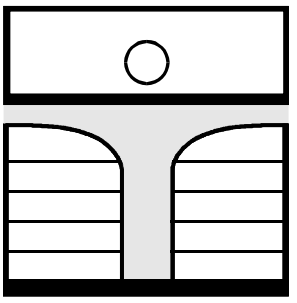

HOCHSCHULE
University
of
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Software for the Industrial Formulation IAPWS-IF97 for Water und Steam

FluidTI
LibIF97
for
TI-83 and TI-83 Plus

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Contents

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0. Package Contents

CD " FluidTI for TI-83 and TI-83 Plus " including the following files:

\TI_Files with the program files

FLUIDTI.8xp
FLUIDTI3.8xp
FLUIDTI4.8xp
FLUIDTI5.8xp
FLUIDTI6.8xp

and list files

E.8xl
F.8xl
G.8xl
H.8xl

FluidTI_TI-83_LibIF97_Docu.pdf - User's Guide

User's Guide as printed copy (in case of shipment) .

1. Functions for the IAPWS-IF97

Functional Dependence	Function Name in FluidTI	Property or Function	Units
$p_S = f(t)$	PS(T)	Saturation pressure from temperature	MPa
$t_S = f(p)$	TS(P)	Saturation temperature from pressure	°C
v = f(p,t,x)	V(P,T,X)	Specific volume	m^3/kg
h = f(p,t,x)	H(P,T,X)	Specific enthalpy	kJ/kg
s = f(p,t,x)	S(P,T,X)	Specific entropy	kJ/(kg K)
t = f(p,h)	T(P,H)	Backward function: temperature from pressure and enthalpy	°C
t = f(p,s)	T(P,S)	Backward function: temperature from pressure and entropy	°C
x = f(p,h)	X(P,H)	Backward function: vapor fraction from pressure and enthalpy	kg/kg
x = f(p,s)	X(P,S)	Backward function: vapor fraction from pressure and entropy	kg/kg

Units: t in °C
p in MPa
x in (kg saturated steam)/(kg wet steam)

Range of validity: region 1 and 2 of the IAPWS-IF97 including wet steam

Liquid region 1: $p = p_S(t)$...100 MPa for 0 °C... 350 °C

Steam region 2: 0.000611 MPa... $p = p_S(t)$ for 0 °C... 350 °C

0.000611 MPa... $p_{23}(t) = p(s = 5.2\ kJ/(kg\ K))$ for 350 °C... 590 °C

0.000611 MPa... 100 MPa for 590 °C... 800 °C

Comment on the vapor fraction x and calculations for wet steam

Because wet steam is handled automatically, the following cautions regarding the input value of the vapor fraction x should be noted:

When the point to be calculated is in the single phase region (liquid or superheated vapor), the pressure p and temperature t are given and the value -1 has to be entered for x .

When the point to be calculated is in wet steam, values between 0 and 1 have to be entered for x (the value 0 for saturated liquid, the value 1 for saturated vapor).
For wet steam, either the given value for t and *p = -1* or the given value for p and *t = -1* and (in both cases) the value for x between 0 and 1 have to be entered. For wet steam, if p and t and x are entered, the program tests whether p and t correspond to the saturation line. If this is not true, the calculator shows an error.

Saturation line of the IAPWS-IF97: t = 0 °C ... 350 °C

p = 0.000611 MPa ... $p_S(t = 350\ °C) = 16.5292$ MPa

Note !

If the input values lie outside the range of validity of the IAPWS-IF97 or they do not define a unique state point, the comment “OUT OF RANGE” will be shown.

2. Description of the IAPWS-IF97

The International Association for the Properties of Water and Steam IAPWS-IF97 issued the " IAPWS Industrial Formulation 1997 for the Thermodynamic Properties of Water and Steam" in September 1997 [1,2,3]. It will be abbreviated as IAPWS-IF97. This new industrial standard has to be used in acceptance and guarantee calculations of facilities and plants working with water or steam worldwide. The IAPWS-IF97 Formulation replaces the former Industrial Formulation IFC-67 [12].

Figure 1 shows the entire range of validity of the equation set of the new Industrial Formulation IAPWS-IF97. It covers temperatures from 0 °C up to 800 °C for pressures from 0.000611 up to 100 MPa and temperatures up to 2000 °C for pressures up to 10 MPa.

