

The HTPA32x31L_/_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. Furthermore, this module type can deliver already an object temperature stream, which is measured by each single element of the matrix.

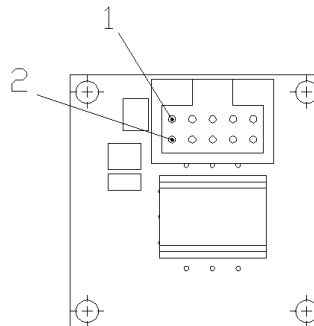
Order Code Example

| HTPA32x31 | L10 / 0.8 | F8-14 | Hi | M | (SPI) | [Si] | |
|-----------|-----------|-------|----|---|-------|------|--|
| | | | | | | | Type: HTPA32x31 Please contact support for all available HTPA and module combinations. |
| | | | | | | | Output: d Not declared HTPA sensor with digital output HTPA sensor with analogous output |
| | | | | | | | Optics: L / Focal length: In example L2,1 = 2,1 mm focal length F-Number: In example /0.85 For optics see also “HTPA standard optics” |
| | | | | | | | Filter: F Not declared Filter characteristics. In example F8-14 (μm, Bandpass) Broad band ARC |
| | | | | | | | Sensitivity: Hi Not declared Increased sensitivity Standard sensitivity |
| | | | | | | | Version: A Always UDP Interface. M Module: HTPA sensor soldered to PCB, calibrated stream S HTPA sensor only. Raw voltage output, not calibrated |
| | | | | | | | Interface: SPI SPI device; Two variants: Analog HTPA, 14bit ADC Digital HTPA, 12bit ADC LC SPI, Only Analogous HTPA. low speed, external processing required UDP Ethernet, CAT5 cable connection |
| | | | | | | | Lens Material: Si Not declared Silicon 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 | 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 Sensor | Digital output |
| 10 | #VD | Valid Data, negotiated | Digital output |



Connector: B10B-PUDSS-1 (LF)(SN), Supplier: J.S.T.

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Specification for HTPA32x31L10/1.0F7.5HiM(SPI)

Rev.0: 2014.03.10 Fg



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"

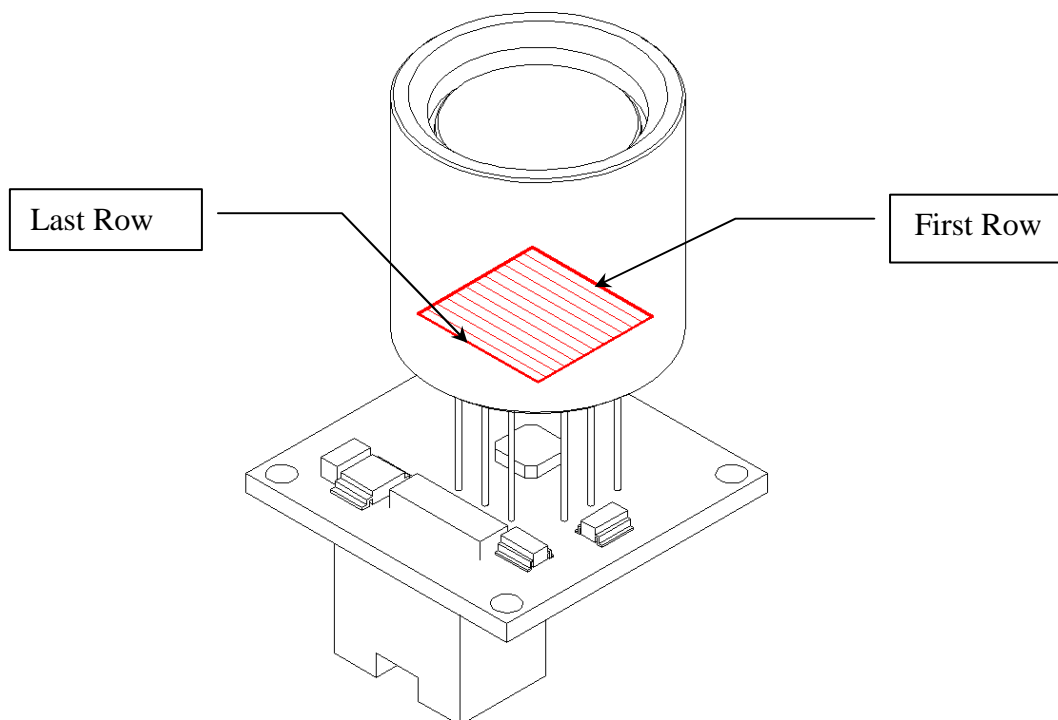
Protocol Specifications:

| | |
|------------------------------|--|
| Data format: | 16 data bits |
| Frame Sync: | None |
| Module-Selection: | \overline{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:

