DESCRIPTION

The FE-356-OA is a dual channel general purpose operational amplifier card for the Micro-Analog 2 system. The card is designed for application specific configuration.

The B14481 application involves the conditioning of various high level output transducers which also have varying power supply requirements. The card is able to receive differentially, apply offset or back off to the signal, gain up to the required level and low pass filter and buffer the signal.

The 2nd stage carries turret mounted resistors which allow large gain and offset adjustment.

SPECIFICATION 2 identical amplifiers per card to following specification

INPUT preamplifier	impedance	>200kΩ differential
	level	±20V max
	CMR	>40dB
GAIN	Input stage	x0.5
	2nd stage	x1 (change by turret mounted resistor)
	output stage	x1, x2, x5 by jumper selection
	Linearity	better than 0.1%.
OFFSET	Configuration	By jumper selection: can be made to back off either +ve or -ve preamplifier output or shift output zero. Degree of shift or backoff controlled by turret mounted resistor.
FILTER	Type	3 pole, preset by plug-in resistor network.
	Range	High band (47Hz - 20kHz).
	Default setting	100kΩ (470Hz)
	Gain	Unity.
	Roll Off	18dB/ Octave, 60dB/decade.
	Offset	±5mV.
	Characteristic	Butterworth.
	Bypass	By single resistor.
TRANSDUCER SUPPLY	Selections	0 and +5V
	by jumper link	±5V
	“”	0 and +12V internal
	“”	±12V internal
	“”	0 and +12V external
	“”	0 and +24V external

PHYSICAL

ENVIRONMENT	Temp. Range	0°C to 50°C operating.
PHYSICAL	Card size	7” x 2.65”. 2u high format (180mm x 67mm).
	Format	FYLDE Micro-Analog 2 system
OUTPUT	direct output	±10V maximum at ±2mA.
	Noise	<1mV pk-pk.
	Offset	<±10mV.

TABLE OF JUMPER SETTINGS

Jumpers	Status	Description
J1, J2, J7, J8	Fitted	Input Coupling (DC)
J3, J9	Fitted	2nd stage DC coupling
J6, J12	"x1"	Output gain set to x1
J13, J14	12V external, 0V	Transducer Supply from external source
J4, J10	"SE"	Bipolar 2nd stage offset
J5, J11	"Bip"	Bipolar 2nd stage offset
Preamplifier	Gain x0.5	Allows up to 20V input
2nd Stage	**Value**	**Description**
Gain R11, R31	10kΩ	Sets 2nd stage gain to x1
Offset R9, R29	10kΩ	Allows output to be offset to 0 to ±2.5V
Control	**Setting**	**Description**
Gain vernier	Anti-clockwise	Vernier gain set to x1
Offset vernier	See text	Set to zero output

Application Specification

Table of Contents Page 1

1 FE-356-OA Card Description

The FE-356-OA is a dual channel operational amplifier, complete with transducer supply and signal filter, intended for the conditioning of high level signals in data acquisition and processing applications. The card has been specially developed to provide high performance at low cost in multi-channel applications, and may be applied with all types of voltage sources.

Presentation is as a printed circuit card with amplifier fine gain and offset controls brought to the front edge. Internal jumpers are provided to adjust gain and filter settings.

Breakdown of amplifier:-

1. Transducer Supply
2. Pre-Amplifiers
3. 2nd Stage
4. Low Pass Filters
5. Output Buffer Amplifiers

1.1 Transducer Supply

The FE-356-OA, depending on the Application Specification, may be configured for +12V, ±12V, +5V or ±5V Transducer Supply. In the case of application in the FE-MMx cases, +2.5V is also available.

1.2 Pre-Amplifiers

The Pre-Amplifiers are differential input type featuring low drift and low noise coupled with high accuracy and good common mode rejection. They have in built protection against over voltage and are provided with an input filter to limit high frequency interference. The pre-amplifier has a fixed gain governed by the Application Specification and has a high Common Mode Voltage capability.
The Pre-Amplifiers may be AC coupled if required by fitment of input capacitors.

