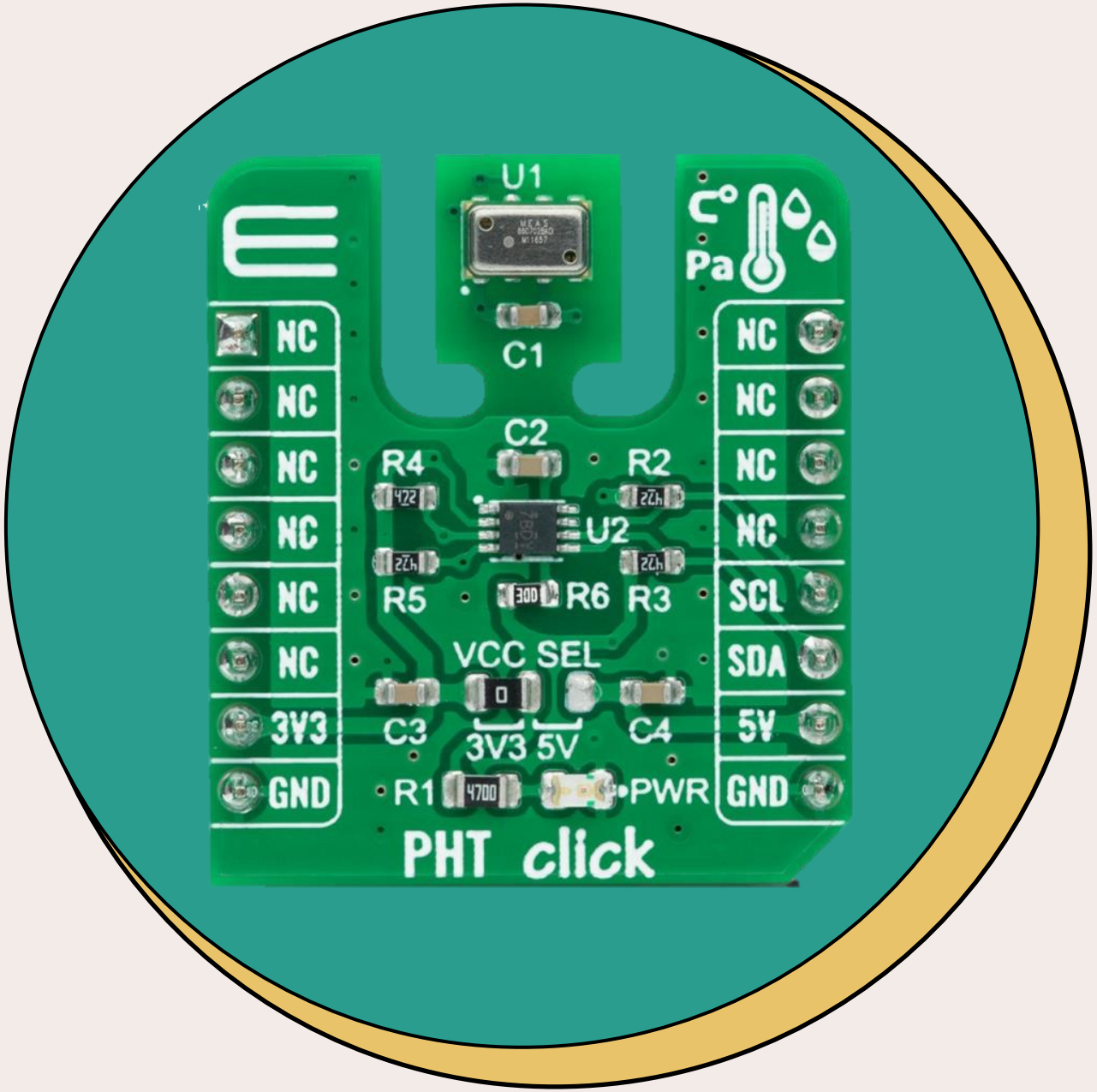
Mikroprocesorski merno-informacioni sistemi 2

Vežbe 8

PHT click


U1
C1
C2
R4
R2
U2
R5
R6
R3
VCC SEL
C3
3V3
5V
C4
R1
PWR
PHT click
NC
NC
NC
NC
NC
NC
3V3
GND
Pa
NC
NC
NC
NC
SCL
SDA
5V
GND

PHT click

- MS8607 senzor – dva senzora
  - Piezo-rezistivni sensor pritiska i temperature
  - Kapacitivni sensor relativne vlažnosti

Sensor type	I²C address (binary value)	I²C address (hex. value)
Pressure and Temperature P&T	1110110	0x76
Relative Humidity RH	1000000	0x40

- Delta-Sigma ADC
  - Senzor pritiska i temperature – 24-bitni
  - Senzor relativne vlažnosti – 12-bitni

PHT click

- Komande za senzor pritiska i temperature:
  - Reset
  - Read PROM
  - Read ADC
  - D1 conversion (pritisak)
  - D2 conversion (temperatura)
- Read ADC – 24-bitna vrednost
- Read PROM – 16-bitna vrednost

