RDP Customer Document

Technical Manual

STRAIN GAUGE AMPLIFIER MODULE
TYPE 628

Doc. Ref CD2017S

This manual applies to units of mod status 8 ONWARDS

ISO 9001:2015 Quality Management

FM 13141

Affirmed by Declaration of Conformity

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I N D E X

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1 INTRODUCTION

The 628 Strain Gauge amplifier is a Eurocard-based module designed as part of the M600 19-inch rack instrumentation system. It is fully compatible with the 602/603/604 backplane system and 631/635 power supply/monitor units.

Direct reading in microstrain units is possible with four switched ranges of 100, 1000, 10000 and 100000$\mu\varepsilon$.

Variable excitation is provided (with remote sense) together with coarse and fine amplification controls, automatic or manual bridge balance, gauge factor, number of gauges, bandwidth and shunt calibration controls. Auto balance may be actioned via front panel switches or logic signals connected to the backplane. Shunt calibration can be actioned in a similar way, although on later units (MOD 6C onwards) the remote control via logic signals is only available as an optional extra.

Voltage and current (4-20mA) outputs are available simultaneously and options include sample/hold and isolated output facilities.

Bridge completion for quarter- or half-bridge systems is provided by resistors mounted on a separate connector board (D12378) which is plugged into the relevant backplane channel. These resistors must be ordered separately stating value (e.g. 120, 350Ω, etc.) and quantity (e.g. 2 for half-bridge, etc.).

An LED warns of gain range overload, and excitation and output may be monitored via a front panel jack (in the absence of a 635/636/650 monitor).

1.1 BEFORE POWERING-UP CHECK...

1	The supply voltage is correct to suit the 631/632 unit fitted and input range selected
2	The various plug-in modules are in the correct positions in the housing.
3	The input and output plugs are in the correct sockets. Note that on the housing back-plane all input sockets and all output sockets are of the same type.
4	Before connecting a transducer, ensure that the correct excitation voltage has been set. <u>Too high a voltage can destroy a transducer</u>
5	That each module has a unique address. (see section 3.12)

Note: Ensure system is switched OFF when removing or replacing modules and ensure each module has a unique address. Failure to do so may cause damage to modules.

1.2 Information on Conformity to EC Directives.

This module is not CE marked because it is intended for use as a component of a larger system. RDP CE mark full modular 600 systems that includes a 60X housing and a 63X power supply where the system is fully populated with either 600 series amplifier/display modules or blank panels.

If module is part of a full 600 system, see system manual (CD2010) for CE certification. If the module is not part of the full 600 system, it is the responsibility of the organization/ individual producing the system to assess and/or test EMC compatibility.

1.3 QUICK-SET-UP

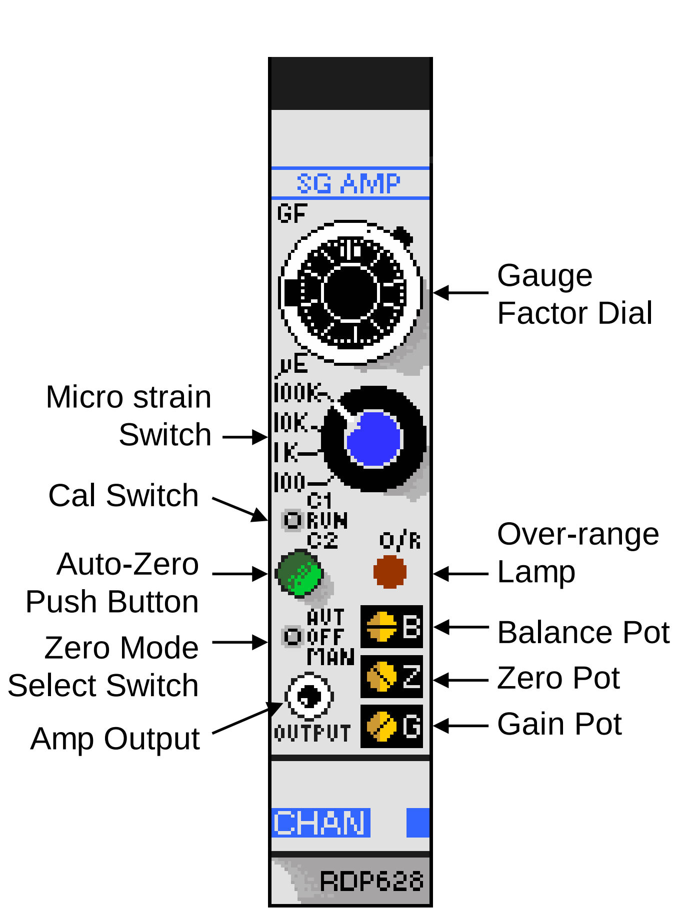
This section gives the basic operating information to enable operation of the instrument with the minimum of effort. Subsequent sections can be referred to on a "need to know" basis.

There are a number of front panel and internal controls which are fully described in Section 3, but the function can generally be followed from the annotated diagrams, Fig.1 and Fig.2.

Unless we are instructed otherwise, the factory settings are:

(a) Excitation voltage = 5V
(b) Gauge factor = 2
(c) Channel number (SW9) set to suit the system
(d) Number of gauges (SW3) set to 1 active gauge

Fig. 1 Front Panel



If these settings suit the application, connect the gauges to the connector board, as shown in Fig.4, and the instrument is ready to use. Refer to TABLE of FIGURES for locations of drawings and illustrations.

Fig. 2 Internal Controls

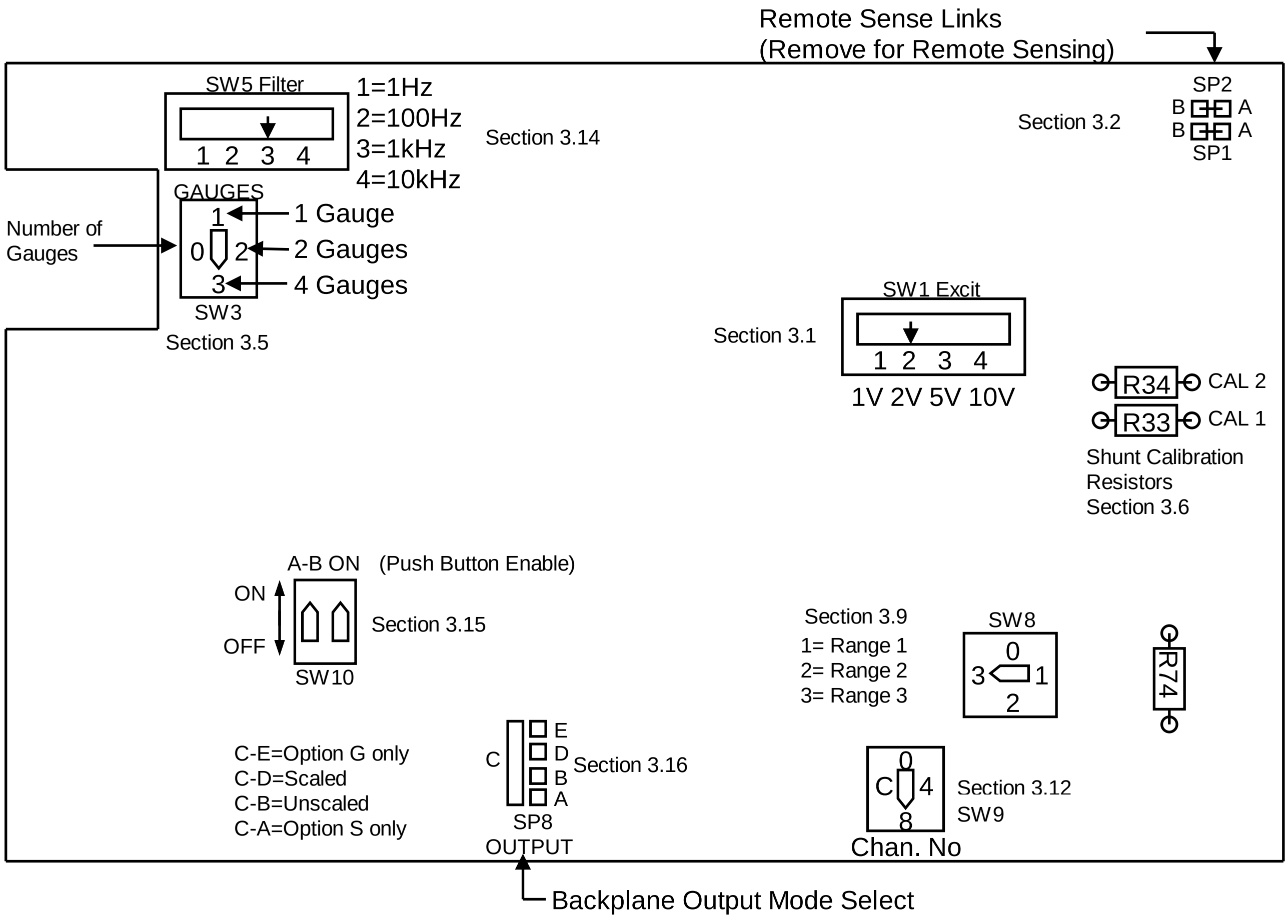
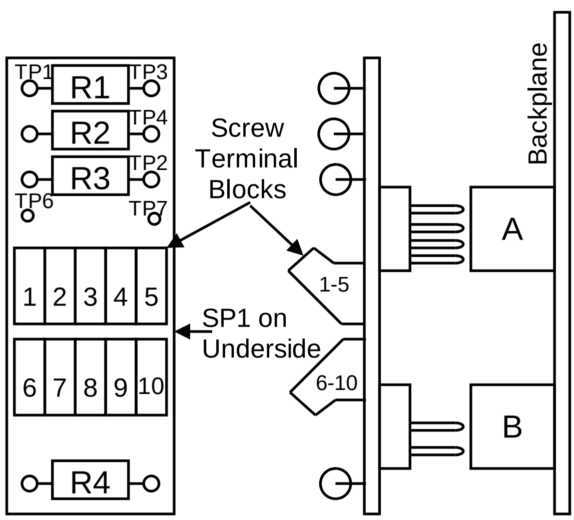