1.3 2nd Stages

The second stage provides additional gain if required and also allows use of the onboard voltage reference to allow level shifting of the signal. Resistors associated with gain and shift are turret mounted to facilitate easy changing.
This application utilises a 2nd stage gain of x1. The shift control is multi-turn and its range is governed by a turret mounted resistor. The input to the second stage may be AC coupled if required by fitment of input capacitors.

1.4 Low Pass Filters

The2nd Stages are followed by low pass filters. The filters are 3rd order Butterworth Sallen-Key designs whose frequency setting is programmed by plug in resistor networks RP1 and 2. The filters may be used for noise reduction, or as simple alias protection where the signal is to be A-D converted. For highest frequency response coupled with minimum phase shit, the filter may be largely bypassed by use of a bypass resistor.

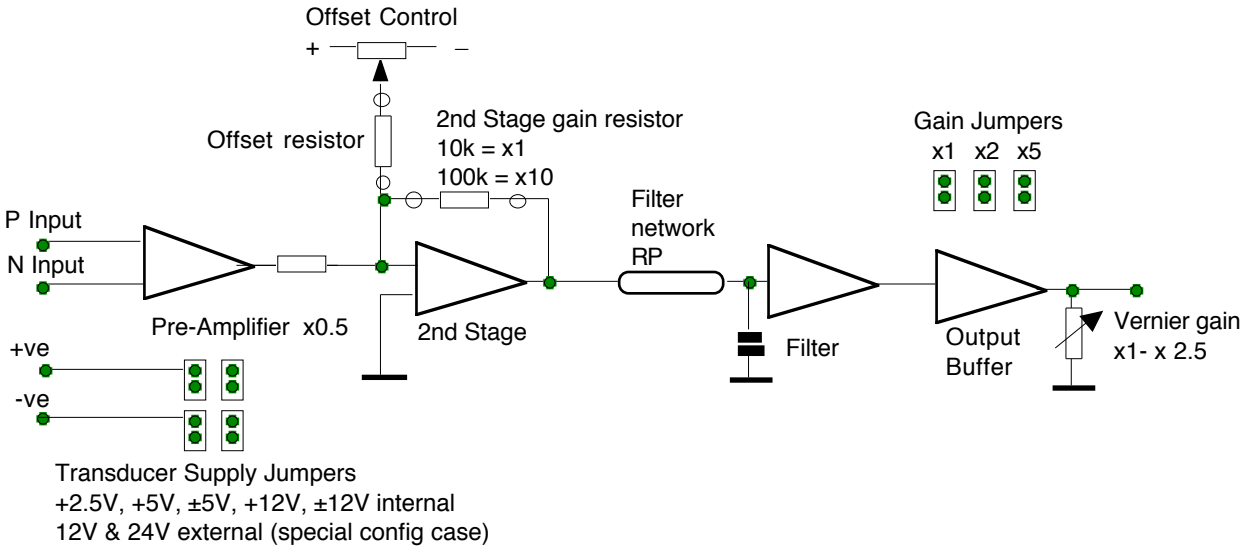
1.5 Output Buffer Amplifiers

The output buffer amplifiers provide additional jumper selected gain settings x1, x2 and x5. Coupled with the pre-amplifier gain setting and 2nd stage gain, they enable a range of calibrated gains to be set.

Vernier gain potentiometers are included. These multi-turn controls give an additional x2.5 minimum and enable coverage between the calibrated gain steps.

Note that for reasons of EMC, ‘T’ form output filters are included; these raise the output impedance to 100Ω.

1.6 Simplified Schematic of 1 Channel



2 Configuration of the Module

The FE-356-OA is normally factory configured for the specific application, refer to the Application Specification, circuit diagram and notes included with this handbook.

Note that the circuit board is silk screen idented to aid component location.