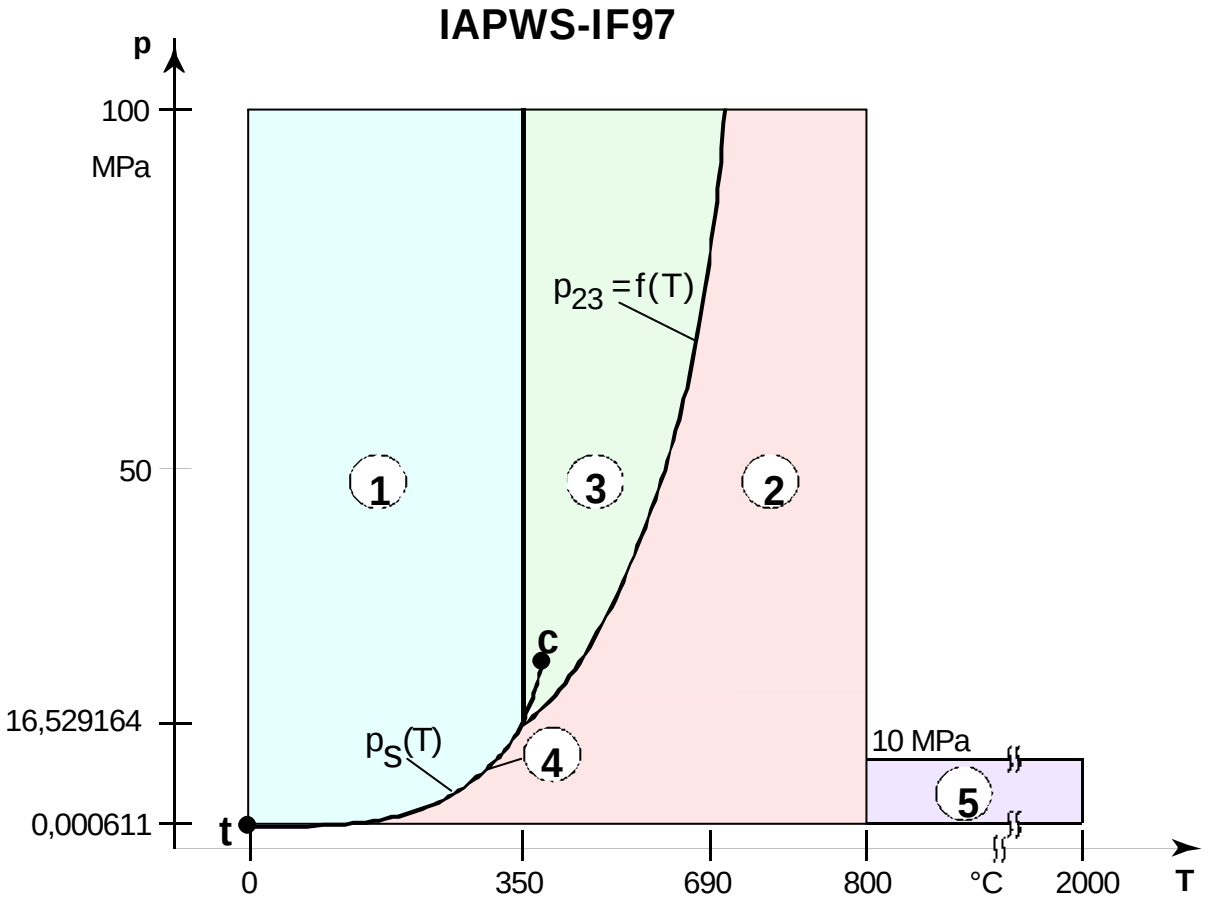


Figure 1: Entire Range of Validity of the IAPWS-IF97

The entire range of validity is divided into five calculation regions. Each of the calculation region contains its own equation of state. The equations are described in detail in the official Release of the IAPWS [1] and in the publications by *Wagner et al.* [2,3].

The student version of FluidTI cannot be used in the entire range of validity. Calculations are possible in regions 1 and 2 and wet steam region up to pressures of 16.529164 MPa (Figure 1).

The determination of the region and the call of the related equation of state is incorporated within the program.

3. Application of FluidTI for the calculation of water and steam

3.1 Installation of FluidTI on TI-83 and TI-83 Plus

The program FluidTI will be copied from the PC to the calculator using a special Link Program and the appropriate Link Cable.

For that, 15 KB free memory (RAM) is required on the TI. For TI-83, free memory can only be reached by deleting other programs, lists, etc. . For TI-83 Plus, programs can be archived in ARC-memory without deleting them. The explanation is given under "Peculiarity: Flash-memory TI-83 Plus:" at the end of paragraph 3.1 .

The link program and the USB-cable can be purchased in a store which sells TI calculators or ordered at Boettcher Datentechnik GmbH

http://www.boettcher-datentechnik.de/.

The following description refers to the link program

TI-Graph Link 83 Plus,

which should be installed before.

This program should be used for TI-83, too.

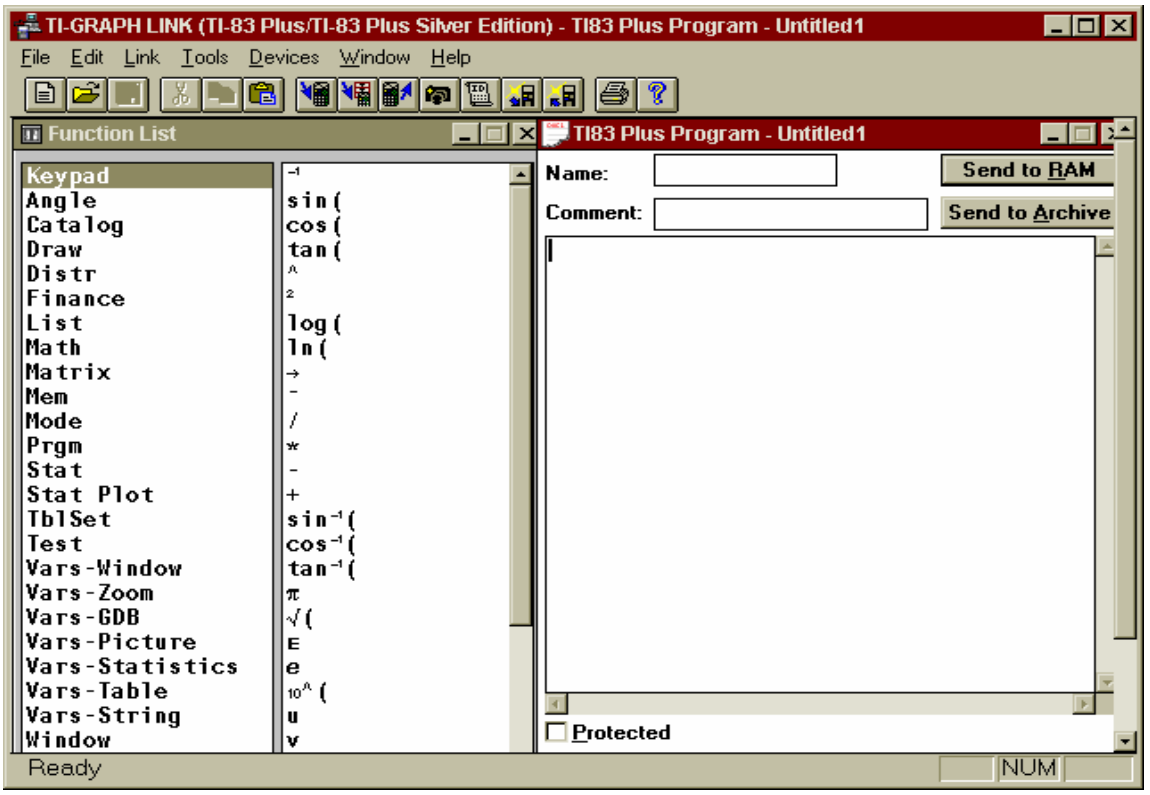
(Instructions for the data transfer using other link programs can be taken from the belonging online helps or user's guides.)

