Description

The FE-386-TC is a dual channel Thermocouple Amplifier with linearisation for type k thermocouples to suit the MA32(40) racking system. It provides high bandwidth with accurate and stable measurements.
The cold junction reference and connections for the thermocouples are incorporated into a connector adaptor type CA-386-TC which mates with the 7 pin Tuchel input connectors fitted to the racking system.
The amplifier has three ranges:- -50°C to 200°C, -50°C to 500°C and -50°C to 1000°C for full output, adjustable by internal jumper link.

Specification

CJC	39.4μV/°C (Type k), set for 0°C ±0.5° (incorporated in CA-386-TC connector adaptor). 0°C to +50°C range.
Amplifier section	Two identical amplifiers and linearisers.
Input Impedance	20kΩ differential.
Common Mode Rejection	>50dB @50Hz.
Stability	±5μV °C referred to input (includes CJC error).
Ranges	-50°C to 200°C, -2.5V to +10V o/p -50°C to 500°C -1V to +10V o/p -50°C to 1000°C -0.5V to +10V o/p
Accuracy	±1°C ±0.5% of full scale.
Vernier Gain	Control increases gain from x1 to x2.5. Calibrated ranges are with vernier in fully anti-clockwise position.
Frequency response Filter	1kHz bandwidth, rise time 0.3mS (10-90%). Jumper reduces bandwidth to 10Hz, rise time=30mS (10-90%).
Voltage Output	Full scale ±10V into 2kΩ, 5nF max. Offset ±10mV typ.

Physical

Temp. Range	0°C to 50°C operating	
Card size	7” x 2.65”. 2u high format (180mm x 67mm)	
Environment	Temp. Range	0°C to 50°C operating
Physical	Card size	7” x 2.65”. 2u high format (180mm x 67mm).

FE-386-TC Specification

Table of Contents **Page 1**

1 FE-386-TC Amplifier Card Description

The FE-386-TC is a dual channel thermocouple amplifier, complete with filter, for data acquisition and processing applications. The card has been specially developed to provide high performance at low cost in multi-channel applications. FE-386-TC is presented as a printed circuit card with amplifier fine gain and zero controls brought to the front edge. Internal jumpers set range and filter selection.
In the following text, the lower case letters a & b are used to differentiate between the two channels of the amplifier card.

The module may be most easily appreciated by consideration of its constituent parts :-

1. Integrated “ice point” connector
2. Active filtered input
3. Instrumentation Operational Amp
4. Lineariser
5. Filter
6. Output Buffer Amplifier

1.1 Integrated “ice point” connector

The CA-386-TC is a dual connector for the Thermocouple Amplifier, with screw connections for the thermocouples. It has an integral ice point reference which accurately measures the cold junction temperature and compensates for errors. The CA-386-TC may be fitted to the connector of any slot occupied by a Thermocouple Amplifier. The application of these “connector adaptors” gives Micro-Analog 2 great versatility.

1.2 Active filtered input

It is recognised that thermocouples are often used unscreened in high noise environments and thus the input stage of the amplifier features a low pass active filter to remove any high frequency pick up.

1.3 Instrumentation Operational Amp

The instrumentation operational amplifiers feature low drift and low noise coupled with high accuracy and excellent common mode rejection. Protection is provided against overvoltage both for series and common mode overloads. The preamplifier has a fixed gain of x100.

1.4 Lineariser

The lineariser is able to linearise the type K thermocouple characteristic from -50°C to +1000°C, thus offering a direct read out in V/°C to high accuracy.

1.5 Filter

The filter has two frequency selections - low frequency (10 Hz) and high frequency (1 kHz). The filters may be used for noise reduction, or as simple alias protection where the signal is to be A-D converted.

1.6 Output Buffer Amplifiers

The output buffer amplifiers provide additional gain settings; these are chosen to be x1, x2 and x5. They enable a temperature of up to 200°C, 500°C or 1000°C, with a Type K thermocouple, to generate an output of up to +10 V. In each case, the minimum temperature able to be linearised is -50°C.