2.1 Connections

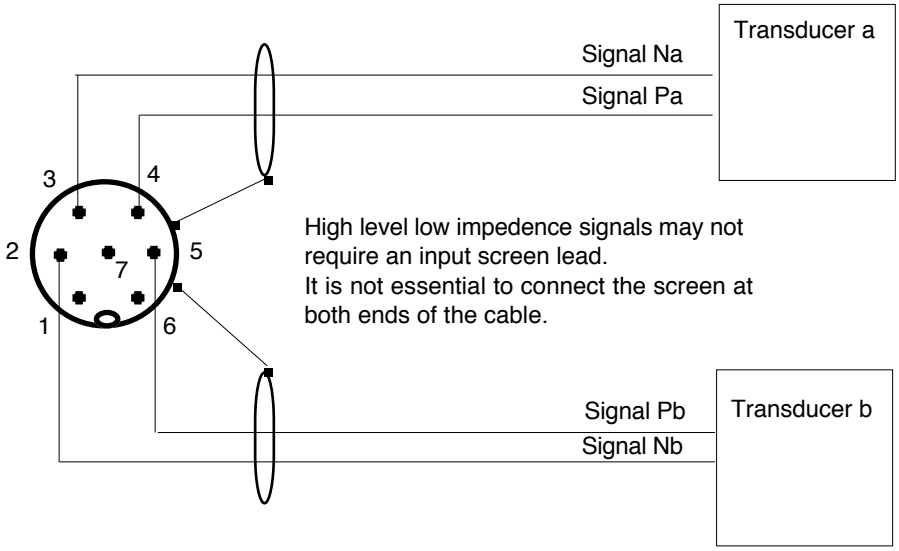
2.1.1 Connection of the Input without Transducer Supply

Depending on the application, connection of the input will entail only the amplifier P and N inputs for each channel, or may include also the Transducer Supply if specified.

In the following text, the lower case letters a & b are used to differentiate between the two channels of the amplifier card.

7 pin Tuchel connector
(view into chassis mounted plug)

Pin 1	Supply -
2	Signal Nb
3	Signal Na
4	Signal Pa
5	Signal Pb
6	Supply +
7	Screen

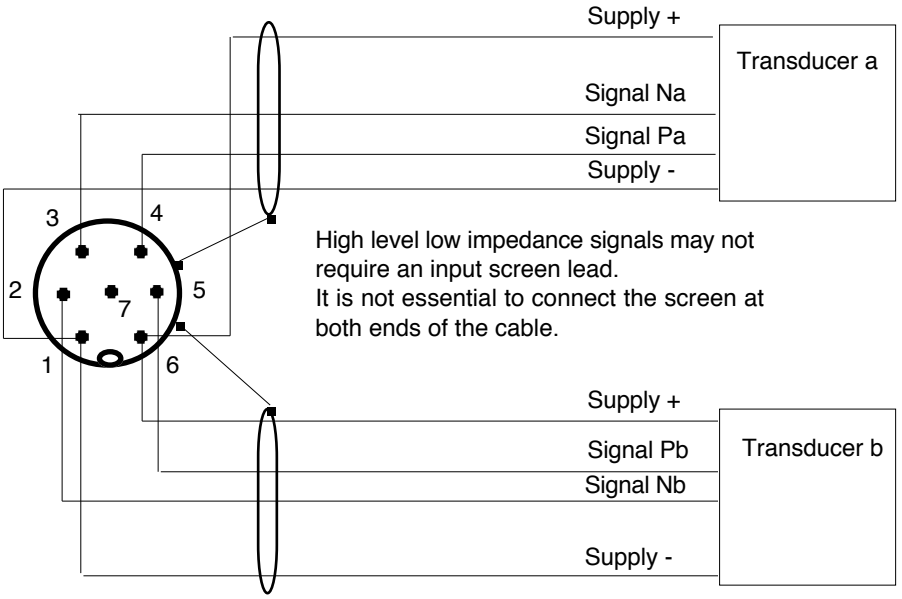


2.1.2 Connection of the Input with Transducer Supply

Where the Transducer Supply is required, the connection is shown below. Note that the same supply is used for both channel a and channel b transducers; it is not possible to set different supplies for each channel on one card.

