



Temperature Sensor

BM43TND80AA-T2

Bestow Mascot

CONTENT

1. Description	1
1.1 General Description	1
1.2 Features	1
1.3 Applications	1
1.4 Package	1
2. Block Diagram	2
3. Signal Conditioning	3
3.1 Signal Conditioning Circuit	3
3.2 Features	3
3.3 Benefits	3
3.4 Physical Characteristics	4
4. Characteristics	5
4.1 Accuracy of Measurement	5
4.2 IC Characteristics	5
4.3 Electrical Parameters	6
4.4 Power Up	7
4.5 Measurements	8
4.6 Operational Modes	8
4.7 I ² C Commands	10
4.8 Communication Interface	13
4.8.1 Common Functionality	13
4.8.2 I ² C TM	14
4.9 MTP Memory Content Assignments	15
4.10 Sensor Data Output Format	21
4.11 Typical Reliability Test Items	22
5. Ordering Information	23
5.1 Part Numbering	23
5.2 TO-46 Package Outline Information (in mm)	24
5.3 Packing Information	25
6. Field of View (FOV)	26
7. Notice	27
8. Revision History	31

1. Description

1.1 General Description

The BM43TND80AA-T2 is a BM digital Far Infrared thermopile temperature sensor based on MEMS (micro-electromechanical systems) technology. BM43TND80AA-T2 consists of thermopile MEMS chip, 5-14um infrared band pass filter, a read-out IC and classic TO-46 Package.

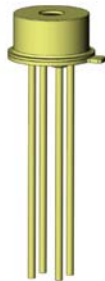
1.2 Features

- Non-contact surface temperature measuring
- Fully integrated digital far infrared thermopile sensor
- 1.68V to 3.6V single supply continuous operation
- Current consumption: 1mA (operating mode)
- Sleep state current: 20nA (typical)
- I²C Interface
- Temperature resolution
 - ✧ 3mK/LSB for body temperature sensing
 - ✧ ±0.5 K for object temperature sensing
- Fast response time
- Operating temperature: -40°C~+85°C
- Optical Option: Infrared Optical Band-pass filter / Infrared Fresnel lens

1.3 Applications

- High precision non-contact temperature measurements
- Hand-held thermometers
- Home appliances with temperature control
- Healthcare

1.4 Package



2. Block Diagram

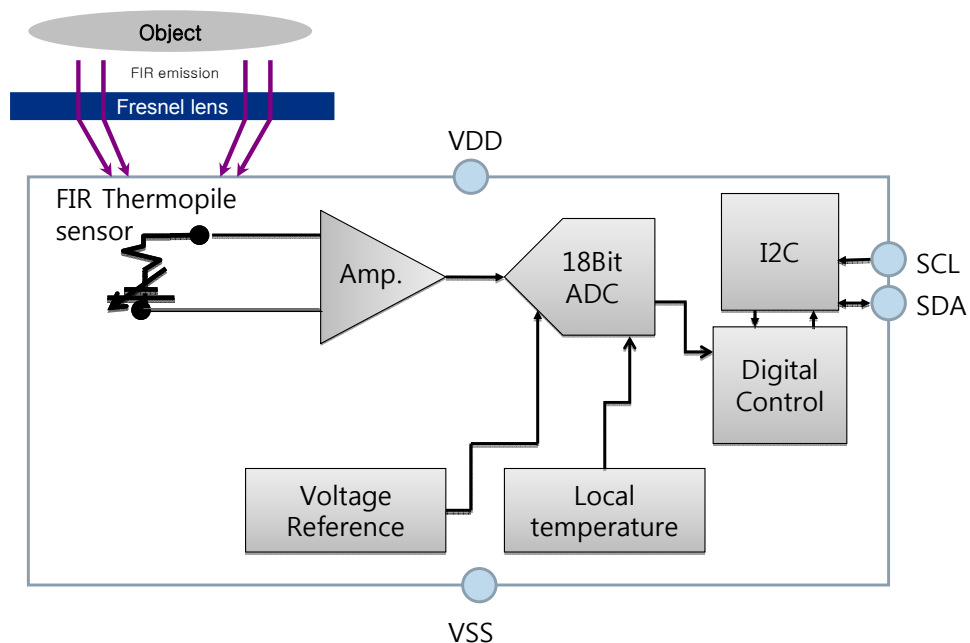


Figure1 Block Diagram

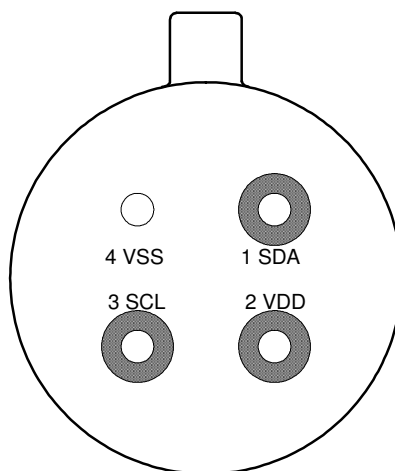


Figure2 Bottom View of BM43TND80AA

Table 1 Pin Description

Pin	Function	Description
1	SDA	Serial Communication
2	VDD	External supply voltage.
3	SCL	Serial Communication
4	VSS	Ground. The metal can is also connected to this pin.

3. Signal Conditioning

3.1 Signal Conditioning Circuit

The BM43TND80AA-T2 is a thermopile sensor module with a sensor signal conditioner (SSC) integrated circuit for nominal-accuracy amplification and analog-to-digital conversion of a differential or pseudo-differential input signal. Designed for variety high-resolution sensor module applications, the integrated signal conditioner of a BM43TND80AA-T2 can perform offset, span, and 1st and 2nd order temperature compensation of the measured signal. The module is developed for correction of absolute voltage sensors; it can also provide a corrected temperature output measured with an internal sensor.

The measured and corrected sensor values are provided at the digital output pins, which can be configured as I²C. Digital compensation of signal offset, sensitivity, temperature, and non-linearity is accomplished via a 26-bit internal digital signal processor (DSP) running a correction algorithm. Calibration coefficients are stored on-chip in a highly reliable, non-volatile, multiple-time programmable (MTP) memory. Programming the BM43TND80AA-T2 is simple via the serial interface. The interface is used for the PC-controlled calibration procedure, which programs the set of calibration coefficients in memory. The BM43TND80AA-T2 provides accelerated signal processing, increased resolution, and improved noise immunity in order to support high-speed control, safety, and real-time sensing applications with the highest requirements for energy efficiency.

3.2 Features

- Flexible, programmable analog front-end design; up to 18-bit analog-to-digital converter (ADC)
- Fully programmable gain amplifier for optimizing sensor signals: gain range 6.6 to 216 (linear)
- Internal auto-compensated temperature sensor
- Digital compensation of individual sensor offset; 1st and 2nd order digital compensation of sensor gain as well as 1st and 2nd order temperature gain and offset drift
- Programmable interrupt operation
- High-speed sensing: e.g. 16-bit conditioned sensor signal measurement rate $>500\text{s}^{-1}$
- Typical sensor elements can achieve accuracy of better than $\pm 0.10\%\text{FSO}^{**}$ at -40 to 85°C

3.3 Benefits

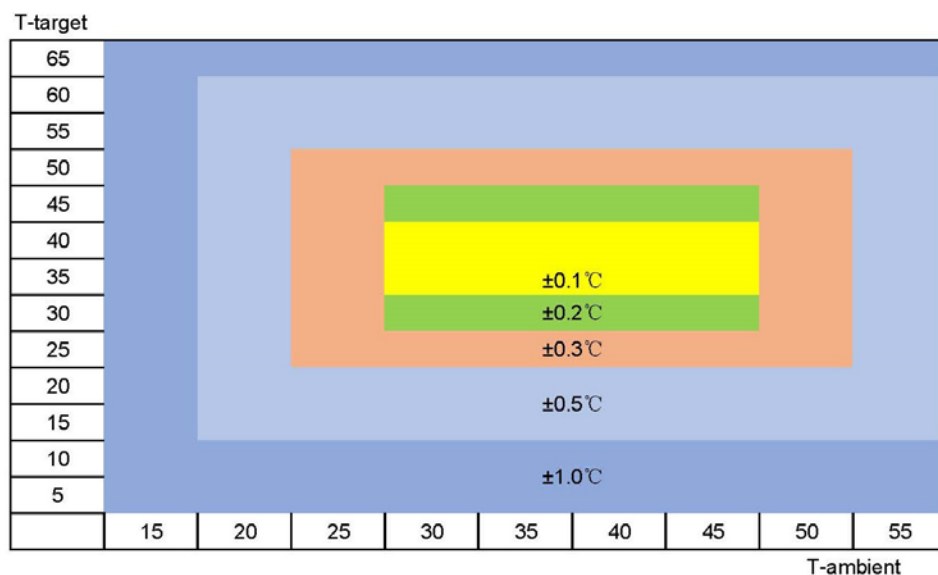
- Integrated 26-bit calibration math digital signal processor (DSP)
- Fully corrected signal at digital output
- One-pass calibration minimizes calibration costs
- No external trimming, filter, or buffering components required
- Highly integrated CMOS design
- Integrated reprogrammable non-volatile memory
- Excellent for low-voltage and low-power battery applications

3.4 Physical Characteristics

- Supply voltage range: 1.68V to 3.6V
- Current consumption: 1.0mA (operating mode)
- Sleep State current: 20nA (typical)
- Temperature resolution: <0.003K/LSB
- Best-in-class energy-efficiency with 16-bit resolution: <140pJ/step with 18-bit resolution: <50pJ/step
- Operation temperature: -40°C~+85°C

4 Characteristics

4.1 Accuracy of Measurement



4.2 IC Characteristics

Absolute Maximum Ratings: The absolute maximum ratings are stress ratings only.