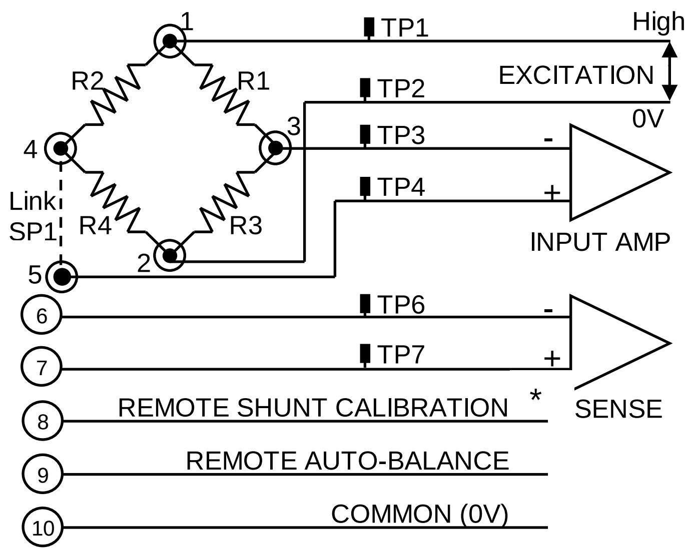
Fig. 3 Connector Board (D12378) with Bridge Completion Resistors

Refer Also to Section 2.1.2

Layout of Connector Board



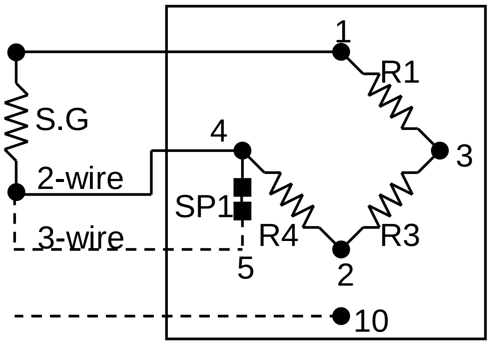
Circuit diagram of Connector Board



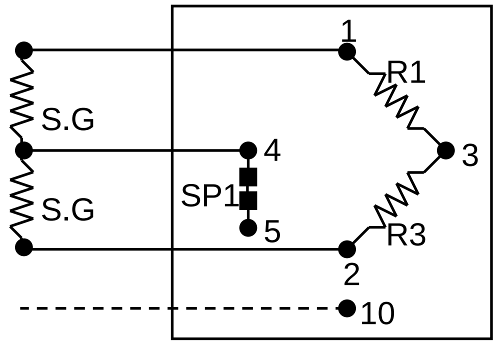
* If remote shunt option fitted

Fig. 4 Bridge connections using Connector Board (D12378)

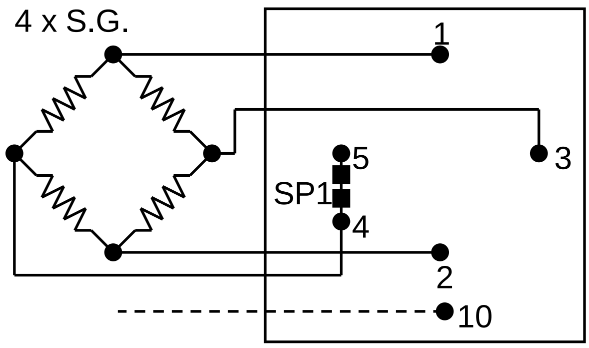
a) 1/4 Bridge Connection
Remove link SP1 (4 to 5) when using 3 wire connection



b) 1/2 Bridge Connection



c) Full Bridge Without Remote Excitation Sensing



d) 1/2 Bridge With Remote Excitation Sensing
On amplifier PCB remove SP1, SP2.

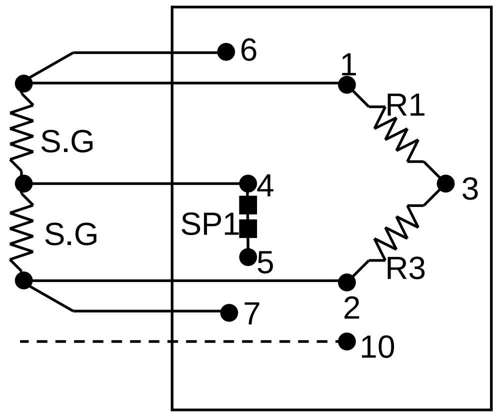
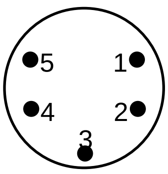
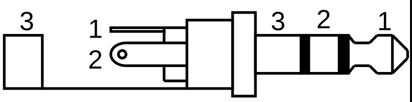


Fig. 5 Backplane Output Connections
The connector fits into row C of the column into which the 628 module is fitted



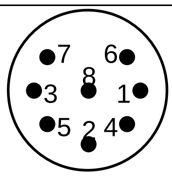
PIN	Function
1	Voltage Output
2	Output Common (0V, Ground)
3	Current Output (4-20mA)
4	Isolated Output Common (option G only)
5	No connection

Fig. 6 Output/Excitation Check Jack Connector



PIN	FUNCTION
1	Excitation V Check
2	Output V (unscaled)

Fig. 7 Rear Panel Auxiliary Connections (If fitted)
These connections are an option & if fitted are located on the rear of the housing near to the power connection. Refer to section 3.15, fig. 9 and CD2010.



(rear view)

PIN	Function
1	NOT Auto balance (Active low)
2	No Connection
3	0V (Common, Ground)
4	NOT Shunt Calibration (Active Low)

3	Output Com. (0V)

	5-8	No Connection

2. CONNECTIONS

2.1 With M600 Backplane

(Refer also to System Manual CD2010, figure 6 etc.)

The backplane transducer/output connectors are arranged in (up to) fifteen columns of three circular DIN sockets, 7-pin for transducers, 5-pin for outputs. Each channel is identified with its number (1 - 15) and each connector with a letter A, B or C. Connectors A and B are for transducer excitation and signal, and C is for amplifier outputs.

