

Physics

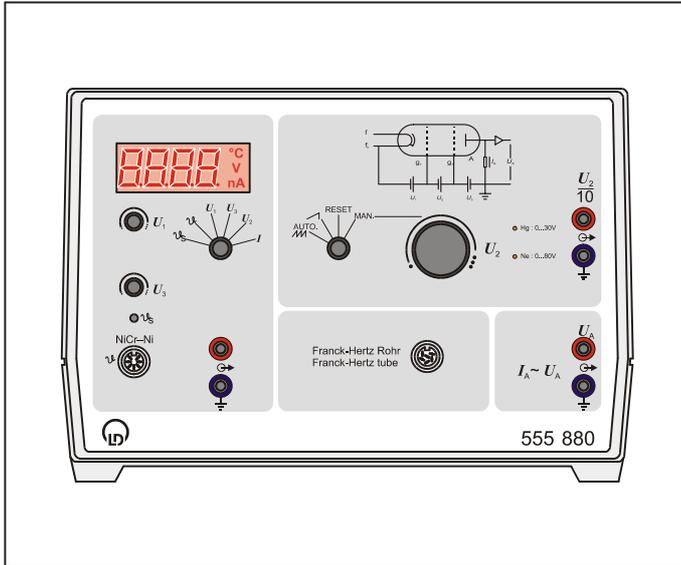
Chemistry · Biology

Technology



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06/05-W97-Kem



Instruction sheet 555 880

Franck-Hertz supply unit (555 880)

Safety notes

The Franck-Hertz supply unit complies with the safety requirements for electrical measuring, control and laboratory equipment in accordance with DIN EN 61010 part 1, and it is constructed in compliance with safety class I. The device is intended for use in dry rooms that are suited for the operation of electrical equipment and devices.

If the device is used as prescribed, its safe operation is guaranteed. However, safety is not guaranteed if the device is improperly used or carelessly handled. If it has to be assumed that safe operation is no longer possible (e.g. in the case of visible damage), shut the device down immediately.

- When putting the device into operation for the first time, check whether the value for the mains voltage indicated on the rating plate (back of housing) agrees with the local value.
- Before putting the device into operation, examine the housing for damage. In case of malfunction or visible damage shut the device down and make sure that it is not used inadvertently.
- Connect the device only to socket-outlets with grounded neutral wire and protective conductor.
- Replace a defective fuse only with a fuse that corresponds to the original value (see fuse plate on the back of the housing).
- Always keep the ventilation slots and the heat sink on the back of the housing free in order to ensure sufficient air circulation for the cooling of internal components.
- Allow only skilled persons to open the device.

1 Description

The Franck-Hertz supply unit is intended for carrying out experiments with the Hg Franck-Hertz tube (555 854) or the Ne Franck-Hertz tube (555 870). It comprises a nanoammeter for measuring the collector current, supplies the cathode heating voltage, the emitting grid voltage, the accelerating voltage, and the countervoltage, and, as a temperature measuring and control device, controls the heating for the Hg Franck-Hertz tube.

For recording the Franck-Hertz curve, i.e. the collector current as a function of the accelerating voltage, there is a choice between three operating modes:

- manual operation
- quick overview with two-channel oscilloscope:

The accelerating voltage rises quickly from zero to the maximum value again and again.

- automatic recording with XY recorder or CASSY:

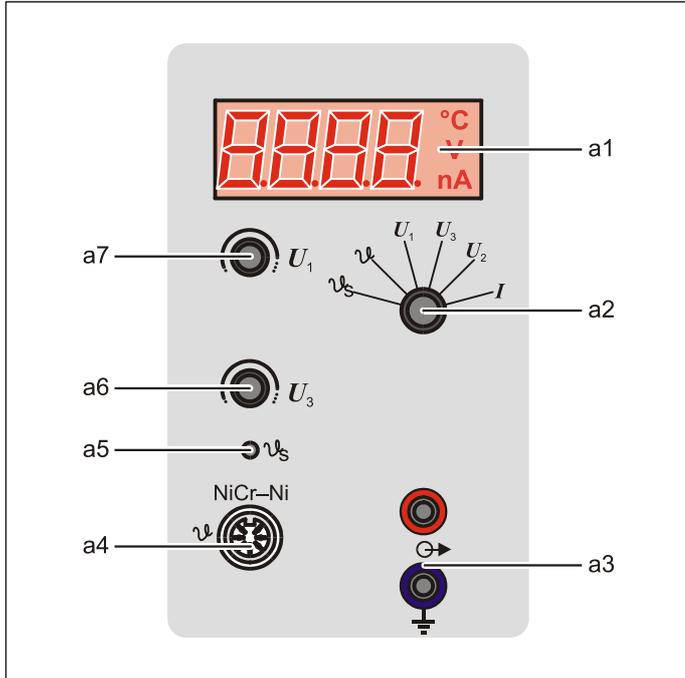
The accelerating voltage once rises slowly from zero to the maximum value.

2 Accessories

1	Hg Franck-Hertz tube	555 854
1	socket for Hg Franck-Hertz tube, with DIN connector	555 864
1	electric oven 230 V	555 81
or		
1	electric oven 115 V	555 82
1	NiCr-Ni temperature sensor	666 193
1	Ne Franck-Hertz tube	555 870
1	holder with socket and screen, for Ne Franck-Hertz tube	555 871
1	connecting cable for Ne Franck-Hertz tube	555 872

3 Components

a) Parameter and display panel:



- a1 Digital display
- a2 Meas. quantity switch
- a3 Analog output
- a4 DIN socket, 5-pin
- a5 Screwdriver potentiometer
- a6 Voltage regulator U_3
- a7 Voltage regulator U_1

Digital display

displays the selected measurement quantity in °C, V or nA. Blinks if there is a fault in the experimental setup.

Measurement quantity switch

for selecting the measurement quantity ϑ_s (setpoint temperature), ϑ (actual temperature), U_1 (emitting grid voltage), U_3 (counter voltage), U_2 (accelerating voltage) or I (collector current) for the digital display and the analog output.

Analog output

supplies an output voltage U proportional to the selected measurement quantity:

$$\vartheta_s = 100^\circ\text{C} \cdot \frac{U}{V}, \quad \vartheta = 100^\circ\text{C} \cdot \frac{U}{V}, \quad U_1 = 1\text{V} \cdot \frac{U}{V}, \quad U_3 = 1\text{V} \cdot \frac{U}{V},$$

$$U_2 = 10\text{V} \cdot \frac{U}{V} \quad \text{and} \quad I = 1\text{nA} \cdot \frac{U}{V}$$

Screwdriver potentiometer

for setting the setpoint temperature ϑ_s of the Hg Franck-Hertz tube (default: $\vartheta_s = 180^\circ\text{C}$)

DIN socket, 5-pin

for connecting a NiCr-Ni temperature sensor (666 193)

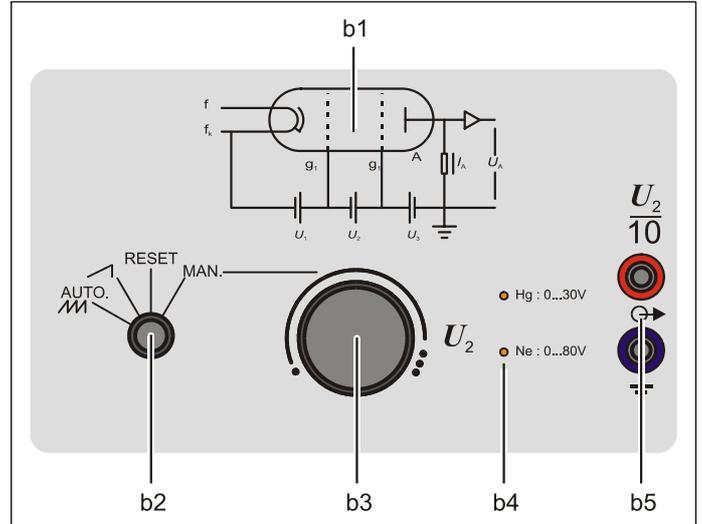
Voltage regulator U_3

for adjusting the countervoltage U_3

Voltage regulator U_1

for adjusting the emitting grid voltage U_1 .

b) Operation panel



- b1 Schematic circuit diagram
- b2 Operating mode switch
- b3 Voltage regulator U_2
- b4 Status LEDs
- b5 Analog output $U_2 / 10$

Schematic circuit diagram

shows schematically the circuit for the Franck-Hertz experiment.