Installing FluidTI:

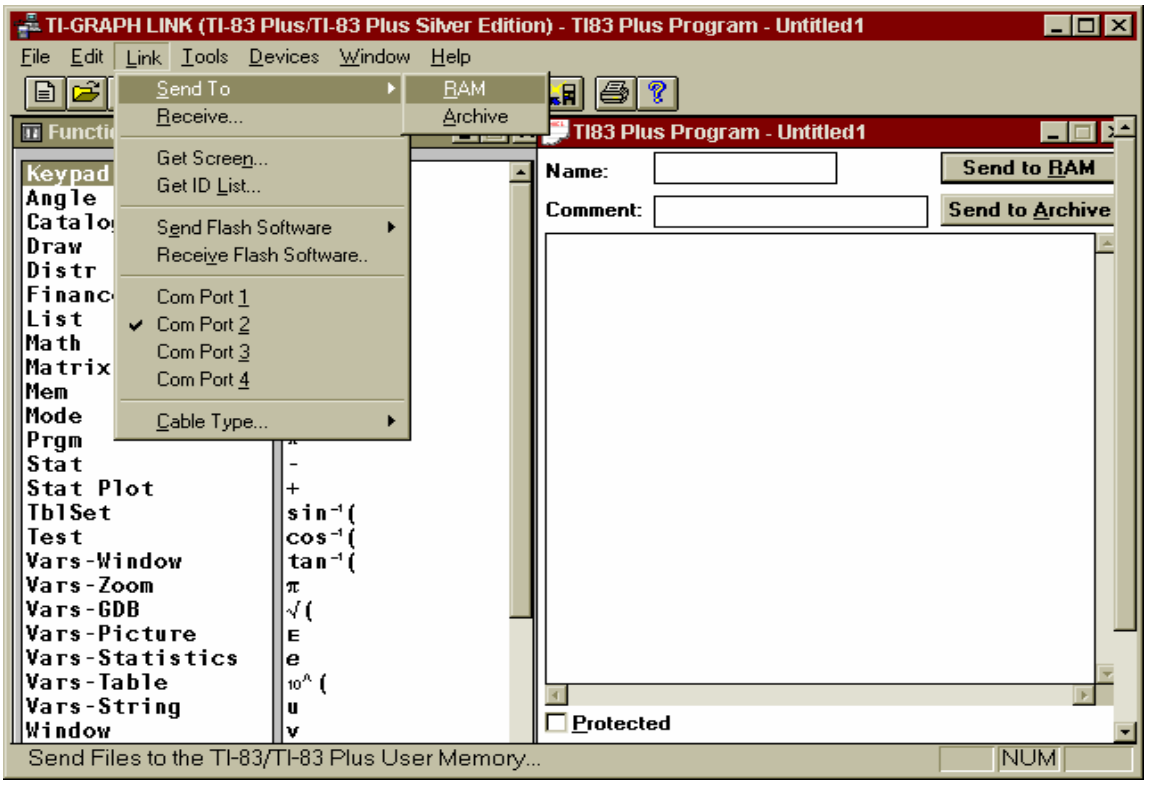
The description refers to both calculators TI-83 and TI-83 Plus.

1. Connect the TI calculator with the PC as follows.
   Pluck the link cable in a free serial interface of the PC (COM1 or COM2) and in the TI calculator.
2. Switch the TI-83 calculator on [The TI-83 Plus switches on automatically when plucking in the cable].
3. Insert the CD "FluidTI for TI-83 and TI-83 Plus" into the CD-drive of the PC.