Although the amplifier signal inputs require a bias current of only about 10nA, both inputs require a ground current path to prevent them floating to saturation. Normally this is automatically provided by the bridge circuit. If other types of input circuit are used, then the bias path must be provided separately, e.g. as shown in Fig.10.

2.1.1 Direct transducer connection

(Without connector board for bridge completion, i.e. only possible with a full bridge configuration). The transducer is connected to A as follows:

Pin No.	Function
1	Excitation high (+1 to +15V)
2	Excitation low (0V/ground)
3	Signal -
4	Signal +
5	Cable screen/shield (0V)
6	Excitation remote sense high
7	Excitation remote sense low

Note: If remote sense is not required, (and SP1, SP2 are linked) ignore pins 6 and 7.

2.1.2 With connector board

(For bridge completion etc. i.e. for use with individual strain gauges)

<table>
<tr><td rowspan="11">This board is plugged into the backplane A and B sockets and the transducer is connected via two 5-way screw-terminal blocks as shown below. Bridge completion is effected by fitting precision resistors to the relevant mounting pins. See Figs. 3 & 4 and connection list below.</td><td>Terminal</td><td>Function</td></tr>
<tr><td>1</td><td>Excitation high (+1 to 10V or +15V)</td></tr>
<tr><td>2</td><td>Excitation low (0V or –15V)</td></tr>
<tr><td>3</td><td>Signal -</td></tr>
<tr><td>4</td><td>Signal +</td></tr>
<tr><td>5</td><td>Signal + (1/4 bridge, 3-wire only)</td></tr>
<tr><td>6</td><td>Excitation remote sense high</td></tr>
<tr><td>7</td><td>Excitation remote sense low</td></tr>
<tr><td>8</td><td>Remote shunt calibration control (TTL) (if fitted)</td></tr>
<tr><td>9</td><td>Remote auto balance control (TTL)</td></tr>
<tr><td>10</td><td>Common (0VD)</td></tr>
</table>

Note: To unplug connector board from backplane, grip the terminal blocks from above and below via finger and thumb. Pull while rocking in a vertical plane.

2.1.3 Output connections

Refer to Fig.5.

2.2 Jack Connections (Refer to Fig.6)

Excitation and unscaled voltage output may be monitored, with a voltmeter etc., via the front panel jack socket as shown in Fig.6. Note that the excitation voltage output is derived from the remote sense amplifier indicating the voltage at the transducer, even when long cables are used (with sense lines connected).

2.3 32-way DIN 41612 Connections

These connections are internal on a MOD600 system housing with backplane and can normally be ignored. They are only required if a 628 is used on its own, i.e. not plugged into a MOD600 system:-

<table>
<tr><td>1</td><td colspan="2">Excitation High</td></tr>
<tr><td>2</td><td colspan="2">Excitation Low (0V)</td></tr>
<tr><td>3</td><td>Signal Low</td><td rowspan="2">Differential</td></tr>
<tr><td>4</td><td>Signal High</td></tr>
<tr><td>5</td><td colspan="2">Screen (0V)</td></tr>
<tr><td>6</td><td colspan="2">Sense High</td></tr>
<tr><td>7</td><td colspan="2">Sense Low</td></tr>
<tr><td>8</td><td>Voltage Output</td><td rowspan="3">Outputs</td></tr>
<tr><td>9</td><td>Output Common (0V)</td></tr>
<tr><td>10</td><td>Current Output</td></tr>
<tr><td>11</td><td colspan="2">Cal. Control (channel)</td></tr>
<tr><td>12</td><td colspan="2">Auto-Bal. Control (channel)</td></tr>
<tr><td>13</td><td colspan="2">Control common (0V)</td></tr>
<tr><td>14</td><td colspan="2">No connection</td></tr>
<tr><td>15</td><td colspan="2">No connection</td></tr>
<tr><td>16</td><td colspan="2">Gain Address</td></tr>
</table>

<table>
<tr><td>17</td><td>Gain Address</td><td></td></tr>
<tr><td>18</td><td>Scaled Output</td><td rowspan="3">Multiplexed for use with 635/6 only</td></tr>
<tr><td>19</td><td>Unscaled Output</td></tr>
<tr><td>20</td><td>Excitation Output</td></tr>
<tr><td>21</td><td colspan="2">Cal. Control (system)</td></tr>
<tr><td>22</td><td colspan="2">Output Hold /Auto.Bal. Control (system)</td></tr>
<tr><td>23</td><td colspan="2">Isolated Output 0V</td></tr>
<tr><td>24</td><td>Channel Address</td><td rowspan="4">(from 635/6)</td></tr>
<tr><td>25</td><td>Channel Address</td></tr>
<tr><td>26</td><td>Channel Address</td></tr>
<tr><td>27</td><td>Channel Address</td></tr>
<tr><td>28</td><td colspan="2">+5VD</td></tr>
<tr><td>29</td><td colspan="2">0VD</td></tr>
<tr><td>30</td><td colspan="2">+15V</td></tr>
<tr><td>31</td><td colspan="2">-15V</td></tr>
<tr><td>32</td><td colspan="2">0VA</td></tr>
</table>

3. CONTROLS

(For access, loosen the captive top and bottom panel screws and withdraw module from rack). Refer to Fig.2 for locations and schematic circuit diagram, Fig.8.

3.1 Excitation Voltage

Note: excitation may be monitored via the 635/6 - Refer to Section 4.8.

<table>
<tr><td rowspan="4">Sliding DIL switch SW1 provides the following voltages: Note that when SW1 is operated, the amplifier gain is also compensated to retain a</td><th>SW 1 Slider Position</th><th>Excitation</th></tr>
<tr><td>1</td><td>1V</td></tr>
<tr><td>2</td><td>2V</td></tr>
<tr><td>3</td><td>5V</td></tr>
</table>

constant με signal to output voltage ratio.	4	10V

For 15V excitation, without remote sense, jumper link J1 C-D must be changed to A-B (Refer to Fig. 7a). For ±15V also change link E-F to G-H.

3.2 Remote Sense Selection

This is made via solder links SP1 & 2. Units are normally supplied with these links fitted, for use without remote sense, thus terminals 6 and 7 of the transducer connector are not used.

To use the remote sense facility, remove the links SP1 and SP2 and connect the remote sense wires to terminals 6 and 7 as shown in Fig.4(d).

Note: remote sense is not available with +15V/-15V excitation. In this case, SP1 and SP2 must still be fitted to prevent amplifier instability. (**Note**: SP1 on the main pcb is not to be confused with SP1 on the connector pcb.)

3.3 Microstrain (με) Switch

This four-position, front panel mounted rotary switch alters the gain of the signal amplifier to allow optimum scaling of output (and 635 display, etc.) to suit input signals equivalent to between 100 and 100,000με.

When used in conjunction with gauge factor and number of gauge controls, the output (or display) may be calibrated to give 10V (or 10000 display) for full scale input, e.g. with the switch set to 1k, 1,000με input = 10V output (or 10000 display) etc.
Refer to sections 3.4, 3.5 and 4.8.

3.4 Gauge Factor Potentiometer (G.F.)

This 10-turn, front panel mounted, calibrated dial allows setting of gauge factor between 1 and 10. The dial is calibrated in increments of 0.02 and is normally used in conjunction with the με switch and number of gauges switch to allow the amplifier output to indicate directly in με (refer to sections 3.3 and 3.5).
Refer also to gauge data which should include the relevant gauge factor.

If it is not required to have an output scaled in με, i.e. use the unit as a high gain mV amplifier, then the G.F. potentiometer may be used as a fine gain control with 10:1 range.
For high output, e.g. semiconductor gauges with gauge factors between 10 and 100, solder link SP6 (see Fig. 7a) may be changed to B-C producing in effect a 1/10 reduction in amplifier gain. In this case the G.F. control reading is 1.00 = G.F. of 10, 5.00 = G.F. of 50, etc.

3.5 Number of Gauges Switch (SW3)

This pcb-mounted, four-position, screwdriver-adjusted rotary switch is set according to the number of active strain gauges connected to the amplifier input in order to retain the correct output indication in με.