The BM43TND80AA-T2 might not function or be operable above the recommended operating conditions. Stresses exceeding the absolute maximum ratings might also damage the device. In addition, extended exposure to stresses above the recommended operating conditions might affect device reliability. BM does not recommend designing to the “Absolute Maximum Ratings.”

Table2 Maximum Ratings

Parameter	Symbol	Min.	Typ.	Max.	Units
Voltage Reference	VSS	0	-	0	V
Analog Supply Voltage	-	-0.4	-	3.63	V
Input Current into any Pin except RES, SS ^{1), 2)}	IIN	100	-	100	mA
Electrostatic Discharge Tolerance – Human Body Model (HBM1) ³⁾	V _{HBM1}	±4000	-	-	V
Operating Temperature Range	T _{AMB}	-40		85	°C
Storage Temperature	T _{STOR}	-40	-	125	°C

Note:

1) Latch-up current limit for RES, BM-test and SS: $\pm 70\text{mA}$.

2) Latch-up resistance; reference for pin is 0V.

3) HBM1: C = 100pF charged to V_{HBM1} with resistor R=1.5k in series based on MIL 883, Method 3015.7. ESD protection referenced to the Human Body Model is tested with devices in ceramic dual in-line packages (CDIP) during product qualification.

Table 3 Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Units
Supply Voltage	V_{DD}	1.68	-	3.6	V
Supply Current	-	-	-	1.0	mA
VDD Rise Time	t_{VDD}	-	-	200	μ s
External (Parasitic) Capacitance between VDDDB and VSS	CL	0.01	-	50	nF
Note: The reference for all voltages is Vss.					

A dynamic power-on-reset circuit is implemented in order to achieve minimum current consumption in idle mode. The VDD low level and the subsequent rise time and VDD rising slope must meet the requirements in Table 3 to guarantee an overall IC reset; lower VDD low levels allow slower rising of the subsequent on-ramp of VDD. Other combinations might also be possible. For example, the reset trigger can be influenced by increasing the power-down time and lowering the VDD rising slope requirement. Alternatively, the RES pin can be connected and used to control safe resetting of the BM43TND80AA-T2. RES is active-low; a VDD-VSS-VDD transition at the RES pin leads to a complete IC reset.

4.3 Electrical Parameters

All parameter values are valid only under the specified operating conditions. All voltages are referenced to Vss.

Table 4 Electrical Parameters

Parameter	Symbol	Conditions/Comments	Min	Typ	Max	Unit
Supply						
External Sensor Supply Voltage, ADC Reference Voltage	V _{DDB}	Internally generated	1.60	1.68	1.75	V
Current Consumption	I _{VDD}	Active State, average		1050	1500	μA
		Sleep State, idle current, ≤85°C		20	250	nA
Power Supply Rejection 20·log10(V _{DD} /V _{DDB})	PSR _{VDD}	V _{DD} =1.8V	17	60	88	dB
		V _{DD} =2V	32	65	91	dB
Analog-to-Digital Converter (ADC, A2D)						
Resolution	r _{ADC}		12		18	Bit
ADC Clock Frequency	f _{ADC}	Internal ADC clock	0.9	1	1.1	MHz
Conversion Rate	f _{S,RAW}	Conversions per second for single 18-bit external sensor A2D conversion (w/o AZ)			1.1	kHz
		Conversions per second for single 16-bit temperature sensor A2D conversion (w/o AZ)			2.3	kHz
Amplifier						
Gain	G _{amp}	64 steps	6.6		216	

Parameter	Symbol	Conditions/Comments	Min	Typ	Max	Unit
Gain Error	G _{err}	Referenced to nominal gain	-2.5	-	2.5	%
Sensor Signal Conditioning Performance						
IC Accuracy Error*	Err _{AJC}	Accuracy error for sensor that is ideally linear (in temperature and measurand)			0.01	%FSO
Conversion Rate, 18-Bit SSC	f _{S,SSC}	Conversion per second for fully corrected 18-bit measurement		270	300	Hz
Input						
Input Voltage Range	V _{INP} , V _{INN}	Input voltage range at INP and INN	0.65		1.05	V
External Sensor Bridge Resistance	R _{BR}	Full power supply disturbance rejection (PSRR) capabilities	1	10	50	kΩ
		Reduced PSRR, but full functionality	100		999	Ω
Power-Up						
Start-up Time	t _{STA1}	VDD ramp up to interface communication			1	ms
	t _{STA2}	VDD ramp up to analog operation			2.5	ms
Wake-up Time	t _{WUP1}	Sleep to Active State interface communication			0.5	ms
	t _{WUP2}	Sleep to Active State analog operation			2	ms
Oscillator						
Internal Oscillator Frequency	f _{CLK}		3.6	4	4.4	MHz
Internal Temperature Sensor						
Temperature Resolution		-40°C to +85°C		0.003		K/LSB
Interface and Memory						
SPI Clock Frequency	f _{C,SPI}	Maximum capacitance at MISO line: 40pF at VDD=1.8V		1	20	MHz
I ² C™ Clock Frequency	f _{C,I2C}				3.4	MHz
Program Time	t _{prog}	MTP programming time per 16-bit register		5	16	ms
Endurance	n _{MTP}	Number of reprogramming cycles	1000	10000		numeric
Data Retention	t _{RET_MTP}	1000h at 125°C	10			a
Note: See important table notes at the end of the table						
*: Percentage referred to maximum full-scale output (FSO)						

4.4 Power Up

Specifications for this section are given in sections 4.2 and 4.3. On power-up, the BM43TND80AA-T2 communication interface is able to receive the first command after a time t_{STA1} from when the VDD supply is within operating specifications. The BM43TND80AA-T2 can begin the first measurement after a time of t_{STA2} , from when the VDD supply is operational. Alternatively, instead of a power-on-reset, a reset and new power-up-sequence respectively can be triggered by an IC-reset signal (high low) at RES pin. The wake up time from Sleep State to Active State (see section 4.5) after receiving the activating

command is defined as t_{WUP1} and t_{WUP2} . In Command Mode, subsequent commands can be sent after t_{WUP1} . The first measurement starts after t_{WUP2} if a measurement request was sent.

4.5 Measurements

Available measurement procedures are

- AZSM: auto-zero (external) sensor measurement
- SM: (external) sensor measurement
- AZTM: auto-zero temperature measurement
- TM: temperature measurement

AZSM: The configuration is loaded for measuring the external sensor; i.e., a resistive bridge or an absolute voltage source. The “Multiplexer” block connects the amplifier input to the AGND analog ground reference. An analog-to-digital (A2D) conversion is performed so that the inherent system offset for the respective configuration is converted by the ADC to a digital word with a resolution according to the respective MTP configuration.

SM: The configuration is loaded for measuring the external sensor; i.e. a resistive bridge or an absolute voltage source. The “Multiplexer” block connects the amplifier input to the INP and INN pins. An A2D conversion is performed. The result is a digital word with a resolution according to the MTP configuration.

AZTM: The configuration for temperature measurements is loaded. The “Multiplexer” block connects the amplifier input to AGND. An analog-to-digital conversion is performed so that the inherent system offset for the temperature configuration is converted by the ADC with a resolution according to the respective MTP configuration.

TM: The configuration for temperature measurements is loaded. The “Multiplexer” block connects the amplifier input to the internal temperature sensor. An A2D conversion is performed. The result is a digital word with a resolution according to the MTP configuration.

The typical application’s measurement cycle is a complete SSC measurement (using the commands AA_{HEX} to AF_{HEX}; see section 4.7) with AZSM, SM, AZTM, and TM followed by a signal correction calculation.

4.6 Operational Modes

Figure 3 illustrates the BM43TND80AA-T2 power-up sequence and subsequent operation depending on the selected interface communication mode as determined by interface-related first activities after power-up or reset. If the first command after power-up is a valid I²CTM command, the interface will function as an I²CTM interface until the next power-on-reset. If there is no valid I²CTM command, but an active signal at the SS pin is detected as the first valid activity, then the interface will respond as an SPI slave. With either interface, after the voltage regulators are switched on, the BM43TND80AA-T2’s low-voltage section (LV) is active while the related interface configuration information is read from memory. Then the LV section is switched off, the BM43TND80AA-T2 goes into Sleep State, and the interface is ready to receive commands. The interface is always powered by V_{DD}, so it is referred to as the high voltage section (HV).

Figure 4 shows the BM43TND80AA-T2 operation in Normal Mode (with two operation principles: “Sleep” and “Cyclic”) and Command Mode, including when the LV and HV sections are active as indicated by the color legend. The Normal Mode automatically returns to Sleep State after executing the requested measurements, or periodically wakes up and conducts another measurement according to the setting for the sleep duration configured by CYC_period (bits[14:12] in memory register 02_{HEX}). In Command Mode, the BM43TND80AA-T2 remains active if a dedicated command (Start_NOM) is sent, which is helpful during calibration. Command Mode can only be entered if Start_CM is the first command received after POR.

