

## Chapter Thirteen CO<sub>2</sub> Measuring (Optional)

### 13.1 General

This chapter offers some relevant data concerning CO<sub>2</sub> monitoring.

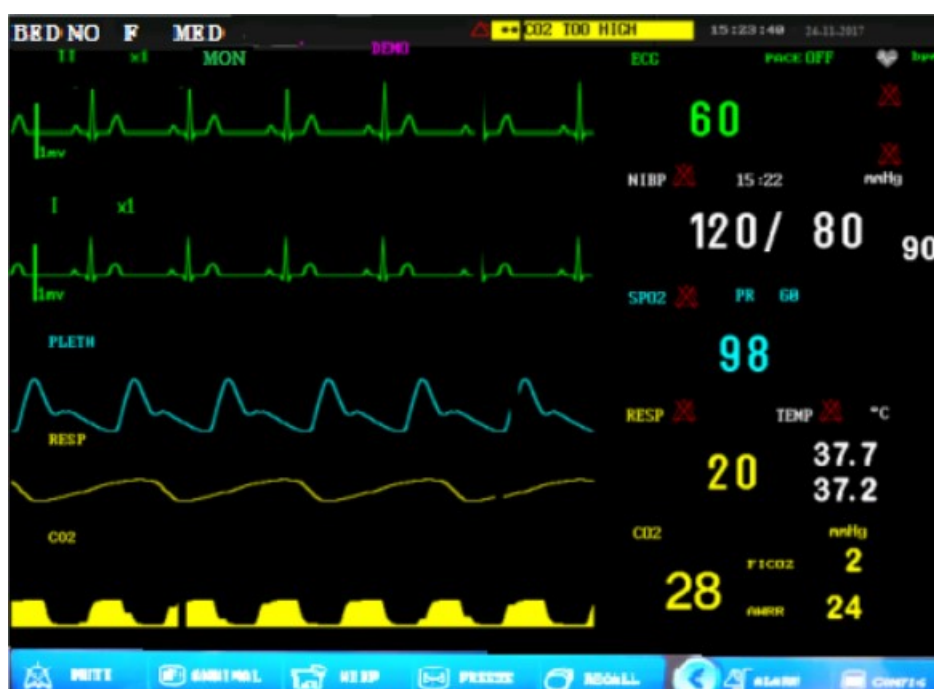
The monitor provides one kind of CO<sub>2</sub> measuring method, which is SideStream.

This module can be applied in operation room, monitor units etc, it can measure the CO<sub>2</sub> partial pressure or concentration of animal Air Way, obtain EtCO<sub>2</sub>, Inspired Maximum CO<sub>2</sub> (InsCO<sub>2</sub>), Air Way Respiration Rate (AwRR), and display CO<sub>2</sub> concentration waveforms. The parameter symbols displayed on the screen are defined as following:

CO<sub>2</sub>: EtCO<sub>2</sub>

INS: InsCO<sub>2</sub>

AWRR: Air Way Respiration (AwRR)(Resp. times/MIN)



Picture 13-1 The CO<sub>2</sub> display

#### ⚠️Note⚠️

**Don't use the device in the environment with flammable anesthetic gas.**

**The device can only be operated by personnel having taken professional training and familiar with this manual.**

#### ⚠️Warning⚠️

**CO<sub>2</sub> module shall be avoided from crash and vibration.**

## 13.2 Monitoring Procedure

CO<sub>2</sub> measurement principle is based on the CO<sub>2</sub> absorption wavelength for 4.3um infrared characteristics carried. The measuring method of the CO<sub>2</sub> gas supplied to the measuring chamber side with the infrared irradiation, and the other side with a sensor measuring the acceptable degree of attenuation of infrared rays, the degree of attenuation is proportional to the concentration of CO<sub>2</sub>.

CO<sub>2</sub> partial pressure and CO<sub>2</sub> concentration conversion relationship:

CO<sub>2</sub> partial pressure (mmHg) = CO<sub>2</sub> concentration (%) \* Pamp (ambient pressure mmHg) / 100

CO<sub>2</sub> partial pressure (kPa) = CO<sub>2</sub> points pressure (mmHg) / 7.5

### CO<sub>2</sub> measurement setups:

1. Insert the sampling tube into the CO<sub>2</sub> jack which is on the side panel of the monitor, and then connect the nasal tube.
2. In the menu, choose "CO<sub>2</sub> setup", change the "operating mode" to "measurement", on the screen, it will appear "CO<sub>2</sub> module is running".
3. After start, in the screen it will appear "CO<sub>2</sub> module is warming up", then the module is in precision measurement state.
4. After warming up, the module will come into the full precision measurement state.

When the instrument is turned on, the CO<sub>2</sub> module's default mode of operation "to standby", the user breath" operating mode "is set to" measure "to start the CO<sub>2</sub> module. Instrument restarts, will remain before the last shutdown "mode of operation, that if the shutdown is selected measurement, the next time you turn on the CO<sub>2</sub> module will automatically enter the measurement mode. More information, see "mode of operation" Other Settings section 13.3 of carbon dioxide menu chapter.

- If the packaging has been opened or damaged parts, internal, please do not use this accessory, and returned to the supplier
- "CO<sub>2</sub> WARM UP" or "CO<sub>2</sub> SENSOR START UP" displayed on the screen indicates that the sensor is in warm-up or starting-up. When the module is warming-up, the module can measure the CO<sub>2</sub> value, but it is not standard value. After the information disappears from the screen, the standard measurement can then be generated.
- Keep sampling tube apart from its socket when not in use.
- Nothing except sampling tube should be inserted to sampling tube socket of CO<sub>2</sub> Module.
- Please insert the sampling tube before connecting the nasal tube to breathing circuit.
- Please ensure the nasal tube is removed from breathing circuit before pulling out sampling tube.
- Sampling tube is one-off consumables that can not be repeatedly used by different animals.

## 13.3 CO<sub>2</sub> Menu


### 13.3.1 Parameter Setup and Adjustment

Turn the knob to select and press CO<sub>2</sub> hot key on the screen to activate "CO<sub>2</sub> Setup" menu as shown below:



Picture 13-2 CO2 Setup Menu

Following functions can be realized via CO2 SETUP menu.

- ALM: select “ON” to enable and store alarm prompt when CO2 parameters have alarms. Select “OFF” to disable alarm and display  beside CO2. The default is “ON”.
- ALM REC: select “ON” to generate output from the recorder ever since CO2 parameter alarm occurs. The default is “OFF”.
- ALM LEV: select from HIGH, MED and LOW. Level HIGH represents the most serious alarm, followed by Level MED and Level LOW with a decrease of seriousness. Change in “ALM LEV” can only affect the physiological alarm levels of CO2 parameters including EtCO2 upper limit, EtCO2 lower limit, InsCO2 upper limit, AwRR upper limit and AwRR lower limit. The default alarm level is “MED”.
- CO2 ALM HI: to adjust the upper alarm limit of EtCO2. If the measuring value is larger than CO2 upper alarm limit, “CO2 TOO HIGH” appears on the screen. After the measuring value returns to the normal one, the information disappears.
- CO2 ALM LO: to adjust the lower alarm limit of EtCO2. If the measuring value is smaller than CO2 lower alarm limit, “CO2 TOO LOW” appears on the screen. After the measuring value returns to the normal one, the information disappears.
- INS ALM HI: to adjust the upper alarm limit of InsCO2. If the measuring value is larger than InsCO2 upper alarm limit, “INS TOO HIGH” appears on the screen. After the measuring value returns to the normal one, the information disappears.
- AWRR ALM HI: to adjust the upper alarm limit of AwRR. If the measuring value is larger than the upper alarm limit of AwRR, “AWRR TOO HIGH” appears on the screen. After the measuring value returns to the

normal one, the information disappears.

- **AWRR ALM LO:** to adjust the lower alarm limit of AwRR. If the measuring value is smaller than the lower alarm limit of AwRR, “AWRR TOO LOW” appears on the screen. After the measuring value returns to the normal one, the information disappears.
- **UNIT:** to change the display units of CO2 and InsCO2 parameters. “mmHg” and “kPa” are available for selection.
- **SWEEP:** to adjust the display rate of CO2 waveforms with “6.25 mm/s”, “12.5 mm/s”, or “25.0 mm/s” selectable.
- **Exit:** to close CO2 SETUP menu.

**⚠Note⚠**

**“APNEA ALM” cannot be closed.**

When various alarms occur simultaneously, the alarm information of highest level will be displayed on the screen.

13.3.2 CO2 other step

pick this item in the menu to call up CO2 more setup sub-menu.



Picture 13-3 More Setups Menu

Now we introduce you to the functions of each item in CO2 SETUP submenu.

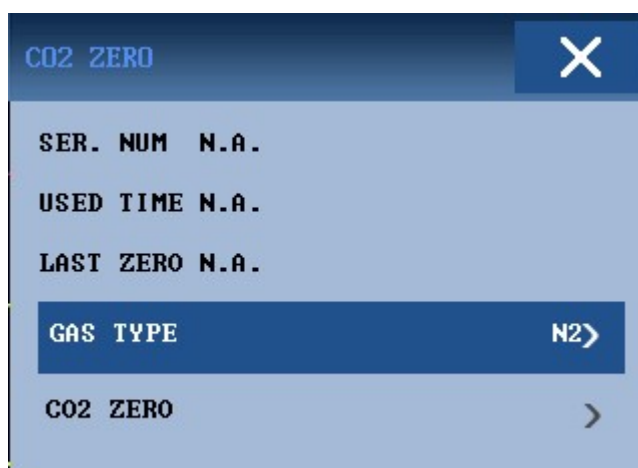
- **WAVE SCALE:** to adjust full scale size of CO2 waveform display area with “LOW” or “HIGH” selectable. The default value is “LOW”.

- WORK MODE: to change the work mode of CO2 with “MEASURE” mode or “STANDBY” mode selectable.

**⚠Note⚠**

**When not using CO2 monitoring function, it is suggested not to connect SideStream sampling tube and to adjust to “STANDBY” mode.**

- CO2 COMPEN: to perform compensate operations as per the selection of the user.
- BALANCE GAS: ROOM AIR, N2O, HELIUM.
- Anaesthesia Agent: The intensity of the Anaesthesia Agent
- GAS TEMP: Current Temperature of the gas
- Barometric: Current Atmospheric Pressure
- ETCO2 Period: The period to calculate the ETCO2, Per breath, 10s, 20s
- To perform the ZERO. The usage of the module will be display in the MENU.



Picture 13-4 CO2 ZERO Menu

**⚠Note⚠**

1. If Compensate item is not correctly set as per the operation conditions, the result will be far from the actual value, thus leading to severe misdiagnosis.
2. The default of Water Vapor Compensate is on. Turn it off when measuring dry gas, such as when performing regular maintenance or measurement validation by using dry calibrated gas.
3. The default of BTPS is on. Turn it on when measuring the VA saturated “damp” gas under the body temperature and ambient pressure and turn it off when measuring the “dry” gas under the ambient temperature and pressure.
4. Operate by strictly observing the Compensate operation method.

- DEFAULT: pick this item to access the CO2 DEFAULT CONFIG dialog box, in which the user may select whether the FACTORY DEFAULT CONFIG or the USER DEFAULT CONFIG is to be used. After selecting any of the items and exiting the dialog box, the system will pop up the dialog box asking for the user’s confirmation.

EtCO<sub>2</sub> upper alarm limit: when parameter value exceeds this limit, there will be alarm for exceeding the upper limit.

Default:

Large animals: 50 mmHg

Medium-sized animals: 50 mmHg

Small animals: 45 mmHg

EtCO<sub>2</sub> lower alarm limit: when parameter value is smaller than the lower limit, there will be alarm for exceeding lower limit.

Default:

Large animals: 15 mmHg

Medium-sized animals: 20 mmHg

Small animals: 30 mmHg

InsCO<sub>2</sub> upper alarm limit: when parameter value exceeds this limit, there will be alarm for exceeding upper limit.

Default:

Large animals: 4 mmHg

Medium-sized animals: 4 mmHg

Small animals: 4 mmHg

AwRR upper alarm limit: when parameter value exceeds this limit, there will be alarm for exceeding upper limit.

Default:

Large animals: 30 rpm

Medium-sized animals: 30 rpm

Small animals: 100 rpm

AwRR lower alarm limit: when parameter value is smaller than the limit, there will be alarm for exceeding lower limit.

Default:

Large animals: 8 rpm

Medium-sized animals: 8 rpm

Small animals: 30 rpm

APNEA Time: Selections are 10S to 40S,

Default: 20S.

Work Mode: MainStream: Standby, Measurement;

SideStream: Standby, Measurement.

Default: Measurement

Compensate Method:

MainStream: General/O<sub>2</sub>/N<sub>2</sub>O/DES/ALL

SideStream: General/O<sub>2</sub>/N<sub>2</sub>O/DES/ALL

Default Methods: General.

Pump Rate: 100 – 200 ml/min.

Default: 100 ml/min

Unit: mmHg/kPa.

Default: mmHg

Waveform Sweep: 25.0/12.5/6.25 (mm/s)

Default: 25.0 mm/s

Waveform Scale: LOW/HIGH

Default: LOW

Besides, for alarm function of CO2 module, refer to Chapter Alarm, for its recording function, refer to Chapter Recording, and for information about alarm event review, graphic and tabular trend of CO2 parameters, refer to Chapter Trend and Event.

### 13.4 Alarm Information and Prompt

Among physiological alarms, those belonging to the type that the parameter has exceeded the limits may activate the recorder to automatically output the parameters and related measured waveforms when the alarms occur on the condition that the alarm record switch in the related menu is On.

Tables below describe the possible physiological alarms, technical alarms and prompt messages occurring during CO2 measurement.

Physiological alarms:

Message	Cause	Alarm Level
CO2 TOO HIGH	EtCO2 measuring value is above upper alarm limit.	User-selectable
CO2 TOO LOW	EtCO2 measuring value is below lower alarm limit.	User-selectable
INS TOO HIGH	InsCO2 measuring value is above alarm limits.	User-selectable
AWRR TOO HIGH	AwRR measuring value is above upper alarm limit.	User-selectable
AWRR TOO LOW	AwRR measuring value is below lower alarm limit.	User-selectable
CO2 APNEA	In specific time interval, no RESP can be detected using CO2 module.	HIGH

Technical alarms:

Message	Cause	Alarm Level	Remedy
CO2 CHECK THE SAMPLING TUBE	the sampling tube is plugged	LOW	replace the sampling tube
CO2 SIGNAL LOW	Measuring module technical failure	LOW	If necessary, re-start the monitor. If failure persists, stop using measuring function of CO2 module, notify biomedical engineer or Our service staff.
CO2 SIGNAL TOO LOW		LOW	
CO2 BAROMETRIC TOO LARGE		MED	
CO2 PNEUMATIC LEAK		MED	

CO2 SIGNAL NOISY		LOW	
CO2 SIGNAL SATURATE		LOW	
CO2 CALCULATION ERR		HIGH	
CO2 SENSOR FAULT		HIGH	
CO2 SENSOR TEMP HIGH		HIGH	
CO2 SENSOR TEMP LOW		HIGH	
CO2 WATCHDOG TIMEOUT		HIGH	
CO2 INT COMM ERR		HIGH	
CO2 SYSTEM ROM ERR		HIGH	
CO2 FLASH CRC ERR		HIGH	
CO2 INT RAM ERR		HIGH	
CO2 FLASH CHECK ERR		HIGH	
CO2 EXT RAM ERR		HIGH	
CO2 STACK OVER		HIGH	
CO2 PUMP FAULT		HIGH	
CO2 REVERSE FLOW		HIGH	
CO2 FORWARD FLOW		HIGH	
CO2 MALFUNCTION		HIGH	
CO2 BAROMETRIC HIGH		HIGH	
CO2 BAROMETRIC LOW		HIGH	
CO2 COMM ERR	CO2 module communication failure	HIGH	Stop using measuring function of CO2 module,notify biomedical engineer or Our service staff.
CO2 INIT ERR	CO2 module is not properly connected or failed.	HIGH	Stop using measuring function of CO2 module,notify biomedical engineer or Our service staff.
CO2 COMM STOP	Measuring module failure or communication failure.	HIGH	Stop using measuring function of CO2 module,notify biomedical engineer or Our service staff.
CO2 ALM LMT ERR	Functional safety failure	HIGH	Stop using measuring

INS ALM LMT ERR	Functional safety failure	HIGH	function of CO2 module, notify biomedical engineer or Our service staff.
AWRR ALM LMT ERR	Functional safety failure	HIGH	

Prompt message:

Message	Cause	Alarm Level
CO2 STANDBY STATUS	Turn from measuring mode to standby mode, making the module in energy-saving status.	No alarm
CO2 WARM UP	Shows that the sensor is in warming-up stage.	No alarm
CO2 SENSOR START UP	Shows that the sensor has just entering start-up stage.	No alarm

## 13.5 Maintenance and Cleaning

### ■ Care and Maintenance

1. Sample tube is for one-off use in SideStream module. Do not sterilize or clean for reuse on another animal.
2. Please keep the sampling tube clean, dust isolated, in case of any stoppage. It is suggested to replace sampling tube every 12 hours (Using time could extend to 120 hours when the sampling tube be used with a filter), or change the sampling tube when any leaks, damage or pollution found.
3. No routine calibration required in Sidestream CO2 module.