7 pin Tuchel connector
(view into chassis mounted plug)

Pin 1	Supply -
2	Signal Nb
3	Signal Na
4	Signal Pa
5	Signal Pb
6	Supply +
7	Screen



2.1.3 Use of the CA-376-IP BNC Connector Adaptor

When the amplifier is applied without a Transducer Supply, the CA-376-IP BNC Connector Adaptor may be used to connect the inputs. This connection harness converts the 7 pin Tuchel connector into 2 BNC sockets.
Important Note: Because the "low" side of the signal input may not be electrically at 0V, ensure that the shells of the BNC connectors do not contact each other or electrical ground otherwise proper operation may be impaired.

2.1.4 Connecting the Output

The amplifier outputs are capable of generating up to ±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.

The FE-Mx32/40 chassis is fitted with a 50 way output connector carrying 40 channels of single ended output signals. The FE-MM4, FE-MM8 & FE-MM16 chassis use D connectors carrying the single ended output signals. Refer to the "System Chassis" section of the system folder for details of these connectors.

2.2 Setting the Gain

The pre-amplifier has a fixed gain setting dependent on the application. The arrangement is generally identical for channels 'a' and 'b'.

The 2nd stage allows additional gain if required. The resistor associated with gain setting is turret mounted for easy change but will have been factory fitted to suit the the Application Specification.

Channel	Gain resistor
a	R11
b	R31

2nd Stage Gain	Resistor value
x1	10kΩ
x10	100kΩ

The output buffer amplifiers provide additional Output Gain settings; these are chosen to be x1, x2 and x5. Vernier gain potentiometers are included on the front card edge. These multi-turn controls gives an additional x2.5 maximum and enable coverage between the calibrated gain steps, and a maximum gain of > x100 overall. For calibrated gain steps, be certain to set these controls in the fully anticlockwise position.

2.3 Setting the Offset

The Offset potentiometers are multi-turn controls which enable a signal to be level shifted. The degree of offset available is governed by the configuration of the potentiometer voltage reference links and by the value of the resistors associated with the offset controls.

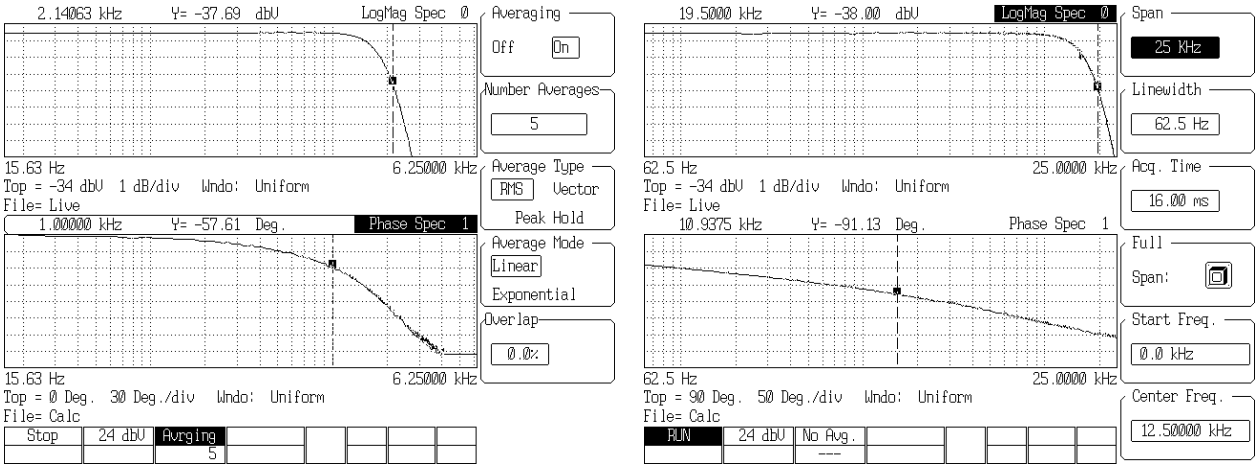
Channel	Offset resistor
a	R9
b	R29

2.4 The Low Pass Filter

The low pass filter is a 3 pole (-18 dB / octave) Sallen Key design with Butterworth response. Two choices of filter capacitors allow factory configuration of the filter as Low Band (4.7Hz to 2kHz) or High Band (47Hz to 20kHz).

