Description

The FE-396-FV is a dual channel micro analogue 2 presentation of the established FE-570-FV, and accepts frequency inputs from proximity detectors, flow meters, toothed wheel, or any electromagnetic or light activated source.
The FE-396-FV will operate from as low as 0.5 Hz up to 20 kHz .

Specification Two identical channels as below:-

Frequency	range (jumper selectable in 1, 2, 5 steps.)	Min 0- 50 Hz gives 0 to +10 V output. Max. 0- 20 kHz gives 0 to +10 V output.
Input	sensitivity (threshold)	35 mV peak at 100 Hz. (25 mV rms)
	trigger control	25 turn screwdriver control adjusts trigger threshold.
	CMR	40 dB dc-1kHz.
	impedance	20 kΩ typical.
	transducer supply	Power to opto pickup, proximity detector or flowmeter. +12V @50mA current limited.
	completion	Pull up or hold down resistor positions are available.
Conversion	method	Digital period measurement and 10 bit D/A conversion.
Linearity		Better than 0.1% of full scale.
Response time (all ranges up to 5 kHz)	0.5 Hz to 5 kHz	Responds within two periods of input frequency or 1.5 ms whichever is greater.
Response time (10 kHz and 20 kHz ranges)	3 kHz to 20 kHz	Responds within 32 periods of input frequency or 1.5 ms whichever is greater.
Digital Averaging	Filter Jumper	Output is average of last 8 sample periods with this jumper fitted.
	Prescaler Jumper	Input is prescaled by an additional factor of 16 with this jumper fitted.
Output	voltage	Capability ±10 V into 2kΩ, 5000 pF max. Offset < ± 5 mV.
Indication	Signal Present LED	Flashes when frequency is too high for selected range.
	Tune LED	Intensity of illumination indicates quality of input signal.

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).

Specification

Table of Contents **Page 1**

1 FE-396-FV Frequency to Voltage Converter Description

The FE-396-FV is a dual channel frequency to voltage converter, for data acquisition and processing applications. The card has been specially developed to provide high performance at low cost in multi-channel applications. FE-396-FV has front edge controls to set sensitivity to the input signal and front edge indicators to show the status of the input signal. Internal jumpers set the frequency range and the speed of response to changes in input frequency. In the following text, the lower case letters a & b are used to differentiate between the two channels of the frequency to voltage converter.

Breakdown of module:-

1. Signal Input
2. Prescaling
3. Frequency Measurement
4. Digital Filtering
5. PWM Output Stage
6. Output Buffer Amplifiers
7. Transducer Power Supply

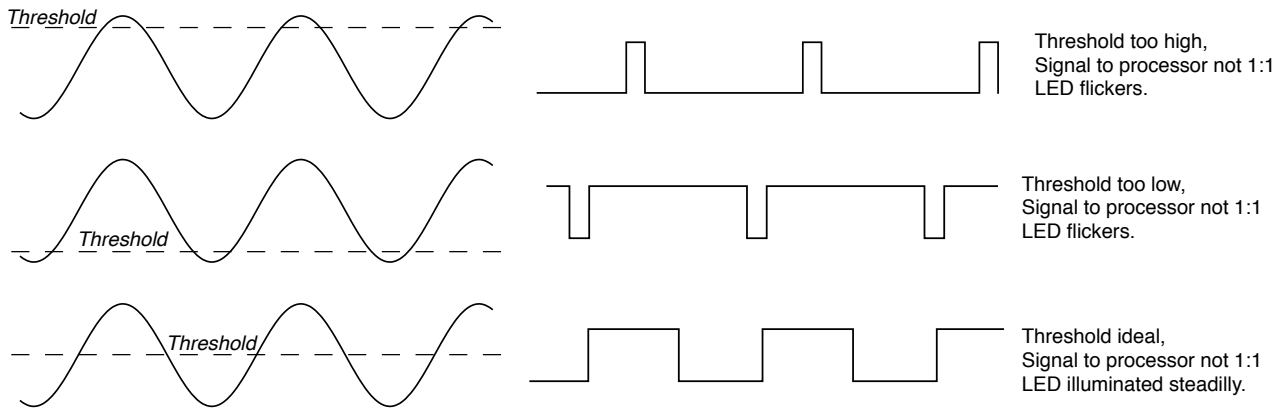
1.1 Signal Input

The FE-396-FV accepts signal sources from a variety of transducers. For differential signals, each channel has an associated P (positive) and N (negative) input connection. In addition there is a common 0 V reference to which the 0 V reference of a single ended input signal may be connected. If signals have a DC offset with respect to any available reference, AC coupling is available.

Each input has a position for a pull up or pull down resistor which can be used if the input signal path requires completing in this way ; e.g. signals from open collector outputs.

The front edge sensitivity control is used in conjunction with the red indicator. The control should be adjusted for steady illumination of the red indicator. The control sets a threshold level which is compared with the input signal to produce the digital signal to the processors and prescalers. Ideally this threshold level should be half way between the signal maximum and signal minimum, and noise immunity will be reduced if the threshold is set near to the signal maximum or minimum.

The diagram below shows the effect of the sensitivity control on the red LED intensity.



1.2 Prescaling

Prescaling refers to the unit counting a number of periods of the input frequency before computing and producing an updated output signal. Prescaling affects the response of the unit to changes in input frequency, and is necessary to produce the best compromise between a good response to changes of frequency and the improved accuracy which may be produced by measuring and averaging the period of a number of input pulses.

Prescaling affects only the response time of the unit and does not affect the output when the input frequency is constant.

At all frequencies the FE-396-FV requires a minimum of two periods of the input frequency before the output is changed (2:1 prescaler) . The user may fit a jumper to introduce a further 16:1 prescaler in which case a minimum of 32 periods of the input frequency are measured before updating the output.

On the 10 kHz and 20 kHz ranges and at frequencies above approximately 4 kHz an additional 16:1 prescaler is automatically introduced. This automatic prescaling at higher frequencies is only removed when the frequency drops below approximately 3 kHz.

1.3 Frequency Measurement

The frequency measurement is carried out by two on board microprocessors operating at a clock frequency of 16 MHz. Measurement accuracy exceeds 0.1% at all frequencies up to 20 kHz. The processors apply the required prescaling before carrying out the frequency measurement, and also apply digital filtering to the resulting output voltage if the filter jumper is present. The signal indicator (green) is illuminated when the input signal frequency is present, and the tune indicator (red) is continuously illuminated when a clean signal is present. (Random noise spikes rather than signal input will cause the tune indicator to flicker. When the input signal frequency is higher than the selected full scale frequency the signal indicator blinks.

1.4 Digital Filtering

A digital filter may be selected to reduce noise in the output signal. When the digital filter is selected the output is a running average of the last eight frequency measurements. Hence a step change in frequency will cause the output to ramp to the new output voltage after eight frequency measurements. Note that typically the unfiltered output will have noise of ±10 mV due to the 10 bit (0.1%) resolution of the output from the processors. The digital filter removes this noise.

1.5 PWM Output Stage

The processors produce outputs which are PWM signals at 16 kHz. (This is a fixed frequency signal with a mark / space ratio which depends upon the amplitude of the output. A 3 pole 1 kHz filter is applied to this signal to produce the output voltage. This filter has been chosen so that it does not limit the speed of response of the output to a change in input frequency. Note that the voltage output can carry a very small residual 16 kHz frequency (<3 mV pk-pk) which will be most noticeable at half of full scale (1:1 PWM mark/space ratio).

1.6 Output Buffer Amplifiers

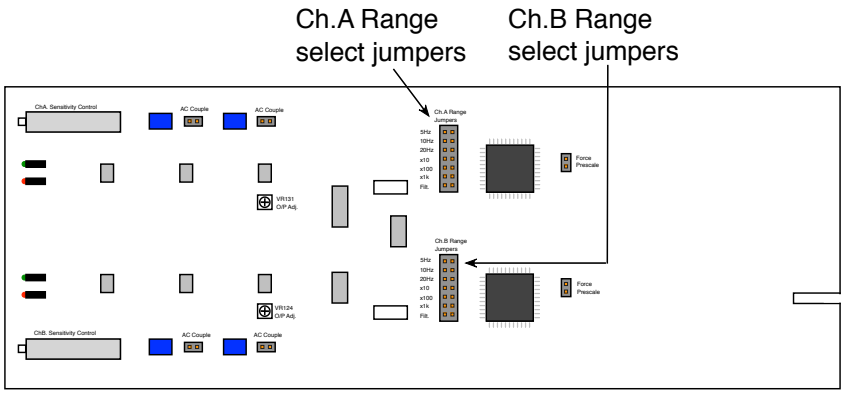
The output buffer amplifiers provide an output between 0 V and +10.00 V over the selected frequency range. Note that input frequencies which are higher than full scale do not drive the output voltage higher than +10.00 V (the green indicator flashes to indicate that the input frequency is too high). The output stage is capable of driving long coaxial cables and is filtered to maintain the immunity of the unit to EMC.

2 Configuration of the Module

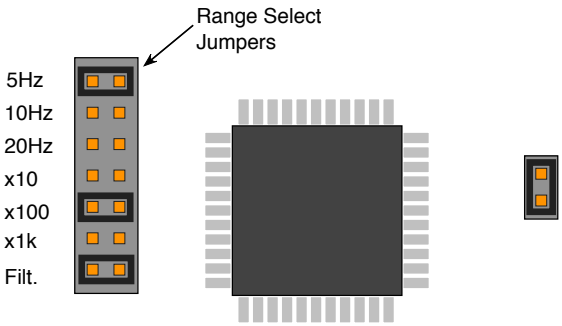
Refer to 'Component Idents' drawing 920PC for additional configuration information. Note that the circuit board is silk screen idented to aid component location.

Modules are withdrawn from the case by removing the front panel and pulling on the module's handle. The system should be switched off before the module is removed. The module is refitted by pushing the module firmly back into place.

2.1 Selecting Full Scale Frequency

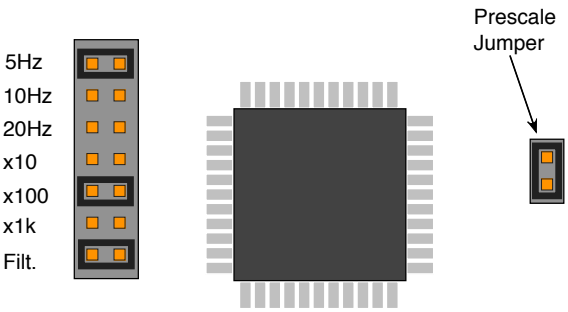


Each channel has a jumper area associated with the selection of the full scale frequency. For channel 'a', this area is to the left of the upper square black IC, and for channel 'b' it is to the left of the lower square black IC. The jumper area is depicted below.



Two jumpers must be fitted to select any full scale frequency. One must be one of the x5 , x10, and x20 jumpers, and the other must be one of the 10Hz, 100Hz, 1kHz jumpers. The full scale frequency is the multiple of the two selected values. e.g. in the diagram above 5Hz x 100 = 500Hz is selected.

2.2 Selecting Additional Prescaler



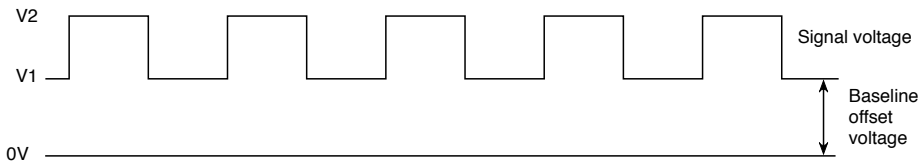
The prescaler jumper for each channel is located on the opposite side of its associated processor device as shown above. This jumper is only effective when the filter jumper is also fitted. This jumper (and the associated filter jumper) should be fitted to provide the maximum smoothing of input signal frequency variations.

2.3 Selecting Digital Filtering

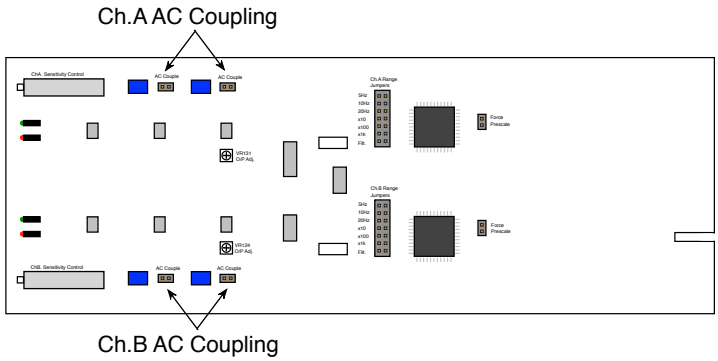
At the bottom of the frequency range jumper set is a single jumper which, when present, applies digital filtering to reduce output jitter. The unit is shipped from the factory with this jumper fitted. If the fastest possible response time is required, this jumper should be removed.

2.4 Using AC Coupling

When a single ended signal stands above its 0 V reference and does not return to zero (as shown in the diagram below), the offset voltage must be removed for the input stage to detect the signal frequency.



For a small baseline offset voltage (up to 0.7 V) it is possible to detect the signal frequency, since the front panel control allows some adjustment of the detection threshold. For larger offsets AC coupling can be introduced by removing the pair of factory fitted jumpers shown below.



Note that at low frequencies (i.e. below approximately 10 Hz) the AC coupled signal will be blocked, and the signal frequency will not be detected.

2.5 Connecting the Input

2.5.1 Using screened cable

To prevent unwanted signals being induced onto signal wires, the use of screened cable is recommended. The connection of the screen to an earth at one or the other end of the cable is essential for the screen to be effective, and the following guidance should be followed when connecting screens.

If the transducer is supplied with a screened cable already fitted, and the screen connects to the chassis (earth) of the equipment under test, then leave the screen unconnected at the Micro Analog 2 Tuchel connector.

If the transducer is supplied with a screened cable, but there is no electrical path to chassis (earth) from the screen to the chassis of the equipment under test, then connect the screen to the shell of the Micro Analog 2 Tuchel connector. A tag is provided inside the connector for this purpose.

If the transducer is not supplied with screened cable, then leave the screen unconnected at the transducer, and connect it to the shell of the Micro Analog 2 Tuchel connector as above.

Pin 7 of the Micro Analog 2 Tuchel connector is normally only used in the application of the FE-366-TA Transducer Amplifier.

2.5.2 Transducer Power

The FE-396-FV provides transducer power at approximately +12 V and 50 mA maximum. An accidental short circuit of the power supply will not affect the operation of the system, although if two transducers are used with the same FE-396-FV, failure of one transducer could prevent the other transducer from operating.

The FE-396-FV powers transducers using the ±12.6 V supply of the Micro Analog 2 system. This is a different supply from the precise 10.00 V / 5.00 V supply which is available for bridge type transducers. This prevents noise being induced onto the 10.00 V / 5.00 V supply by frequency sensors which may present a frequency dependent load to the power supply.

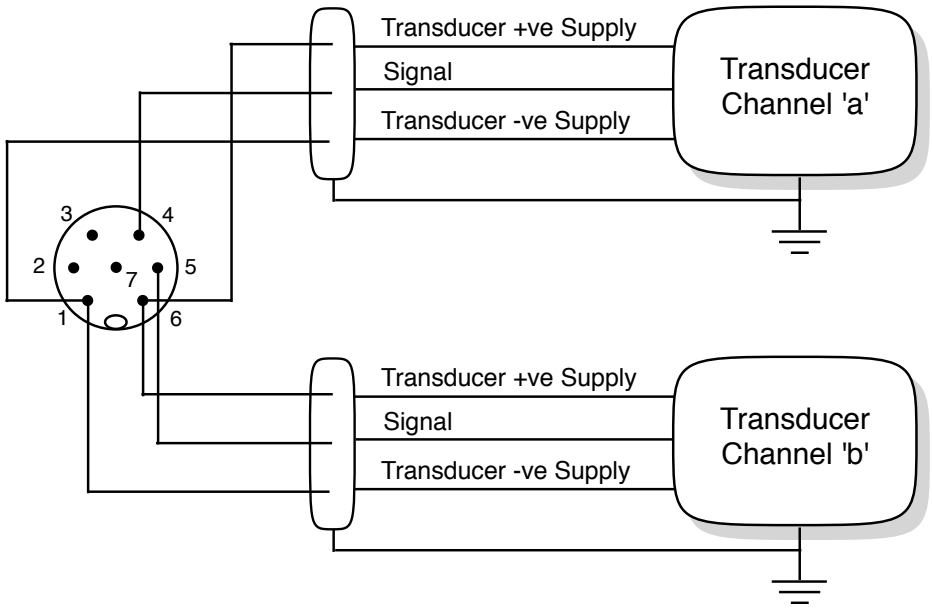
As a consequence of the use of the ±12.6 V supply for frequency transducers, there will be no front panel overload indication if there is a transducer short circuit.

2.5.3 Single Ended Connection

Transducers (sensors) which have a voltage output are normally connected as shown below.

7 Pin Tuchel Connector
(View into chassis mounted plug)

Pin no.	
1	Supply -ve
2	Signal Nb
3	Signal Na
4	Signal Pa
5	Signal Pb
6	Supply +ve
7	Screen

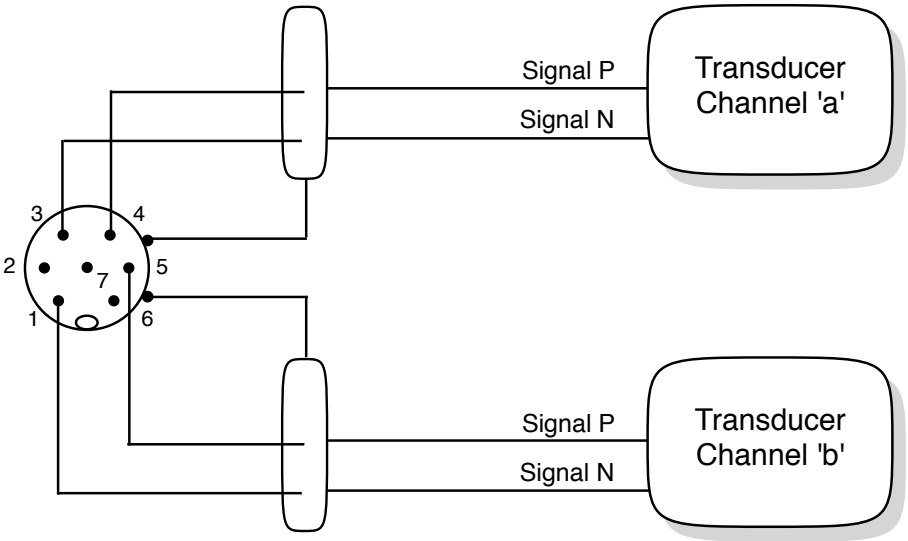


2.5.4 Differential Connection

Magnetic pick-ups (inductive speed sensors) operate without the need for a transducer power supply. The magnetic flux produced by the moving target induces a varying differential voltage at the transducer output.

7 Pin Tuchel Connector
(View into chassis mounted plug)

Pin no.	
1	Supply -ve
2	Signal Nb
3	Signal Na
4	Signal Pa
5	Signal Pb
6	Supply +ve
7	Screen

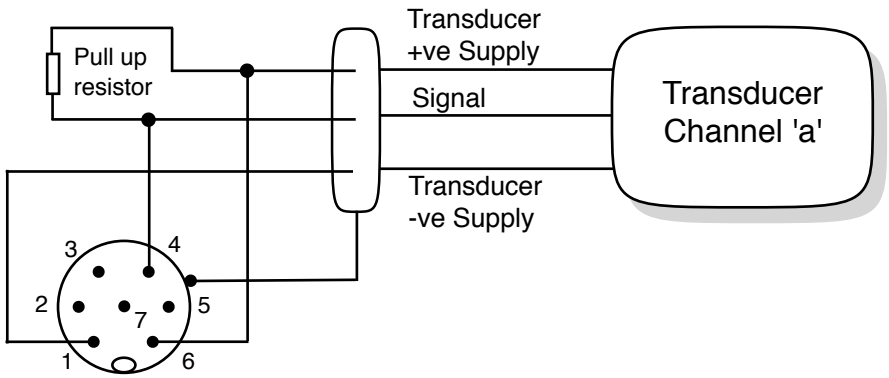


2.5.5 Open Collector Output Connection

Some transducers generate their output voltage by passing current through an external resistor. This resistor is usually referred to as a pull up resistor. The FE-396-FV provides an on board location for a pull up resistor (see drawing 920PC in the appendix to this section.) The transducer manufacturer will normally suggest a suitable value for this resistor.
It is also possible to mount the pull up resistor within the free half of the 7 pin connector, which may be desirable to avoid committing the FE-396-FV channel to use only with sensors requiring a pull up resistor.

7 Pin Tuchel Connector
(View into chassis mounted plug)

Pin no.	
1	Supply -ve
2	Signal Nb
3	Signal Na
4	Signal Pa
5	Signal Pb
6	Supply +ve
7	Screen

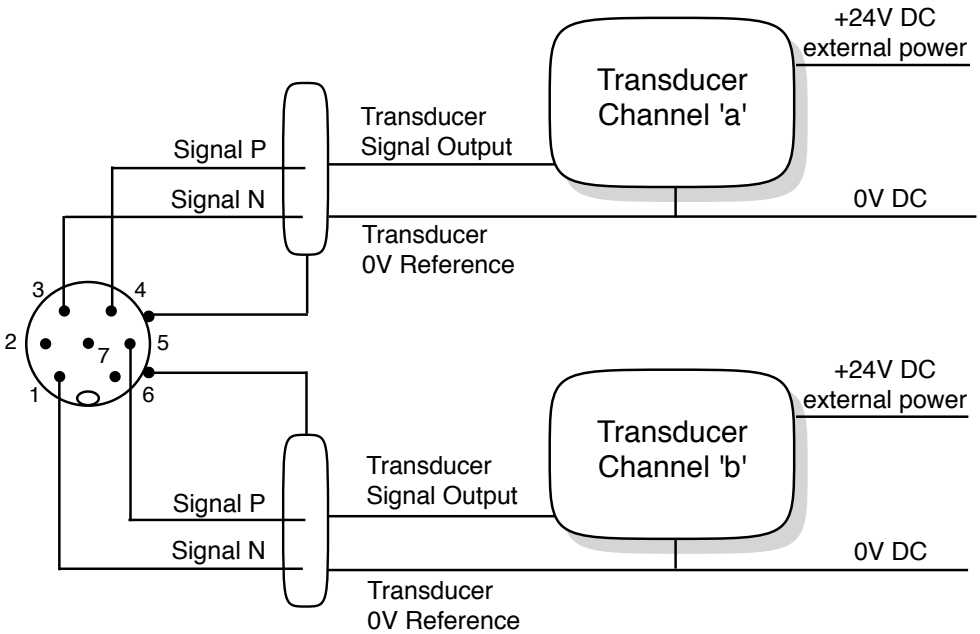


2.5.6 AC Coupled Inputs

When AC coupling is selected by removing the pair of jumpers at the trimmer & LED end of the module, the recommended connection to the module for a transducer with a standing DC offset on its signal output is shown below.

7 Pin Tuchel Connector
(View into chassis mounted plug)

Pin no.	
1	Supply -ve
2	Signal Nb
3	Signal Na
4	Signal Pa
5	Signal Pb
6	Supply +ve
7	Screen



2.5.7 Termination of Unused Inputs

It is not necessary to terminate unused inputs.

2.6 Connecting the Output

The amplifier outputs are 0 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-MA32/40 chassis is fitted with a 50 way output connector carrying 40 channels of single ended output signals. The FE-MM8 and FEMM16 chassis are fitted with 15 way output connectors carrying 8 channels per connector. Refer to the "System Chassis" section of this handbook for details of these connectors.

Note that BNC expander boxes (FE-MAC40C and FE-MAC8C) are available for MA32/40 and MM8/16 respectively.**3**

Operation

Before operating the system, it is advisable to study the previous pages referring to frequency range setting etc.

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-396-FV 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 Setting Input Sensitivity

With the frequency input present, the red LED on the front edge of the module should be illuminated. (The upper red LED is for channel "a", and the lower red LED is for channel "b".) If the LED is not illuminated, rotate the trimmer potentiometer (upper trimmer for channel "a") on the front edge of the card until it comes on, and then adjust for maximum intensity.

If the red LED does not illuminate at all, check the input connections.

3.3 Signal Indication

The green LED on the front edge of the module is normally illuminated when the red LED is illuminated. Note that when the signal is above the chosen full scale frequency, this indicator will flash. Also when the signal is removed, this indicator will remain on for approximately 3 seconds. (The module treats the missing signal as a very low frequency for three seconds.)

4 Calibration

The long term stability of the frequency measurement relies on the high quality crystal oscillator and the stability of the output stage gain. Routine recalibration is not necessary to maintain the unit within specification, but users may choose to calibrate the unit for other reasons.

The unit may be returned to FYLDE for calibration, but the unit can be easily calibrated by users or third parties since no special test equipment is needed.

Appendix

Iss.	Date	Change History
1	18/07/16	New Drawing (SMT)

Signal Indicators.

When flashing: signal frequency is too high for selected range.

When off: signal frequency is too low for selected range.

5Hz
10Hz
20Hz
x10
x100
x1k
Filt.

To set the full scale (10V) output,
fit one jumper only of the set x5, x10, x20
and one jumper only of the set x10Hz, x100Hz, x1kHz.
e.g. x10Hz and x100 select 1000Hz input for 10V output.

Remove the "Filt." jumper for fastest response to changes in the input frequency.

Fit the "Filt." jumper to reduce noise at the voltage output.

R147,148, 150 & 151 to R43 are pull up and pull down resistor positions. These components are not normally fitted.

R150: Channel A Pull Up.
R151: Channel A Pull Down.
R147: Channel B Pull Up.
R148: Channel B Pull Down.

Remove these jumpers to AC couple the input signal to Channel A.

Channel A Full Scale Trimmer. Factory set for +10.00V maximum output volts

Channel A Prescaler.

Fit this jumper to provide maximum averaging of the input signal frequency.

Note that the "Filter" jumper must be fitted for this jumper to be effective.

Adjust this control to ensure that the red LED does not flicker

Channel A

AC Couple

AC Couple

Channel A Signal indicator

Grn.

Red

Channel B Signal indicator

Grn.

Red

VR131 O/P Adj. Ch.A

Ch.A Range Jumpers

5Hz
10Hz
20Hz
x10
x100
x1k
Filt.

Prescale Ch.A

R151

R148

R150

R147

16Mhz

16Mhz

Ch.B Range Jumpers

5Hz
10Hz
20Hz
x10
x100
x1k
Filt.

VR124 O/P Adj.

Prescale Ch.B

Channel B

AC Couple

AC Couple

Channel B Prescaler.

Fit this jumper to provide maximum averaging of the input signal frequency.

Note that the "Filter" jumper must be fitted for this jumper to be effective.

Use one or the other oscillator, not both.

Adjust this control to ensure that the red LED does not flicker

Remove these jumpers to AC couple the input signal to Channel B.

Channel B Full Scale Trimmer. Factory set for +10.00V maximum output volts

TITLE: FE-396-FV Dual Frequency to Voltage Converter - user diagram	REF:	DRG.No. : 1297	Issue : 1	Date : 18th July '16	Checked

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