

**PIILIX-Design**

**USER MANUAL  
EGT-AMP v2**



© 2020 PIILIX Design



Järvensivuntie 11A, FI-33100 TAMPERE, FINLAND [www.piilix-design.fi](http://www.piilix-design.fi)

## Contents

<b>1. General</b>	3
1.1 Specification.....	3
<b>2. Assembly</b>	3
2.1 Mechanical Assembly .....	3
2.2 Electrical Assembly .....	4
<b>3. Instructions for use</b>	5
3.1 Theory of thermocouple measurement.....	5
3.2 Electrical Operation.....	6
<b>4. Warranty</b>	7
<b>5. Proof of Calibration</b>	

**Revision: A**

**Date: 22.02.2020**

**Written: Veli-Pekka Vuoristo**

## 1. General

EGT-AMP-v2 is a high-quality K-type thermocouple amplifier with Cold Junction Compensation. It is designed for nominal 12V DC-power supply and 0-1000°C (32-2012°F) sensor temperature will give 0-4.994V output voltage. Because of differential output stage EGT-AMP-v2 gives accurate readings also in situations where grounding potential errors are present. EGT-AMP is protected from environmental and electrical hazards normally present on automotive environment.

### 1.1 Specification

- Type of thermocouple: K (Alumel / Cromel), non-grounded
- Thermocouple connector: Miniature, K-type
- Internal gain: 121 x
- Output voltage function: 0°C=0V, 1000°C=4,994V (32°F = 0V, 2012°F=4,994V)
- Operational supply voltage: 8.5-16Vdc
- Current consumption: 30mA (no load, supply voltage = 14V, 1000°C input)
- Polarity protection: -16Vdc continuous, -45V, t < 20ms
- Supply voltage transient: +40V, t < 20ms
- Supply voltage transient, 600W power max, 10/1000µs pulse
- Internal fuse protection: 2 x F2A (Non-serviceable)
- Operational temperature range: -40 - +85°C (-40 - +185°F)
- Cold junction compensation: -30 - +85°C (-22 - +185°F)
- Measurement accuracy: ±3°C (±5,5°F)
- Cold junction compensation accuracy: ±5°C (±9°F)
- Dimensions (W x D x H): 85.0 x 45.0 x 20.0mm (3.35 x 1.77 x 0.79 inch)
- Environmental protection (IP-class): IP57 (not applicable to TC-connector)
- Weight (unit only): 90g (3.17oz)
- Mating 4-pole connector, body: TE-Connector 794805-1
- Mating 4-pole connector, socket pin: TE-Connector 1-770988-0
- Mating 4-pole connector, wire seal: TE-Connector 794758-1
- Mating 4-pole connector, interface seal: TE-Connector 794772-4

## 2. Assembly

### 2.1 Mechanical Assembly

**WARNING ! DUE TO CHOSEN MANUFACTURING PROCESS (Turret punch press with universal tooling) ALUMINIUM SHEETS ON TOP AND BOTTOM OF THE UNIT MAY HAVE SHARP EDGES !**

Due to high quality parts used in EGT-AMP-v2 it can be assembled in many different type of conditions; wet, dry, dysty, cold or hot. Best possible accuracy and reliability can only be achieved in dry, room temperature atmosphere.

Mechanical fixing should be done using four (4) ready-made fixing points located on the bottom side of the unit. Screw thread size is metric M3x0.5. Maximum screw penetration inside the unit is 5mm (0.2 inch). Separately supplied printed fixing pattern jig can be used for fixing hole drilling. Depending on the thickness of the mounting surface material use correct length screws/set screws + nuts (M3x6; 0.5-2.5mm, M3x8; 2.5-4.5mm and M3x25 set screw; 0.5-14mm thickness). Spring washers are recommended to prevent vibration caused loosening. Alternatively medium strength threadlock can be used (Loctite 243 or similar) to lock screws or set screws to the body of the EGT-AMP-v2.

Local heat, cold and wind sources should be avoided in the assembly location. Strong sources of heat or cold may deteriorate the operation of the Cold Junction Compensation and cause additional measuring errors.

