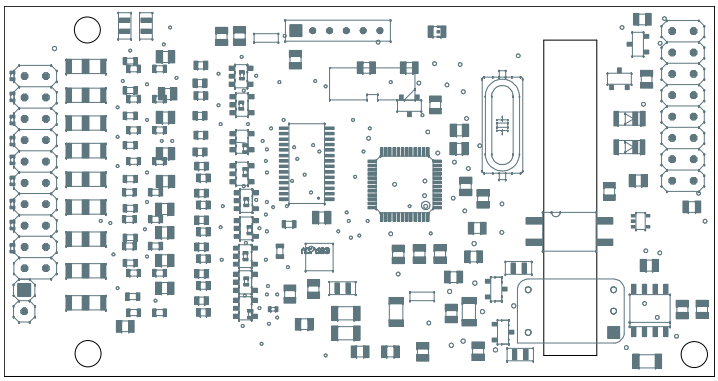
9 Channel Temperature OEM board

EG 00751

Technical Manual



Version 1.3

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Introduction

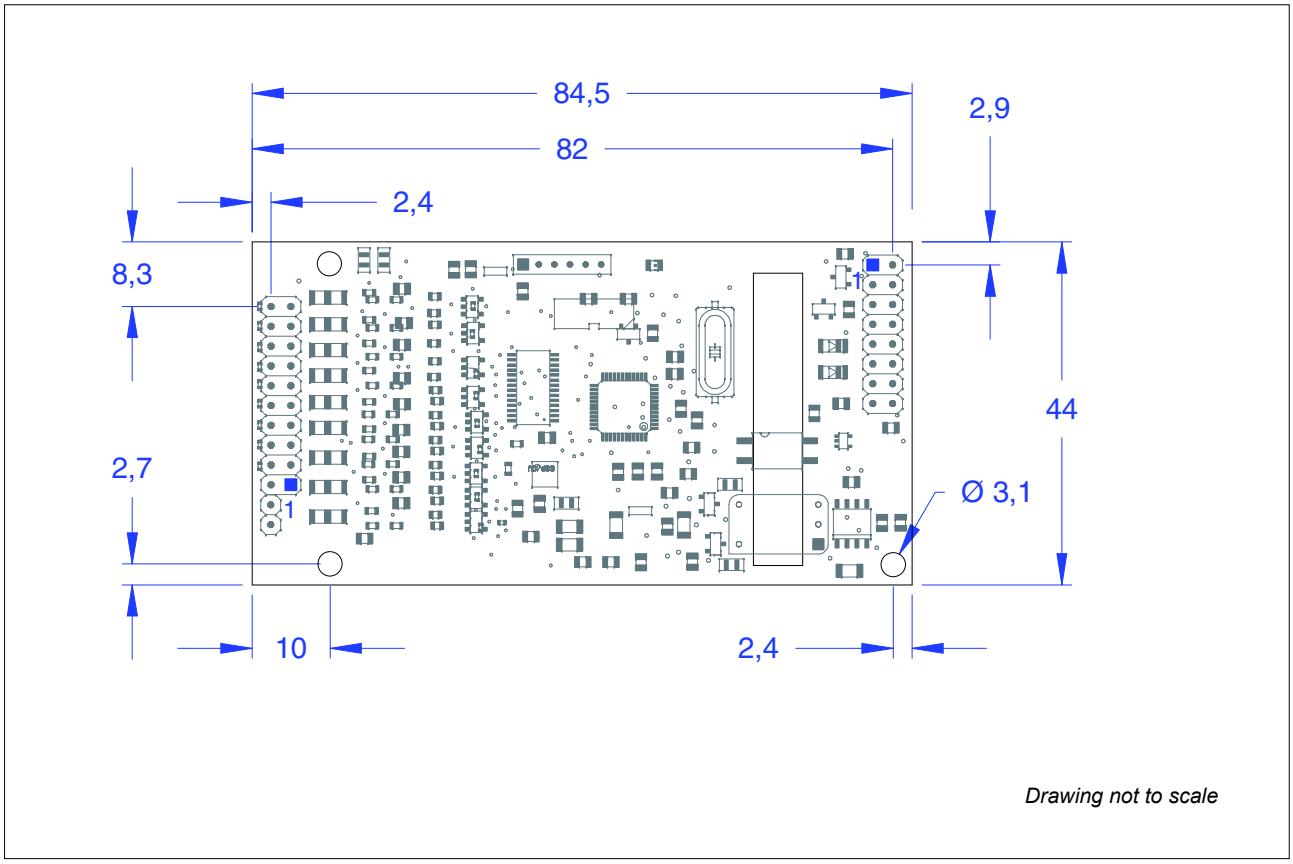
The EG00751 is a module that can connect up to nine NTC type temperature probes and measures, digitizes and filters the readings of these probes with high accuracy, at a speed of ten conversions per second. The EG00751 has nine NTC inputs and a reference input that reads as 38.81 °C. This channel can be used as a functional control of the system.