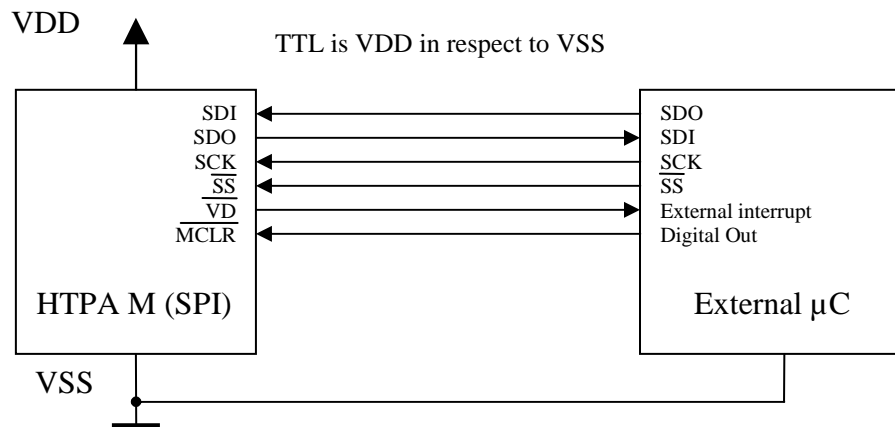
| | |
|-----------------------|-------------------------|
| VDD Range: | Supply (2.8 – 3.3 V DC) |
| SPI Transmit/Receive: | TTL |
| VSS | GND |
| Power Supply: | 2.8-3.3 VDC |
| IDD (Idle mode) | 35 mA |
| IDD (Operating mode) | 65 mA |

HTPA32x31L10/1.0F7.5HiM(SPI) Optical Orientation of Pixels:

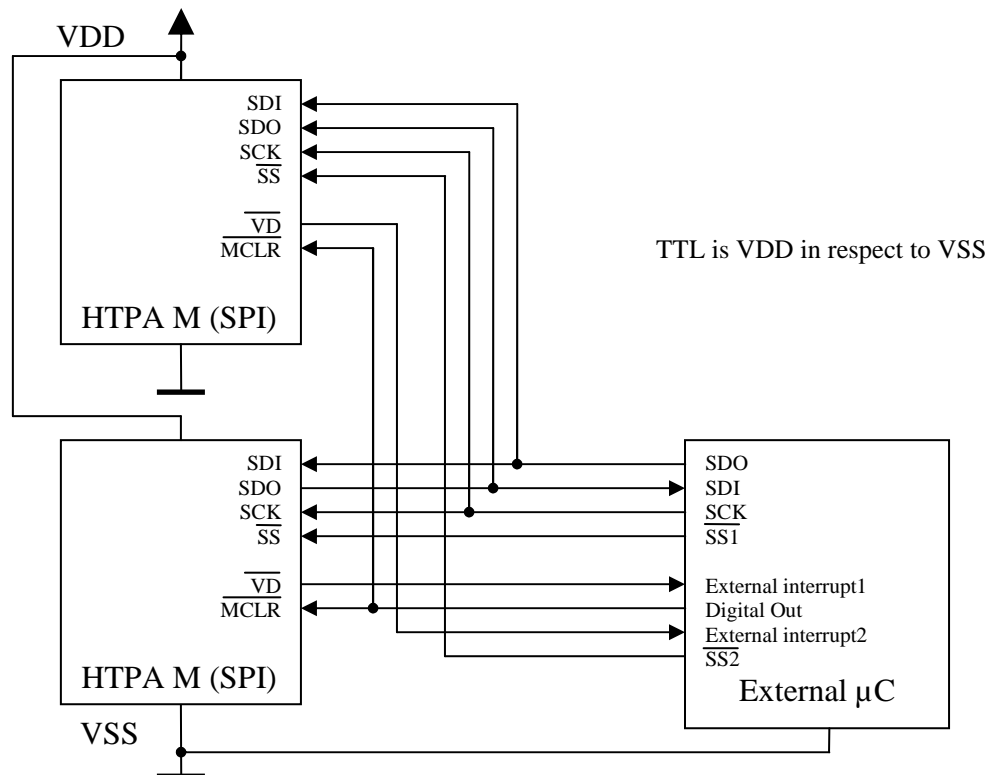


Electrical Connections:

Single Module:

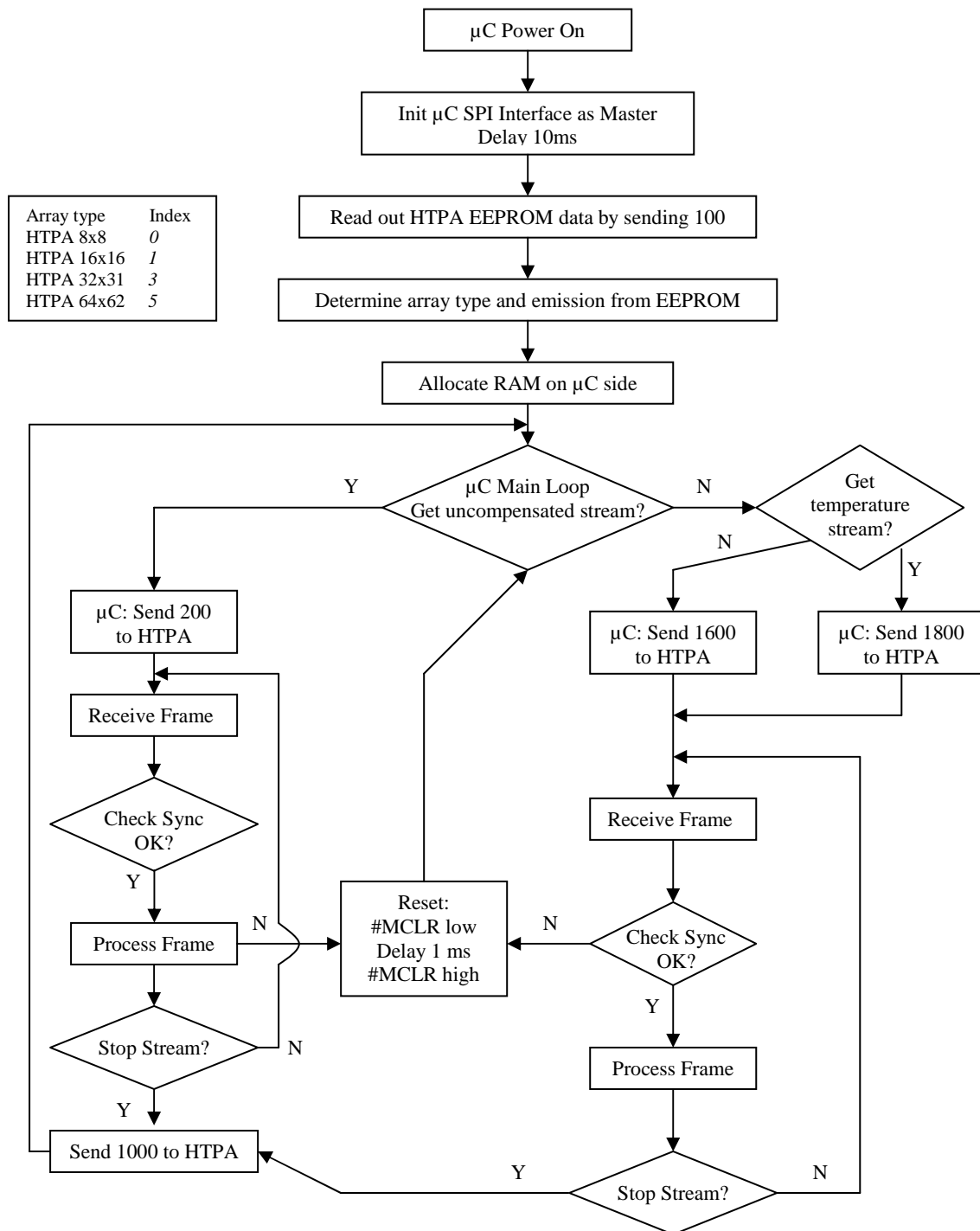


Multiple Modules (preliminary):



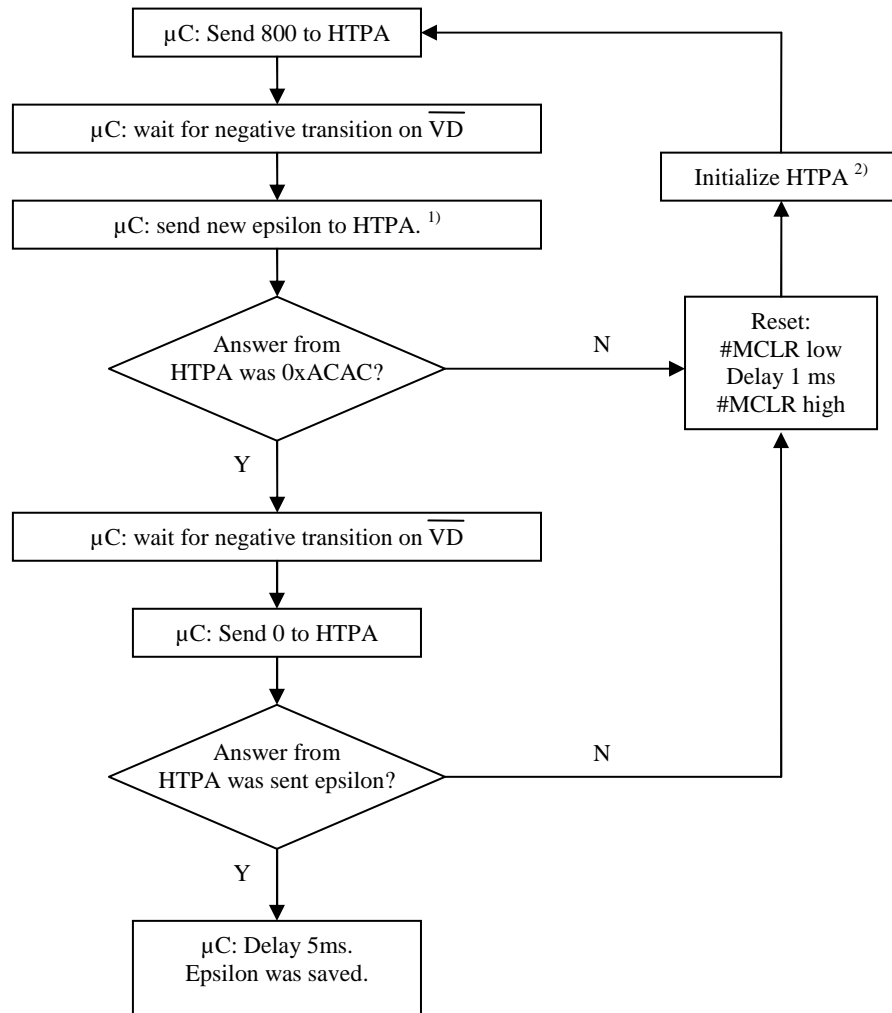
Communication and Timings:

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



Communication and Timings:

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

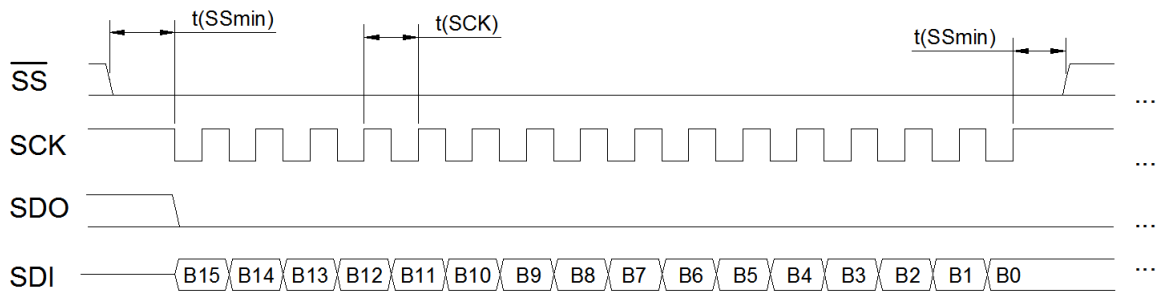


¹⁾ Epsilon needs to be >0 and <=100. (Decimal)

²⁾ See “Proposed flow chart of communication”.

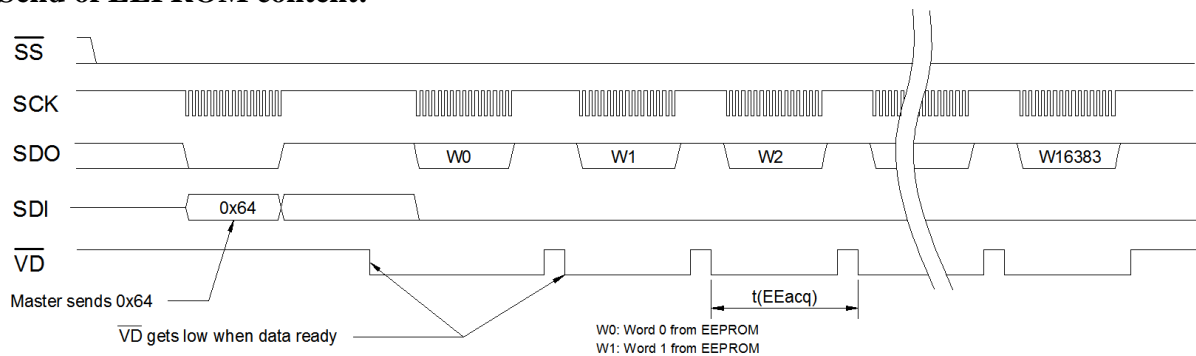
Communication and Timings (continuation):

Receive of command:

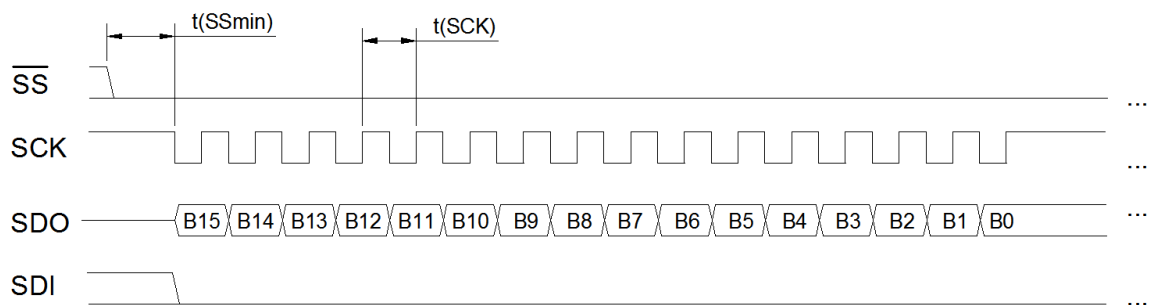


(High state of #SS is not necessary, only for communication with multiple devices)

Send of EEPROM content:

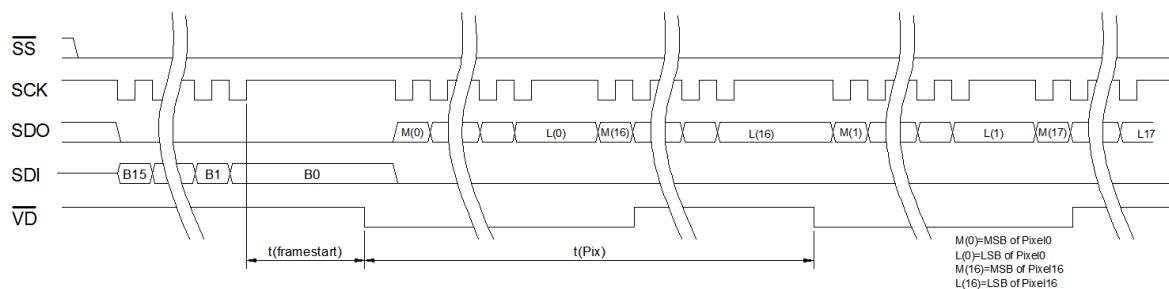


Pixel data:



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

Receive of stream command:



Communication and Timings (continuation):

Absolute values:

| | MIN | NOM | MAX | Unit | Remarks |
|------------------------|-----|-----|------|------|---------------|
| MCLR pulse width (low) | 2 | | | µs | |
| t(SSmin) | 175 | | | ns | |
| t(SCK) | 0.1 | 1 | 2.86 | µs | 1) |
| t(EEacq) | 185 | | | µs | |
| t(framestart) | | 120 | | ms | f(MCLK)=1 MHz |
| t(Pix) | | 200 | | 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: $32 \cdot t(SCK) < t(Pix)$

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

| | |
|--|---|
| $t(Pix) = \frac{200}{f(MCLK)} = \frac{200}{1003000} = 199,4 \mu s$ | $t(framestart) = \frac{t(Pix) \cdot 32 \cdot 33}{2} + 14ms = 119,3ms$ |
|--|---|

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 | PT ATgrad |
| 0x38 | 0x3B | float | PT AToff |
| 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:

$$MCLK_{LB} = \text{EEPROM}[0x59] \quad MCLK_{HB} = \text{EEPROM}[0x5A]$$

$$MCLK = 256 \cdot MCLK_{HB} + MCLK_{LB}$$

Details for Moduletype:

| Value | Declaration |
|-------|-------------------------|
| 255 | M(LC) |
| 0 | M(SPI) + Analogous Chip |
| 1 | M(SPI) + Digital Chip |

Serial order of data in stream:

| Compensated Voltage Mode | |
|--------------------------|--|
| Dataset | Value |
| 0 | offset corrected Voltage of Pixel0 in digits |
| 1 | offset corrected Voltage of Pixel16 in digits |
| 2 | offset corrected Voltage of Pixel1 in digits |
| 3 | offset corrected Voltage of Pixel17 in digits |
| ... | ... |
| 30 | offset corrected Voltage of Pixel15 in digits |
| 31 | offset corrected Voltage of Pixel31 in digits |
| 32 | offset corrected Voltage of Pixel32 in digits |
| 33 | offset corrected Voltage of Pixel48 in digits |
| ... | ... |
| 991 | offset corrected Voltage of Pixel991 in digits |
| 992 | eIOff0 in digits |
| 993 | eIOff16 in digits |
| 994 | eIOff1 in digits |
| 995 | eIOff17 in digits |
| ... | ... |
| 1022 | eIOff15 in digits |
| 1023 | eIOff31 in digits |
| 1024 | Module transmitts 0x789A (use for sync) |
| 1025 | Module transmitts 0xBCDE (use for sync) |
| 1026 | Tamb |
| 1027 | no value, ignore |
| 1028 | no value, ignore |
| 1029 | no value, ignore |
| ... | ... |
| 1039 | no value, ignore |
| 1040 | PTAT0 in digits |
| 1041 | no value, ignore |
| 1042 | PTAT1 in digits |
| ... | ... |
| 1053 | no value, ignore |
| 1054 | PTAT7 in digits |
| 1055 | no value, ignore |

| Raw Voltage Mode | |
|------------------|---|
| Dataset | Value |
| 0 | absolute Voltage of Pixel0 in digits |
| 1 | absolute Voltage of Pixel16 in digits |
| 2 | absolute Voltage of Pixel1 in digits |
| 3 | absolute Voltage of Pixel17 in digits |
| ... | ... |
| 30 | absolute Voltage of Pixel15 in digits |
| 31 | absolute Voltage of Pixel31 in digits |
| 32 | absolute Voltage of Pixel32 in digits |
| 33 | absolute Voltage of Pixel48 in digits |
| ... | ... |
| 991 | absolute Voltage of Pixel991 in digits |
| 992 | eIOff0 in digits |
| 993 | eIOff16 in digits |
| 994 | eIOff1 in digits |
| 995 | eIOff17 in digits |
| ... | ... |
| 1022 | eIOff15 in digits |
| 1023 | eIOff31 in digits |
| 1024 | Module transmitts 0x789A (use for sync) |
| 1025 | Module transmitts 0xBCDE (use for sync) |
| 1026 | no value, ignore |
| 1027 | no value, ignore |
| 1028 | no value, ignore |
| 1029 | no value, ignore |
| ... | ... |
| 1039 | no value, ignore |
| 1040 | PTAT0 in digits |
| 1041 | no value, ignore |
| 1042 | PTAT1 in digits |
| ... | ... |
| 1053 | no value, ignore |
| 1054 | PTAT7 in digits |
| 1055 | no value, ignore |

