Specification for HTPA8x8L7.0M(SPI)

Rev.0: 2014.11.28 Fg

The HTPA8x8L_/_M(SPI) is a fully calibrated, low cost thermopile array module, with fully digital SPI interface. The module delivers an electrical offset and ambient temperature compensated output stream, which can be already used for image processing, pattern recognition and presence detection purposes. Object temperatures can be easily obtained by this data stream, a look up table and the calibrated sensitivity constants, which can be found in the EEPROM of the module.

Order Code Example

HTPA32x31		L10 / 0.8	F8-14	Hi	M	(SPI)	[Si]

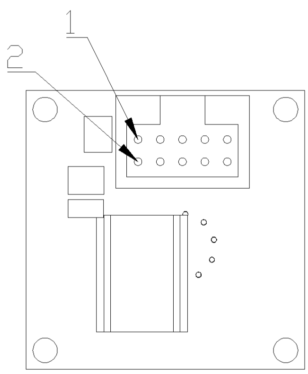
Type:	
HTPA32x31	Please contact support for all available HTPA and module combinations.
Output:	
d	HTPA sensor with digital output
Not declared	HTPA sensor with analogous output
Optics:	
L	Focal length: In example L10 = 10.0 mm focal length
/	F-Number: In example /0.8
	For optics see also "HTPA standard optics"
Filter:	
F	Filter characteristics. In example F8-14 (µm, Bandpass)
Not declared	Broad band ARC
Sensitivity:	
Hi	Increased sensitivity
Not declared	Standard sensitivity
Version:	
A	Application set: comes with GUI, housing, power supply. Always UDP Interface.
C	Calibrated sensor (only digital). Carries calibration constants on internal EEPROM
M	Module: HTPA sensor soldered to PCB, calibrated stream
S	HTPA sensor only. Raw voltage output, not calibrated
Interface:	
SPI	SPI device; Three variants: HTPA82x62: 16bit ADC all other analogous HTPAs: 14bit ADC Digital HTPA: 12bit ADC
LC	SPI,Only Analogous HTPA, 12bit ADC low speed, external processing required
UDP	Ethernet, CAT5 cable connection
PoE	Power over Ethernet, CAT5 connection, UDP protocol
Lens Material:	
Si	Silicon
Not declared	Germanium

For modules, the recommended type is M(SPI). The advantages are the better ADC resolution, wider input voltage range, wider measurement range.

Pinout

Pin Assignment HTPA8x8M(SPI)

Pin	Name	Description	Type
1	#MCLR	Master clear, negotiated	Digital Input
2	VDD	Positive supply voltage	Power
3	VSS	Negative supply voltage	Power
4	VSS	Negative supply voltage	Power
5	#SS	Slave select, negotiated	Digital Input
6	SDO	Serial data out of module	Digital Output
7	SDI	Serial data in of module	Digital Input
8	SCK	Serial clock	Digital Input
9	MCLK	Master clock, drives HTPA sensor	Digital Input
10	#VD	Valid Data, negotiated.	Digital Output



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SPI Interface:

SCK-Frequency: 350 kHz …10 MHz [1)]

[1)] For customer specified devices with higher frame rates than usual, higher SCK-Frequencies than 350 kHz might be needed. See also "Communication and Timings"

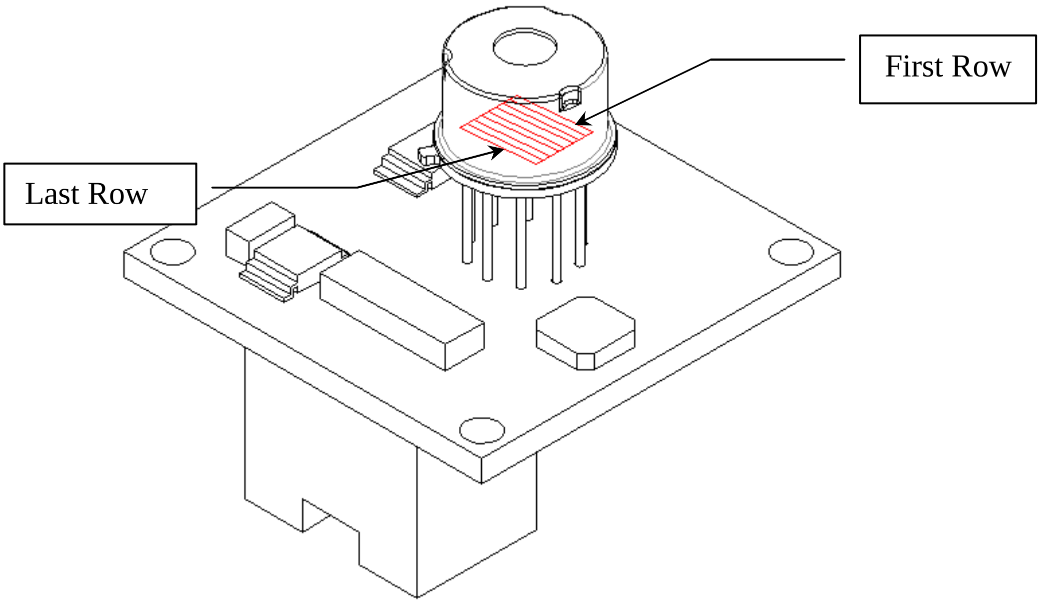
Protocol Specifications:

Data format:	16 data bits
Frame Sync:	None
Module-Selection:	$\overline{\text{SS}}$-Pin
Clock Edge Select:	Serial output data changes on transition from idle to active clock state
SPI Data Input Sample Phase:	Data sampled on transition from active to idle clock state
Clock Polarity:	Idle state is high level, active is low level.

Electrical Specifications:

VDD Range:	Supply (2.8 – 3.3 V DC)
SPI Transmit/Receive:	TTL
VSS	GND
Power Supply:	**2.8-3.3** VDC
IDD (Idle mode)	30 mA
IDD (Operating mode)	120 mA

HTPA8x8L7.0M(SPI) Optical Orientation of Pixels:



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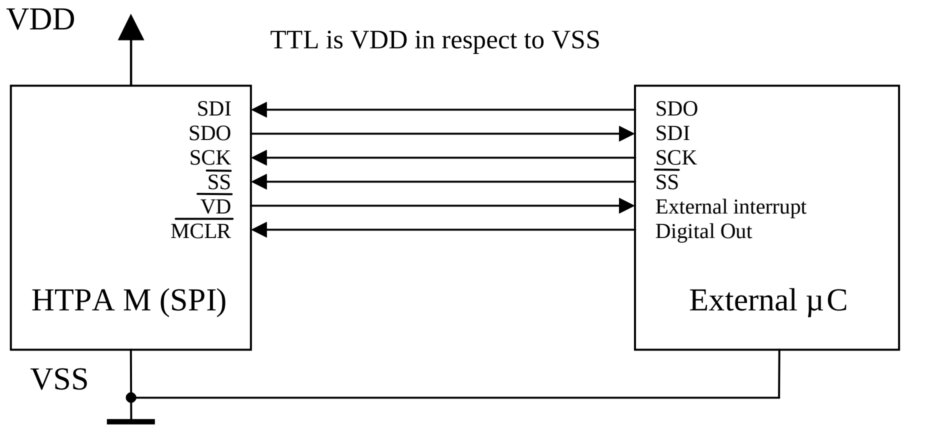
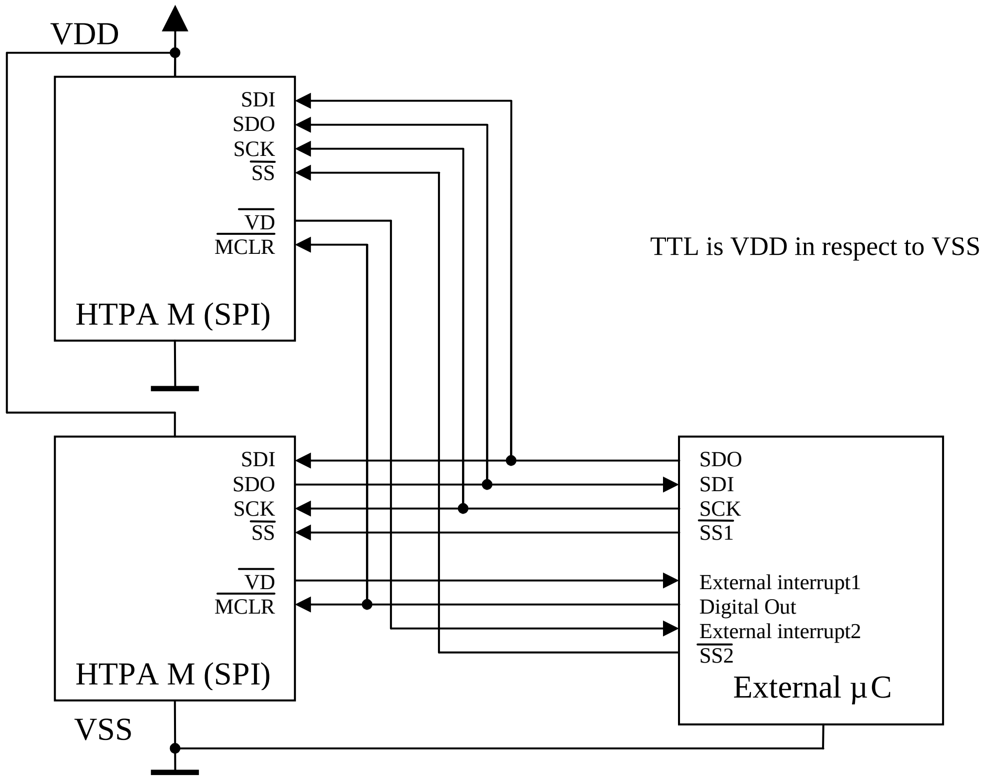
Electrical Connections:

Single Module:



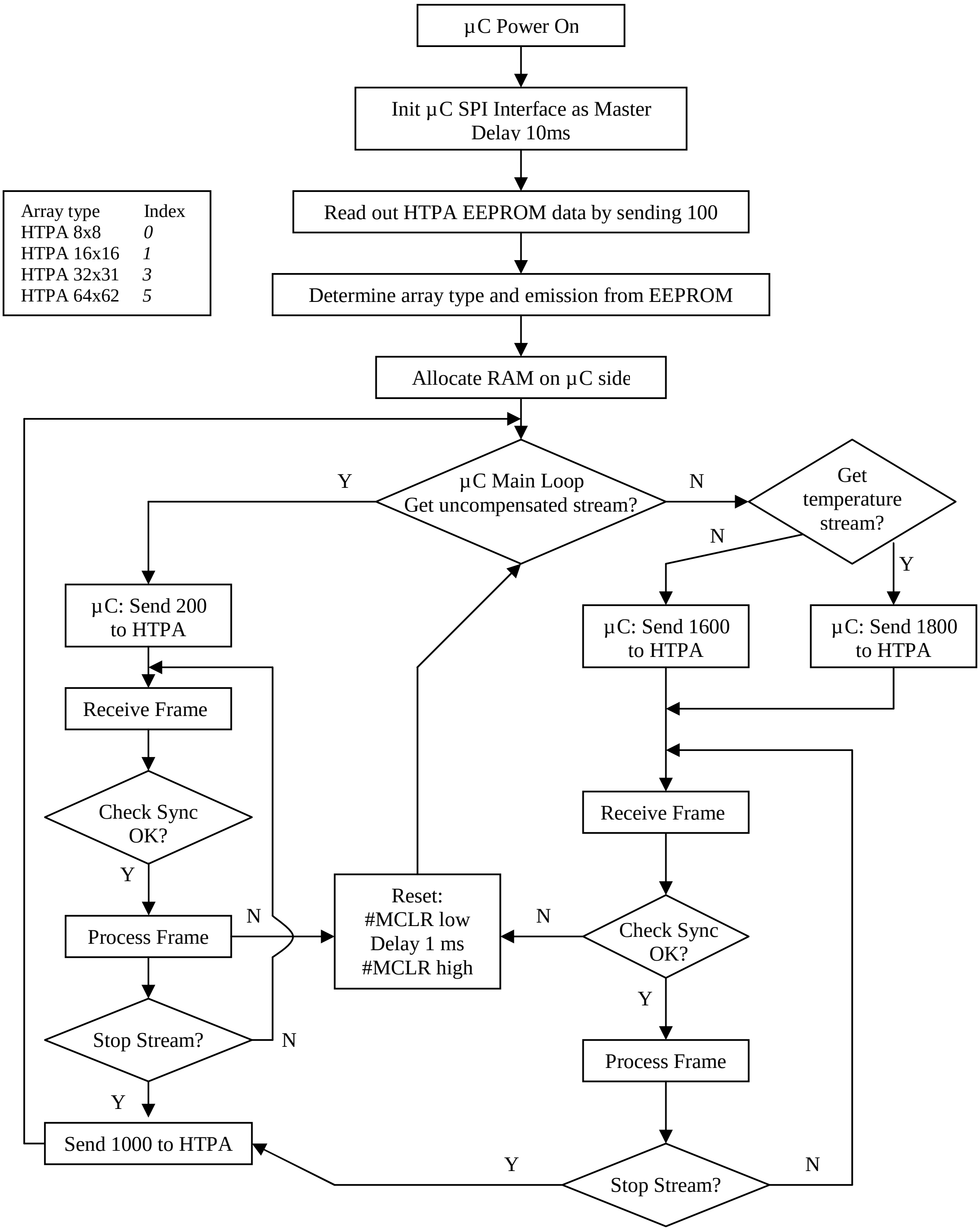
Multiple Modules (preliminary):