Vernier gain potentiometers are included. These multi-turn controls give an additional x2.5 maximum. Note that for reasons of EMC, a ‘T’ form output filter is included; this has the effect of raising the output impedance to 100Ω.

2 Configuration of the Module

Refer to 'Component Idents' drawing 805PC in the appendix to this section for additional configuration information. Note that the circuit board is silk screen idented to aid component location.

2.1 Setting the Desired Ranges

2.1.1 Temperature Range Selection

The module will operate with either of 200°C, 500°C or 1000°C as the maximum temperature (to generate +10 V). Select the appropriate jumper link as shown below. Note that there are separate jumper links for channels a and b on the printed circuit board, and that it is permissible to set different maximum temperatures for each channel.

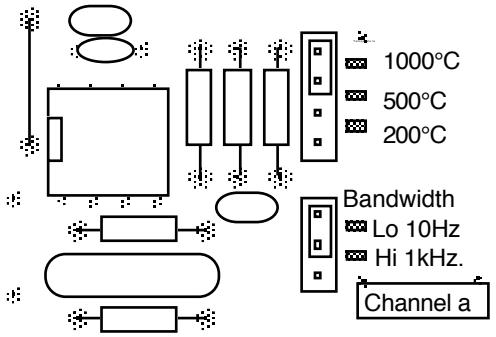


Fig 2.1 (left)

Showing the jumper arrangement for channel "a" . Setting depicted is 1000°C for 10 V output.

Bandwidth setting jumper is shown in the setting for 10 Hz.

2.1.2 Frequency Range Selection

Two bandwidth settings are available in the standard amplifier, select either 10 Hz or 1 kHz as your measurement bandwidth requires. Note that in the "lo" (10 Hz) setting, the frequency response is 10 Hz -3 dB. In the 1 kHz setting however, the response in maximally flat and the response is less than 1 dB down at 1 kHz whereas the -3 dB point is approximately 5 kHz. The resulting rise times (to 90% of final value) are tabulated below.

Bandwidth	Response	Rise time
"lo" 10 Hz	-3 dB @ 10 Hz	30 ms
"hi" 1 kHz	-1 dB @ 1 kHz	60 μs

Note that the 10 Hz setting will offer lower noise for most measurements, but at higher bandwidth noise is only marginally increased and may be used when measurements dictate. Again, channels a and b may be set to different bandwidths.

2.1.3 Vernier Gain Potentiometers

Vernier gain potentiometers are included on the front card edge. These multi-turn controls give up to an additional x2.5 gain and enable coverage between the calibrated gain steps. See 3.2.1 for details of how to set an arbitrary full scale temperature.

In most cases, the x2.5 verniers may be left in the fully-anti clockwise positions (as delivered) when the calibrated ranges set at the factory apply.

2.2 Connections

2.2.1 The Input Connections & the Integrated "Ice Point" Connector

The CA-386-TC is a dual connector adaptor for the Thermocouple Amplifier, with screw connections for the thermocouples. It has an integral ice point reference or Cold Junction Compensator (CJC) which accurately measures the cold junction temperature and compensates for errors. The CA-386-TC may be fitted to the connector of any slot occupied by a Thermocouple Amplifier and is protected against inadvertent connection to other card types.

2.2.2 Specialised Thermocouple Connectors

Thermocouples are often used with connectors incorporating specific metals which generate similar voltages to the thermocouples themselves. The reason for this is that when a thermocouple material connects to a normal conductor, such as copper, another thermocouple is formed (sometimes called the the cold junction). The temperature of the cold junction must be carefully monitored if errors in the measurement are to be avoided. The Micro Analog 2 system addresses this problem by providing a unique input connector incorporating screw connections and compensation circuitry. Specific metal thermocouple connectors are thus not required.