- f: Cathode heating
- f_k : Cathode
- g_1 : Emitting grid
- g_2 : Accelerating grid
- A: Collector

Operating mode switch

for selecting the variation of the accelerating voltage U_2 according to the operating mode.

- oscilloscope
- recording of the curve with CASSY or recorder

RESET Accelerating voltage is set to 0 V

MAN manual adjustment of the accelerating voltage (curve is recorded point by point)

Voltage regulator U_2

for adjusting the accelerating voltage U_2 manually in the "Manual" operating mode.

Status LEDs:

indicate the connection of a Franck-Hertz tube.

LED	Colour	Operating status
Hg	Green	For a short time, immediately after the supply unit has been switched on
	Red	Oven is heating
	Green	Setpoint temperature reached
Ne	Green	Ne Franck-Hertz tube connected via connecting cable

Analog output $U_2 / 10$

supplies an output voltage proportional to the accelerating voltage U_2

c) Connector panel:

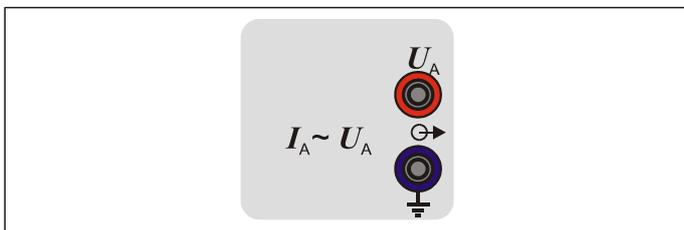


DIN socket, 7-pin

for connecting

- a) the Hg Franck-Hertz tube (555 854) via the socket with DIN connector (555 864) or
- b) the Ne Franck-Hertz tube (555870) via the connecting lead (555 872).

d) Collector current output field:

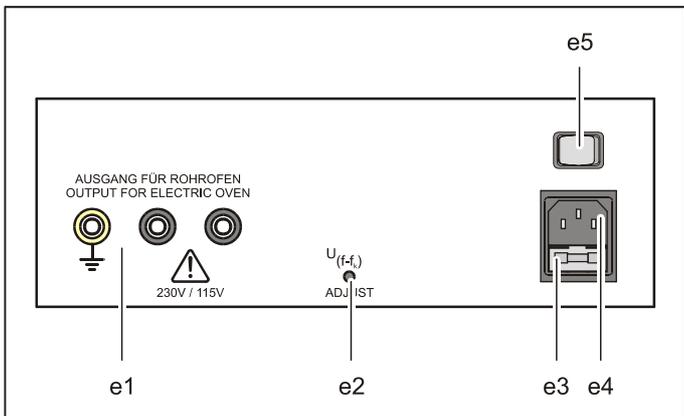


Analog output U_A

supplies an output voltage proportional to the collector current I

$$I = 1 \text{ nA} \cdot \frac{U_A}{V}$$

e) Back of the housing:



- e1 Connector for electric oven
- e2 Screwdriver potentiometer
- e3 Primary fuse
- e4 Mains connector
- e5 Mains switch

Connector for electric oven

for connecting the electric oven and for grounding the copper tube from the scope of delivery of the socket for Hg Franck-Hertz tube.

Screwdriver potentiometer

for adjusting the cathode heating voltage.

4 Technical data

Digital display: four-digit 7-segment display

Emitting grid voltage U_1 : 0 ... 5 V

Accelerating voltage U_2 : 0...30 V for Hg
0...80 V for Ne
(Ne Franck-Hertz tube is recognized automatically)

Countervoltage U_3 : 0 ... 10 V

Cathode heating voltage: 5.9 ... 6.7 V,
default: 6.3 V

Setpoint temperature of the Hg Franck-Hertz tube: 140-210°C

Measuring range for collector current: 10 nA

Repetition frequency for oscilloscope display: 25 Hz / 30 Hz

In the oscilloscope display, the influence of the capacitances of the Franck-Hertz tube and the socket makes itself felt. The current required for transporting the electrons causes a slight shift and distortion of the Franck-Hertz curve.