Set the switch as follows (the switch positions are marked on the body of the switch). For example, if two gauges are used, setting the switch to position 2 reduces the amplifier gain by	**No. of Gauges**	**Switch Position**
	1	1
	2	2

a half. For four gauges the gain is multiplied by a quarter.	4	3

3.6 Shunt Calibration (C1/RUN/C2) Switch

Refer also to Sections 5, 7 and 3.15 (for remote operation) and Fig.11.

This front panel mounted, three-position toggle switch allows connection of two pcb-mounted precision resistors across one arm of the bridge (R3 in Fig.11) to provide a means of checking amplifier calibration, etc.

With the switch in C1 position the resistor is 59kΩ, ±0.1%, and in the C2 position the resistor is 560kΩ. The resistors are mounted on pins to facilitate fitting custom values.

The switch is set to RUN for normal operation.

Note that shunt calibration is more accurate when remote sensing is used (see Section 3.2), reducing cable voltage drop effects. However, accuracy may be improved without using full remote sensing, by removing solder link SP1 only and connecting an extra wire from terminal 7 to the bridge.

3.7 Auto/Manual Balance (Aut/Off/Man) Switches

Refer also to Figs. 8 and 11, Schematic Circuits, and Sections 3.8, 3.9 and 3.15 (for remote operation).

The front panel mounted, three-position toggle switch allows selection of manual balance (see also section 3.8) or automatic (auto) balance. With the switch in the OFF position, both balance circuits are disconnected from the bridge allowing bridge imbalance to be measured.

When AUTO is selected, pressing the adjacent pushbutton causes the auto-bal circuit to assess any imbalance and inject a voltage into the relevant bridge node sufficient to cancel the imbalance, hence producing zero amplifier output (assuming the zero control has been adjusted correctly. Refer to section 3.10).

The range of this control may be changed via the pcb-mounted switch described in section 3.9.

The pushbutton may be disabled, for security reasons etc. (e.g. when using remote commands), by setting the DIL switch SW10, slider 1, to OFF.

3.8 Balance Potentiometer

Refer also to Sections 3.7, 3.9 and Fig.11 Schematic Circuit.

This is a 20turn, screwdriver-adjusted, front panel mounted control. With the Aut/Off/Man switch set to Man (manual), the balance potentiometer may be used to compensate for any bridge imbalance within the specified range. This range may be changed via the pcb-mounted switch described in section 3.9.

With the Aut/Off/Man switch set to Off, the balance potentiometer is disconnected from the bridge.

3.9 Balance Range Switch (SW8), Resistor (R74). (Refer also to Table 2).

This pcb-mounted, screwdriver-adjusted, four-position rotary switch may be used to alter the range of the auto and manual balance controls as shown in the table. The switch positions are marked on the switch body.

When SW8 is in position 3, the balance range and resolution are determined by the value of R74. This resistor is mounted on pins and may be changed to suit the application if the standard ranges are unsuitable.

The standard value for R74 is 6.2kΩ to give the ranges detailed in Table 2. Reducing the value will increase the range but degrade the resolution. Increasing the value will reduce the range but improve the resolution.

For example, to double the range, halve the resistor value or to improve the resolution by a factor of 10, increase the resistor value by 10, etc.

3.10 Zero Potentiometer

This 20-turn, screwdriver-adjusted, front panel mounted control is used to set the amplifier output to zero with zero signal input. It may be used in conjunction with or instead of the balance controls detailed in 3.7 and 3.8 to provide an exactly zero output signal for zero load, pressure, etc.

Note that it controls both voltage outputs (scaled and unscaled) and also the current output, e.g. the 4mA setting.

TABLE 2 BALANCE CONTROL RANGES

(Note: all four bridge arms are assumed to be the same nominal value)
GF = 2. R = nominal gauge resistance.

1. AUTO BALANCE 350Ω Bridge
(1G = 1 active gauge, etc., 5V = 5 volts excitation)

SW8 Position	Range %R	Range με			Resolution με (1G, 5V)
		1G	2G	4G	
1	±0.5	±2k	±1k	±500	±0.5
2	2	8k	4k	2k	2
3	6	30k	15k	7.5k	7.5

2. AUTO-BALANCE 120Ω Bridge
(1G = 1 active gauge, etc., 5V = 5 volts excitation)

SW8 Position	Range %R	Range με			Resolution με (1G, 5V)
		1G	2G	4G	
1	±0.17	±680	±340	±170	±0.2
2	0.67	2.5k	1.4k	680	0.7
3	2	10k	5k	2.5k	2.6

3. MANUAL BALANCE 350Ω Bridge
(1G = 1 active gauge, etc., 5V = 5 volts excitation)

SW8 Position	Range %R	Range με			Resolution με (1G, 5V)
		1G	2G	4G	
1	±0.2	±800	±400	±200	±0.5
2	0.8	3k	1.6k	800	2

4. MANUAL BALANCE 120Ω Bridge
(1G = 1 active gauge, etc., 5V = 5 volts excitation)

SW8 Position	Range %R	Range με			Resolution με (1G, 5V)
		1G	2G	4G	
1	±0.7	±280	±140	±70	±0.2
2	0.25	1k	500	250	0.7

3	2.4	12k	6k	3k	7.5	3	0.5	2k	1k	500	2.6

The values for 50Ω and 1kΩ bridges will be approximately ½ and 10x, respectively, the 120Ω values.

For different excitation voltages, resolution will change by 5/V EX

(but the %R range will be unchanged).

3.11 Gain Potentiometer (Refer also to Section 4.8)

This 20-turn, screwdriver-adjusted, front panel mounted control is used to adjust the gain of the scaled output only.

For example, once the με, gauge factor, etc. controls have been set to provide, say, 0 to 10V (or 4-20mA) unscaled output, the gain potentiometer may be adjusted to set the 635 display to read directly in engineering units of, say, 50.00 Newtons, etc. (with A selected). The adjustment range is from x0.2 to x1, providing a 635 display range of 2000 to 10000 digits.

3.12 Channel Number (Address) Switch (SW9)

(Refer also to M600 System Manual, CD2010, Section 9)

This is a 16-way (hexadecimal), screwdriver-adjusted, rotary switch scaled 0 to F. When the module is used in a system with a backplane, the individual channel address number must be set on this switch.

Each module must have a different number set to avoid signal contention on the A, B and E (excitation) output busses to the monitor (635/636 when fitted). **Failure to do so may cause damage to modules.**

For example, if the switch is set to 1 then, when the monitor switch is set to 1, only the output of Channel No.1 is enabled and connected to the monitor. Similarly, for numbers 2 to 9. For modules 10 to 15, the switch positions A to F are used, as shown below.

Channel No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Switch Position.	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F

3.13 Overrange Lamp

This front panel mounted LED indicates when the signal amplifier first stage is saturated, requiring selection of the next highest με range. If the lamp continues to light, check for transducer or connection faults.
Note: following amplifier stages may saturate without LED indication.

3.14 Filter (Bandwidth) Switch (SW5)

This pcb-mounted, four-position, sliding DIL switch is used to select one of four amplifier bandwidths as shown below. The switch controls a two-pole analogue, Sallen-Key type, active filter giving a substantially flat response up to the frequency values shown (note these are <u>not</u> the -3dB points). Thereafter the fall-off rate is 12dB/octave.

Switch Position	Bandwidth (flat) Hz	Output Noise
1	10	1
2	100	2
3	1k	5
4	10k on 100kμε and 10kμε ranges 5k on 1kμε range 1k on 100με range	10 10 10

3.15 Remote Control of Shunt Calibration and Auto-Balance

Refer also to Section 3.6 and 3.7, and Figs. 7, 7a and 9.

Auto-Balance may be controlled by logic low signals or external switches connected to 0V, either via (a) the connector board, or (b) when OPTION 600 IO is fitted to the system housing (e.g. to 604), the system housing rear panel 8-way DIN socket. (Refer to System Manual CD2010, Section 7.6. Note: this facility is not compatible with master-slave systems using e.g. 621, 615). Shunt calibrations can be controlled in the same way on older 628's (up to MOD 5C). From MOD 6C onwards this is only available as an optional extra.

Shunt Calibration
The remote signal operates on the CAL 1 resistor (59kΩ) only, duplicating operation of the front panel CAL 1 switch. For single channel operation, solder link SP7 is set to A-C and for multi-channel operation SP7 is set to B-C.