2.2.3 Making the Input Connections

The use of the CA-386-TC enables simple screw connection of the type K thermocouples. Please remember however that polarity is important, and the positive connection of the thermocouple must be made to the screw connection marked "+". The adaptor is 2 channel and is marked for channel "a" and channel "b". In a multi channel system, odd channel numbers (1-31) will be "a" and even channel numbers (2-32) will be "b".

2.2.4 Functional Verification

When either pair of the screw terminal connectors is short circuited, the output will read the equivalent of ambient temperature. This is a useful method of verifying system operation.

2.2.5 Thermocouple Colour Codes

Type K thermocouples are made from Nickel Chromium / Nickel Aluminium and the table below denotes the BS4937 Part 30: 1993 (IEC 584-3: 1989) standard colour codes in force.

Type K Thermocouples	
Nickel Chromium (+)	Nickel Aluminium (-)
colour green	colour white
(old colour brown)	(old colour blue)

2.2.6 Use of Compensating Cable

Thermocouple cable of the highest grade is expensive, and in long installations is often replaced for the bulk of the length with a cheaper alternative known as "compensating cable". Compensating cable has good thermocouple fidelity over a limited temperature range and will enable accuracy to be maintained in long installations at reasonable cost.

2.2.7 Common Mode Voltage

The input amplifiers used in the FE-386-TC are unusual amongst thermocouple amplifiers in that they are arranged in a differential configuration. Although thermocouples can often be conditioned by non-differential or "single ended" amplifiers, the use of a differential connection had advantages when the thermocouple measuring junction is electrically connected to the test structure.

continued

The amplifier is able to reject any electrical interference which is common to both inputs (common mode) whilst amplifying only the voltage between the inputs (series mode). It is, however, necessary to ensure that the average voltage of the signal source with respect to mains earth remains inside the common mode limit of the preamplifiers; this is ±10 V with respect to mains earth. Any signal source which has one end connected to mains earth will obviously satisfy this requirement, but care should be taken to ensure that voltages in excess of ±10 V with respect to mains earth are not present on the subject to be monitored. Voltages higher than this should be prevented from making contact with either input lead or the amplifier will be unable to function.

2.2.8 Input Protection

The amplifier is well protected against overload, and can be applied with confidence as long as inputs are likely to be below ±100 V DC or Peak.

2.2.9 Connection to "Floating" Sources

The amplifier will work well if the measuring junction is "floating" i.e., it has no connection to mains earth or any supply voltage.

2.2.10 Connecting the Output

The amplifier outputs are ±10 V full scale with a capability of ±2 mA. Please note that due to EMC qualification of this equipment, 'T' form passive filters are included in series with the voltage outputs; these components have the effect of raising the output impedance to 100Ω.

For FE-MA32/40, the output connector is a 50 way ribbon contact connector, popularly known as a 'Centronics' style.
For FE-MM8 and FE-MM16, 15 way 'D' sockets are used , 2 are fitted on the 16 channel system.
Mating leads to wire ends are provided.

A connection list is given in the "System Chassis" section of this manual.

2.2.11 BNC Expander Boxes

FYLDE offer BNC expander boxes to fit the output connectors. For the FE-MA32/40 this is known as the FE-MAC-40C. The FE-MM8 and FE-MM16 both utilise the FE-MAC8C, note that 2 are required for the FEMM16. These boxes bring out all outputs onto BNC sockets whilst providing "D" connectors for control lines.

Connectors for ribbon cables and a version with flying leads are available. Output harnesses may also be obtained to suit various Data Acquisition systems - please contact the factory for advice.

3.0 Operation

Before operating the system, it is advisable to study the previous pages referring to Temperature and Frequency range setting.

3.1 Switching On

The system power switch is located on the rear panel.