	Command byte								hex value
Bit number	7	6	5	4	3	2	1	0	
Bit name	PROM	CONV	-	Typ	Ad2/ Os2	Ad1/ Os1	Ad0/ Os0	Stop	
Command									
Reset	0	0	0	1	1	1	1	0	0x1E
Convert D1 (OSR=256)	0	1	0	0	0	0	0	0	0x40
Convert D1 (OSR=512)	0	1	0	0	0	0	1	0	0x42
Convert D1 (OSR=1024)	0	1	0	0	0	1	0	0	0x44
Convert D1 (OSR=2048)	0	1	0	0	0	1	1	0	0x46
Convert D1 (OSR=4096)	0	1	0	0	1	0	0	0	0x48
Convert D1 (OSR=8192)	0	1	0	0	1	0	1	0	0x4A
Convert D2 (OSR=256)	0	1	0	1	0	0	0	0	0x50
Convert D2 (OSR=512)	0	1	0	1	0	0	1	0	0x52
Convert D2 (OSR=1024)	0	1	0	1	0	1	0	0	0x54
Convert D2 (OSR=2048)	0	1	0	1	0	1	1	0	0x56
Convert D2 (OSR=4096)	0	1	0	1	1	0	0	0	0x58
Convert D2 (OSR=8192)	0	1	0	1	1	0	1	0	0x5A
ADC Read	0	0	0	0	0	0	0	0	0x00
PROM Read P&T	1	0	1	0	Ad2	Ad1	Ad0	0	0xA0 to 0xAE

PHT click

- Komande za senzor relativne vlažnosti:
  - Reset
  - Write user register
  - Read user register
  - Measure RH – hold master (senzor povuče SCK liniju na 0 tokom merenja)
  - Measure RH – no hold master (polling – da li je merenje završeno)
  - Read PROM

	8 bits Command								hex value
Bit number	7	6	5	4	3	2	1	0	
Command :									
1. Reset	1	1	1	1	1	1	1	0	0xFE
2. Write user register	1	1	1	0	0	1	1	0	0xE6
3. Read user register	1	1	1	0	0	1	1	1	0xE7
4. Measure RH (Hold master)	1	1	1	0	0	1	0	1	0xE5
5. Measure RH (No Hold master)	1	1	1	1	0	1	0	1	0xF5
6. PROM read RH	1	0	1	0	adr2	adr1	adr0	0	0xA0 to 0xAE

PHT click

- **User register:**

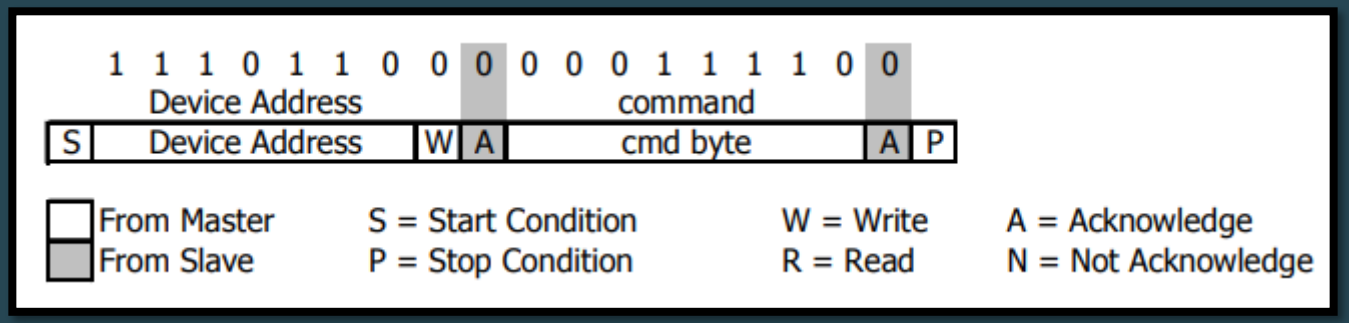
<table>
<tr><th>User register Bit</th><th>Bit Configuration/Coding</th><th>Default value</th></tr>
<tr><td>bit 7, bit 0</td><td>Measurement resolution

<table><tr><td>Bit 7</td><td>Bit 0</td><td>OSR</td><td>Resolution</td></tr><tr><td>0</td><td>0</td><td>4096</td><td>Highest</td></tr><tr><td>0</td><td>1</td><td>2048</td><td></td></tr><tr><td>1</td><td>0</td><td>1024</td><td></td></tr><tr><td>1</td><td>1</td><td>256</td><td>Lowest</td></tr></table></td><td>‘00’</td></tr>
<tr><td>bit 6</td><td>Battery state:
‘0’ VDD>2.25V
‘1’ VDD<2.25V</td><td>‘0’</td></tr>
<tr><td>bit 3,4,5</td><td>Reserved</td><td>‘000’</td></tr>
<tr><td>bit 2</td><td>on-chip heater:
‘0’ heater disabled
‘1’ heater enabled</td><td>‘0’</td></tr>
<tr><td>bit 1</td><td>Reserved</td><td>‘0’</td></tr>
</table>

PHT click

- Pritisak i temperatura:

1. Reset



2. Read PROM

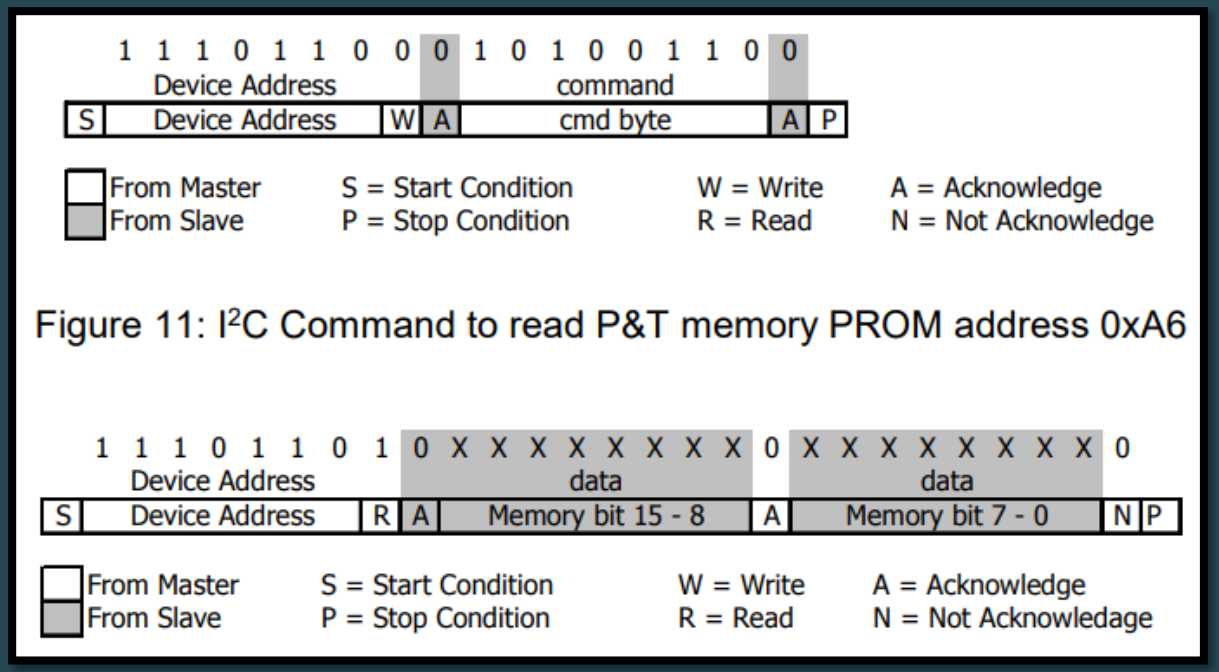
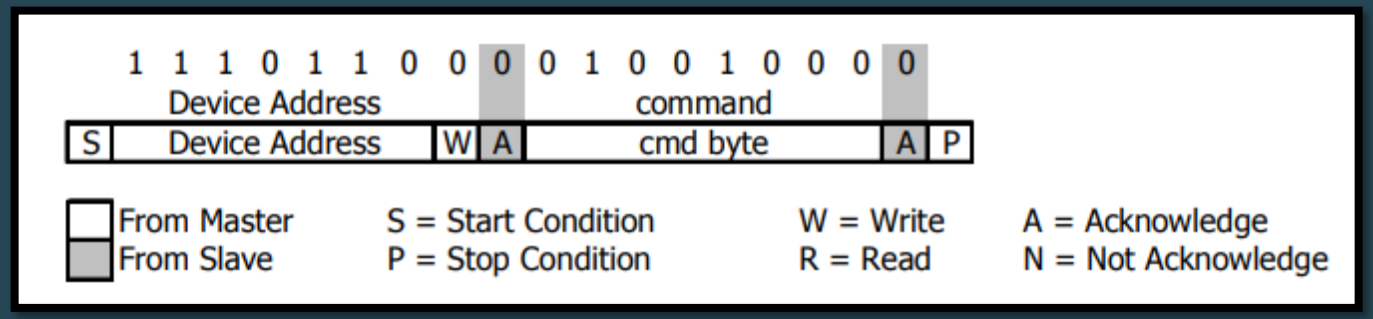


Figure 11: I²C Command to read P&T memory PROM address 0xA6

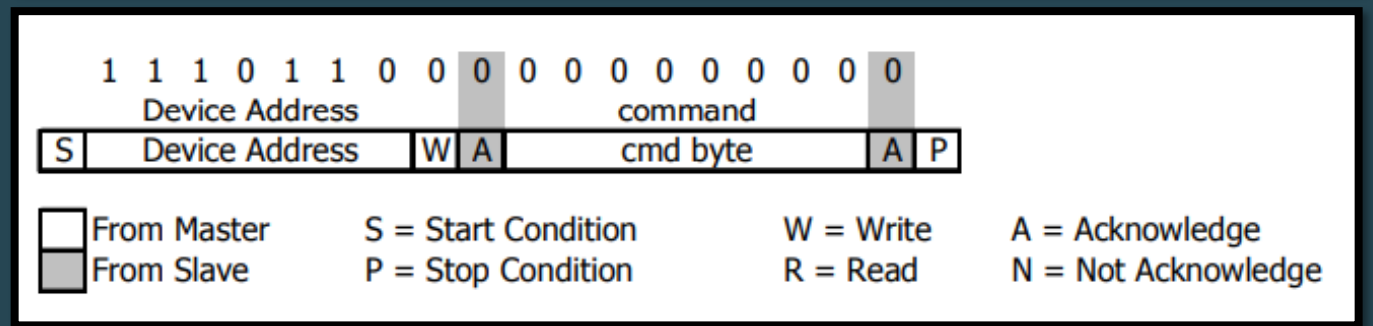
PHT click

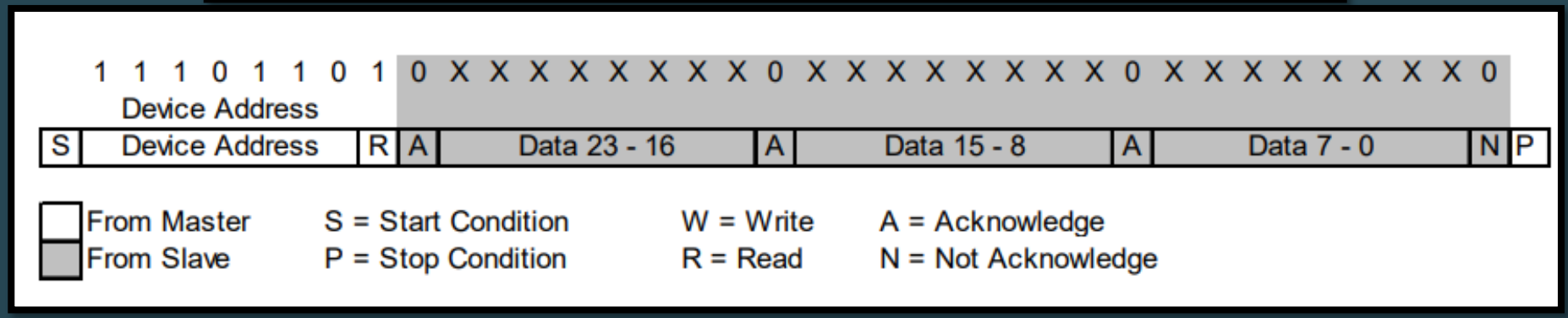
- Pritisak i temperatura:

3. Start conversion



4. Read ADC

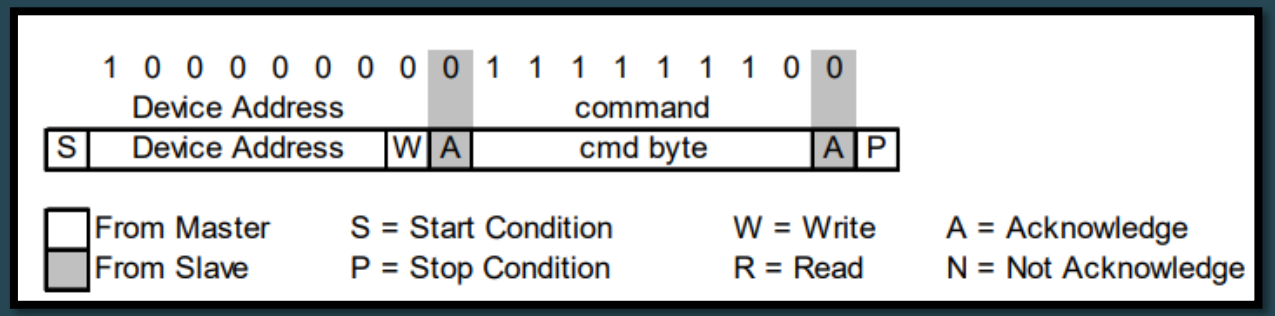




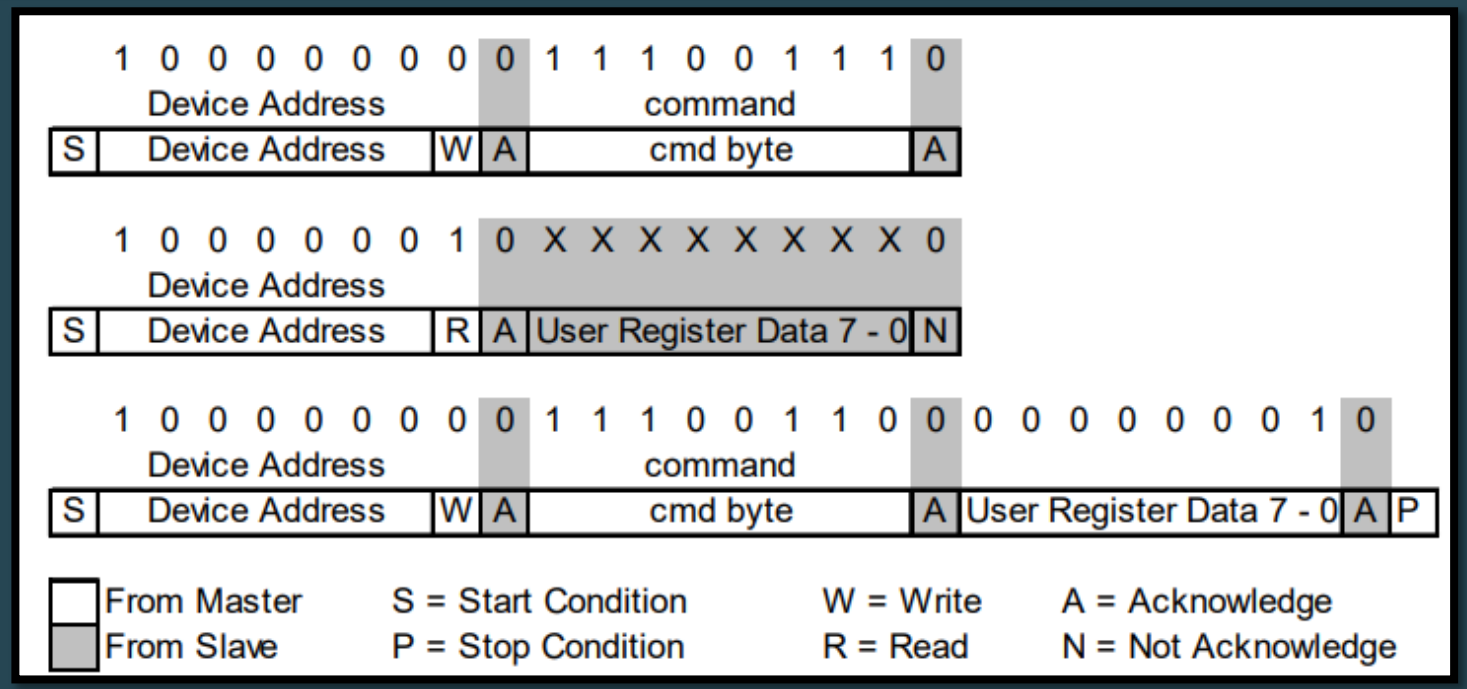
PHT click

- Relativna vlažnost:

1. Reset



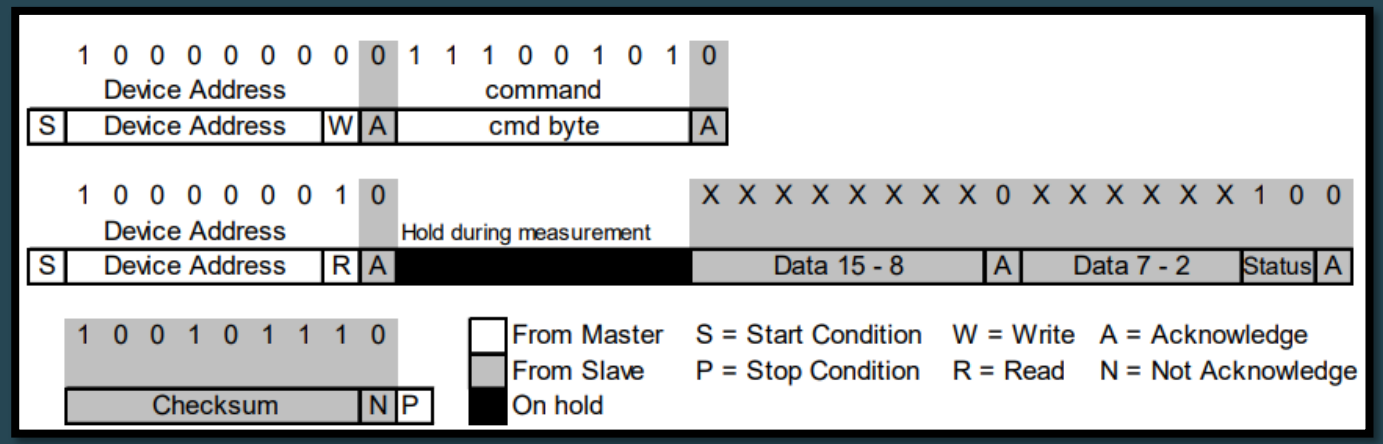
2. R/W user register



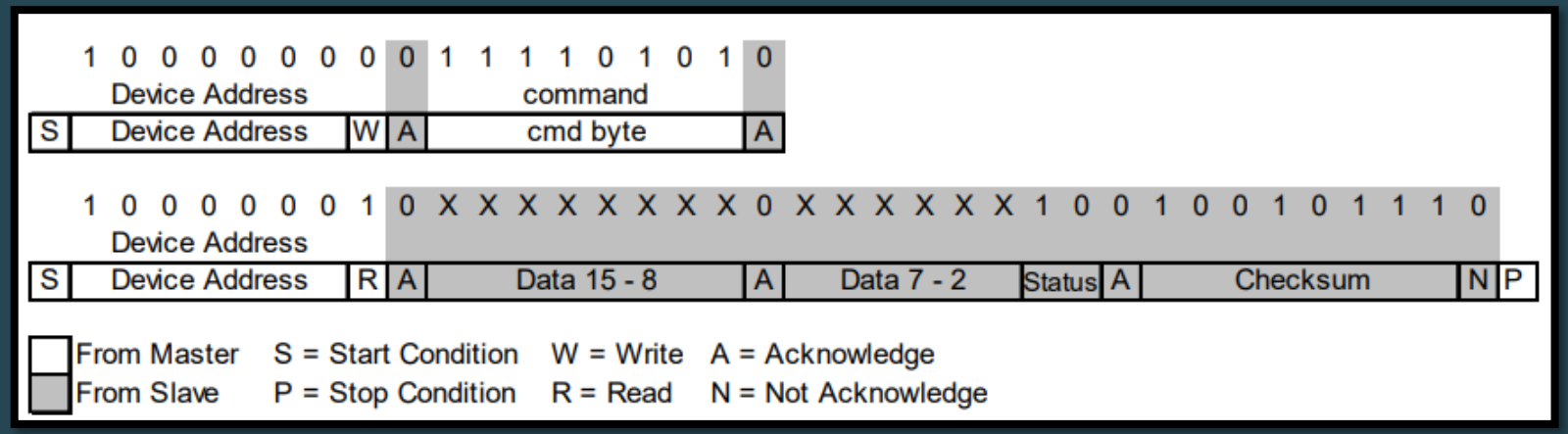
PHT click

- Relativna vlažnost:

3. Measure
   a. Hold master



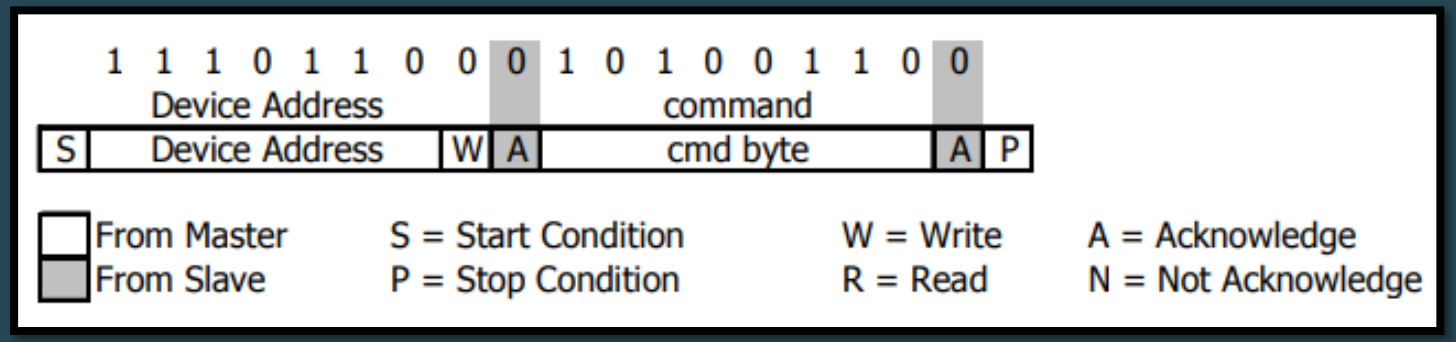
   a. No hold master

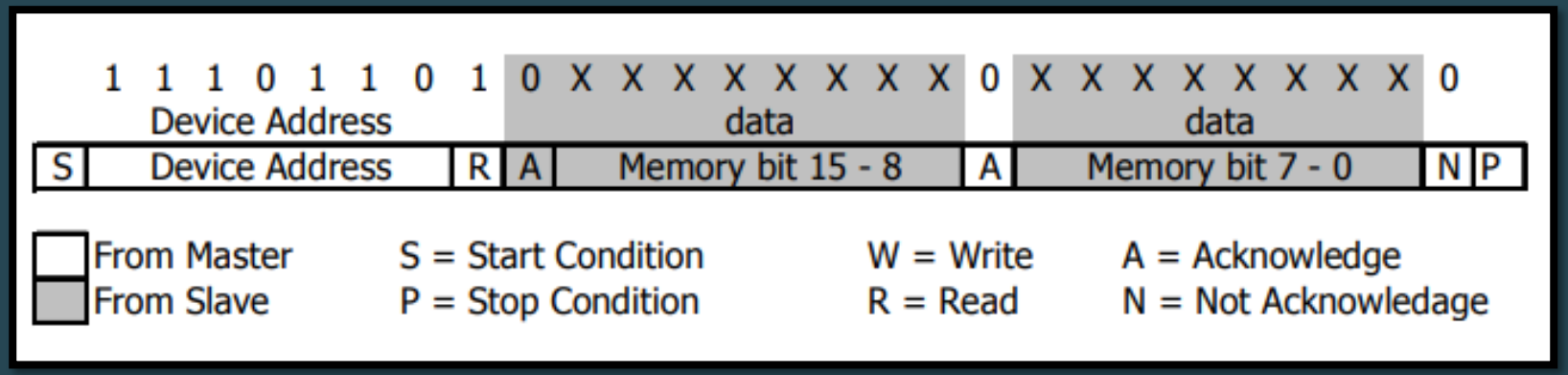


PHT click

- Relativna vlažnost:

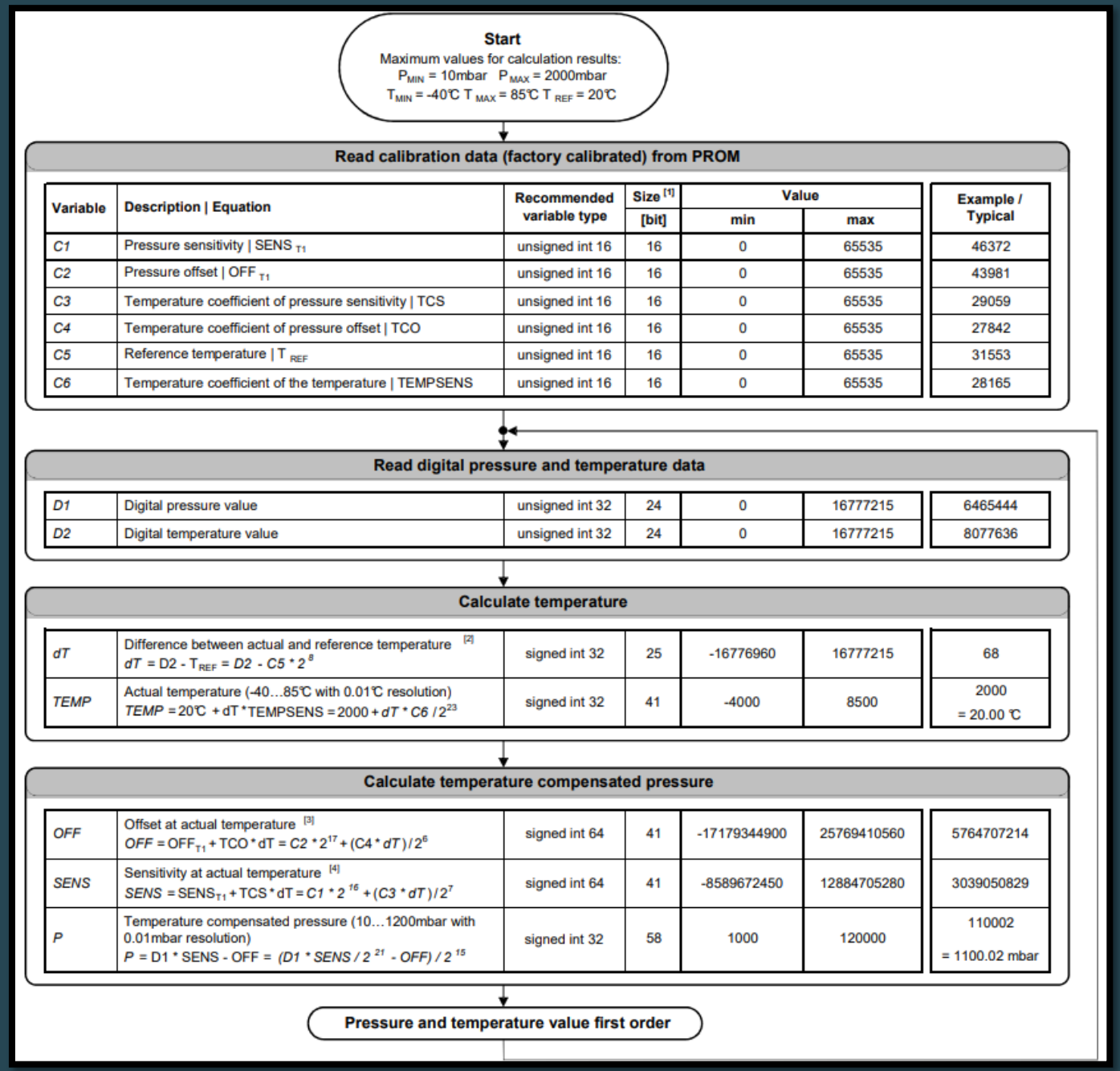
4. Read PROM





PHT click

- Pritisak i temperatura:



Start

Maximum values for calculation results:
P_{MIN} = 10mbar P_{MAX} = 2000mbar
T_{MIN} = -40°C T_{MAX} = 85°C T_{REF} = 20°C

Read calibration data (factory calibrated) from PROM

Variable	Description | Equation	Recommended variable type	Size [1] [bit]	Value min	Value max	Example / Typical
C1	Pressure sensitivity | $SENS_{T1}$	unsigned int 16	16	0	65535	46372
C2	Pressure offset | OFF_{T1}	unsigned int 16	16	0	65535	43981
C3	Temperature coefficient of pressure sensitivity | TCS	unsigned int 16	16	0	65535	29059
C4	Temperature coefficient of pressure offset | TCO	unsigned int 16	16	0	65535	27842
C5	Reference temperature | T_{REF}	unsigned int 16	16	0	65535	31553
C6	Temperature coefficient of the temperature | TEMPSENS	unsigned int 16	16	0	65535	28165

Read digital pressure and temperature data

D1	Digital pressure value	unsigned int 32	24	0	16777215	6465444
D2	Digital temperature value	unsigned int 32	24	0	16777215	8077636

Calculate temperature

dT	Difference between actual and reference temperature [2] $dT = D2 - T_{REF} = D2 - C5 * 2^8$	signed int 32	25	-16776960	16777215	68
TEMP	Actual temperature (-40…85°C with 0.01°C resolution) $TEMP = 20°C + dT * TEMPSENS = 2000 + dT * C6 / 2^{23}$	signed int 32	41	-4000	8500	2000 = 20.00 °C

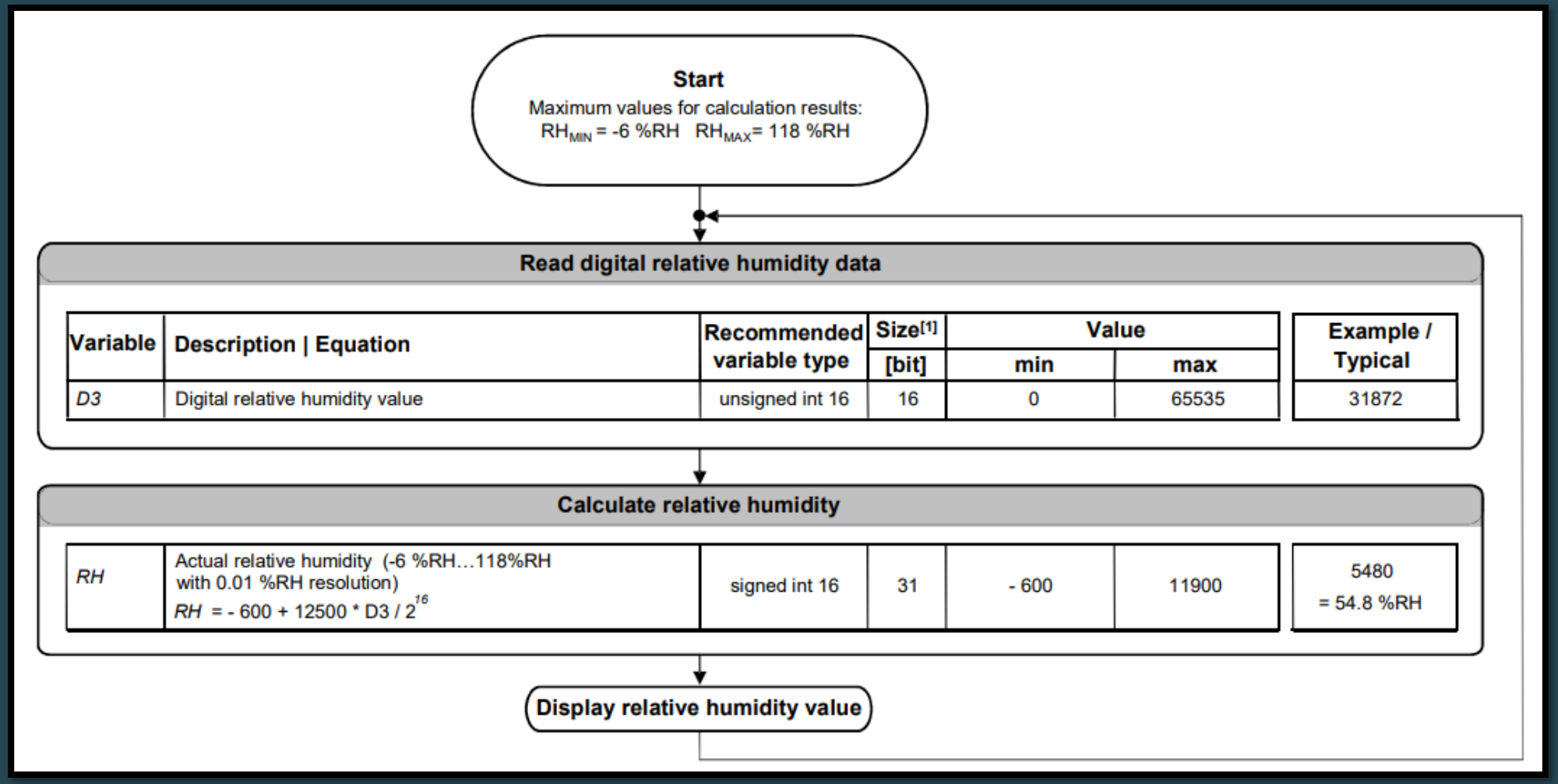
Calculate temperature compensated pressure