## 2.2 Electrical Assembly

EGT-AMP-v2 needs a stable +12V (8.5-16Vdc) voltage feed for operation, +12V feed (**RED** cable) should be free of excessive disturbances. Feed point near starter, alternator or ignition coil is not recommended; high voltage spikes may interfere EGT-AMP-v2 operation or in worst case cause harm to it. Grounding is good when ground cable (**BLACK** cable) is short and equipped with a proper grounding ring connector.

Output of the EGT-AMP-v2 is differential and it can adapt to a small potential differences ( $\pm 1.5V$ ) between the grounds of the EGT-AMP-v2 and the unit to be controlled. This potential difference means the voltage measured between **BLACK** and **BLUE** cable. Negative Output- cable (**BLUE**) should always be connected; not doing so will give falsely readings.

Best possible accuracy can only be achieved when negative Output- cable (**BLUE** cable) is connected very near the grounding pin of the controlled unit like seen on Picture 1. With this arrangement a voltage drop in controlled unit grounding cable don't have effect on measurement. If controlled unit has a separate signal ground, then negative Output- cable should be connected to that. Especially this is important when controlling ECU's; these have strong ground currents because of injector and ignition control. 0.1V voltage drop in ECU's ground cable with wrong grounding of OUTPUT- cable can cause error of 20°C (36°F).

Positive Output+ cable (**YELLOW** cable) should be connected directly to the positive analog/signal input of the controlled/measurement unit.

EGT-AMP-v2 output stage is designed to control high impedance inputs; excessive loading of the output can cause measurement errors or in extreme case can cause permanent failure to the EGT-AMP-v2.

**Maximum load of the output of EGT-AMP-v2: 5 k $\Omega$  (kilo-ohm). Meaning the input impedance of the receiving unit must be over 5 k $\Omega$  (kilo-ohm).**

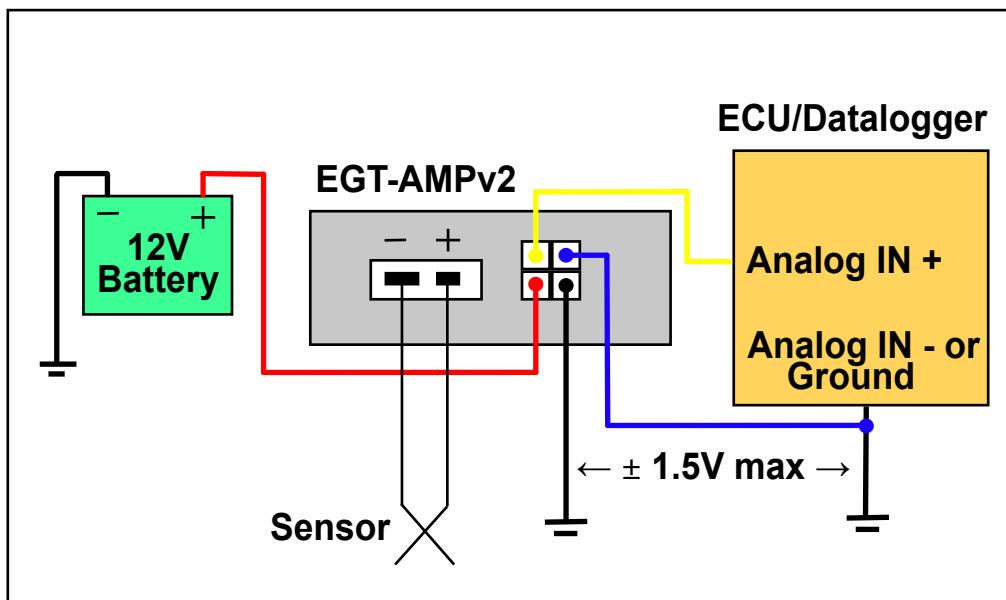
**Direct capacitive loading of the EGT-AMP-v2 output is forbidden! Direct capacitive loading may cause oscillations in the output signal; this causes no harm for the EGT-AMP-v2, but measurement accuracy will be lost. If there is a direct capacitive loading on the input of the controlled unit, then a suitable series resistor should be added between the Output+ of the EGT-AMP-v2 and the input of the controlled unit, 4.7k $\Omega$  (kilo-ohm) should be ok. Measurement accuracy should be studied case by case after this modification (ie. resistive divider effect).**