The inputs are fully compatible with all YSI 400 standard - and compatible temperature probes. These probes are a de-facto standard in most hospitals and are used for medical applications worldwide.

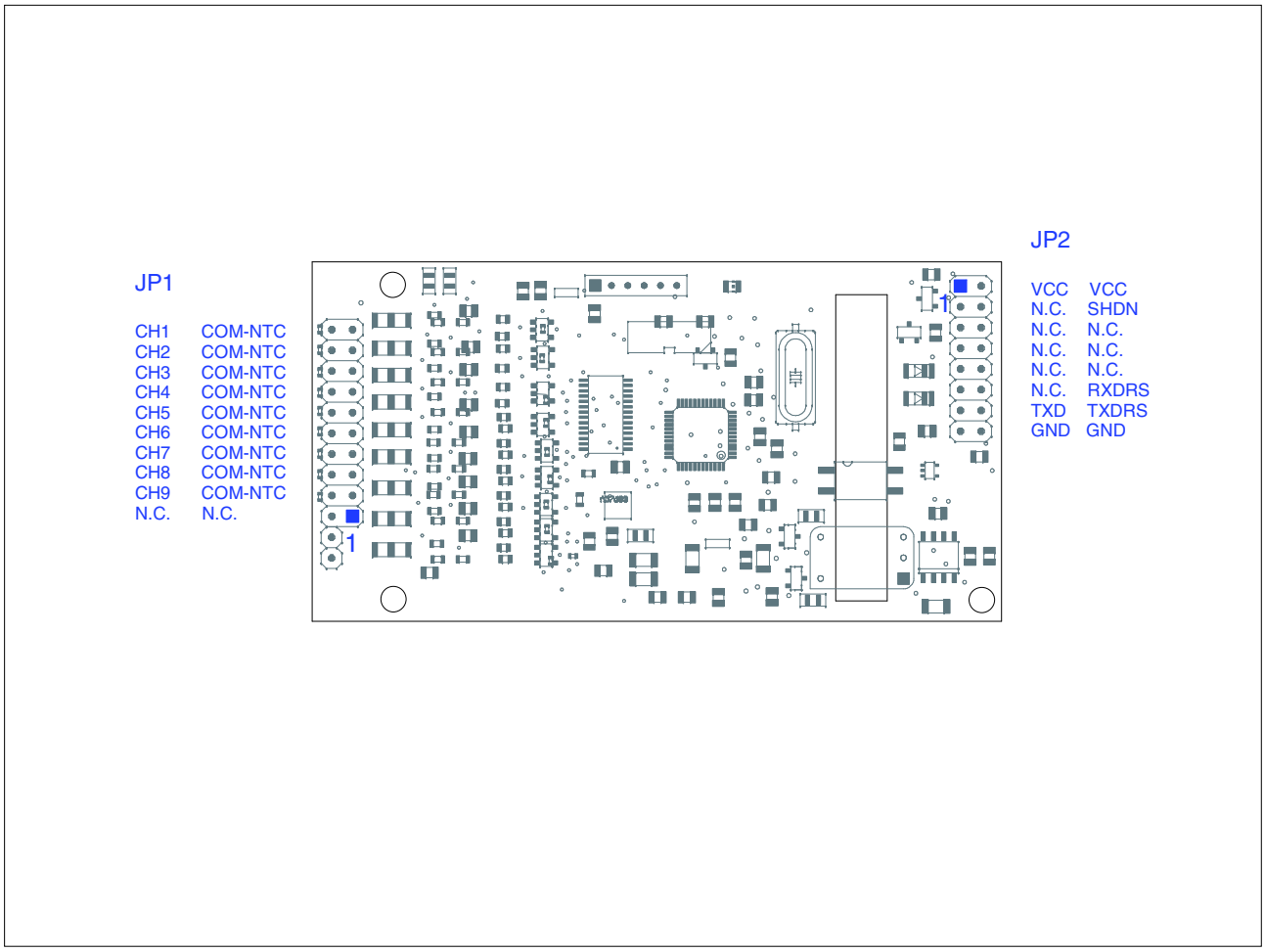
Featuring a high input range, of 15.00 to 59.00 °C, the module has a tolerance of ±0.02 °C for higher temperatures and ±0.01°C for lower temperatures.