For FE-MA32 chassis, two mains voltage settings are available; be sure to select the most suitable setting for your available supply :-

'120' 103 - 127 V AC 50/60 Hz 50 VA max. '240' 207 - 253 V AC 50/60 Hz 50 VA max.

The fuse rating is marked on the rear panel.

For FE-MM8 and FE-MM16, power is 10-36VDC and fusing is internal. Refer to the appropriate handbook section for connection information. Note that an inline mains power supply is available for these systems.

On switch on, the green power led should illuminate. If this led flashes, this is indicative of power supply overload.

Note: The FE-386-TC does not connect to the power overload circuits, hence a flashing supply LED is most probably due to incorrect input wiring on a different module type such as FE-366-TA.

3.2 Output from the FE-386-TC

The FE-386-TC will output a voltage proportional to temperature dependent on the range selected (see section 2.1, "Setting the Desired Ranges"). The table below shows idealised output against temperature for the 3 temperature ranges.

Temp (°C)	200°C	500°C	1000°C
-50	-2.5 V	-1 V	-0.5 V
0	0	0	0
50	2.5 V	1 V	0.5 V
100	5 V	2 V	1 V
200	10 V	4 V	2 V
300		6 V	3 V
400		8 V	4 V
500		10 V	5 V
600			6 V
700			7 V
800			8 V
900			9 V
1000			10 V

3.3 Setting an Arbitrary Full Scale Temperature

If required, the user may apply gain to make any temperature in the range 80°C to 1000°C generate a desired output voltage.

As an example, if the required output is +10 V for an input temperature of 250°C, proceed as follows:-

1. Select the 500°C range for the amplifier (Refer to section 2.1 "Setting the Desired Ranges").

2. Connect a voltage calibrator to the connector adaptor (integrated ice point connector) in place of the thermocouple; be sure to observe correct polarity. Set an input voltage equivalent to the thermocouple.

3. The voltage required is calculated as :-

Voltage due to thermocouple at 250°C - voltage due to ambient temperature (say, 20°C).

10.15 mV - 0.798 mV

= 9.352 mV

4. The x2.5 gain control may be turned in a clockwise direction until the output reads +10 V.

For the above example, the output for 250°C on the 500°C range without the use of the vernier gain control would be +5 V and it is left to the user to decide if the higher output voltage delivered sufficiently merits the adjustment of the control.

Standard reference tables for the K Type Thermocouple may be used to determine the appropriate input voltage to be set for the voltage calibrator.

In most cases the available range and resolution of the data acquisition system will dictate, but often the x2.5 verniers may be left in the fully-anti clockwise positions (as delivered) when the calibrated ranges as set at the factory apply.

4.0 Calibration

4.1 Calibration Interval

A calibration interval of 12 months is recommended for the FE-386-TC.