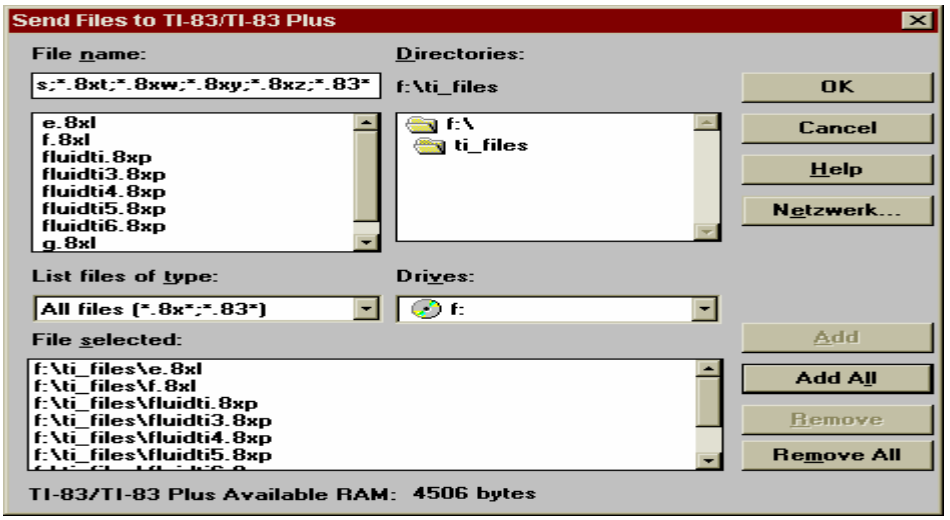
4. Start the program TI-Graph Link 83 Plus on PC as follows.
   Click in the Windows task bar on "Start", then on "Programs", then on "TI-Graph Link" and on "TI-Graph Link 83 Plus".
   The following window appears:



5. Click in the pull down menu "Link" on "Send To", there on "RAM".



6. A Sending-Window appears. If the PC shows an error, look under paragraph 8 for help.



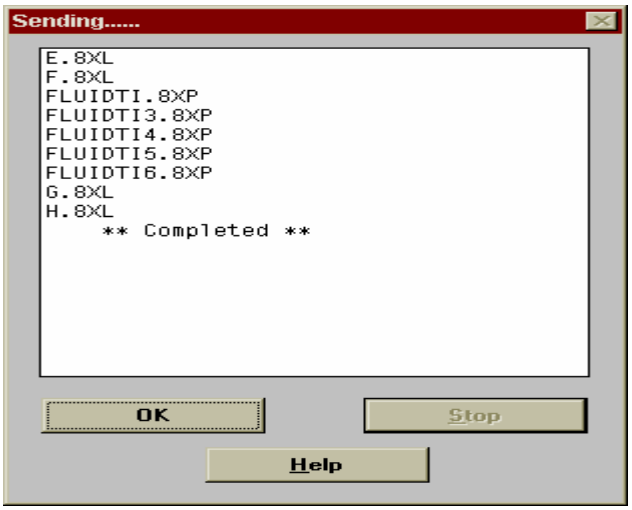
Choose your CD-drive under "Drives" . Then choose the file "TI-Files" under "Directories" with a double click. All TI-files will be shown under "File name:" .

7. Now, click in the Sending-Window on the button "Add All" . All files will be shown under "File selected".

8. Click on "OK" to start the transfer.

   All marked files are copied on the pocket calculator. This can last some minutes.

   After copying is completed, confirm the following window by clicking "OK". That's all.



If the files were not copied, there are the following possibilities of errors:

- A wrong or defective link cable is used.

  In order to remove this, click in the menu border on "Link" and then on "Cable type". Select the used cable by clicking the correct button.

- The wrong serial interface is chosen in the PC link program.

  Then choose the right Com Port in the pull down menu "Link" and confirm by clicking "OK".

- The needed serial interface is used by another program.

  Cut this disturb connection.

- The plugs are not correctly put in.

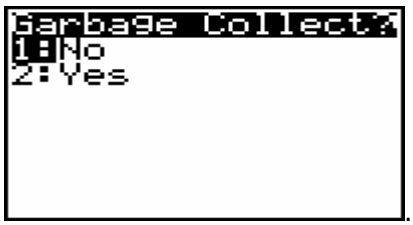
Peculiarity: Flash-memory at TI-83 Plus:

The following steps show how to archive programs to reach more RAM memory.

1. Enter the memory menu by pressing <2nd> and <MEM> (upper the <+> - key). The following screen will be shown:

2. Choose "2: Mem Mgmt/Del…" with the cursor-block and press <ENTER> or press key <2>. The following window appears:

3. If the number behind "RAM FREE" is higher than 15000, there are enough RAM-memory for the installation of FluidTI. Press <2nd> and <QUIT> (upper the <MODE> - key) to return. Otherwise read the next paragraphs:
4. Choose "7: Prgm…" and confirm with <ENTER> or press key <7>.
5. Now all programs are listed with their memory capacity in Byte (on the right). Behind "RAM FREE" will be shown the size of free RAM-memory. Behind "ARC FREE" the free ARCHIVES-memory. Place the cursor with the cursor-block in front of a program and press <ENTER> to archive it. Now a star appears in front of the program. (If instead the window "Garbage Collect?" opens, read at first paragraph 7.) The star symbolizes the archived state. The figure behind "RAM FREE" rises about the size of the archived program. Repeat this up to 15 KB free RAM-memory.
6. To un-archive a program, place the cursor again in front of it and press <ENTER>. The star disappears and the program is back in the RAM-memory. After archive and un-archive some programs, the following window appears:



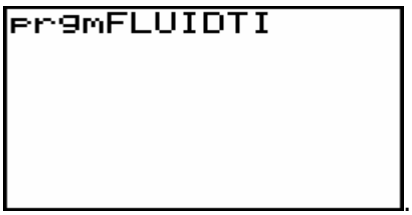
7. Choose "2: YES" with the cursor-block and confirm with <ENTER> or press key <2>.This lasts half a minute. The pocket calculator deletes some unnecessary data in the archives.