Communication and Timings:

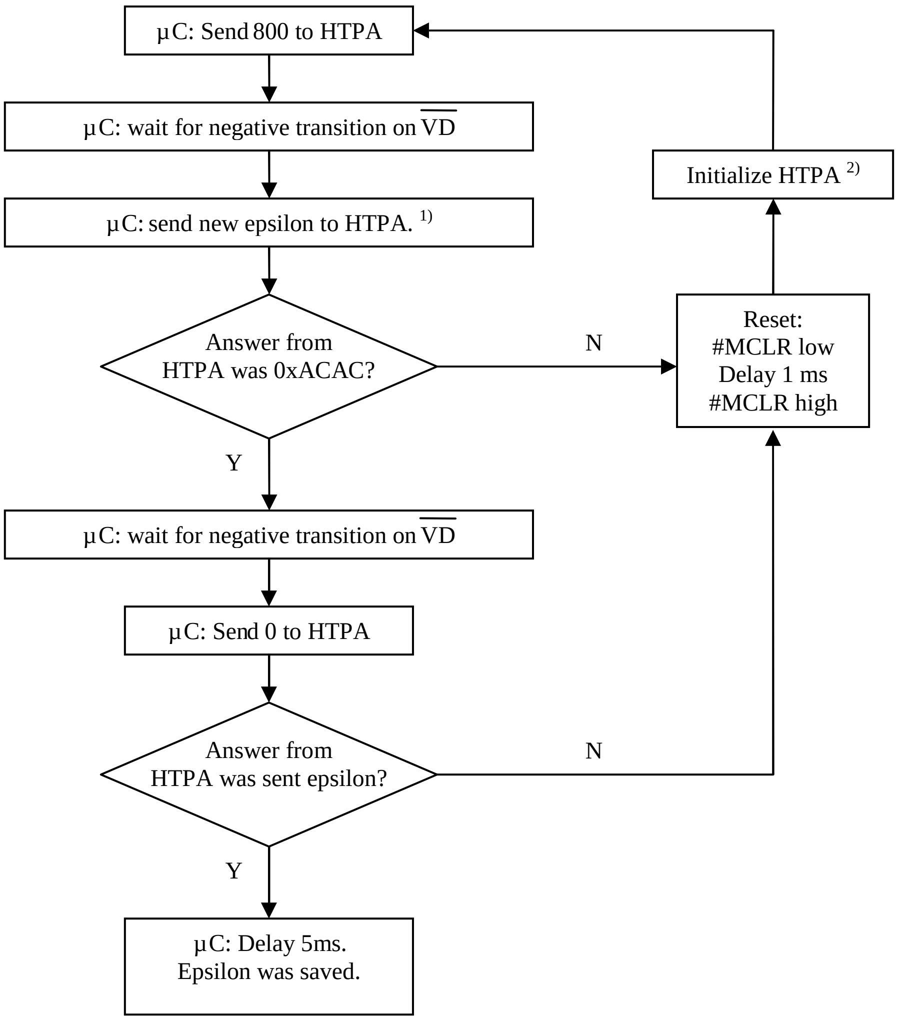
Proposed flow chart of communication. (Master is referred as µC, Slave as HTPA module)

Array type	Index
HTPA 8x8	*0*
HTPA 16x16	*1*
HTPA 32x31	*3*
HTPA 64x62	*5*



Communication and Timings:

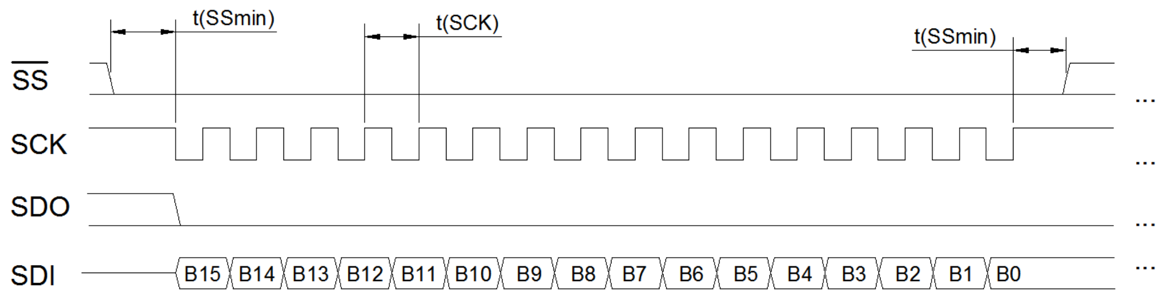
Setting emission coefficient epsilon. (Master is referred as µC, Slave as HTPA module)



1) Epsilon needs to be >0 and <=100. (Decimal)
2) See "Proposed flow chart of communication".