**Never connect Output+ and Output- signals to any high voltage circuits, voltages exceeding -2V - +8V may cause permanent damage to the EGT-AMP-v2!**

PIN	SIGNAL	CABLE COLOR
1	Output -	Blue
2	Output +	Yellow
3	Ground / Power -	Black
4	+12V Power	Red

Table-1 Pinning of the EGT-AMP v2 (Pin numbers are visible on mating connector's body)

**NOTE! WIRE HARNESS CONNECTOR NEEDS SUBSTANTIAL FORCE WHEN MATING TO UNIT. MAKE SURE THAT LOCKING CLIP IS SECURELY LOCKED TO AVOID WIRE HARNESS LOOSENING!**



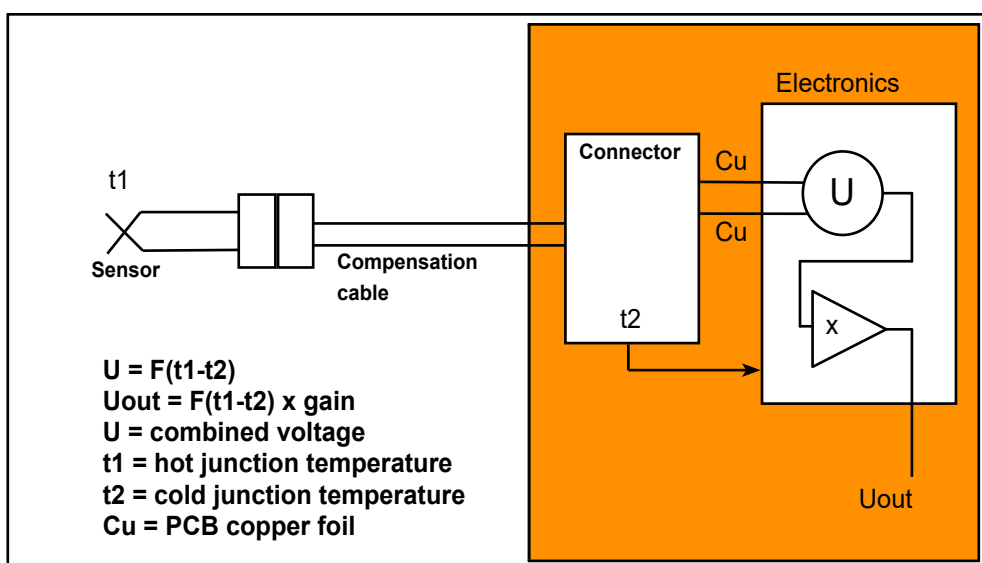
Picture-1 EGT-AMP-v2 Electrical Connection

### 3. Instructions for use

#### 3.1 Theory of thermocouple measurement

Thermocouple temperature measurement is based on temperature dependant voltage generation over dissimilar metal junctions. Voltage is dependant on metals used and the temperature of the junction, voltage generation is nearly linear over usable temperature range of the materials used.

Real measurement system always have two measuring points; the actual measuring point called 'hot junction' and the reference junction called 'cold junction'. Measuring device sees the difference of the voltage produced by these two junctions and to get the actual hot point temperature ( $t_1$ ) the measuring system needs to know the absolute temperature of the cold junction ( $t_2$ ). Below is a picture of the measuring principle.