Auto-Balance
The remote signal duplicates operation of the front panel pushbutton. For single channel operation, solder link SP4 is set to A-D, and for multi-channel operation SP4 is set to A-C. (This facility is not available if the sample/hold option is fitted.)

For security purposes it may be desirable to disable the front panel Auto-Bal pushbutton. To do this, set the Auto-Bal (A-B) On/Off switch SW10 to off (both sliders down).

3.16 Output Selector Solder Link SP8
(Refer also to Fig.8 Schematic Circuit)

The backplane output may be linked to provide various output signals as shown. Modules are normally supplied linked C-B to utilise the amplifier 100με = 10V, etc. scaling.

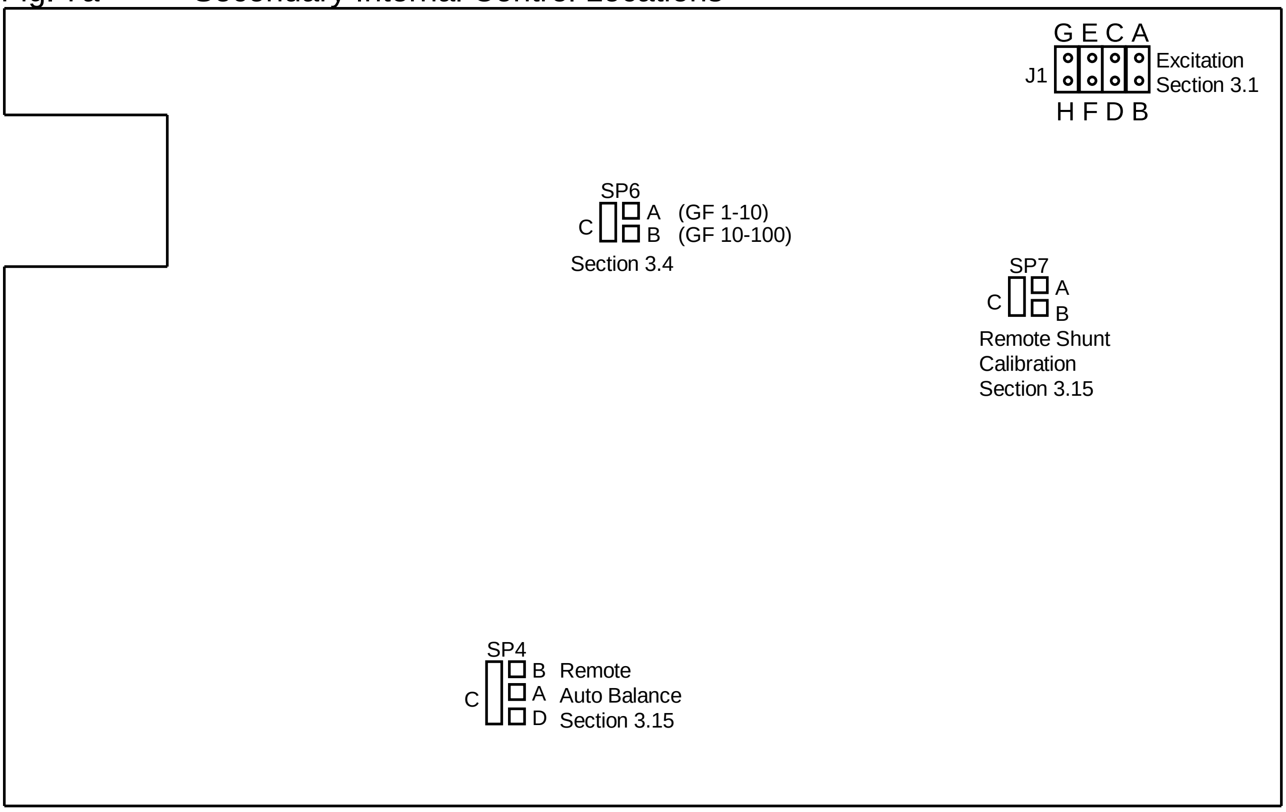
SP Link	Function
C – A	Sample/Hold Option (Option S only)
C – B	Unscaled Output (±10V)
C – D	Scaled Output (±10V)
C – E	Isolated Output (Option G only)

TABLE 1
SENSITIVITY OF 628 AMPLIFIER WITH DIFFERENT CONTROL SETTINGS FOR 10V OUTPUT WITH 5V EXCITATION Refer also to Section 7

Range SW2	Number of Gauges SW3	Input when G.F. = 2.0	Input when G.F. = 1.0	Amplifier Gain (G.F. = 1)
100με	1	250μV	125μV	80,000

1kμε		2.5mV	1.25mV	8,000
10kμs		25mV	12.5mV	800
100kμε		250mV	125mV	80
100με	2	500μV	250μV	40,000
1kμε		5mV	2.5mV	4,000
10kμs		50mV	25mV	400
100kμε		500mV	250mV	40
100με	4 (switch position 3)	1mV	0.5mV	20,000
1kμε		10mV	5mV	2,000
10kμs		100mV	50mV	200
100kμε		1V	500mV	20

Fig. 7a Secondary Internal Control Locations



4. SETTING-UP PROCEDURE

4.1 Connect the strain gauges and output signals as detailed in section 2. Do <u>not</u> switch on power. Check the correct completion resistors are fitted on the connector board. (Refer to Fig.3, etc.)

4.2 Unless specially calibrated, modules will normally be supplied with the internal controls set as follows:

Excitation (SW1)	:	5V
Remote Sense (SP1, 2)	:	Internally linked (disabled)
Number of Gauges (SW3)	:	1
Filter (SW5)	:	Position 1 (10Hz bandwidth)
Channel No. (SW9)	:	0 (unless installed in rack)
Auto-Balance Range (SW8)	:	Position 3 (±2%R for 120R bridge)

To change settings, refer to Section 3, or Fig.2. **<u>Reduce the excitation if 5V could damage the strain gauge.</u>**

4.3 Switch on power and check the excitation voltage via the 635/636/650 monitor (set to "EX") or front panel jack, etc. Set the $\mu\varepsilon$ switch and Gauge Factor dial to suit the application. Allow 15 minutes warm-up time for optimum accuracy.

4.4 Monitoring the unscaled output (via 635 set to B, etc.) with no load/pressure, etc. applied to the transducer, set the C1/C2 switch to RUN and Aut/Man switch to OFF. The amplifier zero potentiometer is factory set for zero output with zero input. However, as this setting may have been changed, it is recommended that this is checked before using balance controls. (If necessary, select a higher $\mu\varepsilon$ range.)
To check the amplifier zero, link both inputs to common (0V). Adjust the zero

potentiometer, if necessary, for exactly zero output.

4.5 Set the Aut/Man switch to AUT and press the pushbutton. The output should now go to zero, within the specified auto-zero resolution (the zero control may be used as a fine trim). If the auto-balance does not produce an approximate zero, check Table 2 and ensure the correct auto-balance range is selected, via range switch SW8. Alternatively, the Manual Balance potentiometer (B) may be used instead of auto-balance, after setting the Aut/Off/Man switch to Man.

4.6 The unscaled output or 635 B display should now indicate any transducer signal in $\mu\varepsilon$. The gain may be checked via the Shunt Calibration method detailed in section 5 or 7.

4.7 For some applications it may be required to have an analogue output signal which is not directly equivalent to the 635 display (normally 10V = 10000 display, etc.) For example, it may be required to indicate a 1000$\mu\varepsilon$ signal as 500.0 (kg) with a simultaneous 10V signal at the backplane output connector.

In this case, with a signal applied to give a 10V output (or 1000.0 display with 635B selected), select A on the 635 and adjust gain G for a display of 500.0, etc.

Note: If checking amplifier zero, etc. without a bridge connected to the input, it is necessary to ground (to 0V) one input (as these are both floating unless referred to 0V by input bridge).