| Temperature Mode | |
|------------------|---|
| Dataset | Value |
| 0 | Object temp. at Pixel0 in dK |
| 1 | Object temp. at Pixel16 in dK |
| 2 | Object temp. at Pixel1 in dK |
| 3 | Object temp. at Pixel17 in dK |
| ... | ... |
| 30 | Object temp. at Pixel15 in dK |
| 31 | Object temp. at Pixel31 in dK |
| 32 | Object temp. at Pixel32 in dK |
| 33 | Object temp. at Pixel48 in dK |
| ... | ... |
| 991 | Object temp. at Pixel991 in dK |
| 992 | eIOff0 in digits |
| 993 | eIOff16 in digits |
| 994 | eIOff1 in digits |
| 995 | eIOff17 in digits |
| ... | ... |
| 1022 | eIOff15 in digits |
| 1023 | eIOff31 in digits |
| 1024 | Module transmitts 0x789A (use for sync) |
| 1025 | Module transmitts 0xBCDE (use for sync) |
| 1026 | Tamb |
| 1027 | no value, ignore |
| 1028 | no value, ignore |
| 1029 | no value, ignore |
| ... | ... |
| 1039 | no value, ignore |
| 1040 | PTAT0 in digits |
| 1041 | no value, ignore |
| 1042 | PTAT1 in digits |
| ... | ... |
| 1053 | no value, ignore |
| 1054 | PTAT7 in digits |
| 1055 | no value, ignore |

Each dataset 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 or temperature mode an unsigned 16 bit value. Signed values are always in 2's complement.

Specification for HTPA32x31L10/1.0F7.5HiM(SPI)