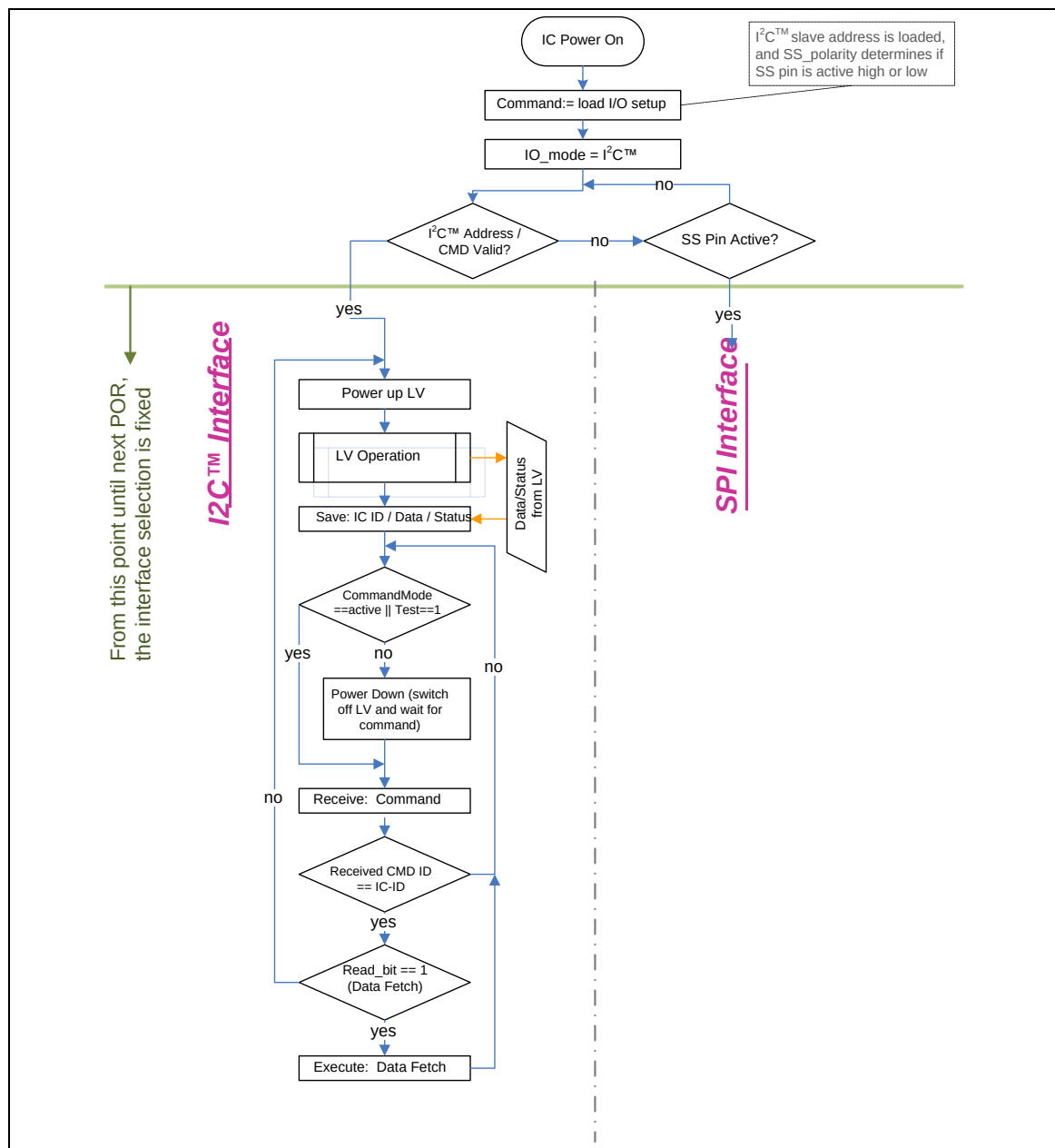


Figure 3 Operational Flow Chart: Power Up

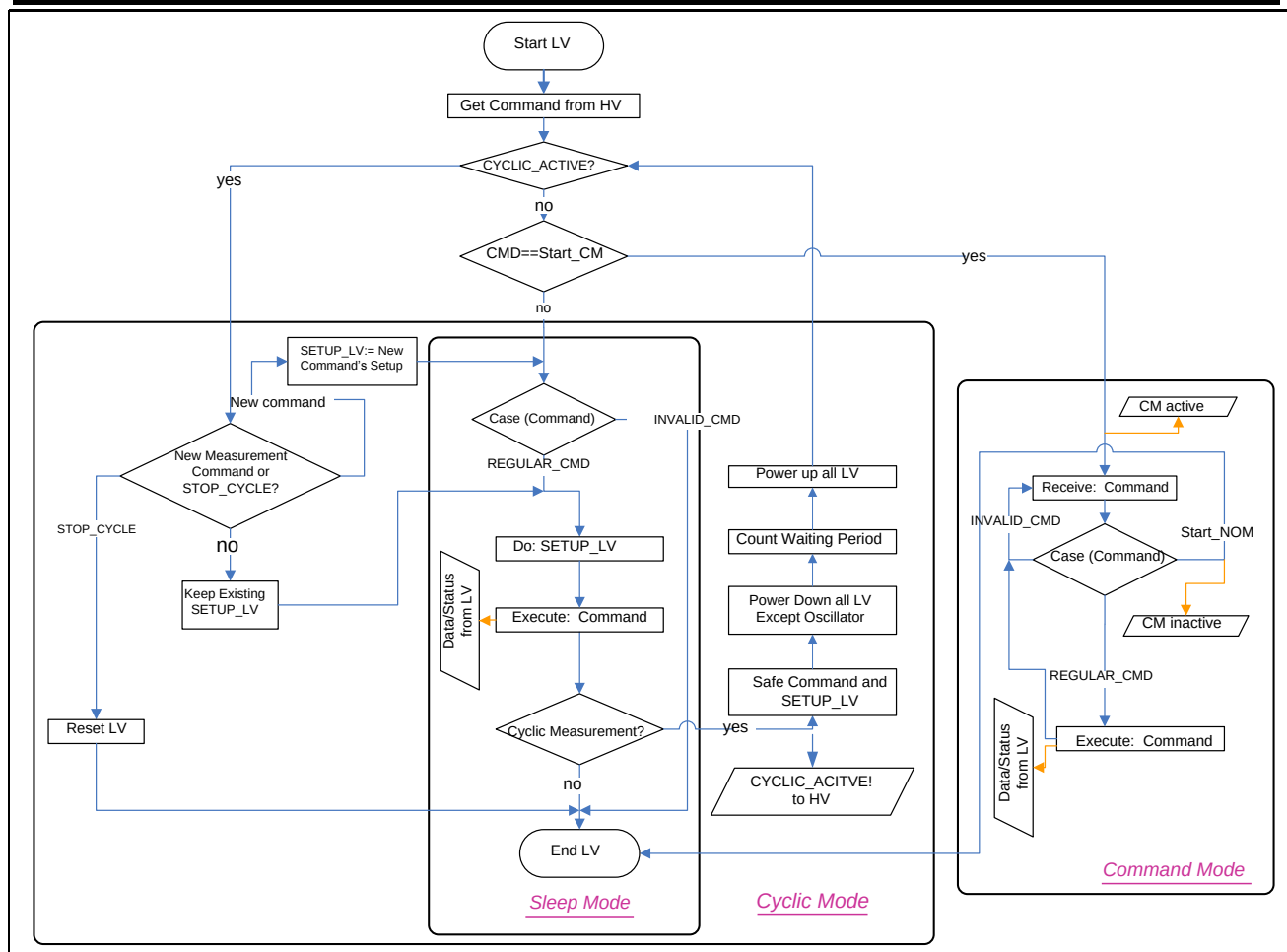


Figure 4 Operational Flow Chart: Command Mode and Normal Mode (Sleep and Cyclic)

4.7 I²C Commands

The I²C commands supported by the BM43TND80AA-T2 are listed in Table5. The command to read an address in the user memory is the same as its address. The command to write to an address in user memory is the address plus 40HEX.

There is a BM-reserved section of memory that can be read but not over-written by the user.