4.8 628 with Monitors Type 635/636/650

4.8.1 Outputs

The 635/6/650 ±19999 display is normally calibrated to indicate ±10000 for ±10V signals. When used with the 628 this may be used to indicate directly in $\mu\varepsilon$ depending on the 628 range switch setting as follows:

628$\mu\varepsilon$ Range	635/636/650 Display (B selected)
100k	100.00
10k	10.000
1k	1.0000
100	100.00

Note 1: As there is no facility for automatically changing the decimal point, the decimal point selector in the 635 will need changing manually to provide the above displays, if required. (Refer to 635/636 Manual, CD2004).

Note 2: Selecting A on the monitor displays the scaled output as set via the gain (G) control. Refer to section 3.11.

The display accuracy will depend on various specified parameters, the typical effects of which are detailed below:

Parameter	**Specification**	**635/636 Digital Accuracy**	**%F.S.**
Gain G.F. dial	±0.25%	±25	±0.125
Noise	5µV	±25 (gain = 5,000)	±0.125
Auto-Bal Resolution	5µV	±25 " "	±0.125
" " "	1µV	±5 " "	±0.025

4.8.2 Excitation

The 635/6/650 may be used to indicate the excitation voltage for any channel by selecting EX on the monitor. As the input to the monitor is derived from the 628 sense amplifier, then even if long cables are used with the remote sense facility connected, the monitor will display the voltage at the transducer, i.e. compensating for cable voltage drop.

5. SHUNT CALIBRATION

Refer also to Fig.9 and Fig.11.

Shunt calibration is the term applied to the method of connecting a precision resistor (usually 59K 0.1%) across one arm of a resistance bridge to check or set an amplifier gain, etc. If the excitation voltage and nominal bridge resistance are known, then the resulting signal voltage can be determined. For 10V excitation with a 350 ohm bridge, the signal is about 15mV which is typically half full scale for many bridge types. For maximum accuracy, the remote sense facility should be used (see Section 3.2).

The simulated value of strain signal produced by the shunt resistor is given approximately by the formula:-

$$\mu\varepsilon = \frac{Rg \times 10^6}{GF \times R_{SH} \times NG}$$

where Rg = Nominal gauge resistance
GF = Gauge factor
R_{SH} = Shunt resistor value
NG = Number of active gauges or bridge arms

For example, with a 350Ω bridge, gauge factor of 2, 59kΩ shunt resistor and one active arm, the simulated value of strain produced by selecting CAL 1 is:

With the $\mu\varepsilon$ switch set to 10k and GF dial set to 2.0, then the amplifier output will be approximately 2.97V.

$$\mu\varepsilon = \frac{350 \times 10^6}{2 \times 59000 \times 1} = 2{,}966$$

With CAL 2 selected, the value would be 312$\mu\varepsilon$ producing an amplifier output of approximately 3.12V with the 1k range selected.

6. BASIC THEORY OF STRAIN GAUGE BRIDGE

With a strain gauge bridge the output voltage of an initially balanced bridge is found from the formula:

$$\text{Output Voltage} = E \times \frac{N}{4} \times \frac{\Delta R}{R} \qquad \text{(i)}$$

Where N = Number of active gauges
E = Excitation Voltage
$\frac{\Delta R}{R}$ = Fractional change in arm resistance which causes the bridge imbalance

Each strain gauge element has associated with it a number called the "gauge factor", i.e. the ratio between the incremental change in resistance caused by the incremental change in length of specimen. This is represented as follows:

$$\text{Gauge Factor} = \frac{\Delta R}{R} \div \frac{\Delta L}{L} \qquad \text{(ii)}$$

Reduced to

$$\frac{\Delta R}{R} = \frac{\Delta L}{L}$$

Substituting this in equation (i), output voltage becomes:

$$e = E \times \frac{N}{4} \times \text{Gauge Factor} \times \frac{\Delta L}{L}$$

thus giving the relationship between the actual strain in the test piece and the output voltage from the bridge.

The 628 instrument's most sensitive range is 100 micro strain full scale with a 1-active-arm bridge with gauge factor = 1, hence:

$$e = 5 \times \tfrac{1}{4} \times 1 \times 100 \times 10^{-6} = 125 \text{ micro volts}$$

Since strain gauges invariably have a factor of greater than 1, for a given strain the bridge will produce a greater output than shown above. The gauge factor control on the 628 instrument is arranged such that the input voltage is attenuated according to the gauge factor. (i.e. for a gauge factor if 2, the output from the bridge used in the above example would be 250 micro volts but the Gauge Factor control on the instrument would be set to 2 which effectively halves amplifier gain in order to maintain the pre-calibrated direct reading ranges).

7 USING FULL BRIDGE TRANSDUCERS (REFER ALSO TO TABLE 1)

The 628 amplifier has pre-calibrated ranges for direct reading in micro strain units when used with strain gauges. When used with transducers rather than individual strain gauges, the gain setting of the amplifier can be calculated in the following way, with reference to Table 1.

The sensitivity figures in columns 3 and 4 give the maximum sensitivity with the Range switch (SW2) and Gauges switch (SW3) in the positions indicated (in columns 1 and 2). The Gauge Factor control can be used as a gain control to set the actual sensitivity required.

Sensitivity = S x G.F. Where S is the sensitivity figure given in column 4, and G.F. is the setting of the Gauge Factor control.

Example 1

With 5V excitation, a load cell with a sensitivity of 2mV/V will produce a full scale signal of 10mV.

With the Range switch set to 1kμε and the Gauge switch set to 4, the sensitivity of the amplifier is variable between 5mV and 50mV by means of the Gauge Factor control.

With G.F. = 1 (100%), sensitivity = 5 x 1 = 5mV
With G.F. = 10 (10%), sensitivity = 5 x 10 = 50mV

The sensitivity figures quoted are those that give a full scale output from the amplifier of 10 volts d.c.

So, for 10V output with a 10mV signal, set the G.F. dial to 2.0. <u>**Alternatively**</u>, the amplifier <u>**gain**</u> may be deduced from the formula:

$$\text{GAIN} = \frac{4 \times 10^{7}}{\mu\varepsilon \times \text{G.F.} \times \text{N.G.} \times \text{E}}$$

Where
με = the με switch setting
G.F. = the Gauge Factor dial setting
N.G. = the number of gauges switch setting
E. = Excitation in volts (SW1)

Example 2 With the following control settings:

$\mu\varepsilon$ range = 1k (1000)
G.F. dial = 7.55
N.G. switch = 1 gauge
Excitation = 10 volts (SW1)

$$\text{GAIN} = \frac{4 \times 10^7}{1000 \times 7.55 \times 10} = 529.8$$

7.1 A Shunt Calibration Check

If the prime calibration has been made by applying a precisely known load or pressure to the transducer, then the CAL switch may be operated (with load removed) and the display recorded as a calibration check figure. A quick check can then be made at any time by comparing new shunt calibration readings with the original.
Note: If the reading is not at zero when the switch is operated, the true calibration check figure is the shunt calibration reading less the initial reading. If desired, the Fine Gain control may be adjusted (and/or zero) to restore the original display/output signal.

7.2 A Secondary Calibration

The shunt calibration method may be used to calibrate a system accurately without recourse to known loads or pressures by using the shunt calibration figure from the Transducer Calibration Certificate. The procedure is:

(a) Calculate the shunt calibration figure required from the Calibration Certificate

From Transducer Calibration Certificate
Output for 100% = W mV
Output with shunt = Y mV

Therefore the reading required in CAL is:

Y/W x required full scale reading.

Note: If the Calibration Certificate states shunt resistor different from the one fitted (59K ohm is standard: other values to order), then it may still be possible to obtain a calibration from:

$$\text{CAL figure calculated} \times \frac{\text{R shunt}}{\text{59K}} = \text{New CAL figure}$$

(b) Connect up transducer. Apply power to the 628 and allow a 30 minute warm-up (for optimum accuracy).

(c) Ensure no load or pressure applied to the transducer.

(d) Operate CAL switch and adjust the Gauge Factor or Fine Gain control to give the required reading as calculated in (a) above.