Rev.0: 2014.03.10 Fg



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 |
| 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 |
| 96 | 97 | 98 | 99 | 100 | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 | 121 | 122 | 123 | 124 | 125 | 126 | 127 |
| 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 |
| 160 | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 | 181 | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 |
| 192 | 193 | 194 | 195 | 196 | 197 | 198 | 199 | 200 | 201 | 202 | 203 | 204 | 205 | 206 | 207 | 208 | 209 | 210 | 211 | 212 | 213 | 214 | 215 | 216 | 217 | 218 | 219 | 220 | 221 | 222 | 223 |
| 224 | 225 | 226 | 227 | 228 | 229 | 230 | 231 | 232 | 233 | 234 | 235 | 236 | 237 | 238 | 239 | 240 | 241 | 242 | 243 | 244 | 245 | 246 | 247 | 248 | 249 | 250 | 251 | 252 | 253 | 254 | 255 |
| 256 | 257 | 258 | 259 | 260 | 261 | 262 | 263 | 264 | 265 | 266 | 267 | 268 | 269 | 270 | 271 | 272 | 273 | 274 | 275 | 276 | 277 | 278 | 279 | 280 | 281 | 282 | 283 | 284 | 285 | 286 | 287 |
| 288 | 289 | 290 | 291 | 292 | 293 | 294 | 295 | 296 | 297 | 298 | 299 | 300 | 301 | 302 | 303 | 304 | 305 | 306 | 307 | 308 | 309 | 310 | 311 | 312 | 313 | 314 | 315 | 316 | 317 | 318 | 319 |
| 320 | 321 | 322 | 323 | 324 | 325 | 326 | 327 | 328 | 329 | 330 | 331 | 332 | 333 | 334 | 335 | 336 | 337 | 338 | 339 | 340 | 341 | 342 | 343 | 344 | 345 | 346 | 347 | 348 | 349 | 350 | 351 |
| 352 | 353 | 354 | 355 | 356 | 357 | 358 | 359 | 360 | 361 | 362 | 363 | 364 | 365 | 366 | 367 | 368 | 369 | 370 | 371 | 372 | 373 | 374 | 375 | 376 | 377 | 378 | 379 | 380 | 381 | 382 | 383 |
| 384 | 385 | 386 | 387 | 388 | 389 | 390 | 391 | 392 | 393 | 394 | 395 | 396 | 397 | 398 | 399 | 400 | 401 | 402 | 403 | 404 | 405 | 406 | 407 | 408 | 409 | 410 | 411 | 412 | 413 | 414 | 415 |
| 416 | 417 | 418 | 419 | 420 | 421 | 422 | 423 | 424 | 425 | 426 | 427 | 428 | 429 | 430 | 431 | 432 | 433 | 434 | 435 | 436 | 437 | 438 | 439 | 440 | 441 | 442 | 443 | 444 | 445 | 446 | 447 |
| 448 | 449 | 450 | 451 | 452 | 453 | 454 | 455 | 456 | 457 | 458 | 459 | 460 | 461 | 462 | 463 | 464 | 465 | 466 | 467 | 468 | 469 | 470 | 471 | 472 | 473 | 474 | 475 | 476 | 477 | 478 | 479 |
| 480 | 481 | 482 | 483 | 484 | 485 | 486 | 487 | 488 | 489 | 490 | 491 | 492 | 493 | 494 | 495 | 496 | 497 | 498 | 499 | 500 | 501 | 502 | 503 | 504 | 505 | 506 | 507 | 508 | 509 | 510 | 511 |
| 512 | 513 | 514 | 515 | 516 | 517 | 518 | 519 | 520 | 521 | 522 | 523 | 524 | 525 | 526 | 527 | 528 | 529 | 530 | 531 | 532 | 533 | 534 | 535 | 536 | 537 | 538 | 539 | 540 | 541 | 542 | 543 |
| 544 | 545 | 546 | 547 | 548 | 549 | 550 | 551 | 552 | 553 | 554 | 555 | 556 | 557 | 558 | 559 | 560 | 561 | 562 | 563 | 564 | 565 | 566 | 567 | 568 | 569 | 570 | 571 | 572 | 573 | 574 | 575 |
| 576 | 577 | 578 | 579 | 580 | 581 | 582 | 583 | 584 | 585 | 586 | 587 | 588 | 589 | 590 | 591 | 592 | 593 | 594 | 595 | 596 | 597 | 598 | 599 | 600 | 601 | 602 | 603 | 604 | 605 | 606 | 607 |
| 608 | 609 | 610 | 611 | 612 | 613 | 614 | 615 | 616 | 617 | 618 | 619 | 620 | 621 | 622 | 623 | 624 | 625 | 626 | 627 | 628 | 629 | 630 | 631 | 632 | 633 | 634 | 635 | 636 | 637 | 638 | 639 |
| 640 | 641 | 642 | 643 | 644 | 645 | 646 | 647 | 648 | 649 | 650 | 651 | 652 | 653 | 654 | 655 | 656 | 657 | 658 | 659 | 660 | 661 | 662 | 663 | 664 | 665 | 666 | 667 | 668 | 669 | 670 | 671 |
| 672 | 673 | 674 | 675 | 676 | 677 | 678 | 679 | 680 | 681 | 682 | 683 | 684 | 685 | 686 | 687 | 688 | 689 | 690 | 691 | 692 | 693 | 694 | 695 | 696 | 697 | 698 | 699 | 700 | 701 | 702 | 703 |
| 704 | 705 | 706 | 707 | 708 | 709 | 710 | 711 | 712 | 713 | 714 | 715 | 716 | 717 | 718 | 719 | 720 | 721 | 722 | 723 | 724 | 725 | 726 | 727 | 728 | 729 | 730 | 731 | 732 | 733 | 734 | 735 |
| 736 | 737 | 738 | 739 | 740 | 741 | 742 | 743 | 744 | 745 | 746 | 747 | 748 | 749 | 750 | 751 | 752 | 753 | 754 | 755 | 756 | 757 | 758 | 759 | 760 | 761 | 762 | 763 | 764 | 765 | 766 | 767 |
| 768 | 769 | 770 | 771 | 772 | 773 | 774 | 775 | 776 | 777 | 778 | 779 | 780 | 781 | 782 | 783 | 784 | 785 | 786 | 787 | 788 | 789 | 790 | 791 | 792 | 793 | 794 | 795 | 796 | 797 | 798 | 799 |
| 800 | 801 | 802 | 803 | 804 | 805 | 806 | 807 | 808 | 809 | 810 | 811 | 812 | 813 | 814 | 815 | 816 | 817 | 818 | 819 | 820 | 821 | 822 | 823 | 824 | 825 | 826 | 827 | 828 | 829 | 830 | 831 |
| 832 | 833 | 834 | 835 | 836 | 837 | 838 | 839 | 840 | 841 | 842 | 843 | 844 | 845 | 846 | 847 | 848 | 849 | 850 | 851 | 852 | 853 | 854 | 855 | 856 | 857 | 858 | 859 | 860 | 861 | 862 | 863 |
| 864 | 865 | 866 | 867 | 868 | 869 | 870 | 871 | 872 | 873 | 874 | 875 | 876 | 877 | 878 | 879 | 880 | 881 | 882 | 883 | 884 | 885 | 886 | 887 | 888 | 889 | 890 | 891 | 892 | 893 | 894 | 895 |
| 896 | 897 | 898 | 899 | 900 | 901 | 902 | 903 | 904 | 905 | 906 | 907 | 908 | 909 | 910 | 911 | 912 | 913 | 914 | 915 | 916 | 917 | 918 | 919 | 920 | 921 | 922 | 923 | 924 | 925 | 926 | 927 |
| 928 | 929 | 930 | 931 | 932 | 933 | 934 | 935 | 936 | 937 | 938 | 939 | 940 | 941 | 942 | 943 | 944 | 945 | 946 | 947 | 948 | 949 | 950 | 951 | 952 | 953 | 954 | 955 | 956 | 957 | 958 | 959 |
| 960 | 961 | 962 | 963 | 964 | 965 | 966 | 967 | 968 | 969 | 970 | 971 | 972 | 973 | 974 | 975 | 976 | 977 | 978 | 979 | 980 | 981 | 982 | 983 | 984 | 985 | 986 | 987 | 988 | 989 | 990 | 991 |