The board is built around a Cortex M3 type of microcontroller, that acquires, filters and corrects the measured values. The correction is done using internally stored calibration tables that are generated for each individual board during factory calibration.

The patient side of the module is fully isolated from the rest of the module, the system includes also the DC/DC conversion for the power supply of the isolated side. The leakage currents of the board are low enough to meet class CF regulations of IEC 601. The insulation withstands voltages as high as 4000 VAC RMS.
Inputs of the module are protected against high voltage transients that could be present on the module during ESD tests and while applying defibrillation pulses to the patient that are capacitively and inductively coupled to the temperature probe cable and to the NTC body.



Mechanical Dimensions, all values in mm (DXF data available upon request)



Connection to the host system and to the temperature sensors

Basic Features

- Temperature OEM module for medical and industrial purposes
- Compatible with all YSI series 400 type probes
- 9 Temperature Channels, 1 internal reference channel (38.81°C)
- Measurement range: 15.00 .. 59.00 °C
- Accuracy: between +/- 0.01 and +/- 0.02 °C, see technical data
- Power loss in NTC less than 100 µW (nearly no self heating)
- Serial UART type interface has both TTL and RS232 level outputs
- Two protocol versions available
- Packet type output format, with packet checksum
- LED for functional control, blinks at 1Hz during normal operation
- 4000 Volt RMS isolation of patient side (CF Type)
- Warm up time less than 10 seconds
- Small size: PCB 84,5 mm x 44 mm x 10 mm
- Low power: less than 35 mA @ 5 Volts
- Integrated reference channel

Connectors

JP1	Temperature Probe Connector	
1	N.C.	Not Connected
2	N.C.	Not Connected
3	COM-NTC	Common probe return path. Connect probes between this pin and CHx pin
4	CH9	Channel 9 input
5	COM-NTC	Common probe return path. Connect probes between this pin and CHx pin
6	CH8	Channel 8 input
7	COM-NTC	Common probe return path. Connect probes between this pin and CHx pin
8	CH7	Channel 7 input
9	COM-NTC	Common probe return path. Connect probes between this pin and CHx pin
10	CH6	Channel 6 input
11	COM-NTC	Common probe return path. Connect probes between this pin and CHx pin
12	CH5	Channel 5 input
13	COM-NTC	Common probe return path. Connect probes between this pin and CHx pin
14	CH4	Channel 4 input
15	COM-NTC	Common probe return path. Connect probes between this pin and CHx pin
16	CH3	Channel 3 input
17	COM-NTC	Common probe return path. Connect probes between this pin and CHx pin
18	CH2	Channel 2 input
19	COM-NTC	Common probe return path. Connect probes between this pin and CHx pin
20	CH1	Channel 1 input

JP2	Host Connector	
1	VCC	5V DC, +/- 5%
2	VCC	5V DC, +/- 5%
3	N.C.	not used
4	SHDN	Shutdown, high level powers down the board. Leave open if not used
5	N.C.	not used
6	N.C.	not used
7	N.C.	not used
8	N.C.	not used
9	N.C.	not used
10	N.C.	not used
11	N.C.	not used
12	RxDRS	Receive data line, RS232 level. Used to generate TxD RS232 voltage only
13	TxD	Data output, 0..5 V level
14	TxDRS	Data output, RS232 level
15	GND	Ground (isolated from patient ground)
16	GND	Ground (isolated from patient ground)

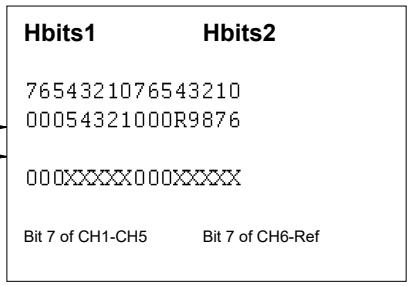
Serial Data Format

The data is transmitted in serial format, at 19200 baud, 8 bits, no parity, 1 stop bit.
The boards transmits data in blocks. There are four types of blocks:

„Data“ Blocks	transmitted 10 times per second (see technical data, two protocol versions)
„Identifier“ blocks	transmitted once per five seconds
„No cal“ blocks	transmitted only if the internal calibration table is corrupted
„Error“ blocks	transmitted on selftest error during power up

The last two types of blocks are only sent if necessary, once per second. No data blocks are sent in case of a detected selftest - or calibration error. If one of these errors is detected during power-up, the module never goes into normal measuring state.
All blocks have a length of 26 bytes. In order to allow for synchronisation, the first byte in every block has the same value, 0x82. This is also the only byte in the blocks having bit 7 set to 1. Therefore, data bit seven of the low byte of the temperature values are grouped into two bytes at the beginning of the data block and masked out in data transmission later. The high byte cannot be larger than 0x7f, since upper temperature limit is 59 °C. Checksum is a 16 Bit sum over all bytes, anded with 0x7F7F in the end. The checksum is therefore effectively reduced to 14 bit.
Temperatur data values are in straight binary, and degree Celsius, e.g a value of 0x1000 is 4096, meaning 40.96 °C. If temperature of a certain channel is out of range, TOOHIGH (0x0001) or TOOLOW (0x7FFF) constant is transmitted. If no probe is connected to a channel, NOPROBE (0x0002) is transmitted.

	Name of member	Data Block
Byte 1	Marker	0x82
Byte 2	Block Type	**0x04**
Byte 3	Hbits1	Bit 7 of ChannelL 1-5 values
Byte 4	Hbits2	Bit 7 of ChannelL 6-ref values
Byte 5	Channel1L	Channel 1 low byte & 0x7F
Byte 6	Channel1H	Channel 1 high byte
Byte 7	Channel2L	Channel 2 low byte & 0x7F
Byte 8	Channel2H	Channel 2 high byte
Byte 9	Channel3L	Channel 3 low byte & 0x7F
Byte 10	Channel3H	Channel 3 high byte
Byte 11	Channel4L	Channel 4 low byte & 0x7F
Byte 12	Channel4H	Channel 4 high byte
Byte 13	Channel5L	Channel 5 low byte & 0x7F
Byte 14	Channel5H	Channel 5 high byte
Byte 15	Channel6L	Channel 6 low byte & 0x7F
Byte 16	Channel6H	Channel 6 high byte
Byte 17	Channel7L	Channel 7 low byte & 0x7F
Byte 18	Channel7H	Channel 7 high byte
Byte 19	Channel8L	Channel 8 low byte & 0x7F
Byte 20	Channel8H	Channel 8 high byte
Byte 21	Channel9L	Channel 9 low byte & 0x7F
Byte 22	Channel9H	Channel 9 high byte
Byte 23	ChannelRefL	Channel ref low byte & 0x7F
Byte 24	ChannelRefH	Channel ref high byte
Byte 25	ChksumL	Chksum low byte & 0x7F
Byte 26	ChksumH	Chksum high byte & 0x7F



	Name of member	Error Block
Byte 1	Marker	0x82
Byte 2	Block Type	**0x01**
Byte 3	Error	Error number, currently only defined is 1, selftest error
Byte 4-24	unused	always 0
Byte 25	ChksumL	Chksum low byte & 0x7F
Byte 26	ChksumH	Chksum high byte & 0x7F

	Name of member	**No Cal Block**
Byte 1	Marker	0x82
Byte 2	Type	**0x02**
Byte 3-24	unused	always 0
Byte 25	ChksumL	Chksum low byte & 0x7F
Byte 26	ChksumH	Chksum high byte & 0x7F

	Name of member	**Identify Block**
Byte 1	Marker	0x82
Byte 2	Type	**0x03**
Byte 3	VersionL	Low part of firmware version
Byte 4	VersionH	High part of firmware version
Byte 5	Name	„E“
Byte 6	Name	„G“
Byte 7	Name	„0“
Byte 8	Name	„0“
Byte 9	Name	„7“
Byte 10	Name	„5“
Byte 11	Name	„1“
Byte 12	Firmware	0 (0x00) for Firmware b or „A“ (0x41) for firmware version a, see technical data
Byte 13-24	unused	always 0
Byte 12	ChksumL	Chksum low byte & 0x7F
Byte 26	ChksumH	Chksum high byte & 0x7F

A few useful „C“ language definitions:

```
                                        //(U8 unsigned 8 bit number)
                                        //(U16 unsigned 16 bit number)
#define MARKER          0x82            // A few defines
#define TERR            0x01
#define TNOCAL          0x02
#define TIDENT          0x03
#define TVAL            0x04
#define TOOLOW          0x7FFF
#define NOPROBE         0x0002
#define TOOHIGH         0x0001

__packed struct OUTPUT                  // structure definition

{
 U8 marker;
 U8 type;
 U8 hbit1;
 U8 hbit2;
 U16 ch[10];
 U16 chksum;
};

__packed struct OUTPUT Output;          // variable definition

// Checksum routine example
U16 do_chksum(U8 *ptr,U16 length)
{
 U16 chksum=0;
 while(length—)
   chksum += *ptr++;
 return chksum;
}

//How to call the checksum routine:

Output.chksum = do_chksum((U8 *)&Output,sizeof(Output)-2);
Output.chksum &= ~0x8080;               // clear high bits
```

Technical Data

Power supply:	5V DC, ± 5 %		
Power consumption:	35 mA		
Channels:	9 input channels, one reference channel		
Measurement range:	15.00 - 59.00 °C		
Accuracy:	15.00 - 35.00 °C	± 0.01 °C	
	35.00 - 59.20 °C	± 0.02 °C	
	The sensor tolerance has to be added to these tolerances		
Out of range output:	< -17.00 °C	NOPROBE	output
	-17.00 °C ... 14.99 °C	TOOLOW	output
	15.00 °C ... 59.20 °C	Temperature value	output
	> 59.20 °C	TOOHIGH	output
Reference accuracy:	38.81°C, ± 0.01 °C		
Data output frequency:	9 channels + ref channel, at 10 Hz (protocol a) or 8 Hz (protocol b)		
Measuring frequency:	Two different firmware protocol versions have been implemented: a) all 10 channels are measured within 100 ms, and freshly updated values for all channels are output with each data block, ten times per second. b) only one channel is updated in each output block, e.g. the data block is sent eight times per second, but only one channel is updated for each transmitted block. It takes nine blocks until all channels are updated once. (Standard protocol).		
Current through NTC:	150-200 µA		
Power loss in NTC:	50-90 µW		
Isolation:	Patient isolation, according to type CF, 4000VAC RMS		
Leakage current:	< 10 µA		
Defibrillation protection:	Defibrillation protected in common mode, and for isolated probes in differential mode.		
Data interface:	Serial UART interface, 19200 baud, 8 bits, no parity, 1 stop bit.		
Dimensions:	84,5 x 44 x 10 mm		
Operating temperature:	10 °C..40 °C full accuracy, -10 °C..50 °C reduced accuracy		
Humidity range:	10 %-90 % relative humidity, non condensing		

Revisions

After major changes in 2012, the EG00750 has been renamed to EG00751

Firmware:

V1.0	Adapted channel switching scheme from EG00750 to EG00751	15.10.2012
V1.1	Changed Identification block from „EG00750“ to „EG00751“	13.12.2012
V1.2	Internal revision	
V1.3	Internal revision	
V1.4	One Temperature was not updated in one block, every few seconds	13.04.2013

Hardware:

Rev. A	EG00751 generated from EG00750 Rev. C	01.10.2012
Rev. B	Moved 100nF caps at inputs to bottom PCB side	01.02.2013

Manual:

V1.0	First version released	13.12.2012
V1.1	Correct current consumption, page 5 and page 9	28.02.2013
V1.2	Corrected too high and too low definitions	06.06.2013
V1.3	Corrected layout	27.02.2019

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