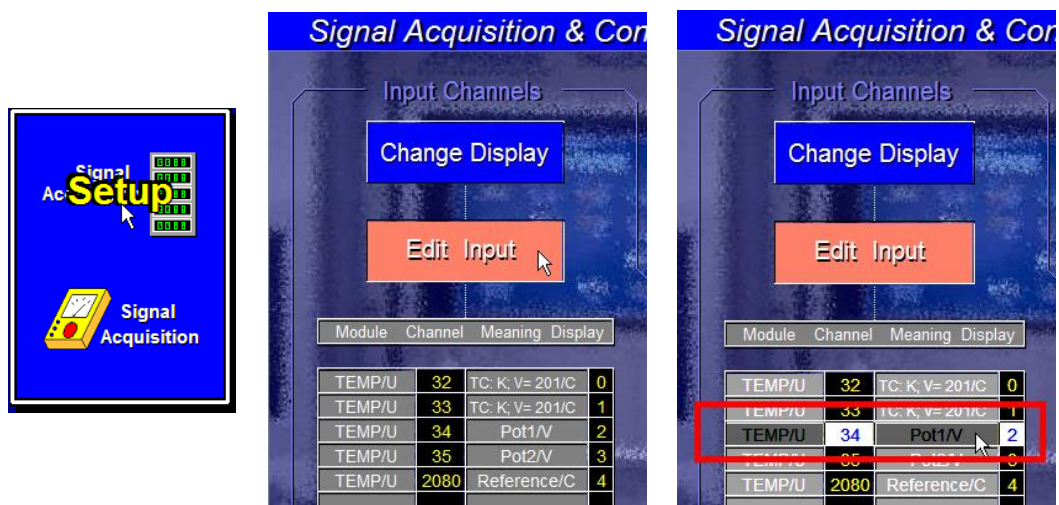
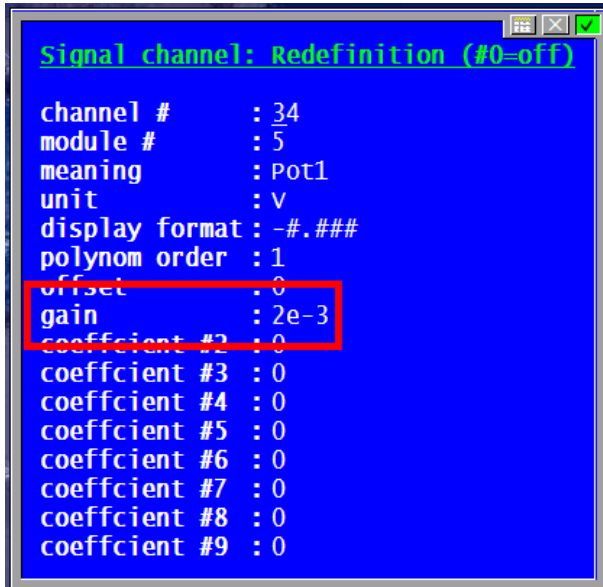


Fig. 6 Editing voltage input channels for different full scale voltages

In the configuration dialog (Fig. 7) enter the appropriate gain setting for the voltage range set with the jumpers of the TEMP/U card.



Voltage Range	Gain Setting
±10 V	5e-3
±4 V	2e-3
±2 V	1e-3

Fig. 7 Gain settings of the voltage channels

The configuration of the voltage channels can be saved as default, so it is used every time the electrochemical workstation is started. In the Thales main menu select the EIS method (see Fig. 8, left hand side). In the EIS configuration page click the setup hippo (see Fig. 8, middle) and select save settings as default (see Fig. 8, right hand side). The configuration of signal acquisition is now saved to the file c:\thales\im6setup.bin.

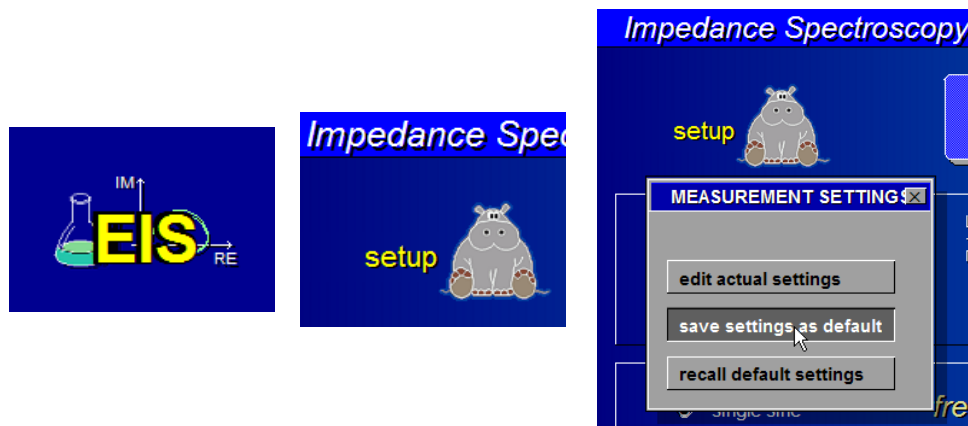


Fig. 8 Saving voltage channel configuration as default

5. Multi Card Configuration

5.1. Hardware configuration

The TEMP/U card and the Thales software suite is preconfigured for one TEMP/U card installed to the Zennium electrochemical workstation.

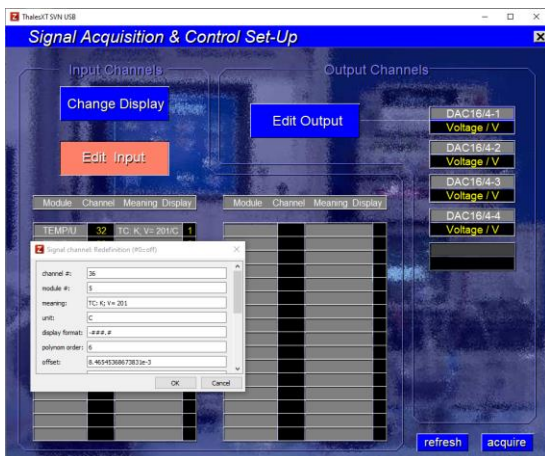
The DIP switch configuration for the installation of multiple TEMP/U cards is shown in the following table.

Card Number	Switch A1	Switch A2	TC0 channel	TC1 channel	POT0 channel	POT1 channel	REF channel
TEMP/U#1	0000	00000010	32	33	34	35	2080
TEMP/U#2	0100	00000010	36	37	38	39	2084
TEMP/U#3	1000	00000010	40	41	42	43	2088
TEMP/U#4	1100	00000010	44	45	46	47	2092

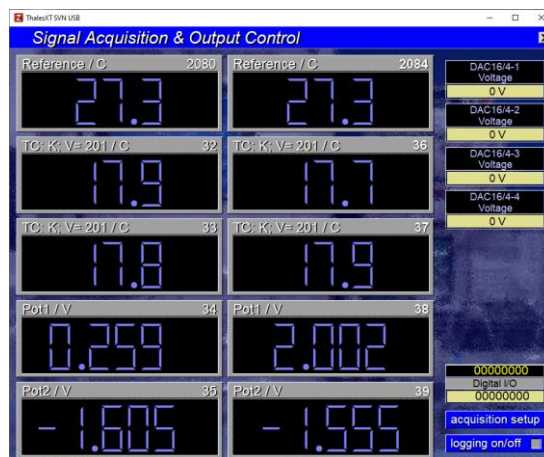
The corresponding analog channel numbers for the Signal Acquisition Setup configuration are given in the yellow rows.

5.2. Signal Acquisition Setup

The Thales XT software package is predefined for one TEMP/U card. Adding additional analog channels from multiple TEMP/U cards to the Signal Acquisition Setup can be easily done by copying an existing TEMP/U channel to another channel number.



Use the “Edit Input” function and select the existing TEMP/U channel. Edit the channel number (first line) to the channel number of the other TEMP/U card (refer to table above) and finish with “OK”. The new channel will be created as a copy including all settings.



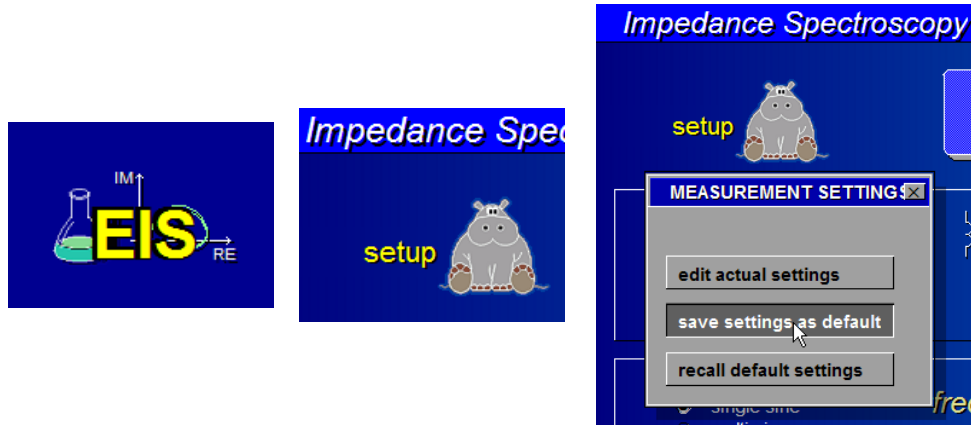
Example: Add all channels of a second TEMP/U card configured like “TEMP/U#2” in table above.

5.2.1. Saving Signal Acquisition setup

The configuration of the whole Signal Acquisition channel setup can be saved as default, so it is used every time the electrochemical workstation is started.

In the Thales main menu select the EIS method.

In the EIS configuration page click the setup hippo and select save settings as default.



The configuration of signal acquisition is now saved to the file c:\thales\im6setup.bin.