Time interval for automatic recording: >10 s

Electrical data:

Power consumption: up to 30 W without electric oven
up to 230 W with electric oven

Mains voltage: see rating plate on the back of the housing.

Primary fuse: see fuse plate on the back of the housing.

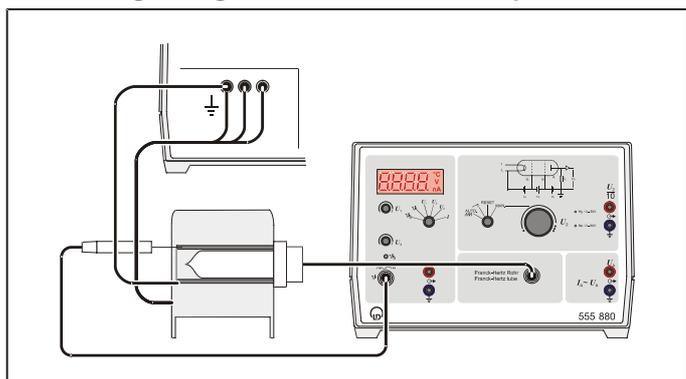
General data:

Dimensions: 21 cm × 30 cm × 23 cm

Weight: 3 kg

5 Operation

5.1 Putting the Hg Franck-Hertz tube into operation:



additionally required:

- | | |
|--|---------|
| 1 Hg Franck-Hertz tube | 555 854 |
| 1 socket for Hg Franck-Hertz tube,
with DIN connector | 555 864 |
| 1 electric oven 230 V | 555 81 |
| or | |
| 1 electric oven 115 V | 555 82 |
| 1 NiCr-Ni temperature sensor | 666 193 |

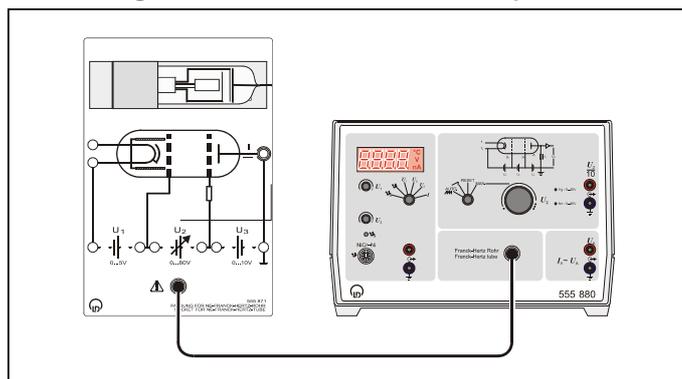
- Insert the copper tube from the scope of delivery of the socket in the electric oven, and guide the copper strand through the opening on the back of the electric oven.
- Connect the electric oven on the back of the Franck-Hertz supply unit, and ground the copper tube with the aid of the copper strand.
- Insert the NiCr-Ni temperature sensor through the small bore on the back of the electric oven in the blind hole of the copper tube, and connect it to the 5-pin DIN socket of the Franck-Hertz supply unit.
- Plug the Hg Franck-Hertz tube into the socket, and connect it on the terminal panel of the Franck-Hertz supply unit.
- Insert the Hg Franck-Hertz tube completely in the copper tube.
- Switch the Franck-Hertz supply unit on, and wait until the operating temperature of the Hg Franck-Hertz tube is reached.
- Adjust the emitting grid voltage $U_1 = 1.5$ V and the counter-voltage $U_3 = 1.5$ V.

A few seconds after switching on, the red light of the LED indicates that the electric oven is heating. After 10 to 15 min, the operating temperature is reached, and the LED shines green.