Picture-2 Principle of the thermocouple measurement

Temperature °C	Temperature °F	Thermovoltage mV
-270	-454	-6.458
-200	-328	-5.891
-100	-148	-3.554
-50	-58	-1.889
0	32	0.000
100	212	4.096
200	392	8.138
300	572	12.209
400	752	16.397
500	932	20.644
600	1112	24.905
700	1292	29.129
800	1472	33.275
900	1652	37.326
1000	1832	41.276
1100	2012	45.119
1200	2192	48.838
1300	2372	52.410
1370	2498	54.819

Table-2 K-Type sensor theoretical output voltage (cold junction  $t_2 = 0^\circ\text{C}$  ( $32^\circ\text{F}$ ))

### 3.2 Electrical Operation

EGT-AMP-v2 is basically an analog amplifier and it has linear input-to-output voltage conversion. Voltage output of the K-type sensor is slightly non-linear over full operational temperature range; a table type conversion from voltage to temperature is needed for best accuracy. In low-end ECUs etc there are only linear type conversions available, this causes some measurement errors that are not induced by EGT-AMP v2.

For temperature conversion a following table can be used (Table 3) or in simplified case this can be done by the function:

$$0,000\text{V} = 0^\circ\text{C}, 4,994\text{V} = 1000^\circ\text{C} \quad (0,000\text{V} = 32^\circ\text{F}, 4,994\text{V} = 2012^\circ\text{F})$$

Temperature °C	Temperature °F	Nominal Output Voltage (V)
-270	-454	-0.781
-200	-328	-0.713
-100	-148	-0.430
-50	-58	-0.229
0	32	0.000
100	212	0.496
200	392	0.985
300	572	1.477
400	752	1.984
500	932	2.498
600	1112	3.014
700	1292	3.525
800	1472	4.026
900	1652	4.516
1000	1832	4.994
1100	2012	5.459
1200	2192	5.909
1300	2372	6.342
1370	2498	6.633

Table-3 Temperature vs Output Voltage of the EGT-AMP-v2

*NOTE! Due to the technical reason the output voltage of the EGT-AMP-v2 is not limited from 0V to 5V and in extreme temperatures (< 0°C (<32°F) or >1000°C (>1832°F)) or in special operational cases (start-up or sensor failure) the output voltage can be anything from -2V to +8V. Before connecting EGT-AMP-v2 to any system, please make sure the controlled unit can handle this voltage range without problems. Resistor connected between Output+ of the EGT-AMP-v2 and the input of the controlled unit can solve this possible problem in most cases. Measurement accuracy should be studied case by case after this modification. If there are any questions, please contact manufacturer for technical support.*

*Extreme temperature and offset combinations may saturate the output of the amplifier and cause measurement errors. Limitations and calculation formula seen on Table-4 below.*

Ground offset (V)	Min. temperature (C°/F°)	Max. temperature (C°/F°)
-1.5	-55 / -67	+1370 / +2498
0.0	-270 / -454	+1370 / +2498
+1.5	-270 / -454	+1280 / +2336
Calculation: $-1.75V < U_{in} \times 121 + \text{Offset} < 7.75V$ . $U_{in}$ = thermocouple thermovoltage.		

Table-4 Input / offset limitations

## 4. Warranty

EGT-AMP-v2 has a full three (3) year warranty from the date of the purchase. Warranty includes component failures and workmanship. Not included are natural wear, usage against specification and Force Majeure -type failures. Warranty does not cover failures in other systems connected to EGT-AMP-v2, it is assumed that the end-user of the EGT-AMP-v2 have skills necessary to assemble and analyse the product so it causes no risk to any other systems even in cases of malfunction and failure.

Warranty does not cover external environment caused issues. These includes; vibration wear-out in connectors and in wire-harness, salt-water caused corrosion on unit / connectors and any similar type of premature wear-out of the unit.

Warranty does not cover engine failures caused by the malfunction or breakage of the EGT-AMP -v2.

Warranty includes competition use.

Warranty is void if unit has been opened or it has been modified.

Before any warranty returns please contact manufacturer first.

Warranty return postage from customer to manufacturer should be paid by customer. Once unit has been checked and if it has been found faulty postage refund will be given against original postage cost invoice/receipt. Refund is limited to standard postage rates only, do not use Express-services for return without manufacturers permission. Parcels send from the outside of the European Union (EU) should be marked 'Warranty Return' to avoid extra Customs tariffs.