The low pass frequency response is determined by the user's choice of resistor pack (RP). The plots below are given for both Fc = 20 kHz and Fc = 2 kHz.

Low pass phase match between channels is approximately ±1° at 0.75 Fc.



2.4.1 RP value

Depending on the factory configuration of the filter capacitors as High Band or Low Band, the following tables allow the correct value of filter network to be chosen.

High Band	
Cut-off (Fc)	RP1 value
47Hz	1MΩ
100Hz	470kΩ
200Hz	220kΩ
470Hz	100kΩ
1kHz	47kΩ
2kHz	22kΩ
4.7kHz	10kΩ
10kHz	4.7kΩ
20kHz	2.2kΩ

Low Band	
Cut-off (Fc)	RP1 value
4.7Hz	1MΩ
10Hz	470kΩ
20Hz	220kΩ
47Hz	100kΩ
100Hz	47kΩ
200Hz	22kΩ
470Hz	10kΩ
1kHz	4.7kΩ
2kHz	2.2kΩ

2.4.2 Filter Bypass

For maximum bandwidth applications when configured as High Band, the filter may be bypassed by fitting a single resistor across the RP network socket between pin 1 and 8 (extreme ends of socket). Using a resistor value of 1kΩ will then give a filter break frequency of >100kHz.

3 Operation

Before operating the system, it is advisable to study the previous pages referring to configuration of connection and gain setting etc.

3.1 Switching On

3.1.1 FE-MA32 or FE-MA40

The system power switch is located on the rear panel. Two mains voltage settings are available; be sure to check that the most suitable setting for your available supply is selected :-

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

Fusing is 0.63 A(T) located in the pull out tray which forms part of the IEC mains connector (a spare is included).

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

Note: If this should occur, input connectors should be removed in stages in order to isolate the fault. If the rack contains a mixture of boards, remember that the FE-366-TA Transducer Amplifier, and in some instances the FE-356-OA Operational Amplifier, route the internal bridge supply voltage directly to the transducers in some configurations and it may be worth removing these modules first (Note, the FE-366-TA handbook carries notes regarding overloaded bridge supply problems).