3.2 Example: Calculation of h = f(p, t, x)

The specific enthalpy h as a function of pressure p, temperature t, and vapor fraction x can be calculated for the Industrial-Formulation IAPWS-IF97 [1,2,3]

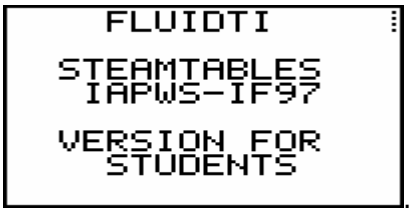
To do this, the following steps must be completed:

- Press on the <PRGM> - key to open the program menu.
- Start the program by choosing "FLUIDTI" with the cursor block and press <ENTER> to confirm. "prgmFLUIDTI" will be shown on your calculator screen.



Press <ENTER> again.

- The following screen will be shown:



Hint for TI-83 Plus:

In case the following message arises

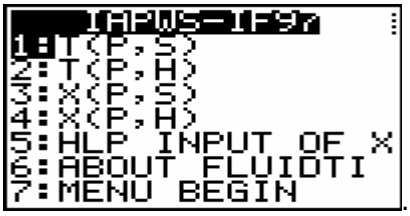
,

TI could not find the program FLUIDTI. Press <ENTER> and un-archive the file FLUIDTI. For this, follow the description "Peculiarity: Flash-memory TI-83 Plus:" at the end of paragraph 3.1 .

Then, start the example again.

- Press <ENTER> for the function menu of FluidTI:

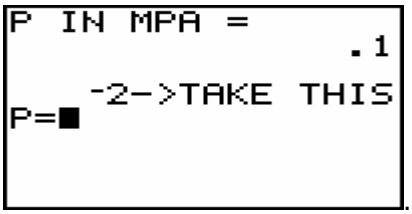
- Move with the cursor to "6:CONTINUE" and then press <ENTER> or press the key <6> for further functions:



  Move with the cursor to "4:MENU BEGIN" and then press <ENTER> or press the key <4> to return to the first part of the menu.

- In the first menu part mark "4:H(P,T,X)" with the cursor block and confirm with <ENTER> or press the key <4> to choose the function "h(p,t,x)".

  The following input window for pressure p in MPa appears:



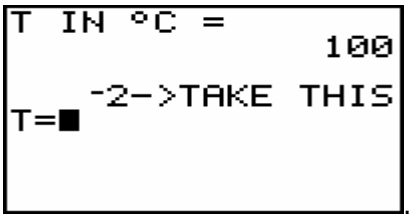
  Pay attention to the range of validity of the IAPWS-IF97:

  p = 0.000611 MPa ... 100 MPa

  → e.g.: Enter the value 10 and confirm with <ENTER>.

  Note: *The current value shown in the second line can be taken over by entering of -2.*

- The input window for the temperature t in °C appears:

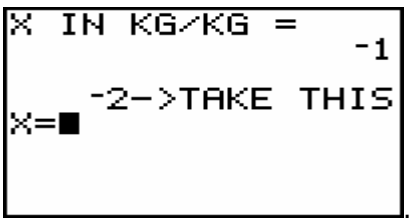


  Pay attention to the range of validity of the IAPWS-IF97:

  t = 0 °C ... 350 °C

  → e.g.: Enter the value 400 and confirm with <ENTER>.

- The input window for the vapor fraction x in (kg saturated steam)/(kg wet steam) is shown:



Because wet steam is handled automatically, the following cautions regarding the input value of the vapor fraction x should be noted:

In case, the point to be calculated is in the single phase region (liquid or superheated vapor), the pressure p and temperature t are given and the value -1 has to be entered for x.

In case, the point to be calculated is in the wet steam region, values between 0 and 1 have to be entered for x (the value 0 for saturated liquid, the value 1 for saturated vapor).

For wet steam, either the given value for t and *p = -1* **or** the given value for p and *t = -1* and (in both cases) the value for x between 0 and 1 have to be entered.

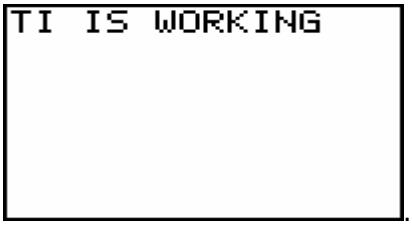
For wet steam, if p and t and x are entered, the program tests whether p and t correspond to the saturation line. If this is not true, appears "OUT OF RANGE".

Wet steam region: t = 0 °C ... 350 °C

p = 0.000611 MPa ... 16.5292 MPa

→ e.g.: The point which should be calculated is situated in the single phase region. Therefore, enter the value -1 for x. Here the program show -1 and you can take over it by entering -2.
For example enter -2 (Attention: press the key <(-)> for the sign).

- During the calculation, the following window will be shown:



Hint for TI-83 Plus

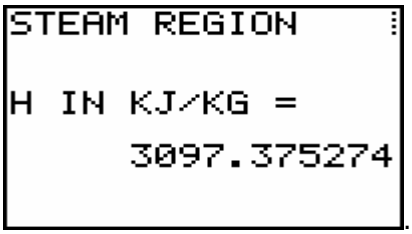
In case the following message arises

,

TI could not find all files. Press <ENTER> and un-archive the files FLUIDTI3, FLUIDTI4, FLUIDTI5, FLUIDTI6 and the lists "E", "F", "G" and "H" . For this, follow the description under "Peculiarity: Flash-memory TI-83 Plus:" at the end of paragraph 3.1 .