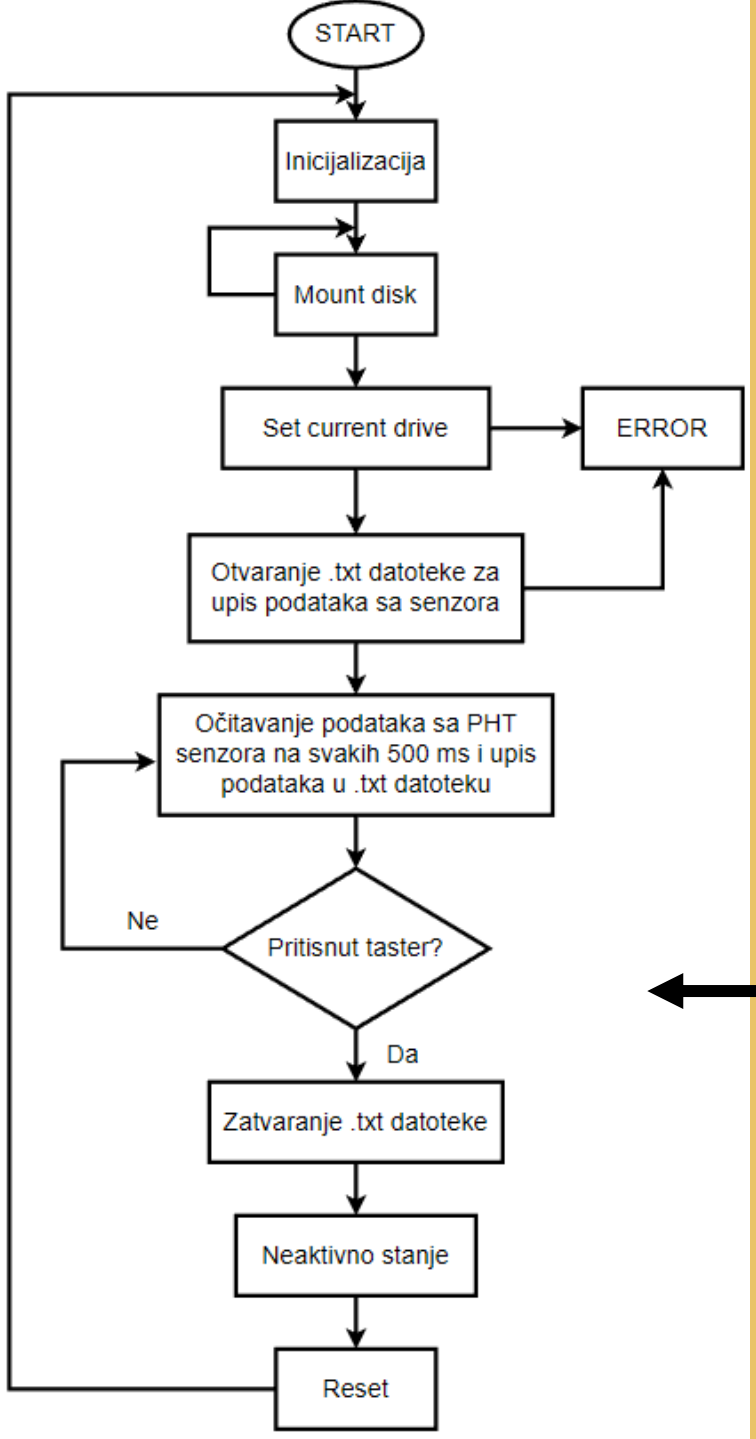
OFF	Offset at actual temperature [3] $OFF = OFF_{T1} + TCO * dT = C2 * 2^{17} + (C4 * dT) / 2^6$	signed int 64	41	-17179344900	25769410560	5764707214
SENS	Sensitivity at actual temperature [4] $SENS = SENS_{T1} + TCS * dT = C1 * 2^{16} + (C3 * dT) / 2^7$	signed int 64	41	-8589672450	12884705280	3039050829
P	Temperature compensated pressure (10…1200mbar with 0.01mbar resolution) $P = D1 * SENS - OFF = (D1 * SENS / 2^{21} - OFF) / 2^{15}$	signed int 32	58	1000	120000	110002 = 1100.02 mbar

Pressure and temperature value first order

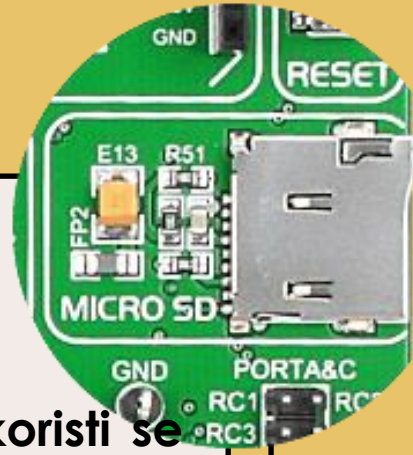
PHT click

- Relativna vlažnost:





SD kartica



- Za razmenu podataka sa SD karticom koristi se SPI6 modul mikrokontrolera
  - MOSI – RF8
  - MISO – RF2
  - CS – RD12
  - +CD (card detect) – RD13

- Zadatak: Realizovati sistem za prikupljanje podataka sa PHT senzora i čuvanje podataka na SD kartici u okviru .txt datoteke. Očitavanje PHT senzora i upis podataka na karticu treba da se vrši na svakih 500 ms, a prekida se pritiskom na taster.