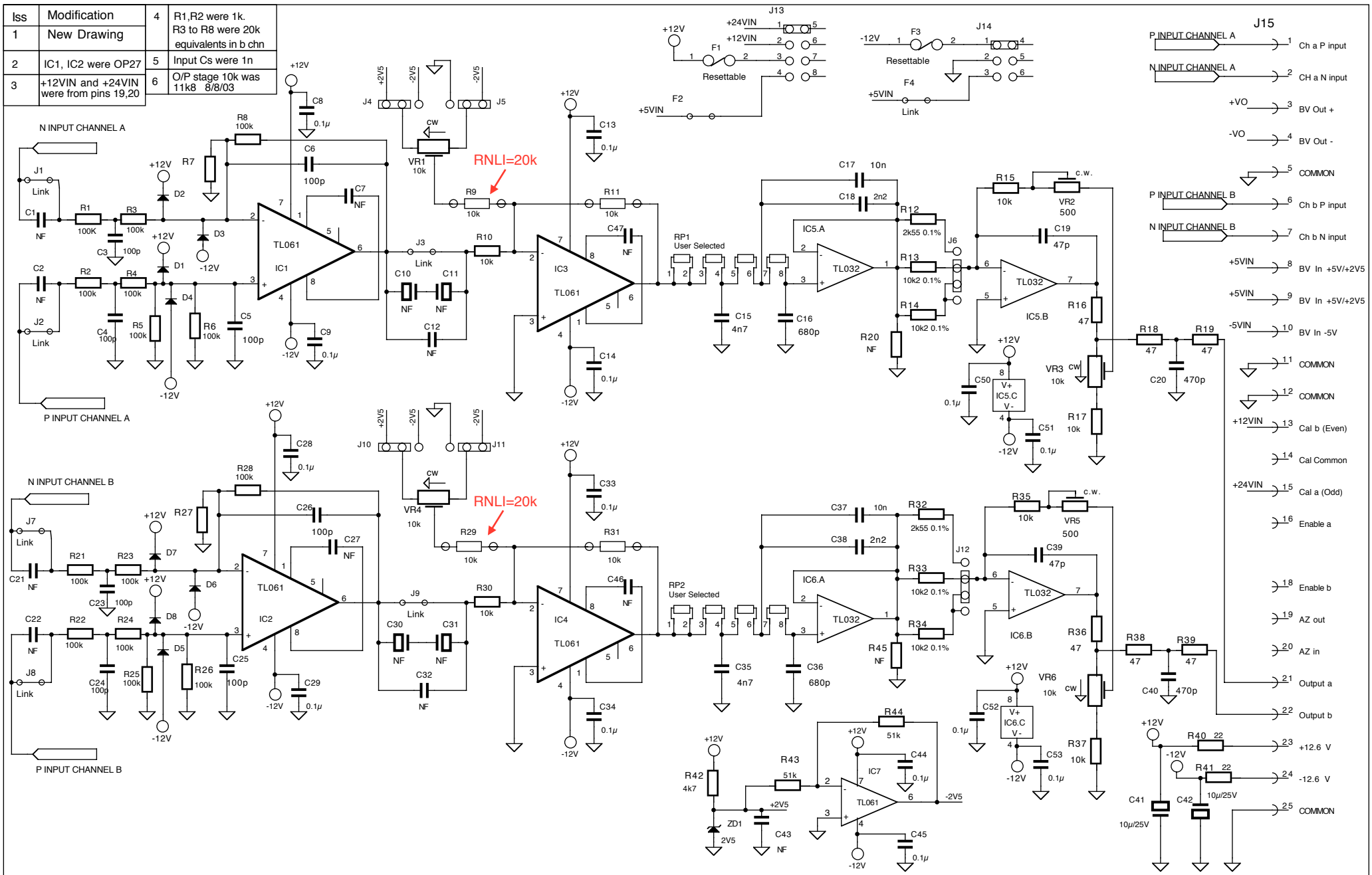
3.1.2 FE-MM4, FE-MM8, FEMM16 and FE-MM40

For FE-MM4 & FE-MM8, apply a DC voltage of between 10V and 36V (5VA max.) via the DC jack socket and lead provided. Note that the centre pin is +ve. For FE-MM16 & FE-MM40, an XCON power input connector is used. In either case an internal fuse is fitted and protection is provided for reverse supply. A mains to DC supply is available.
On switch on, the green power led should illuminate. If the led flashes, this is indicative of power supply overload (see note above).

4 Note regarding Application Specification

The FE-356-OA is generally factory configured for the expected application. For this reason, an Application Specification is included which gives specific configuration and operational notes for the module. For further information regarding configuration and operation, refer to the Application Specification included with this handbook.