Then start the example again.

- After calculation, the result for h in kJ/kg is shown at the display:



→ e.g.: In the example the value 3097.375274 should arise.

The calculation of h = f(p,t,x) is now complete.

Note: The calculated value for h has been stored into the variable "T" (<T> - key).
Afterwards, this variable can be used independently of FluidTI.
In the next calculation, FluidTI will overwrite the variable "T".
The values for v, s, t and x also would be stored after their calculation.

Now, press <ENTER> to return to the main menu.

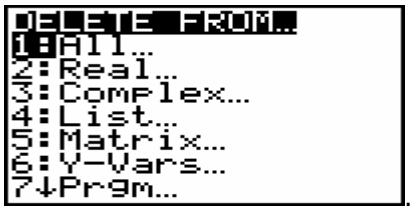
Choose "7:END" with the cursor block and press <ENTER> or press key <7> to finish the program FluidTI.

3.3 Removing FluidTI from TI-83

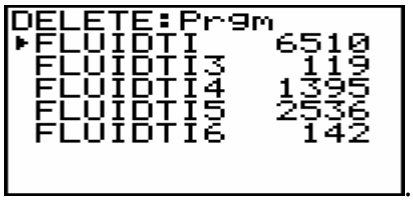
The following steps must be completed:

1. Enter the memory menu by pressing <2nd> and <MEM> (upper the <+> - key). The following screen will be shown:

2. Choose "2:Delete…" with the cursor-block and press <ENTER> or press key <2>. The following window appears:

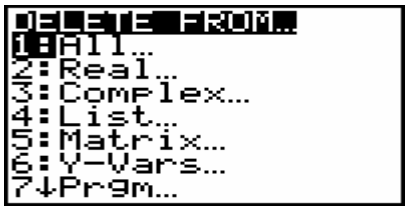


3. Choose "7:Prgm…" and confirm with <ENTER> or press key <7> for the program delete menu. The following window will be shown:



4. Search the file "FLUIDTI" . Press <ENTER> to delete this file.
5. Repeat the deleting process for the following files: "FLUIDTI3", "FLUIDTI4", "FLUIDTI5" and "FLUIDTI6".

6. Repeat the steps under paragraph 1 and paragraph 2. The following window appears:



.

7. Choose "4: List…" and confirm with <ENTER> or press key <4> for the list delete menu. The following window will be shown:

.

8. Search the list "E". Press <ENTER> to delete this list.
9. Repeat the deleting process for the following lists: "F", "G" and "H" .
10. Press <2nd> and <QUIT> (upper the <MODE> - key) to return.

FluidTI has been removed.

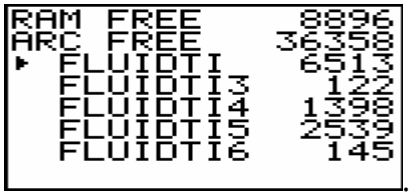
3.4 Removing FluidTI from TI-83 Plus

The following steps must be completed:

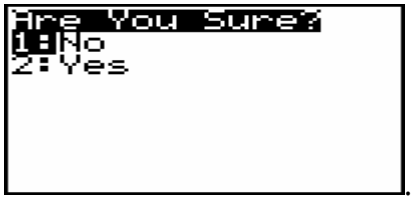
1. Enter the memory menu by pressing <2nd> and <MEM> (upper the <+> - key). The following screen will be shown:

2. Choose "2:Mem Mgmt/Del…" with the cursor-block and press <ENTER> or press key <2>. The following window appears:

3. Choose "7: Prgm…" and confirm with <ENTER> or press key <7> for the program delete menu. The following window will be shown:



4. Search the file "FLUIDTI" . Now press the key <DEL>.



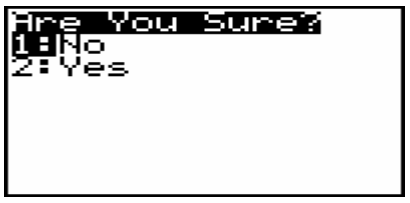
   Choose "2:YES" with the cursor-block and confirm with <ENTER> or press key <2>.

5. Repeat the deleting process for the following files: "FLUIDTI3", "FLUIDTI4", "FLUIDTI5" and "FLUIDTI6".

6. Repeat the steps under paragraph 1 and paragraph 2. The following window appears:

7. Choose "4: List…" and confirm with <ENTER> or press key <4> for the list delete menu. The following window will be shown:

8. Search the list "E". Then press the key <DEL>.



   Choose "2:YES" with the cursor-block and confirm with <ENTER> or press key <2>.

9. Repeat the deleting process for the following lists: "F", "G" and "H" .
10. Press <2nd> and <QUIT> (upper the <MODE> - key) to return.

FluidTI has been removed.

4. Program Documentation

Saturation Pressure $p_S = f(t)$

Name in FluidTI: PS(T)

Input

T - Temperature t in °C

Output

PS - Saturation pressure p_s in MPa

Range of validity

From t = 0 °C to t = 373.946 °C .

Reaction for wrong input

Error message "Out of Range" for input values:

t < 0 °C or t > 373.946 °C

References: [1], [2], [3], [4], [5]

Saturation Temperature $t_S = f(p)$

Name in FluidTI: TS(P)

Input

P - Pressure of p in MPa

Output

TS - Saturation temperature t_s in °C

Range of validity

From p = 0.000611 MPa to p = 22.064 MPa .