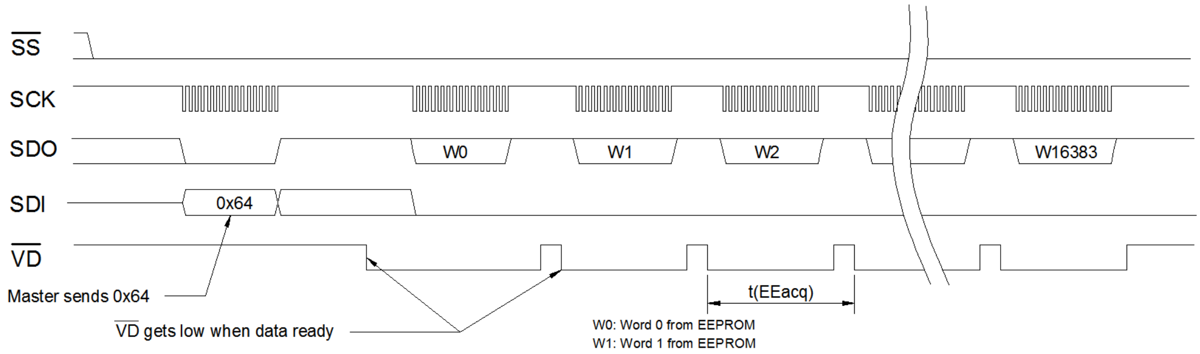
Communication and Timings (continuation):

Receive of command:

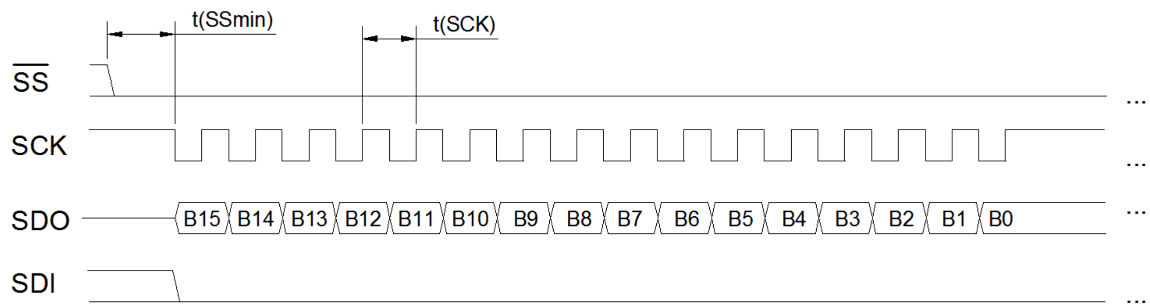


(High state of #SS is not necessary, only for communication with multiple devices)

Send of EEPROM content:

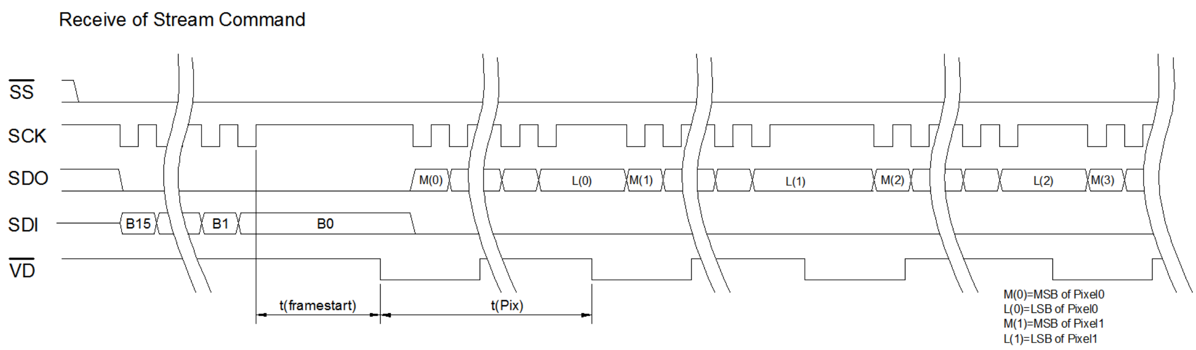


Pixel data:



B15...B0: Raw or compensated ADC reading (depending from streaming mode)

Receive of stream command:



Refer also to “Serial order in stream”. The last dataset consists out of three 16 bit values.