C-Code for all these calculations can be found in our SDK (Software Development Kit). Furthermore, the SDK is able to fetch the data from the module and sends it to our GUI (Graphical User Interface) which can visualize the data, records videos and text files and has many additional features. For more information see www.heimannsensor.com.

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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 |

Precondition for all streaming modes:

VDD must be in the given limits.

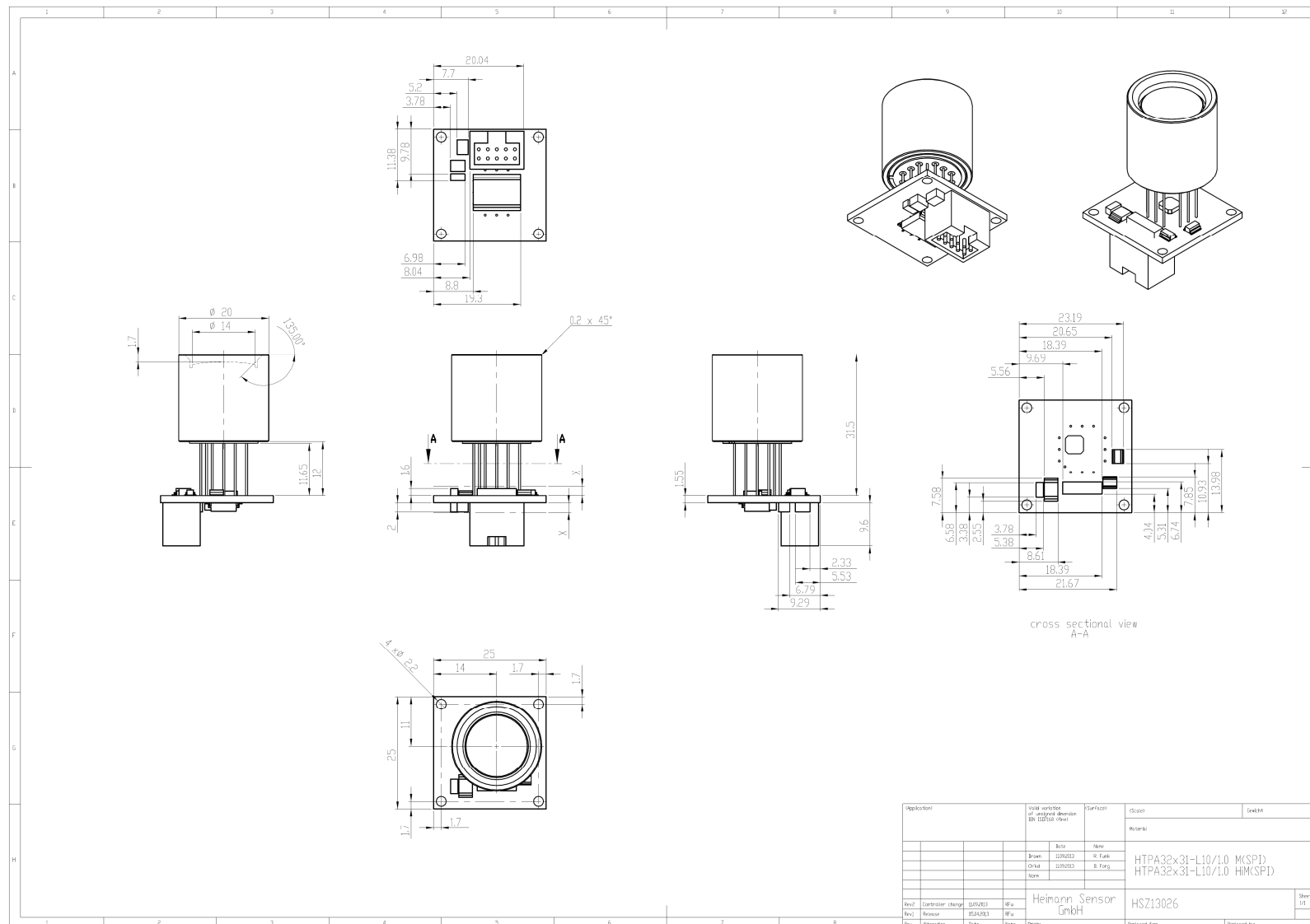
Absolute Maximum Ratings:

| 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 | | 60 | °C | non-condensing |
| Current consumption | | 65 | | mA | In streaming |
| Current consumption | | 35 | | mA | Idle |

Rev.0: 2014.03.10 Fg



Dimensions:



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