Reaction for wrong input

Error message "Out of Range" for input values:

p < 0.000611 MPa or p > 22.064 MPa

References: [1], [2], [3], [4], [5]

Specific Volume v = f(p,t,x)

Name in FluidTI: V(P,T,X)

Input

P - Pressure p in MPa
T - Temperature t in °C
X - Vapor fraction x in (kg saturated steam)/(kg wet steam)

Output

V - Specific volume v in m^3/kg

Range of validity

Liquid region : $p = p_s(t)$... 100 MPa for 0 °C... 350 °C
Steam region : 0.000611 MPa... $p = p_s(t)$ for 0 °C... 350 °C
0.000611 MPa... $p_{23}(t) \approx p(s = 5.2\ kJ/(kg\ K))$ for 350 °C... 590 °C
0.000611 MPa... 100 MPa for 590 °C... 800 °C

Comment on the vapor fraction x and calculations for wet steam

Because wet steam is handled automatically, the following cautions regarding the input value of the vapor fraction x should be noted:

When the point to be calculated is in the single phase region (liquid or superheated vapor), the pressure p and temperature t are given and the value -1 has to be entered for x.

When the point to be calculated is in wet steam, values between 0 and 1 have to be entered for x (the value 0 for saturated liquid, the value 1 for saturated vapor).

For wet steam, either the given value for t and *p = -1* or the given value for p and *t = -1* and (in both cases) the value for x between 0 and 1 have to be entered. For wet steam, if p and t and x are entered, the program tests whether p and t correspond to the saturation line. If this is not true, the calculator shows an error.

Wet steam region: t = 0 °C ... 350 °C
p = 0.000611 MPa ... 16.5292 MPa

Reaction for wrong input

Error message "Out of Range" for input values:

Single phase region: (x = -1) The entered parameters are outside of the above mentioned range of validity.

Wet steam region: ($0 \le x \le 1$)
at p = -1 and t > 350° C or t < 0° C or
at t = -1 and p > 16.5292 MPa or p < 0.000611 MPa or
at p > 16.5292 MPa or p < 0.000611 MPa
and t > 350° C or t < 0° C
at $| t - t_s(p) | > 0.1$ K

References: [1], [2], [3], [4], [5]

Specific Enthalpy h = f(p,t,x)

Name in FluidTI: H(P,T,X)

Input

P - Pressure p in MPa
T - Temperature t in °C
X - Vapor fraction x in (kg saturated steam)/(kg wet steam)

Output

H - Specific enthalpy h in kJ/kg

Range of validity

Liquid region : $p = p_s(t)$... 100 MPa for 0 °C... 350 °C
Steam region : 0.000611 MPa... $p = p_s(t)$ for 0 °C... 350 °C
0.000611 MPa... $p_{23}(t) \approx p(s = 5.2\ kJ/(kg\ K))$ for 350 °C... 590 °C
0.000611 MPa... 100 MPa for 590 °C... 800 °C

Comment on the vapor fraction x and calculations for wet steam

Because wet steam is handled automatically, the following cautions regarding the input value of the vapor fraction x should be noted:

When the point to be calculated is in the single phase region (liquid or superheated vapor), the pressure p and temperature t are given and the value -1 has to be entered for x.

When the point to be calculated is in wet steam, values between 0 and 1 have to be entered for x (the value 0 for saturated liquid, the value 1 for saturated vapor).

For wet steam, either the given value for t and *p = -1* or the given value for p and *t = -1* and (in both cases) the value for x between 0 and 1 have to be entered. For wet steam, if p and t and x are entered, the program tests whether p and t correspond to the saturation line. If this is not true, the calculator shows an error.

Wet steam region: t = 0 °C ... 350 °C
p = 0.000611 MPa ... 16.5292 MPa

Reaction for wrong input

Error message "Out of Range" for input values:

Single phase region: (x = -1) The entered parameters are outside of the above mentioned range of validity.

Wet steam region: ($0 \le x \le 1$)
at p = -1 and t > 350° C or t < 0° C or
at t = -1 and p > 16.5292 MPa or p < 0.000611 MPa or
at p > 16.5292 MPa or p < 0.000611 MPa
and t > 350° C or t < 0° C
at $| t - t_s(p) | > 0.1$ K

References: [1], [2], [3], [4], [5]

Specific Entropy s = f(p,t,x)

Name in FluidTI: S(P,T,X)

Input

P - Pressure p in MPa
T - Temperature t in °C
X - Vapor fraction x in (kg saturated steam)/(kg wet steam)

Output

S - Specific entropy s in kJ/(kg K)

Range of validity

Liquid region : $p = p_s(t)$... 100 MPa for 0 °C... 350 °C
Steam region : 0.000611 MPa... $p = p_s(t)$ for 0 °C... 350 °C
0.000611 MPa... $p_{23}(t) \approx p(s = 5.2\ kJ/(kg\ K))$ for 350 °C... 590 °C
0.000611 MPa... 100 MPa for 590 °C... 800 °C

Comment on the vapor fraction x and calculations for wet steam

Because wet steam is handled automatically, the following cautions regarding the input value of the vapor fraction x should be noted:

When the point to be calculated is in the single phase region (liquid or superheated vapor), the pressure p and temperature t are given and the value -1 has to be entered for x.