If the digital display blinks, there is a fault in the setup for the temperature measurement:

Fault	Display
No temperature sensor connected	Digital display blinks immediately after switching on the Franck-Hertz supply unit
Temperature sensor is connected, but is not inserted in the blind hole of the copper cylinder.	Digital display blinks some minutes after switching on the Franck-Hertz
Temp. sensor has fallen out of the blind hole after reaching the operating temperature.	Digital display blinks some seconds after the sensor has fallen out of the hole.

5.2 Putting the Ne Franck-Hertz tube into operation:



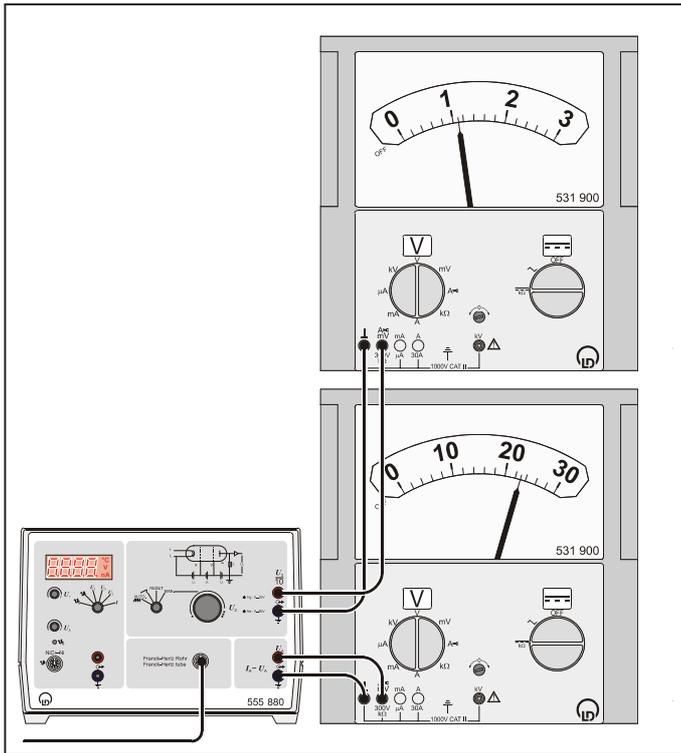
additionally required:

- | | |
|--|---------|
| 1 Ne Franck-Hertz tube | 555 870 |
| 1 holder with socket and screen | 555 871 |
| 1 connecting cable
for Ne Franck-Hertz tube | 555 872 |

- Switch the Franck-Hertz supply unit on.
- Adjust the emitting grid voltage $U_1 = 1.5$ V and the counter-voltage $U_3 = 10$ V.

The Ne Franck-Hertz tube is used at room temperature and is ready for operation approx. 1 min after switching on the supply unit.

5.3 Manual recording with additional measuring instruments:



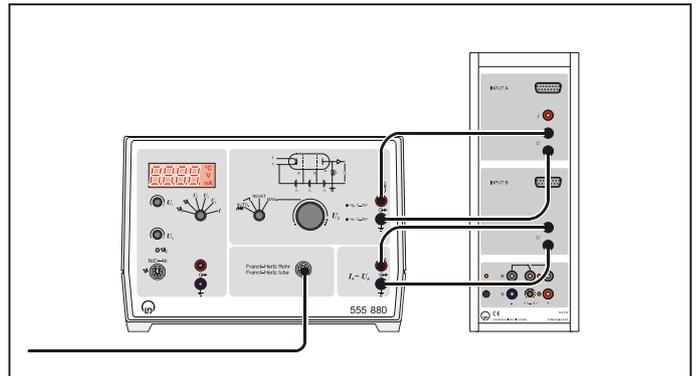
additionally required:

- 2 voltmeters e.g. 531 905
- Connect a voltmeter to the output UA and the other one to the output U2/10.
- Select the range 0...1 V DC for the output UA.
- Select the range 0...3 V DC for Hg or 0...8 V DC for Ne, respectively, for the output U2/10.
- Set the operating mode switch to MAN.
- Slowly increase the voltage from zero to the maximum value with the voltage regulator U_2 , and read the current and the accelerating voltage.

5.4 Manual recording without additional measuring instruments:

- Set the operating mode switch to MAN.
- Set the selector switch to the parameter U_2 , and adjust the first value of U_2 with the voltage regulator.
- Change over to the parameter I , and read the collector current from the digital display.
- Switch back to the parameter U_2 , and adjust the next value of U_2 etc.

5.5 Recording with an XY recorder or CASSY:



additionally required:

- | | |
|--------------------------------------|---------|
| 1 XY recorder | 575 664 |
| or | |
| 1 Sensor-CASSY | 524 010 |
| 1 CASSY Lab | 524 200 |
| 2 pairs of cables, red and blue, 1 m | 501 46 |

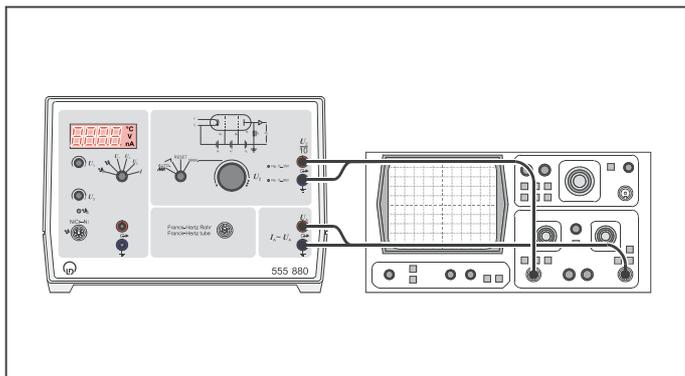
Parameters for XY recorder:

- X-axis: approx. 0.1 V/cm (Hg) or approx. 0.3 V/cm (Ne)
- Y-axis: approx. 1 V/cm

Parameters for CASSY:

- Interval: 100 ms
- Trigger: UA1 = 0.1 V rising
- X-axis: approx. 0.1 V/cm (Hg) or approx. 0.3 V/cm (Ne)
- $I_A / nA = U_{B1} / V$
- $U_2 = 10 UA1$
- Connect the XY recorder to the output UA (Y) and to the output U2/10 (X).
- Set the operating mode switch to \nearrow (the accelerating voltage U_2 rises once slowly from zero to the maximum value).
- Connect the Sensor-CASSY to the output UA (B) and to the output U2/10 (A).
- Set the operating mode switch to RESET, and start the measurement with F9.
- Set the operating mode switch to \nearrow (the accelerating voltage U_2 rises once slowly from zero to the maximum value).

5.6 Quick display with an oscilloscope:



additionally required:

1 two-channel oscilloscope	575 211
2 screened cables BNC/4mm	575 24

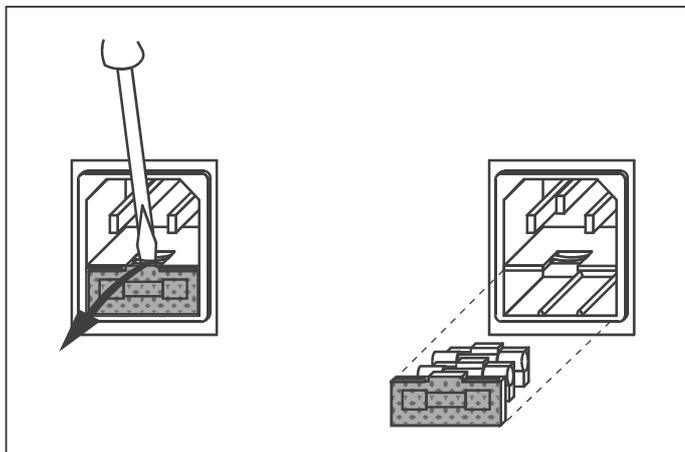
- Connect the two-channel oscilloscope to the output UA (Y) and to the output U2/10 (X), and select the X-Y representation.
- Set the operating mode switch to \mathcal{M} (the accelerating voltage U2 rises quickly from zero to the maximum value again and again).

Parameters:

X-axis: 0.5 V / DIV. (Hg) or 1 V / DIV. (Ne)

Y-axis: 2 V / DIV.

6 Exchanging the fuse



- Lever the insert with the fuse holder and the spare fuse out.
- Replace the defective fuse with a new one.
- Insert a spare fuse, and put the insert back.