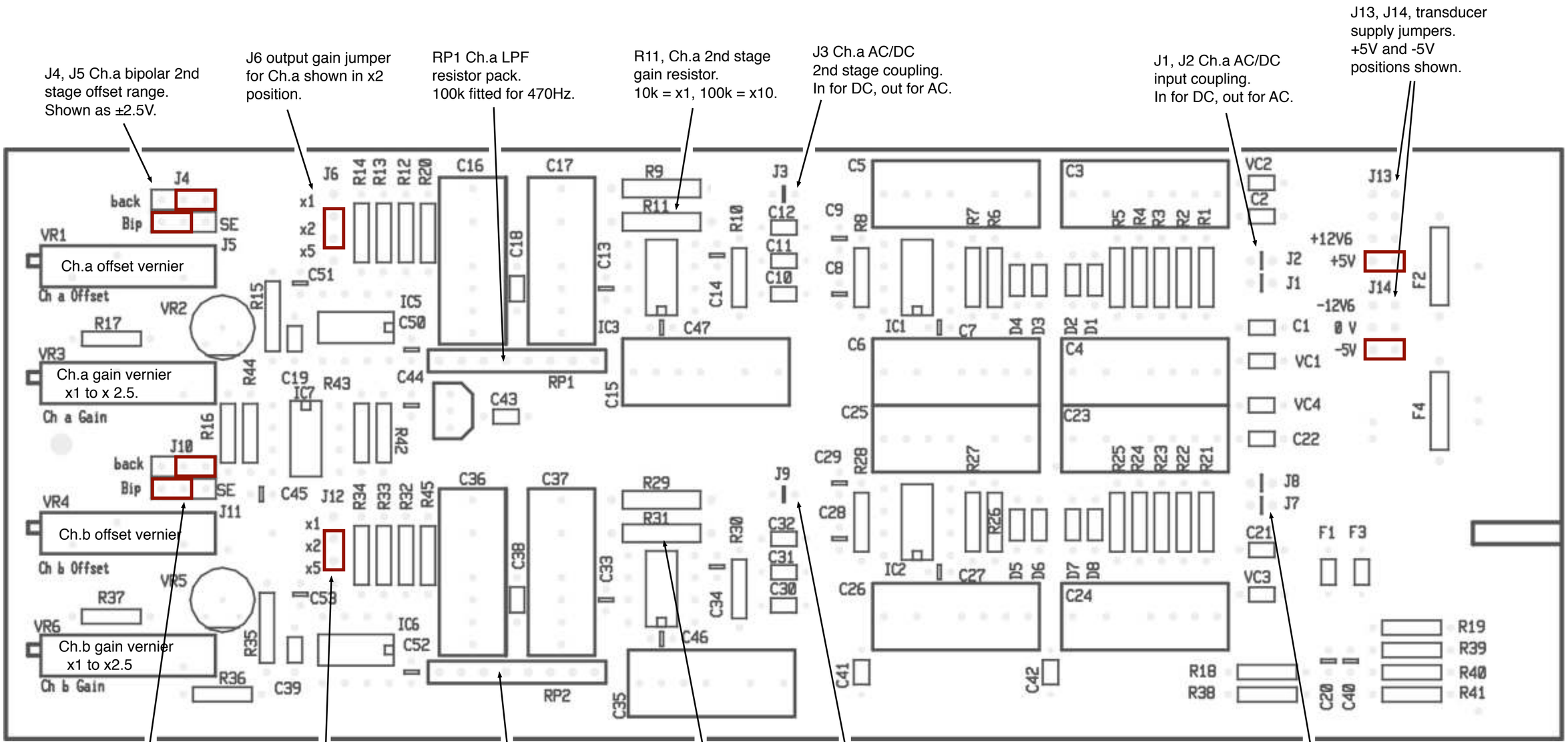
Iss	Modification		
1	New Drawing	4	R1,R2 were 1k. R3 to R8 were 20k equivalents in b chn
2	IC1, IC2 were OP27	5	Input Cs were 1n
3	+12VIN and +24VIN were from pins 19,20	6	O/P stage 10k was 11k8 8/8/03



FE-356-OA Operational Amplifier	Ref B14481	Dwg No. 1305C	Issue 6	Date 8/8/03	Checked SGOD

FYLDE Electronic Laboratories Ltd. 49-51 Fylde Road Preston, Lancs, PR1 2XQ England. Telephone 01772 257560 Fax 01772 821530, http://www.fylde.com

Issue	Date	Change History
1	20/10/17	New Drawing



FE-356-OA Operational Amplifier User Drawing.	REF:	DRG.No. : 1316	Issue : 1	Date : 20/10/17	Checked *DJG*

Appendix