When the point to be calculated is in wet steam, values between 0 and 1 have to be entered for x (the value 0 for saturated liquid, the value 1 for saturated vapor).

For wet steam, either the given value for t and *p = -1* or the given value for p and *t = -1* and (in both cases) the value for x between 0 and 1 have to be entered. For wet steam, if p and t and x are entered, the program tests whether p and t correspond to the saturation line. If this is not true, the calculator shows an error.

Wet steam region: t = 0 °C ... 350 °C
p = 0.000611 MPa ... 16.5292 MPa

Reaction for wrong input

Error message "Out of Range" for input values:

Single phase region: (x = -1) The entered parameters are outside of the above mentioned range of validity.

Wet steam region: ($0 \le x \le 1$) at p = -1 and t > 350° C or t < 0° C or
at t = -1 and p > 16.5292 MPa or p < 0.000611 MPa or
at p > 16.5292 MPa or p < 0.000611 MPa
and t > 350° C or t < 0° C
at $| t - t_s(p) | > 0.1$ K

References: [1], [2], [3], [4], [5]

Backward Function: Temperature t = f(p,h)

Name in FluidTI: T(P,H)

Input

P - Pressure p in MPa
H - Specific enthalpy h in kJ/kg

Output

T - Temperature t in °C

Range of validity

Liquid region:	IAPWS-IF97 region 1 (Figure 1)
Steam region:	IAPWS-IF97 region 2 (Figure 1)
Wet steam region:	p = 0.000611 ... 16.5292 MPa and h'(p) < h < h''(p)

Comment on the calculations for wet steam

The wet steam region is handled automatically. This means with reference to the given values for p and h a subroutine find out whether the condition point to be calculated lies in the one phase area (liquid or steam) or in the wet steam region. Then the concerning condition area will be calculated.

Reaction for wrong input

Error message "Out of Range" for input values:

Liquid region :	at values of p and h outside region 1 of the IAPWS-IF97 (Figure 1)
Steam region:	at values of p and h outside region 2 of the IAPWS-IF97 (Figure 1)
Water steam region:	at values of p > 16.5292 MPa or p < 0.000611 MPa or at values of h < h'(p) or h > h''(p)

References: [1], [2], [3], [4], [5]

Backward Function: Temperature t = f(p,s)

Name in FluidTI: T(P,S)

Input

P - Pressure p in MPa
S - Specific entropy s in kJ/(kg K)

Output

T – Temperature t in °C

Range of validity

Liquid region:	IAPWS-IF97 region 1 (Figure 1)
Steam region:	IAPWS-IF97 region 2 (Figure 1)
Wet steam region:	p = 0.000611 ... 16.5292 MPa

Comment on the calculations for wet steam

The wet steam region is handled automatically. This means with reference to the given values for p and s a subroutine find out whether the condition point to be calculated lies in the one phase area (liquid or steam) or in the wet steam region. Then the concerning condition area will be calculated.

Reaction for wrong input

Error message "Out of Range" for input values:

Liquid region:	at values of p and s outside region 1 of the IAPWS-IF97 (Figure 1)
Steam region:	at values of p and s outside region 2 of the IAPWS-IF97 (Figure 1), with s < 5.85 kJ/(kg K)
Water steam region:	at values of p > 16.5292 MPa or p < 0.000611 MPa

References: [1], [2], [3], [4], [5]

Backward Function: Vapor fraction x = f(p,h)

Name in FluidTI: X(P,H)

Input

P - Pressure p in MPa
H - Specific enthalpy h in kJ/kg

Output

X - Vapor fraction x in kg/kg

Range of validity

Liquid region:	IAPWS-IF97 region 1 (Figure 1)
Steam region:	IAPWS-IF97 region 2 (Figure 1)
Wet steam region:	p = 0.000611 ... 16.5292 MPa and h'(p) < h < h''(p)

Comment on the calculations for wet steam

The wet steam region is handled automatically. This means with reference to the given values for p and h a subroutine find out whether the condition point to be calculated lies in the one phase area (liquid or steam) or in the wet steam region. In case of wet steam the program calculate the value of x. Otherwise the calculator shows x = -1.

Reaction for wrong input

Result x = -1 for input values:

In case the condition point lies in the one phase area (liquid or steam):

for p > 16.5292 MPa or s < s'(p) or s > s''(p)

Error message "Out of Range" for input values:

p < 0.000611 MPa or p > 100 MPa

References: [1], [2], [3], [4], [5]

Backward Function: Vapor fraction x = f(p,s)

Name in FluidTI: X(P,S)

Input

P - Pressure p in MPa
S - Specific entropy s in kJ/(kg K)

Output

X - Vapor fraction x in kg/kg

Range of validity

Liquid region:	IAPWS-IF97 region 1 (Figure 1)
Steam region:	IAPWS-IF97 region 2 (Figure 1)
Wet steam region:	p = 0.000611 ... 16.5292 MPa and s‘(p) < s < s‘‘(p)

Comment on the calculations for wet steam

The wet steam region is handled automatically. This means with reference to the given values for p and s a subroutine find out whether the condition point to be calculated lies in the one phase area (liquid or steam) or in the wet steam region. In case of wet steam the program calculate the value of x. Otherwise the calculator shows x = -1.

Reaction for wrong input

Result x = -1 for input values:

In case the condition point lies in the one phase area (liquid or steam):
for p > 16.5292 MPa or s < s'(p) or s > s"(p)

Error message "Out of Range" for input values:
p < 0.000611 MPa or p > 100 MPa

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