Communication and Timings (continuation):

Absolute values:

	MIN	NOM	MAX	Unit	Remarks
MCLR pulse width (low)	2			µs	
t(SSmin)	150			ns	
t(SCK)	0.1	1	2.86	µs	
t(EEacq)	185			µs	
t(framestart)		29		ms	f(MCLK)=1 MHz
t(Pix)		208		µs	f(MCLK)=1 MHz

1) For customer specified devices with higher frame rates than usual, higher SCK-Frequencies than 350 kHz might be needed.
See below comment: 32*t(SCK)<t(Pix)

t(Pix) and t(framestart) depend on the given MCLK frequency of the master. In example: MCLK frequency is 1003 kHz, then t(Pix) and t(framestart) is calculated via

$$t(Pix) = \frac{208}{f(MCLK)} = \frac{208}{1003000} = 207{,}4\mu s \qquad t(framestart) = t(Pix) \cdot 8 \cdot 9 + 14ms = 28{,}9ms$$

Attention! Above calculation refers only when command 0d200 was sent. If 0d1600 or 0d1800 was sent, the time until first $\overline{\text{VD}}$ transition is 4 times t(framestart).

Important:
The SCK frequency needs to be at least that large, that the 32 bits can be submitted within tPix. Therefore, the following condition must be always true:

$$32 \cdot t(SCK) < t(Pix)$$

EEPROM Mapping:

Overview:

Start address	End address	Data type	Value
0x0	0x9	float	Heimann Sensor reserved
0xA	0xA	char	Table number
0xB	0x33		Heimann Sensor reserved
0x34	0x37	float	PTATgrad
0x38	0x3B	float	PTAToff
0x3C	0x58		Heimann Sensor reserved
0x46	0x46	unsigned char	Emission coefficient epsilon
0x59	0x5A	unsigned int	MCLK Frequency in kHz
0x5B	0x75		Heimann Sensor reserved
0x76	0x76	unsigned char	Moduletype [2)]
0x80	0x3FFF		Heimann Sensor reserved

[2)] Shows which sensor and PCB type the current module is. Refer to table "Details for Moduletype" for details.

Important Note:

unsigned int: 2 byte; float: 4 byte; char: 1 byte
All the values are stored (if larger than one byte) in little endian, the so called „Intel-Format".
Example for the MCLK-Frequency:

$$MCLK_{LB} = \mathrm{EEPROM}[0x59] \quad MCLK_{HB} = \mathrm{EEPROM}[0x5A]$$
$$MCLK = 256 \cdot MCLK_{HB} + MCLK_{LB}$$

Details for Moduletype:

Value	Declaration
255	M(LC)
0	M(SPI) + Analogous Chip
1	M(SPI) + Digital Chip
2	M(UDP) + analogous Chip
3	M(PoE) + 16x16d; BCC stored in Flash
4	M(PoE) + 16x16d; BCC stored in Sensor EEPROM

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Serial order of data in stream:

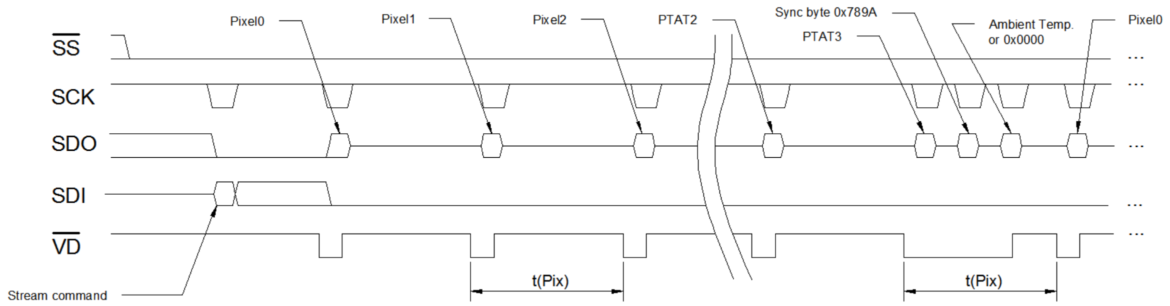
Compensated Voltage Mode	
Dataset	Value
0	offset corrected Voltage of Pixel0 in digits
1	offset corrected Voltage of Pixel1 in digits
2	offset corrected Voltage of Pixel2 in digits
…	…
63	offset corrected Voltage of Pixel63 in digits
64	elOff0 in digits+0x7000
65	elOff1 in digits+(0x800<<4)
66	elOff2 in digits+(0x90<<8)
67	elOff3 in digits+(0xA<<12)
68	PTAT0 in digits | (TA&0xF000)
69	PTAT1 in digits | ((TA&0x0F00)<<4)
70	PTAT2 in digits | ((TA&0x00F0)<<8)
71	PTAT3 in digits | ((TA&0x000F)<<12)
72	Sync byte 0x789A
73	Ambient temperature in dK