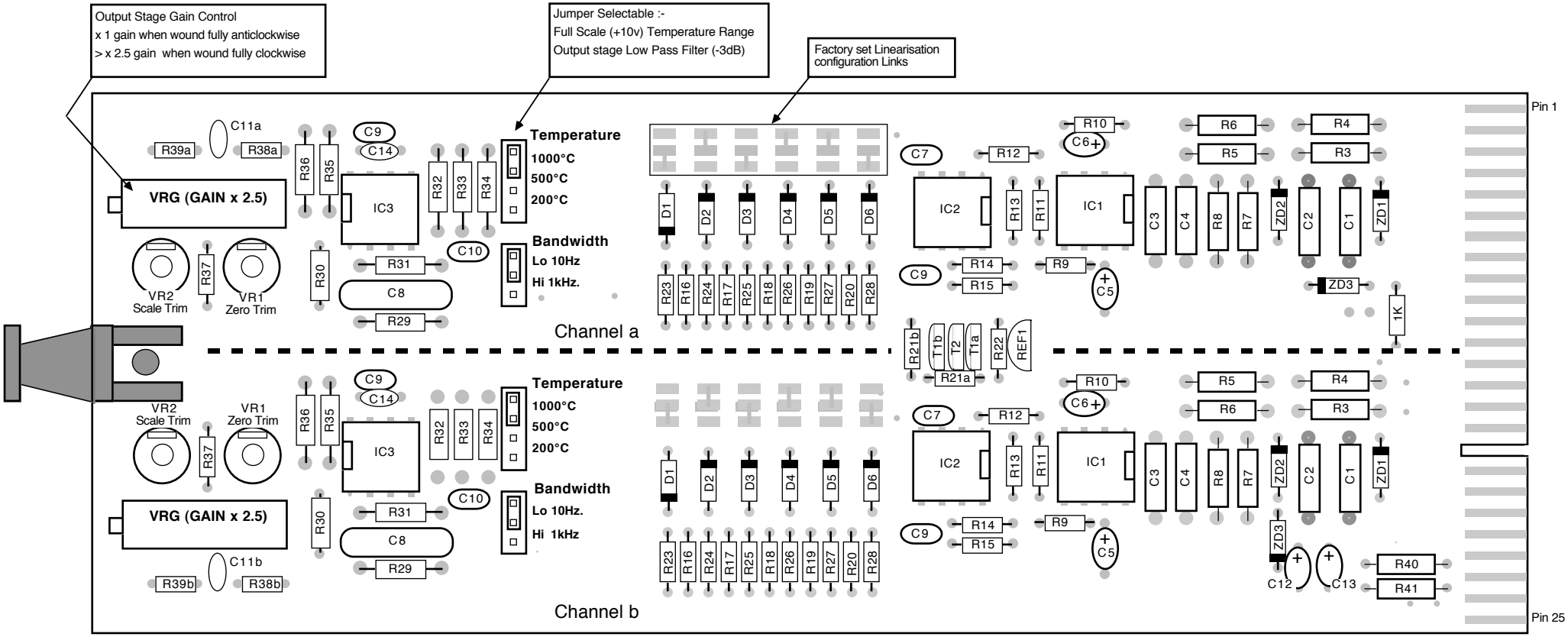
FYLDE offer servicing for the FE-386-TC and are able to test, repair and recalibrate the amplifiers quickly and cost effectively using instruments traceable to national standards and to ISO 9000 quality standard. Please contact the factory for advice.

4.2 Calibration Procedure

A calibration procedure is available for the FE-386-TC on request.

Appendix

Iss	Modification
1	New Drawing



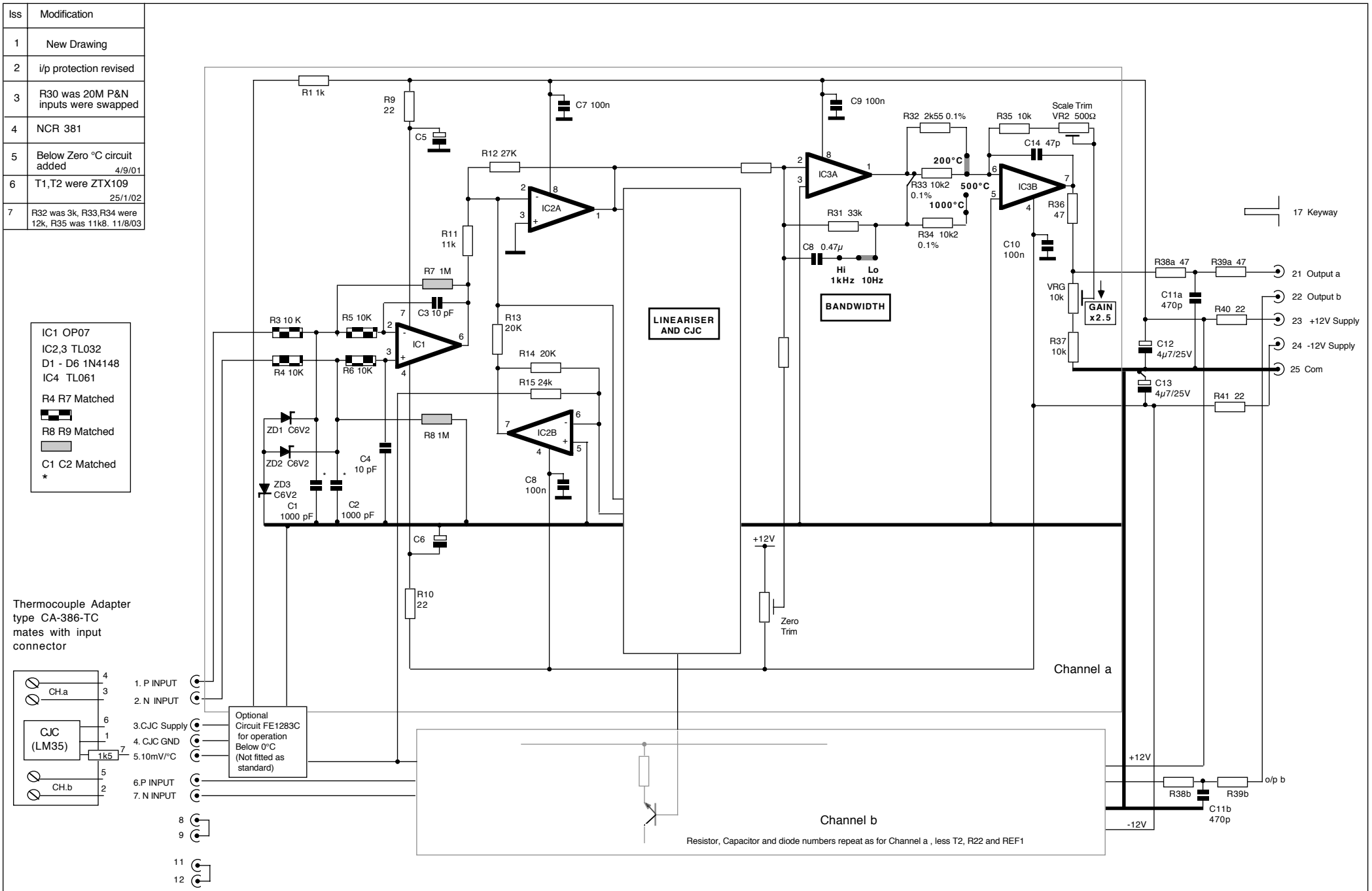
Note:-
The FE-386-TC is a dual channel module. Both channels are identical.
All Controls and Components above the center line relate to Channel a
All Controls and Components below the center line relate to Channel b

The FE-386-TC must only be used in a Fylde Micro Analog 2 compatible racking system.
Cold Junction Compensation is performed by the Fylde Dual Channel, CA-386-TC Connector Adaptor.

FE-386-TC DUAL MICROANALOGUE THERMOCOUPLE AMPLIFIER	DRG No. FE 805PC	Issue 1	Date 30-03-99	Checked

FYLDE Electronic Laboratories Limited. 49-51 Fylde Road, PrestonLancs PR1 2XQ. England. Telephone 01772 257560. Fax. 01772 821530.

Iss	Modification
1	New Drawing
2	i/p protection revised
3	R30 was 20M P&N inputs were swapped
4	NCR 381
5	Below Zero °C circuit added 4/9/01
6	T1,T2 were ZTX109 25/1/02
7	R32 was 3k, R33,R34 were 12k, R35 was 11k8. 11/8/03



FE-386-TC DUAL MICROANALOGUE THERMOCOUPLE AMPLIFIER	DRG No. User	Issue 1	Date 11/8/03	Checked SGOD

FYLDE Electronic Laboratories Limited. 49-51 Fylde Road, PrestonLancs PR1 2XQ. England. Telephone 01772 257560. Fax. 01772 821530.