Table 5 I²C Commands

Command (Byte)	Return	Description	Normal Mode	Command Mode
00 _{HEX} to 39 _{HEX}	16-bit user data	Read data in the user memory address (00 _{HEX} to 39 _{HEX}) matching the command (might not be using all addresses).	Yes	Yes
3A _{HEX} to 3F _{HEX}	16-bit BM-reserved memory data	Read data in BM-reserved memory at address (3A _{HEX} to 3F _{HEX}).	Yes	Yes
40 _{HEX} to 79 _{HEX} followed by data (0000 _{HEX} to FFFF _{HEX})	—	Write data to user memory at address specified by command minus 40 _{HEX} (addresses 00 _{HEX} to 39 _{HEX} respectively; might not be using all addresses).	Yes	Yes
90 _{HEX}	—	Calculate and write memory	Yes	Yes

Command (Byte)	Return	Description	Normal Mode	Command Mode
		checksum (CRC).		
A0 _{HEX} to A7 _{HEX} followed by XXXX _{HEX} (see Table 6)	24-bit formatted raw data	Get_Raw This command can be used to perform a measurement and write the raw ADC data into the output register. The LSB of the command determines how the AFE configuration register is loaded for the Get_Raw measurement	Yes	Yes
A8 _{HEX}	—	Start_NOM Exit Command Mode and transition to Normal Mode (Sleep or Cyclic).	No	Yes
A9 _{HEX}	—	Start_CM Exit Normal Mode and transition to Command Mode (as very first command after power-up).	Yes	No
AA _{HEX}	24-bit formatted fully corrected sensor measurement data + 24-bit corrected temperature data	Measure Trigger full measurement cycle (AZSM, SM, AZTM, and TM, as described in section 4.5) and calculation and storage of data in the output buffer using the configuration from MTP.	Yes	Yes
AB _{HEX}	24-bit formatted fully corrected sensor measurement data + 24-bit corrected temperature data	Measure Cyclic This command triggers a continuous full measurement cycle (AZSM, SM, AZTM, and TM; see section 4.5) and calculation and storage of data in the output buffer using the configuration from MTP followed by a pause determined by CYC_period (bits[14:12] in memory register 02 _{HEX}).	Yes	Yes
AC _{HEX}	24-bit formatted fully corrected sensor measurement data + 24-bit corrected temperature data	Oversample-2 Measure Mean value generation: 2 full measurements are conducted (as in command AA _{HEX}), the measurements' mean value is calculated, and data is stored in the output buffer using the configuration from MTP; no power down or pause between the 2 measurements	Yes	Yes
AD _{HEX}	24-bit formatted fully corrected sensor measurement data + 24-bit corrected temperature data	Oversample-4 Measure Mean value generation: 4 full measurements (as in command AA _{HEX}) are conducted, the measurements' mean value is calculated, and data is stored in the output buffer using the configuration from MTP; no power down or pause between the 4 measurements	Yes	Yes
AE _{HEX}	24-bit formatted fully corrected sensor	Oversample-8 Measure Mean value generation: 8 full measurements (as	Yes	Yes

Command (Byte)	Return	Description	Normal Mode	Command Mode
	measurement data + 24-bit corrected temperature data	in command AA _{HEX}) are conducted, the measurements' mean value is calculated, and data is stored in the output buffer using the configuration from MTP; no power down or pause between the 8 measurements		
AF _{HEX}	24-bit formatted fully corrected sensor measurement data + 24-bit corrected temperature data	Oversample-16 Measure Mean value generation: 16 full measurements (as in command AA _{HEX}) are conducted, the measurements' mean value is calculated, and data is stored in the output buffer using the configuration from MTP; no power down or pause between the 16 measurements	Yes	Yes
B0 _{HEX}	—	Select SM_config1 register (12 _{HEX} in memory) For any measurement using the memory contents for the analog front-end and sensor setup, the respective setup is loaded from the SM_config1 register; status bit[1]==0 (default)	Yes	Yes
B1 _{HEX}	—	Select SM_config2 register (16 _{HEX} in memory) For any measurement using the memory contents for the analog front-end and sensor setup, the respective setup is loaded from the SM_config2 register, status bit[1]==1	Yes	Yes
BF _{HEX}	—	STOP_CYC This command causes a power- down halting the update / cyclic measure- ment operation and causing a transition to Normal-Sleep operation	Yes	Yes
FX _{HEX}	Status followed by last 24-bit data	NOP Only valid for SPI	Yes	Yes
Note: Every return starts with a status byte followed by the data word as described in section				

Table 6 Get_Raw Commands

Command	Measurement	AFE Configuration Register
A0 _{HEX} followed by 0000 _{HEX}	SM–Sensor Measurement	SM_config1 register or SM_config2 register.
A1 _{HEX} followed by ssss _{HEX}	SM – Sensor Measurement	ssss is the user's configuration setting for the measurement provided via the interface. The format and purpose of configuration bits must be according to the

		definitions for SM_config (see Table 9).
A2 _{HEX} followed by 0000 _{HEX}	SM-AZSM – Auto-Zero Corrected Sensor Measurement*	SM_config
A3 _{HEX} followed by ssss _{HEX}	SM-AZSM – Auto-Zero Corrected Sensor Measurement**	sss is the user's configuration setting for the measurement provided via the interface. The format and purpose of configuration bits must be according to the definitions for SM_config.
A4 _{HEX} followed by 0000 _{HEX}	TM – Temperature Measurement	BM-defined register
A5 _{HEX} followed by ssss _{HEX}	TM – Temperature Measurement	sss is the user's configuration setting for the measurement provided via the interface. The format and purpose of configuration bits must be according to the definitions for SM_config and valid for temperature measurement in this case (bits [15:12] will be ignored).
A6 _{HEX} followed by 0000 _{HEX}	TM-AZTM – Auto-Zero Corrected Temperature Measurement 1)	BM-defined register
A7 _{HEX} followed by ssss _{HEX}	TM-AZTM – Auto-Zero Corrected Temperature Measurement 2)	sss is the user's configuration setting for the measurement provided via the interface. The format and purpose of these configuration bits must be according to the definitions for SM_config and valid for temperature measurement in this case (bits [15:12] will be ignored).
*:Recommended for raw data collection during calibration coefficient determination using the measurement setups pre-programmed in MTP. **:Recommended for raw data collection during calibration coefficient determination using un-programmed (not in MTP), external measurement setups; e.g., for evaluation purposes.		

4.8 Communication Interface

4.8.1 Common Functionality

Commands are handled by the command interpreter in the LV section. Commands that need additional data are not treated differently than other commands because the HV interface is able to buffer the command and all the data that belongs to the command and the command interpreter is activated as soon as a command byte is received.

Every response starts with a status byte followed by the data word. The data word depends on the previous command. It is possible to read the same data more than once if the read request is repeated (I²C™). If the next command is not a read request (I²C™), it invalidates any previous data.

The BM43TND80AA-T2 supports the parallel setup of two amplifier-ADC-configurations using SM_config1 and SM_config2. Switching between the two setups can be done with the commands B0_{HEX} and B1_{HEX}. Note that the respective activation command must always be sent prior to the measurement request.

The status byte contains the following bits in the sequence shown in Table7:

- Power indication (bit 6): 1 if the device is powered (V_{DDB} on); 0 if not powered. This is needed for the SPI

Mode where the master reads all zeroes if the device is not powered or in power-on reset (POR).

- Busy indication (bit 5): 1 if the device is busy, which indicates that the data for the last command is not available yet. No new commands are processed if the device is busy.

Note: The device is always busy if cyclic measurement operation has been set up and started.

- Currently active BM43TND80AA-T2 mode (bits [4:3]): 00=Normal Mode; 01=Command Mode; 1X=BM reserved.
- Memory integrity/error flag (bit 2): 0 if integrity test passed; 1 if test failed. This bit indicates whether the checksum-based integrity check passed or failed. The memory error status bit is calculated only during the power-up sequence, so a newly written CRC will only be used for memory verification and status update after a subsequent BM43TND80AA-T2 power-on reset (POR) or reset by means of the RES pin.
- Config Setup (bit 1): This bit indicates which *SM_config* register is being used for the active configuration: *SM_config1* (12_{HEX}) or *SM_config2* (16_{HEX}). The two alternate configuration setups allow for two different configurations of the external sensor channel in order to support up to two application scenarios with the use of only one sensor-BM43TND80AA-T2 pair. This bit is 0 if *SM_config1* was selected (default). This bit is 1 if *SM_config2* was selected.
- ALU saturation (bit 0): If the last command was a measurement request, this bit is 0 if any intermediate value and the final SSC result are in a valid range and no SSC-calculation internal saturation occurred in the arithmetic logic unit (ALU). If the last command was a measurement request, this bit is 1 if an SSC-calculation internal saturation occurred. This bit is also 0 for any non-measurement command.

Table 7 General Status Byte

Bit	7	6	5	4	3	2	1	0
Meaning	0	Powered?	Busy?	Mode		Memory error?	Config Setup	ALU Saturation

Table 8 Mode Status

Status [4:3]	Mode
00	Normal Mode (sleep and cyclic operations)
01	Command Mode
10	BM reserved
11	BM reserved

Further status information can be provided by the EOC pin. The EOC pin is set high when a measurement and calculation have been completed (if no interrupt threshold is used, i.e. INT_setup==00_{BIN}).

4.8.2 I²C™

I²C™ Mode will be selected if the very first interface activity after BM43TND80AA-T2 power-up is an I²C™ command.. Only the number of bytes that are needed for the command must be sent. An exception is the HS-mode where 3 bytes must always be sent as in SPI Mode. After the execution of a command (busy=0), the expected data can be read as illustrated in Figure 6 or if no data are returned by the command, the next command can be sent. The status can be read at any time as described in Figure 5.

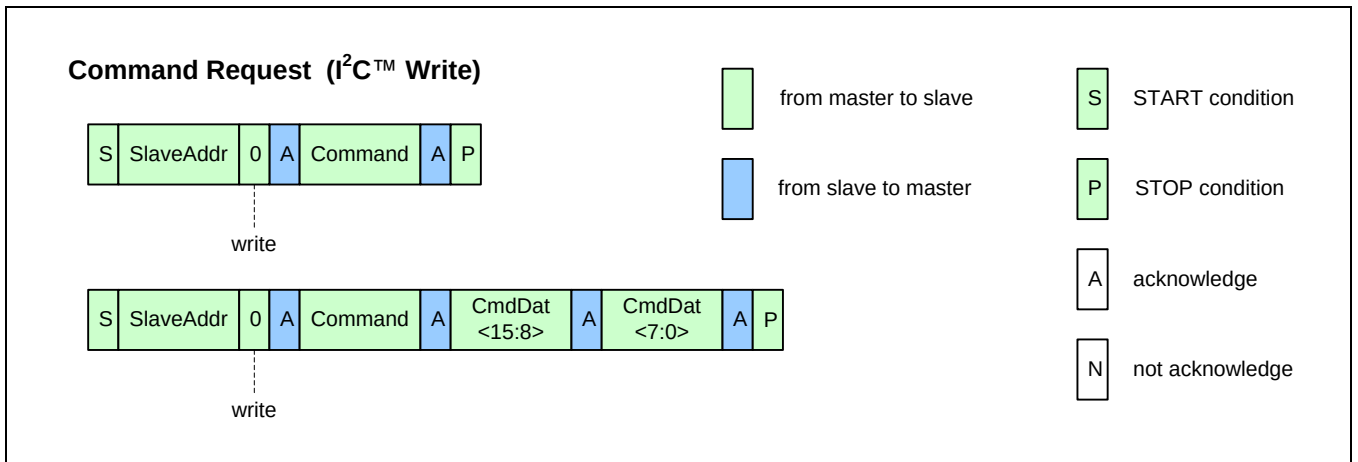


Figure 5 I²C™ Command Request

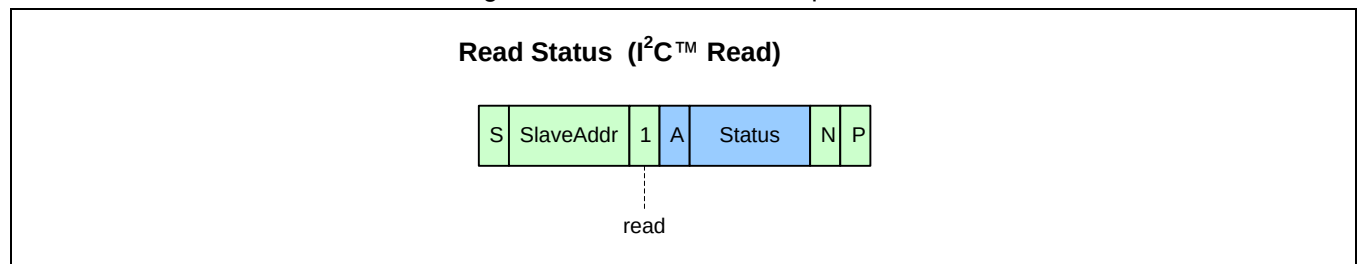


Figure 6 I²C™ Read Status

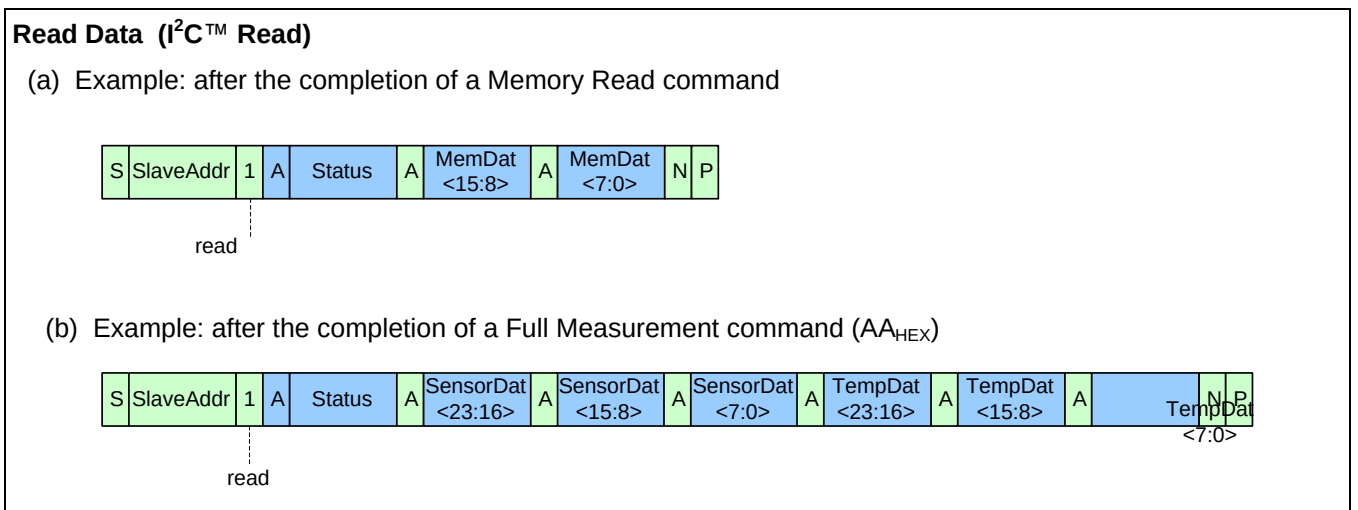


Figure 7 I²C™ Read Data

All mandatory I²C™-bus protocol features are implemented. Optional features such as clock stretching, 10-bit slave address, etc., are not supported by the BM43TND80AA-T2's interface.

In I²C-High-Speed Mode, a command consists of a fixed length of three bytes.

4.9 MTP Memory Content Assignments

Table 9 MTP Memory Content Assignments

MTP Address	Word / Bit Range	Default Setting	Description	Notes
00 _{HEX}	15:0	0000 _{HEX}	Cust_ID0	Customer ID byte 0 (combines with memory word 01 _{HEX} to form customer ID).
01 _{HEX}	15:0	0000 _{HEX}	Cust_ID1	Customer ID byte 1 (combines with memory word 00 _{HEX} to form customer ID).

MTP Address	Word / Bit Range	Default Setting	Description	Notes
Interface Configuration				
02 _{HEX}	6:0	000 0000 _{BIN}	Slave_Addr	I ² C slave address; valid range:00 _{HEX} to 7F _{HEX} : (default:00 _{HEX}). Note: address codes 04 _{HEX} to 07 _{HEX} are reserved for entering the I ² C High Speed Mode.
	8:7	00 _{BIN}	INT_setup	Interrupt configuration, EOC pin functionality: 00 End-of-conversion signal 01 0-1 transition if threshold1 (TRSH1) is exceeded and 1-0 transition if threshold1 is underrun again 10 0-1 transition if threshold1 is underrun and 1-0 transition if threshold1 is exceeded again 11 EOC is determined by threshold settings:If (TRSH1 > TRSH2) then EOC/INT (interrupt level) = 0 if (TRSH1 > MEAS ≥ TRSH2) where MEAS is the conditioned measurement result. Otherwise EOC/INT=1. If (TRSH1 ≤ TRSH2) then EOC=1 if (TRSH1 ≤ MEAS < TRSH2). Otherwise EOC=0.
	9	0 _{BIN}	SS_polarity	Determines the polarity of the Slave Select pin (SS) for SPI operation: 0⇔Slave Select is active low (SPI and BM43TND80AA-T2 are active if SS==0) 1⇔Slave Select is active high (SPI and BM43TND80AA-T2 are active if SS==1)
	11:10	00 _{BIN}	CKP_CKE	Clock polarity and clock-edge select—determines polarity and phase of SPI interface clock with the following modes: 00⇔SCLK is low in idle state, data latch with rising edge and data output with falling edge 01⇔SCLK is low in idle state, data latch with falling edge and data output with rising edge 10⇔SCLK is high in idle state, data latch with falling edge and data output with rising edge 11⇔SCLK is high in idle state, data latch with rising edge and data output with falling edge
	14:12	000 _{BIN}	CYC_period	Update period (BM43TND80AA-T2 sleep time, except oscillator) in cyclic operation: 000⇔not assigned 001⇔125ms 010⇔250ms 011⇔500ms 100⇔1000ms 101⇔2000ms 110⇔4000ms 111⇔not assigned
	15	0 _{BIN}	SOT_curve	Type/shape of second-order curve correction for the sensor signal. 0⇔parabolic curve 1⇔s-shaped curve
Signal Conditioning Parameters				
03 _{HEX}	15:0	0000 _{HEX}	Offset_S[15:0]	Bits [15:0] of the 24-bit-wide sensor offset correction coefficient Offset_S. (The MSBs of this coefficient including sign are Offset_S[23:16], which is bits

MTP Address	Word / Bit Range	Default Setting	Description	Notes
				[15:8] in 0D _{HEX} .)
04 _{HEX}	15:0	0000 _{HEX}	Gain_S[15:0]	Bits [15:0] of the 24-bit-wide value of the sensor gain coefficient Gain_S. (The MSBs of this coefficient including sign are Gain_S[23:16], which is bits [7:0] in 0D _{HEX} .)
05 _{HEX}	15:0	0000 _{HEX}	Tcg[15:0]	Bits [15:0] of the 24-bit-wide coefficient Tcg for the temperature correction of the sensor gain. (The MSBs of this coefficient including sign are Tcg[23:16], which is bits [15:8] in 0E _{HEX} .)
06 _{HEX}	15:0	0000 _{HEX}	Tco[15:0]	Bits [15:0] of the 24-bit-wide coefficient Tco for temperature correction of the sensor offset. (The MSBs of this coefficient including sign are Tco[23:16], which is bits [7:0] in 0E _{HEX} .)
07 _{HEX}	15:0	0000 _{HEX}	SOT_tco[15:0]	Bits [15:0] of the 24-bit-wide 2 nd order term SOT_tco applied to Tco. (The MSBs of this term including sign are SOT_tco[23:16], which is bits [15:8] in 0F _{HEX} .)
08 _{HEX}	15:0	0000 _{HEX}	SOT_tcg[15:0]	Bits [15:0] of the 24-bit-wide 2 nd order term SOT_tcg applied to Tcg. (The MSBs of this term including sign are SOT_tcg[23:16], which is bits [7:0] in 0F _{HEX} .)
09 _{HEX}	15:0	0000 _{HEX}	SOT_sens[15:0]	Bits [15:0] of the 24-bit-wide 2 nd order term SOT_sens applied to the sensor readout. (The MSBs of this term including sign are SOT_sens[23:16], which is bits [15:8] in 10 _{HEX} .)
0A _{HEX}	15:0	0000 _{HEX}	Offset_T[15:0]	Bits [15:0] of the 24-bit-wide temperature offset correction coefficient Offset_T. (The MSBs of this coefficient including sign are Offset_T[23:16], which is bits [7:0] in 10 _{HEX} .)
0B _{HEX}	15:0	0000 _{HEX}	Gain_T[15:0]	Bits [15:0] of the 24-bit-wide absolute value of the temperature gain coefficient Gain_T. (The MSBs of this coefficient including sign are Gain_T[23:16], which is bits [15:8] in 11 _{HEX} .)
0C _{HEX}	15:0	0000 _{HEX}	SOT_T[15:0]	Bits [15:0] of the 24-bit-wide 2 nd -order term SOT_T applied to the temperature reading. (The MSBs of this coefficient including sign are SOT_T[23:16], which is bit [7:0] in 11 _{HEX} .)
0D _{HEX}	7:0	00 _{HEX}	Gain_S[23:16]	Bits [23:16] including sign for the 24-bit-wide sensor gain correction coefficient Gain_S. (The LSBs of this coefficient are Gain_S[15:0] in register 04 _{HEX} .)
	15:8	00 _{HEX}	Offset_S[23:16]	Bits [23:16] including sign for the 24-bit-wide sensor offset correction coefficient Offset_S. (The LSBs are Offset_S[15:0] in register 03 _{HEX} .)
0E _{HEX}	7:0	00 _{HEX}	Tco[23:16]	Bits [23:16] including sign for the 24-bit-wide coefficient Tco for temperature correction for the sensor offset. (The LSBs are Tco[15:0] in register 06 _{HEX} .)
	15:8	00 _{HEX}	Tcg[23:16]	Bits [23:16] including sign for the 24-bit-wide coefficient Tcg for the temperature correction of the sensor gain. (The LSBs are Tcg[15:0] in register 05 _{HEX} .)
0F _{HEX}	7:0	00 _{HEX}	SOT_tcg[23:16]	Bits [23:16] including sign for the 24-bit-wide 2 nd order term SOT_tcg applied to Tcg. (The LSBs are SOT_tcg[15:0] in register 08 _{HEX} .)

MTP Address	Word / Bit Range	Default Setting	Description	Notes
	15:8	00 _{HEX}	SOT_tco[23:16]	Bits [23:16] including sign for the 24-bit-wide 2 nd order term SOT_tco applied to Tco. (The LSBs are SOT_tco[15:0] in register 07 _{HEX} .)
10 _{HEX}	7:0	00 _{HEX}	Offset_T[23:16]	Bits [23:16] including sign for the 24-bit-wide temperature offset correction coefficient Offset_T. (The LSBs are Offset_T[15:0] in register 0A _{HEX} .)
	15:8	00 _{HEX}	SOT_sens[23:16]	Bits [23:16] including sign for the 24-bit-wide 2 nd order term SOT_sens applied to the sensor readout. (The LSBs are SOT_sens[15:0] in register 09 _{HEX} .)
11 _{HEX}	7:0	00 _{HEX}	SOT_T[23:16]	Bits [23:16] including sign for the 24-bit-wide 2 nd - order term SOT_T applied to the temperature reading. (The LSBs are SOT_T[15:0] in register 0C _{HEX} .)
	15:8	00 _{HEX}	Gain_T[23:16]	Bits [23:16] including sign for the 24-bit-wide absolute value of the temperature gain coefficient Gain_T. (The LSBs are Gain_T[15:0] in register 0B _{HEX} .)
Measurement Configuration Register 1 (SM_config1)				
12 _{HEX}	2:0	000 _{BIN}	Gain_stage1	Gain setting for the 1 st PREAMP 1 st stage with Gain_stage1 ⇔ Gainamp1: 000 ⇔ 6 001 ⇔ 12 010 ⇔ 20 011 ⇔ 30 100 ⇔ 40 101 ⇔ 60 110 ⇔ 80 111 ⇔ 120 (Might affect noise and accuracy specifications depending on sensor setup)
	5:3	000 _{BIN}	Gain_stage2	Gain setting for the 2 nd PREAMP stage with Gain_stage2 ⇔ Gainamp2: 000 ⇔ 1.1 001 ⇔ 1.2 010 ⇔ 1.3 011 ⇔ 1.4 100 ⇔ 1.5 101 ⇔ 1.6 110 ⇔ 1.7 111 ⇔ 1.8
	6	0 _{BIN}	Gain_polarity	Set up the polarity of the sensor bridge's gain (inverting of the chopper) with 0 ⇔ positive (no polarity change) 1 ⇔ negative (180° polarity change)
	10:7	0000 _{BIN}	Adc_bits	Absolute number of bits for the ADC conversion ADC_bits: 0000 ⇔ 12-bit 0001 ⇔ 13-bit 0010 ⇔ 14-bit 0011 ⇔ 15-bit 0100 ⇔ 16-bit 0101 ⇔ 17-bit

MTP Address	Word / Bit Range	Default Setting	Description	Notes
				0110⇔18-bit 0111 to 1111⇔not assigned
	11	0 _{BIN}	AbsV_enable	Enable bit for thermopile input selection (INN connected to AGND, INP connected to absolute voltage source) with AbsV_enable: 0⇔absolute voltage input disabled (default) 1⇔absolute voltage input enabled (e.g. for a thermopile)
	14:12	000 _{BIN}	Offset	Differential signal's offset shift in the ADC; compensation of signal offset by x% of input signal: 000⇔no offset compensation 001⇔6.75% offset 010⇔12.5% offset 011⇔19.25% offset 100⇔25% offset 101⇔31.75% offset 110⇔38.5% offset 111⇔43.25% offset Note: Bit 15 below must be set to 1 to enable the offset shift.
	15	0 _{BIN}	Shift_method	Offset shift method switch: 0⇔No offset shift. Offset (bits [14:12] in 12 _{HEX}) must be set to 000 _{BIN} ; Gain _{ADC} = 1 1⇔Offset shift ADC; Gain _{ADC} =2
13 _{HEX}	15:0	0000 _{BIN}	TRSH1[15:0]	Bits [15:0] of the 24-bit-wide interrupt threshold1, TRSH1. (The MSB bits for this threshold are TRSH1[23:16], which is bits [7:0] of register 15 _{HEX} .)
14 _{HEX}	15:0	0000 _{BIN}	TRSH2[15:0]	Bits [15:0] of the 24-bit-wide interrupt threshold2, TRSH2. (The MSB bits for this threshold are TRSH2[23:16], which is bits[15:8] of register 15 _{HEX} .)
15 _{HEX}	7:0	00 _{BIN}	TRSH1[23:16]	Bits [23:16] of the 24-bit-wide interrupt threshold1, TRSH1. (The LSB bits for this threshold are TRSH1[15:0], which is bits[15:0] of register 13 _{HEX} .)
	15:8	00 _{BIN}	TRSH2[23:16]	Bits [23:16] of the 24-bit-wide interrupt threshold2, TRSH2. (The LSB bits for this threshold are TRSH2[15:0], which is bits[15:0] of register 14 _{HEX} .)
Measurement Configuration Register 2 (SM_config2)				
16 _{HEX}	2:0	000 _{BIN}	Gain_stage1	Gain setting for the 1 st PREAMP stage with Gain_stage1⇔Gainamp1: 000⇔6 001⇔12 010⇔20 011⇔30 100⇔40 101⇔60 110⇔80 111⇔120 (Might affect noise and accuracy specifications depending on sensor setup)
	5:3	000 _{BIN}	Gain_stage2	Gain setting for the 2 nd PREAMP stage with Gain_stage2⇔Gainamp2: 000⇔1.1 001⇔1.2

MTP Address	Word / Bit Range	Default Setting	Description	Notes
				010 $\Leftrightarrow$ 1.3 011 $\Leftrightarrow$ 1.4 100 $\Leftrightarrow$ 1.5 101 $\Leftrightarrow$ 1.6 110 $\Leftrightarrow$ 1.7 111 $\Leftrightarrow$ 1.8
16 _{HEX}	6	0 _{BIN}	Gain_polarity	Set up the polarity of the sensor bridge's gain (inverting of the chopper) with 0 $\Leftrightarrow$ positive (no polarity change) 1 $\Leftrightarrow$ negative (180° polarity change)
	10:7	0000 _{BIN}	Adc_bits	Absolute number of bits for the ADC conversion ADC_bits: 0000 $\Leftrightarrow$ 12-bit 0001 $\Leftrightarrow$ 13-bit 0010 $\Leftrightarrow$ 15-bit 0011 $\Leftrightarrow$ 15-bit 0100 $\Leftrightarrow$ 16-bit 0101 $\Leftrightarrow$ 17-bit 0110 $\Leftrightarrow$ 18-bit 0111 to 1111 $\Leftrightarrow$ not assigned
	11	0 _{BIN}	AbsV_enable	Enable bit for thermopile input selection (INN connected to AGND, INP connected to absolute voltage source) with AbsV_enable: 0 $\Leftrightarrow$ absolute voltage input disabled (default) 1 $\Leftrightarrow$ absolute voltage input enabled (e.g. for a thermopile)
	14:12	000 _{BIN}	Offset	Differential signal's offset shift in the ADC; compensation of signal offset by x% of input signal: 000 $\Leftrightarrow$ no offset compensation 001 $\Leftrightarrow$ 6.75% offset 010 $\Leftrightarrow$ 12.5% offset 011 $\Leftrightarrow$ 19.25% offset 100 $\Leftrightarrow$ 25% offset 101 $\Leftrightarrow$ 31.75% offset 110 $\Leftrightarrow$ 38.5% offset 111 $\Leftrightarrow$ 43.25% offset Note: Bit 15 below must be set to 1 to enable the offset shift.
	15	0 _{BIN}	Shift_method	Offset shift method switch: 0 $\Leftrightarrow$ No offset shift. Offset (bits[14:12] in 16 _{HEX}) must be set to 000 _{BIN} ; Gain _{ADC} =1 1 $\Leftrightarrow$ Offset Shift ADC, Gain _{ADC} =2
Post-Calibration Offset Correction Coefficients				
17 _{HEX}	15:0	0000 _{HEX}	SENS_Shift[15:0]	Bits [15:0] of the post-calibration sensor offset shift coefficient SENS_Shift. (The MSB bits of SENS_Shift are bits [7:0] of register 19 _{HEX} .)
18 _{HEX}	15:0	0000 _{HEX}	T_Shift[15:0]	Bits [15:0] of the post-calibration temperature offset shift coefficient T_Shift. (The MSB bits of T_Shift are bits [15:8] of register 19 _{HEX} .)
19 _{HEX}	7:0	00 _{HEX}	SENS_Shift[23:16]	Bits [23:16] of the post-calibration sensor offset shift coefficient SENS_Shift. (The LSB bits of SENS_Shift are in register 17 _{HEX} .)

MTP Address	Word / Bit Range	Default Setting	Description	Notes
	15:8	00 _{HEX}	T_Shift[23:16]	Bits [23:16] of the post-calibration temperature offset shift coefficient T_Shift. (The LSB bits of T_Shift are in register 18 _{HEX} .)
Free Memory – Arbitrary Use				
20 _{HEX}	15:0	0000 _{HEX}		Not assigned (e.g., can be used for Cust_IDx customer identification number)
21 _{HEX}	15:0	0000 _{HEX}		Not assigned (e.g., can be used for Cust_IDx customer identification number)
...				Not assigned (e.g., can be used for Cust_IDx customer identification number)
37 _{HEX}	15:0	0000 _{HEX}		Not assigned (e.g., can be used for Cust_IDx customer identification number)
37 _{HEX}	15:0	0000 _{HEX}		Not assigned (e.g., can be used for Cust_IDx customer identification number)
37 _{HEX}	15:0	-	Checksum	Generated (checksum) for the entire memory through a linear feedback shift register (LFSR); signature is checked on power-up to ensure memory content integrity

The memory integrity checksum (referred to as CRC) is generated through a linear feedback shift register with the following polynomial:

$g(x) = x^{16} + x^{15} + x^2 + 1$ with the initialization value: FFFF_{HEX}. If the CRC is valid, then the “Memory Error” status bit is set to 0.

4.10 Sensor Data Output Format

Regardless ADC resolution, both thermopile and temperature outputs are 24bit format. The values are either in two’s complement or sign-absolute format.

If you use raw data output, the data format should be 2’ complement

RAW Data Reading

Bit	23	22	21	20	...	3	2	1	0
Meaning,Weight	-2 ⁰	2 ⁻¹	2 ⁻²	2 ⁻³	...	2 ⁻²⁰	2 ⁻²¹	2 ⁻²²	2 ⁻²³

Bit	7	6	5	4	3	2	1	0
Meaning,Weight	Meaning	0	Powered ?	Busy?	Mode	Memory error?	Meaning	0

Calibration Coefficients(Factors and Summands) in Memory(sing-magnitude)

Bit	23	22	21	20	...	3	2	1	0
Meaning,Weight	0:Positive 1:Negative	2 ¹	2 ⁰	2 ⁻¹	...	2 ⁻¹⁸	2 ⁻¹⁹	2 ⁻²⁰	2 ⁻²¹

Output Results from SSC-Correction Math or DSP – Sensor and Temperature

Bit	23	22	21	20	...	3	2	1	0
Meaning,Weight	2 ⁰	2 ⁻¹	2 ⁻²	2 ⁻³	...	2 ⁻²⁰	2 ⁻²¹	2 ⁻²²	2 ⁻²³

Interrupt Thresholds TRSH1 and TRSH2 –Format as for SSC-Correction Math Output

Bit	23	22	21	20	...	3	2	1	0
Meaning,Weight	2^0	2^{-1}	2^{-2}	2^{-3}	...	2^{-20}	2^{-21}	2^{-22}	2^{-23}

4.11 Typical Reliability Test Items

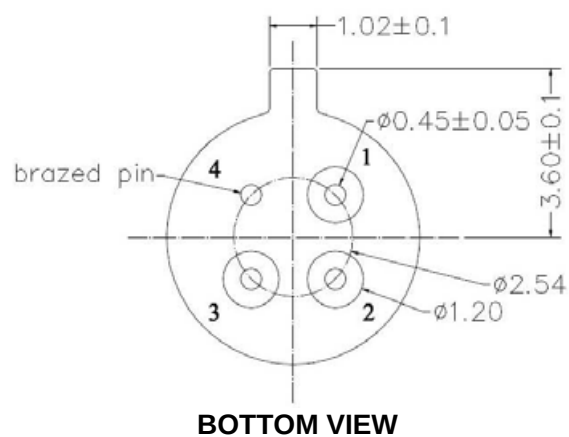
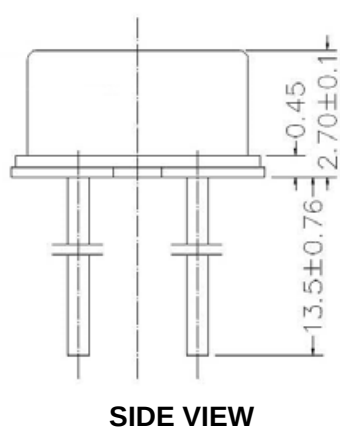
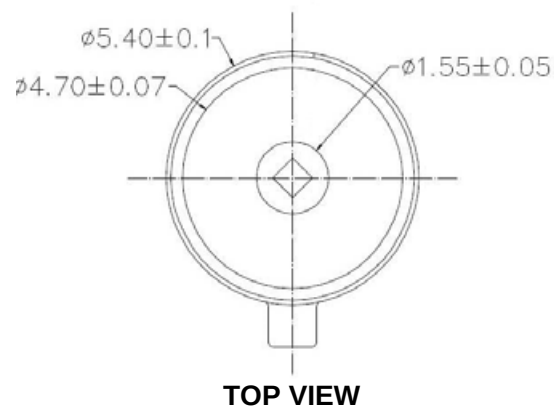
No	Tested Item	Condition	Standard
1	Humidity	+85±2°C, 85±2%RH 120h, 2V	JESD 22-A 101A-B
2	Low Temperature	-40±2°C 200h	IEC 68-2-2 Test Aa
3	High Temperature	+105±2°C 200h	IEC 68-2-2 Test Ba
4	Thermal Shock	(-40±2°C→+85±2°C)×20Cycle 2h	IEC 60068-2-4
5	Drop	Drop 12 times onto thick steel plate from height 1.52m (installed in JIG)	IEC 60068-2-32
6	Vibration	Frequency sweep: 10~55Hz/min→2h Direction : X, Y, X (1.52mm distance for each direction)	MIL 883E, Method 2007.2.A
7	ESD(Contact)	5 discharges at ±8kV direct contact to lid when unit is grounded. 5 discharges at ±2kV direct contact to I/O pins.	IEC 61000-4-2
8	Tumbling	Steel chamber length = 1m, 6.5rpm, 300 times.	SANICO specification
9	Reflow	Peak = 260°C/ 30sec, Repeat 3 times	IPC-JEDEC J-STD- 020D.1

5. Ordering Information

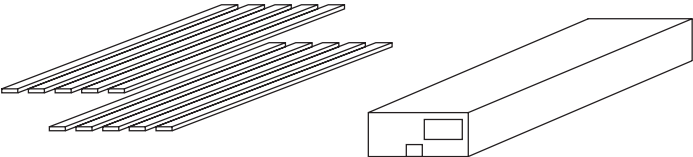
5.1 Part Numbering

	BM	43	T	N	D	80	A	A - T2 - T - G
Company Prefix	Bestow Mascot Technology Ltd.							
Series Name	43: Temperature Sensor							
Measure Type	T-Thermopile IR							
Precision	H-High Precision	N-Normal Precision						
Signal Type	D-Digital							
FOV Value								
Operating Temperature Range	A-High temperature							
Version								
Package	T2-TO Package Type2							
Packing	T-Tube	A-Tray						
Plating Technology	Blank-Standard SnPb Plating							
	R-RoHS compliant							
	G-Green (REACH compliant)							

5.2 TO-46 Package Outline Information (in mm)



5.3 Packing Information

Container	Tube
Quantity	2000 pcs
Direction of feed	Direction of products is fixed in a container tray
 50pcs per tray  40 tube per box MOQ=2000pcs	

6. Field of View (FOV)

BM provides different choice for FOV.

Field of view is determined at 50% thermopile signal and with respect to the sensor main axis.

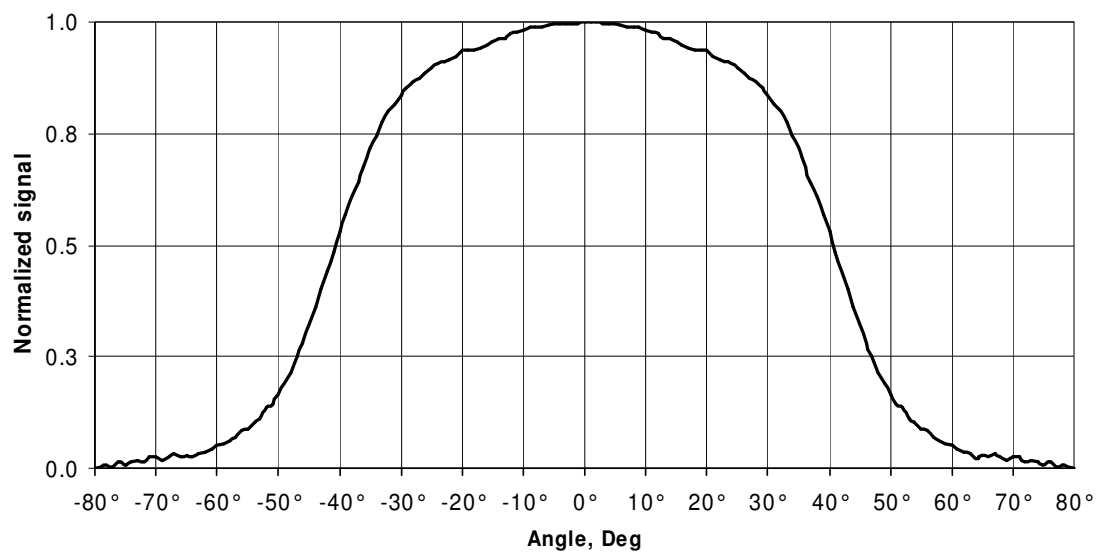


Figure3 Typical FOV of BM43TND80AA-T2 ($80^\circ \pm 5^\circ$)

7. Notice

●General Precaution

- 1) Before you use our Products, you are requested to carefully read this document and fully understand its contents. BM shall not be in any way responsible or liable for failure, malfunction or accident arising from the use of any BM's Products against warning, caution or note contained in this document.
- 2) All information contained in this document is current as of the issuing date and subject to change without any prior notice. Before purchasing or using BM's Products, please confirm the latest information with a BM sales representative.

●Precaution on using BM Products

1) Our Products are designed and manufactured for application in ordinary electronic equipments (such as AV equipment, OA equipment, telecommunication equipment, home electronic appliances, amusement equipment, etc.). If you intend to use our Products in devices requiring extremely high reliability (such as medical equipment, transport equipment, traffic equipment, aircraft/spacecraft, nuclear power controllers, fuel controllers, car equipment including car accessories, safety devices, etc.) and whose malfunction or failure may cause loss of human life, bodily injury or serious damage to property ("Specific Applications"), please consult with the BM sales representative in advance. Unless otherwise agreed in writing by BM in advance, BM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of any BM's Products for Specific Applications.

2) BM designs and manufactures its Products subject to strict quality control system. However, semiconductor products can fail or malfunction at a certain rate. Please be sure to implement, at your own responsibilities, adequate safety measures including but not limited to fail-safe design against the physical injury, damage to any property, which a failure or malfunction of our Products may cause. The following are examples of safety measures:

[a] Installation of protection circuits or other protective devices to improve system safety

[b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure

3) Our Products are designed and manufactured for use under standard conditions and not under any special or extraordinary environments or conditions, as exemplified below. Accordingly, BM shall not be in any way responsible or liable for any damages, expenses or losses arising from the use of any BM's Products under any special or extraordinary environments or conditions. If you intend to use our Products under any special or extraordinary environments or conditions (as exemplified below), your independent verification and confirmation of product performance, reliability, etc, prior to use, must be necessary:

[a] Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents

[b] Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust

[c] Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl_2 , H_2S , NH_3 , SO_2 , and NO_2

[d] Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves

[e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items

[f] Sealing or coating our Products with resin or other coating materials

[g] Use of our Products without cleaning residue of flux (even if you use no-clean type fluxes, cleaning residue of flux is recommended); or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering

[h] Use of the Products in places subject to dew condensation

4) The Products are not subject to radiation-proof design.

5) Please verify and confirm characteristics of the final or mounted products in using the Products.

6) In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse) is applied, confirmation of performance characteristics after on-board mounting is strongly recommended. Avoid applying power exceeding normal rated power; exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.

7) De-rate Power Dissipation (P_d) depending on ambient temperature (T_a). When used in sealed area, confirm the actual ambient temperature.

8) Confirm that operation temperature is within the specified range described in the product specification.

9) BM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

●Precaution for Mounting / Circuit board design

1) When a highly active halogen us (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.

2) In principle, the reflow soldering method must be used; if flow soldering method is preferred, please consult with the BM representative in advance. For details, please refer to BM Mounting specification

●Precautions Regarding Application Examples and External Circuits

1) If change is made to the constant of an external circuit, please allow a sufficient margin considering variations of the characteristics of the Products and external components,

including transient characteristics, as well as static characteristics.

2) You agree that application notes, reference designs, and associated data and information contained in this document are presented only as guidance for Products use. Therefore, in case you use such information, you are solely responsible for it and you must exercise your own independent verification and judgment in the use of such information contained in this document. BM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of such information.

●Precaution for Electrostatic

This Product is electrostatic sensitive product, which may be damaged due to electrostatic discharge. Please take proper caution in your manufacturing process and storage so that voltage exceeding the Products maximum rating will not be applied to Products. Please take special care under dry condition (e.g. Grounding of human body / equipment / solder iron, isolation from charged objects, setting of Ionizer, friction prevention and temperature / humidity control).

●Precaution for Storage / Transportation

1) Product performance and soldered connections may deteriorate if the Products are stored in the places where:

- [a] the Products are exposed to sea winds or corrosive gases, including Cl_2 , H_2S , NH_3 , SO_2 , and NO_2
- [b] the temperature or humidity exceeds those recommended by BM
- [c] the Products are exposed to direct sunshine or condensation
- [d] the Products are exposed to high Electrostatic

2) Even under BM recommended storage condition, solder ability of products out of recommended storage time period may be degraded. It is strongly recommended to confirm solder ability before using Products of which storage time is exceeding the recommended storage time period.

3) Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.

4) Use Products within the specified time after opening a humidity barrier bag. Baking is required before using Products of which storage time is exceeding the recommended storage time period.

●Precaution for Product Label

QR code printed on BM Products label is for BM's internal use only.

●Precaution for Disposition

When disposing, please dispose them properly using an authorized industry waste company.

●Precaution for Foreign Exchange and Foreign Trade act

Since our Products might fall under controlled goods prescribed by the applicable foreign exchange and foreign trade act, please consult with BM representative in case of export.

●Precaution regarding Intellectual Property Rights

- 1) All information and data including but not limited to application example contained in this document is for reference only. BM does not warrant that foregoing information or data will not infringe any intellectual property rights or any other rights of any third party regarding such information or data. BM shall not be in any way responsible or liable for infringement of any intellectual property rights or other damages arising from use of such information or data.
- 2) No license, expressly or implied, is granted hereby under any intellectual property rights or other rights of BM or any third parties with respect to the information contained in this document.

●Other Precaution

- 1) The information contained in this document is provided on an “as is” basis and BM does not warrant that all information contained in this document is accurate and/or error-free. BM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties resulting from inaccuracy or errors of or concerning such information.
- 2) This document may not be reprinted or reproduced, in whole or in part, without prior written consent of BM.
- 3) The Products may not be disassembled, converted, modified, reproduced or otherwise changed without prior written consent of BM.
- 4) In no event shall you use in any way whatsoever the Products and the related technical information contained in the Products or this document for any military purposes, including but not limited to, the development of mass-destruction weapons.
- 5) The proper names of companies or products described in this document are trademarks or registered trademarks of BM, its affiliated companies or third parties.

8. Revision History

Version	Publication date	Pages	Revise Description
1.0	Oct.2019	25	Initial Document Release
1.1	Dec.2019	31	Update functional parameters