Raw Voltage Mode	
Dataset	Value
0	absolute Voltage of Pixel0 in digits
1	absolute Voltage of Pixel1 in digits
2	absolute Voltage of Pixel2 in digits
…	…
63	absolute Voltage of Pixel63 in digits
64	elOff0 in digits+0x7000
65	elOff1 in digits+(0x800<<4)
66	elOff2 in digits+(0x90<<8)
67	elOff3 in digits+(0xA<<12)
68	PTAT0 in digits
69	PTAT1 in digits
70	PTAT2 in digits
71	PTAT3 in digits
72	Sync byte 0x789A
73	Data: 0x0000

Temperature Mode	
Dataset	Value
0	Object temp. at Pixel0 in dK
1	Object temp. at Pixel1 in dK
2	Object temp. at Pixel2 in dK
…	…
63	Object temp. at Pixel63 in dK
64	elOff0 in digits
65	elOff1 in digits
66	elOff2 in digits
67	elOff3 in digits
68	PTAT0 in digits
69	PTAT1 in digits
70	PTAT2 in digits
71	PTAT3 in digits
72	Sync byte 0x789A
73	Ambient temperature in dK

Most datasets consists of a 16 bit value. The 16 bit values are transmitted with MSB first. In case of compensated voltage mode a signed 16 bit value is transmitted, in case of raw voltage mode an unsigned 16 bit value. Signed values are always in 2’s complement.

The last dataset consists out of three 16bit values, refer to following diagram:



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Pixel Map:

0	1	2	3	4	5	6	7
8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23
24	25	26	27	28	29	30	31
32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47
48	49	50	51	52	53	54	55
56	57	58	59	60	61	62	63

C-Code for all these calculations can be found in our SDK (**S**oftware **D**evelopment **K**it). Furthermore, the SDK is able to fetch the data from the module and sends it to our GUI (**G**raphical **U**ser **I**nterface) which can visualize the data, records videos and text files and has many additional features. For more information see www.heimannsensor.com.

Communication commands:

Sent Command	Answer / Result
0d100	Output of EEPROM content. Data ready of each 2 bytes is signified by #VD pin.
0d200	Module streams out uncompensated, raw data stream. Data ready of each 4 bytes is signified by #VD pin.
0d700	Device goes in IDLE mode.
0d1000	Stops streaming mode of module.
0d1600	Module streams offset corrected stream (electrical and thermal). Data ready of each 4 bytes is signified by #VD pin.
0d1800	Module streams temperature stream in deci-Kelvin. Data ready of each 4 bytes is signified by #VD pin