8. SPECIFICATION

Supply	±15V (±1V) unregulated for V output. 1% regulation for 4-20mA output. ± 70mA typical plus excitation current. In a MOD600 System the supply will be taken from the 631 or 632 power supply unit.
Excitation	1, 2, 5, 10V, ±0.2% selectable via internal switch (automatically compensates gain). ±15V selectable via jumper links. Max. load 110mA, 1A per system. Remote sense facility.
Excitation t.c.	0.003%/°C typical
No of Active Gauges	1, 2 or 4 selectable via internal switch
Bridge Balance Modes	Automatic via pushbutton or remote switch/logic input. Manual via 20-turn potentiometer. Auto disable switch.
Auto-Balance:	
Memory:	Capacitor back-up, 7 days typical.
Ranges:	Three ranges selected via internal switch: ±0.5, 2, 6%R for 350Ω bridge, ±0.17, 0.67, 2%R for 120Ω bridge.
Resolution:	Varies with range selected above: ±2.5, 10, 38µV RTI for 350Ω bridge, ±0.8, 3.4, 13µV RTI for 120Ω bridge.
Speed:	500mS typical, 1 second maximum
Manual Balance:	
Ranges: Resolution:	±0.2, 0.9, 2.5%R (350Ω bridge) selected via internal channel. 2.5, 10, 38µV RTI according to range selected.
Bridge Completion	1, 2 or 3 resistors mounted on separate connector pcb
Shunt Calibration	Cal.1 59k ±0.1%, Cal.2 560k ±1% via front panel switch or remote switch logic input (Cal.1 only)
Amplifier:	
Gain Controls	100, 1k, 10k, 100k microstrain range switch and 10-turn Gauge Factor dial (G.F. 1-10) on front panel. 1/2/4 gauges switch internal.
Gain Range	X1 to x80,000 unscaled output. x 0.25 to 80,000 scaled output.
Gain t.c.	±0.002% FS/°C. Optimum at ±10V output.
Gain Accuracy	±0.5% typical
Gain Resolution	0.02% (G.F. dial settability)
Zero Adjustment	±0.4V via 20-turn potentiometer
Zero t.c.	0.2µV/°C RTI +0.1mV/°C RTO typical
Zero Stability	0.4µV/month RTI typical
Input Resistance: CMV Range: CMRR:	100MΩ ±10.5 (linear) ±40V (safe) 110dB typical (G = 1000)
Linearity	0.02% typical
Bandwidth	10, 100, 1k or 10kHz flat, 10V pk-pk, selectable via internal switch (10kHz depends on gain range. Refer to Section 3.14)
Noise (<10Hz)	1, 2, 5, 10µV (2, 5, 10, 20 nA) PK-PK RTI typ. Depending on BW and gain range.
Voltage Outputs	±10V scaled and unscaled (4:1 adjustment on scaled) at ±5mA.
Current Output	4-20mA into 0 to 400Ω. This is an active output that must not be connected to any external power supply as this will damage unit.
Operating Temp.	0°C to 60°C (derate 10°C per watt of excitation load)

Dimensions	200 x 100 x 25mm incl. controls. (Eurocard mounted) (7.9" x 4" x 1")
Front Panel	128 x 25mm (5 x 1 inches)
Monitor Jack	3.5mm stereo type, (unscaled output, excitation and 0V)
Connector Board	
Mounting	Via M600 backplane A and B connectors
Bridge Completion	Turret lugs for mounting 13mm x 6mm (1/2” x ¼”) resistors in any of the four bridge arms
Connections	Screw terminal blocks with cable protectors
Dimensions	70mm high x 25mm wide x 26mm deep(2.8 x 1 x 1 inches)

9 ISOLATED OUTPUT OPTION

This is an add-on pcb which galvanically isolates the amplifier output signal.

Output signal connections are detailed in section 2, i.e. output on pin 1 of the 5-pin backplane connector C, as normal, but the output common signal is now at pin 4 with pin 2 not used.

Option boards are normally supplied set for ±10v output signals. To use the 4-20mA output, change SP1 and 2 on the option board to B - C. No change is required to the main pcb.

If the option board is to be retro-fitted to an existing 628, then to change the output from normal to isolated, the following link needs changing on the main boards:

SP5 to E - C.

The option board has unity gain (fixed) for voltage outputs so the setting-up procedure is as for normal units. Single-turn potentiometers provide a small adjustment of offset and gain for the 4-20mA output as follows:

RV1 set 4mA for channel A
RV2 set 20mA for channel A

Note: these are normally factory-set so that the normal output to 4-20mA output is:

+10V normal = 20mA
0V normal = 4mA

Specification

As for 628 with the following amendments and additions:	
Output, current mode	4-20mA into 0-350Ω
Isolation voltage	500V dc
Isolation resistance	500MΩ
Output noise	Has an additional high frequency component (spikes) of typically 20mV rms at 100kHz which could generally be disregarded
Gain (of extra isolation amplifier)	1 to 1 ±0.05% typical.

10 SAMPLE/HOLD OPTION

This provides a fast, analogue sampling or hold of the amplifier output signal. An external TTL signal is applied to the hold input as follows:

Hold signal high	Normal operation - output follows transducer signal (or open circuit).
Hold signal low	HOLD mode - output holds the value extant at the moment of application. Output droops as detailed in the specification.
Note 1	With no connection to the hold line, internal pull-up resistors allow the amplifier to operate normally.
Note 2	TTL signal referred to 0VD pin 29.
For sample/hold operation, the following solder links need changing if not factory-set: Change SP8 to A - C	

Connections

The hold signal is connected via the 8-pin connector on the rear panel. Pin 1 is hold signal and pin 3 is 0V (common).

Specification

Response speed	20μ sec. typical
Output droop	<2mV (0.01% FS) per sec. typical
Hold step error	<0.1% FS typical
TTL load	10μa max. plus 47k pull-up per board.

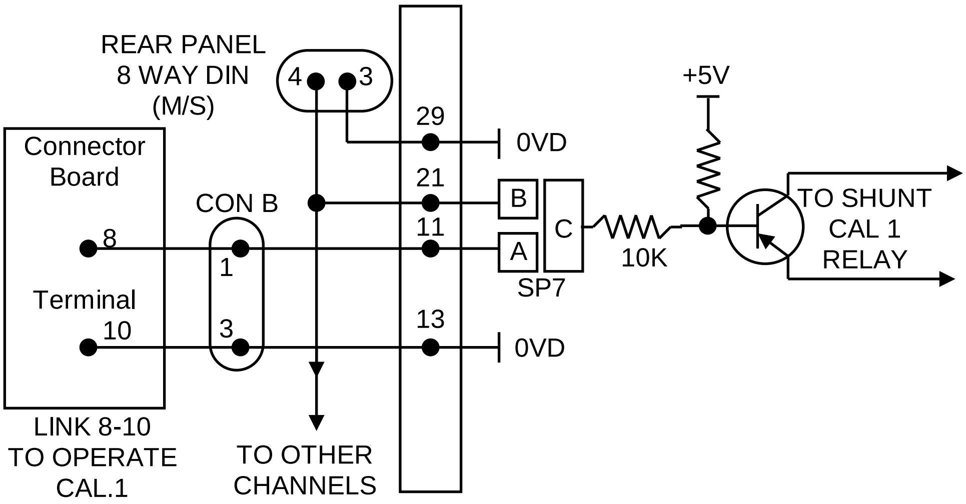
Note: It is not possible to use the 8-pin auxiliary connector for both sample/hold and remote auto-balance simultaneously as these use the same backplane track.

Fig. 9 Remote Shunt Calibration and Auto Balance Connections
Refer also to section 3.15

a) Shunt Calibration (if remove option fitted)

Make links on SP7 to enable Remote Shunt Calibration as:
A to C (via connector board) and B to C (via global command (8 pin DIN))

Connections refer to the 32 way edge connector



b) Auto Balance

Make links on SP4 to enable Remote Auto Balance as:
A to D (via connector board) and A to C (via global command (8 pin DIN))

Connections refer to the 32 way edge connector

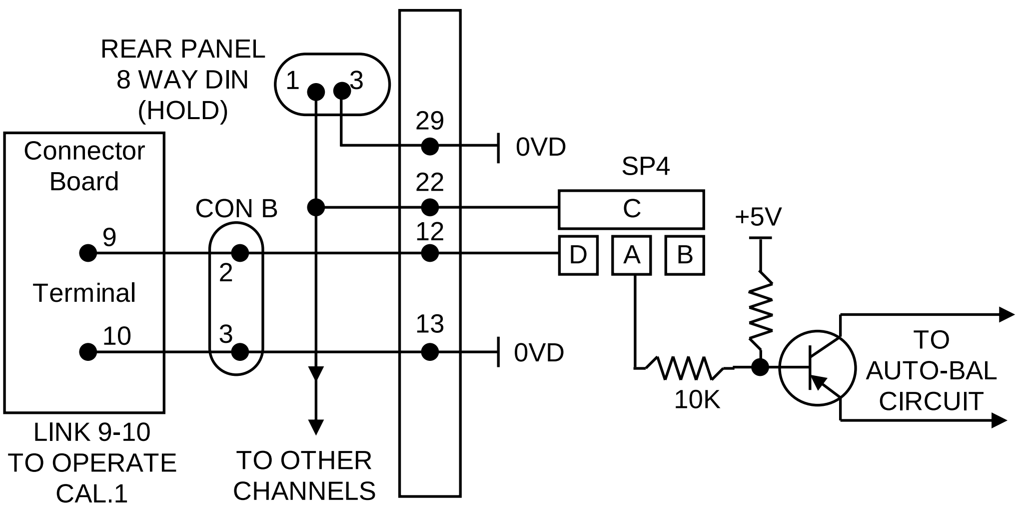


Fig. 10 Connection to Floating Signal Sources

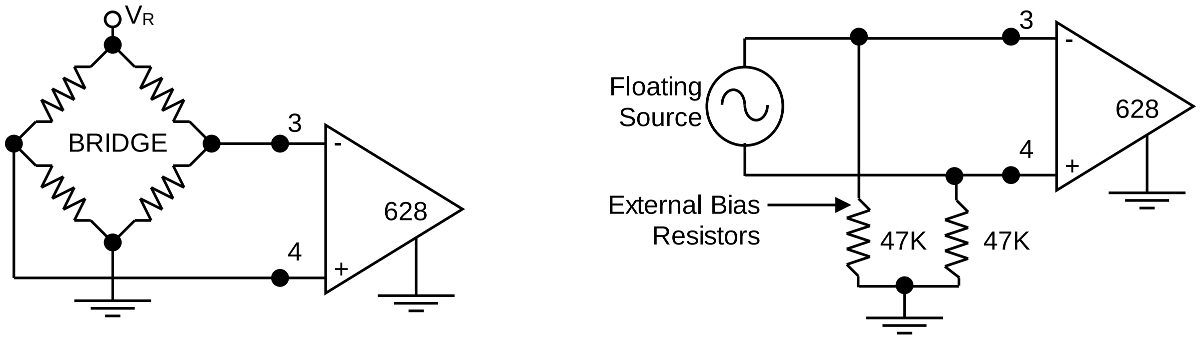
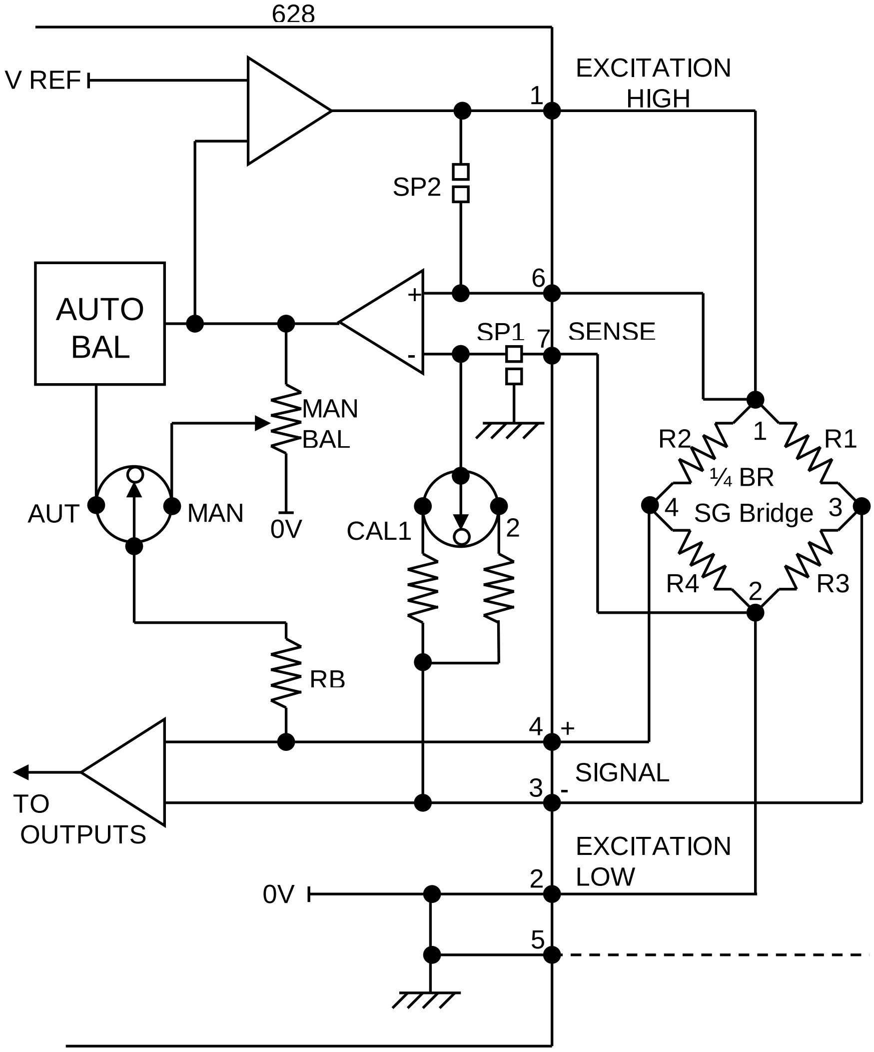


Fig. 11 Shunt Calibration and balance circuit schematic.


628
V REF
EXCITATION
HIGH
1
SP2
6
AUTO
BAL
+
-
SP1
7
SENSE
MAN
BAL
R2
1
R1
¼ BR
4
SG Bridge
3
AUT
MAN
0V
CAL1
2
R4
2
R3
RB
4
+
SIGNAL
3
-
TO
OUTPUTS
EXCITATION
LOW
0V
2
5

11. WARRANTY AND SERVICE

WARRANTY.

R.D.P. Electronics products are warranted against defects in materials or workmanship. This warranty applies for one year from the date of delivery. We will repair or replace products that prove to be defective during the warranty period provided they are returned to R.D.P. Electronics.

This warranty is in lieu of all other warranties, expressed or implied, including the implied warranty of fitness for a particular purpose to the original purchaser or to any other person. R.D.P. Electronics shall not be liable for consequential damages of any kind.

If the instrument is to be returned to R.D.P. Electronics for repair under warranty, it is essential that the type and serial number be quoted, together with full details of any fault.

SERVICE.

We maintain comprehensive after-sales facilities and the instrument can, if necessary be returned to our factory for servicing.

Equipment returned to us for servicing, other than under warranty, must be accompanied by an official order as all repairs and investigations are subject to at least the minimum charge prevailing at the date of return.

The type and serial number of the instrument should always be quoted, together with full details of any fault and services required.

IMPORTANT NOTES.

1. No service work should be undertaken by the customer while the unit is under warranty except with the authorisation of RDP Electronics.

2. If the instrument is to be returned to R.D.P. Electronics for repair, (including repair under warranty) it is essential that it is suitably packed and that carriage is insured and prepaid. R.D.P. Electronics can accept no liability whatsoever for damage sustained during transit.

3. It is regretted that the above warranty only covers repairs carried out at our factory. Should the instrument have been incorporated into other equipment that requires our engineers to perform the repair on site, a charge will be made for the engineer's time to and from the site, plus any expenses incurred.

The aforementioned provisions do not extend the original warranty period of any product that has been either repaired or replaced by R.D.P. Electronics.

THIS WARRANTY MAY BE NULL AND VOID SHOULD THE CUSTOMER FAIL TO MEET OUR TERMS OF PAYMENT.