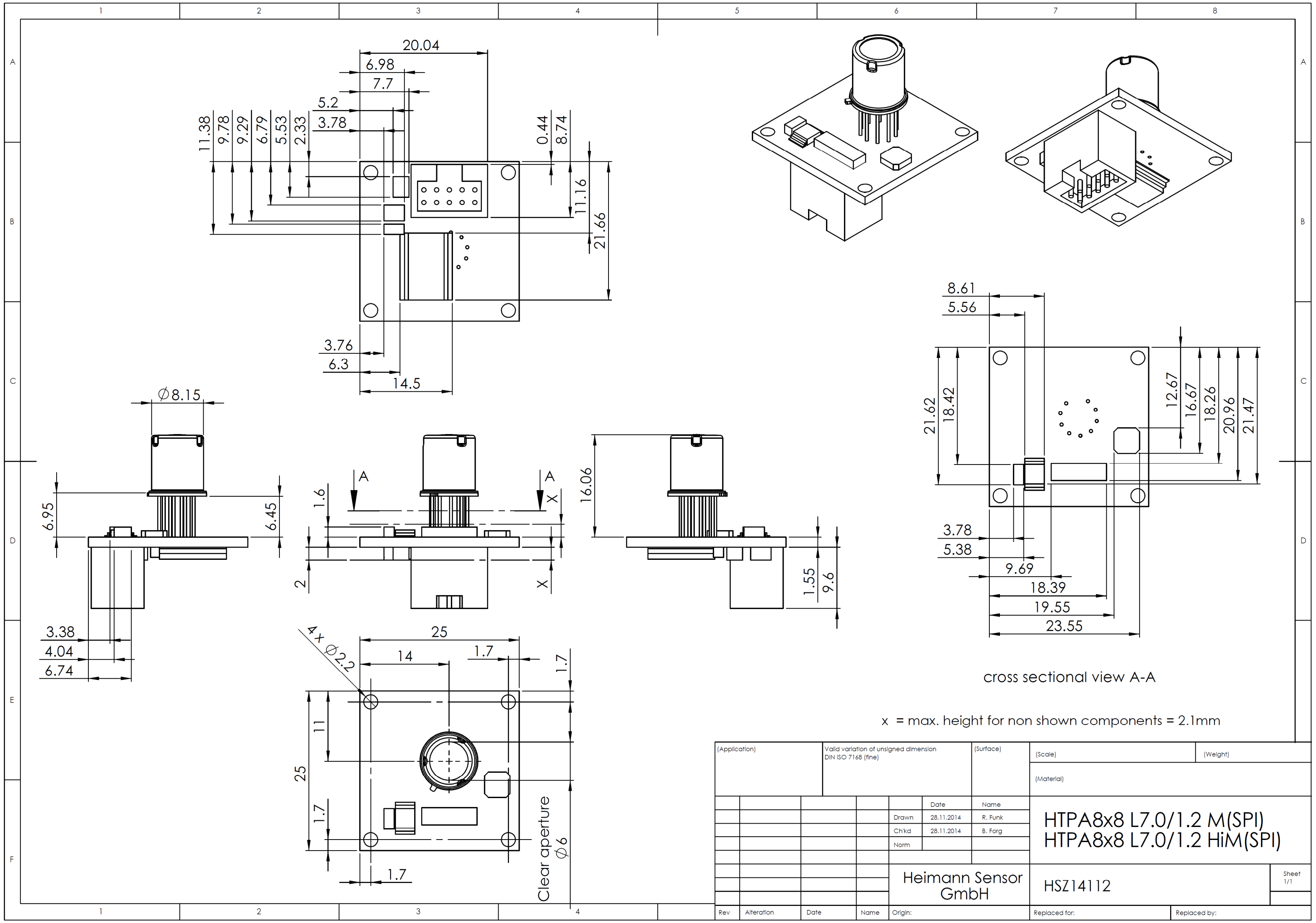
Attention! 0d → Refers to decimal.

Precondition for all streaming modes:
VDD must be in the given limits.

Absolute Maximum Ratings:

Value	MIN	NOM	MAX	Unit	Remarks
VDD in respect to VSS	-0.3	3	4	V	
VDD in streaming mode	2.8	3	3.3	V	False VDD values affect compensation
Voltage on digital pin with respect to VSS	-0.3		VDD+0.3	V	
Storage temperature	-40		120	°C	
ADC reference voltages	VSS		4.096	V	high precision references
ADC resolution		14		bit	4dig/mV
Max. current sunk/sourced on any pin		20		mA	
Operating temperature	-20		85	°C	non-condensing
Current consumption	115	120	130	mA	In streaming
Current consumption	25	30	35	mA	Idle

Dimensions:



20.04
6.98
7.7
5.2
3.78
11.38
9.78
9.29
6.79
5.53
2.33
0.44
8.74
11.16
21.66
3.76
6.3
14.5
∅8.15
6.95
6.45
A
1.6
X
16.06
2
1.55
9.6
3.38
4.04
6.74
4 x ∅2.2
25
14
1.7
11
Clear aperture ∅6
8.61
5.56
21.62
18.42
12.67
16.67
18.26
20.96
21.47
3.78
5.38
9.69
18.39
19.55
23.55
cross sectional view A-A
x = max. height for non shown components = 2.1mm
(Application)
Valid variation of unsigned dimension DIN ISO 7168 (fine)
(Surface)
(Scale)
(Weight)
(Material)
Date
Name
Drawn
28.11.2014
R. Funk
Chk'd
28.11.2014
B. Forg
Norm
HTPA8x8 L7.0/1.2 M(SPI)
HTPA8x8 L7.0/1.2 HiM(SPI)
Heimann Sensor GmbH
HSZ14112
Sheet 1/1
Rev
Alteration
Date
Name
Origin:
Replaced for:
Replaced by: