qualiflow

LVC414

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SECTION 1 INTRODUCTION

1.1. SPECIFICATIONS

1.1.1 GENERAL

MINIMUM CARRIER GAS FLOW	5% of maximum
MAXIMUM SOURCE FLOW	Up to 40 grams/min. full scale
OPERATING PRESSURE RANGE	10-40 psi differential
MAXIMUM GAS PRESSURE	60 psig
GAS AND AMBIENT TEMPERATURE RANGE	60-90°F (15-35°C) up to 43°C on special request
RESPONSE	10 seconds to within 4% of setpoint
CARRIER GASES	Hydrogen, Helium, Nitrogen, Oxygen or Argon, , Mixed gas

1.1.2. PERFORMANCE

(Typical figures based upon silicon tetrachloride in hydrogen)

REPEATABILITY	± 0.5% of full scale
PRESSURE SENSIBILITY	± 0.25% of full scale for pressures from 10 to 40 psid
ACCURACY AND LINEARITY	± 4.0% of full scale over entire operating range

1.1.3. INPUT/OUTPUT

COMMAND SETTING	0.1 to 5 vdc
OUTPUT INDICATION 1. SOURCE 2. CARRIER 3. RATIO	 0.1-5 vdc linearly proportional to mass flow rate of vaporized liquid 0.1-5 vdc linearly proportional to mass flow rate of carrier gas 0.1-5 vdc linearly proportional to ratio of vapor flow (SCCM) to carrier flow (SCCM) scaled with 5 vdc = 50% Note that when there is no bubbling (i.e. no control) Ratio=0 and Carrier will reach value greater than 5vdc (typically 5.6 volts).
OUTPUT IMPEDANCE	10 ohms maximum
RIPPLE	50 mv p-p maximum

1.1.4. INSTALLATION INFORMATION

INPUT POWER	± 15 VDC
POWER CONSUMPTION	15 watts maximum
MOUNTING	Not position sensitive
DIMENSIONS	2.50"x4.50" (63.5x114.3 mm) 5.75” (146.0 mm) high
GAS CONNECTIONS	VCR or Swagelok ¼”
ELECTRICAL CONNECTION	20 pole connector, Elco 8016.

1.2. GENERAL DESCRIPTION

Electronic Vaporizer controller LVC-414 has been designed to accurately measure and control the mass flow rate (grams/min) of doping materials by varying the flow of carrier gas through a bubbler containing the source material.
Source materials include $SiCl_4$, $SiHCl_3$, $POCl1_3$, $GeCl_4$ and BBr_3. Other doping material can also be controlled, provided that they vaporize with adequate concentration for accurate ratiodetection. Carrier gases include H_2, He, N_2, O_2 and Ar.
Three outputs are provided :

- Source (0 to +5VDC).
- Carrier (0 to +5VDC)
- Ratio (0 to +5VDC).

These outputs can be monitored with any 5 volt D.C. voltmeter with a sensitivity of 1000 ohms/volt or more. A built-in valve varies the carrier mass flow rate to control the source gram/min. selected by an external control voltage.

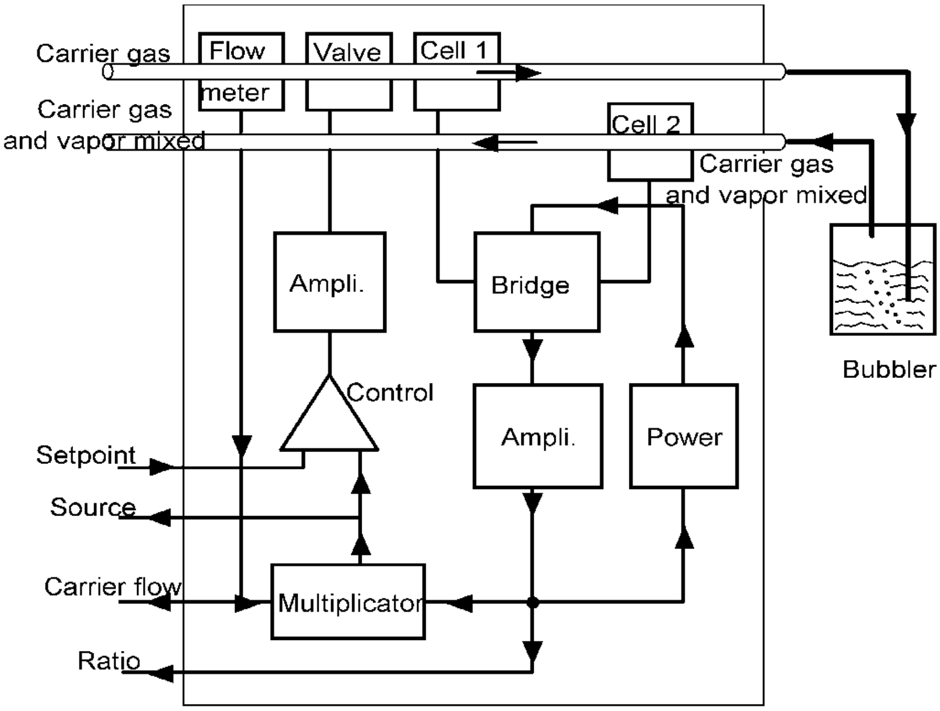
A single small package contains the flowmeter section, ratio detector, control valve and the electronics.

1.3. FLOW PATH

Standard 1/4" VCR fittings are used for input and output connections, Swagelok compression fittings can also be used. The carrier flow measuring section consists of small stainless steel tubing with external resistance sensors and heaters.
A fine-mesh screen is installed in the inlet fitting to prevent accidental clogging of the sensor tubing or valve. The ratio detector section contains thermal conductivity elements that are corrosion resistant. The entire flow path is type 316 stainless steel except for the thermal conductivity elements.

1.4. ELECTRONICS

The electronics associated with the controller include a detection bridge circuit which provides an electrical signal relative to flow; an amplifier circuit to amplify and linearize the carrier flow signal to O - 5 VDC; a detection bridge circuit which provides an electrical signal proportional to source/carrier ratio and linearize the ratio signal to O - 5 VDC; and a multiplier circuit to multiply ratio (source/carrier) times carrier to give the source output signal.



The control section of the electronics uses a 0.5 to 5 VDC command signal. The command voltage is compared with the source signal voltage and the difference amplified to power the valve in the proper sense to regulate the carrier flow to give the commanded source level. Capacitors in this feedback circuit provide dynamic compensation for optimum stability and response. The electrical schematic is shown on section 5.

The unit is contained in a single package which results in an extremely rugged transducer, shielded from electromagnetic fields and inherently protected from external short circuits.

The controller needs a + 15 VDC dual power supply.

SECTION 2 INSTALLATION AND START UP

2.1. GAS CONNECTION

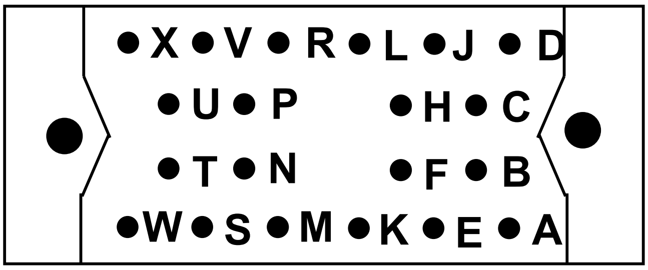
Swagelok compression fittings are standard. Polished 300-series stainless steel tubing should be used to insure a leak-tight system. Insert tubing into the fitting all the way to the shoulder. Check that ferrules are oriented as required. Tighten nut finger-tight, then while holding the fitting body steady with a backup- wrench, tighten the nut 1-1/4 turns. For more detail see Swagelok catalog C-1072. For other types of fittings available on special order, use appropriate standard practice or consult manufacturer.

2.2. MOUNTING

The LVC-414 may be installed in any position since it is not affected by gravity. Four M4 holes are provided for mounting.

2.3. ELECTRICAL CONNECTION

The mating plug (cable end) ELCO 8016 is supplied by Qualiflow to match the connector on the LVC . The pin-assignment is as follows :



A	Carrier Output.
E	Ground.
F	Control (0.5 to 5 VDC).
H	Common (Return of the Output signals).
J	Valve test point.
K	Ratio Output (O to 5 VDC).
L	+5.00 VDC supplied internally on the controller print.
M	Carrier Output / External Measure Input for Modified Low..
N	Source Output.
P	Common (Return setpoint).
S	Common Valve.
T	Only for compatibility with old LVC (-8 Volt unregulated DC).
V	Zener test point.
W	-15 VDC.
X	+15 VDC.

Note: All Commons are interconnected so interchangeable.

2.4. BUBBLER SELECTION

The bubbler should be sized to provide the following :

1. Minimum pressure drop at full carrier flow (3 psi maximum design goal including drop across bubbler tube).

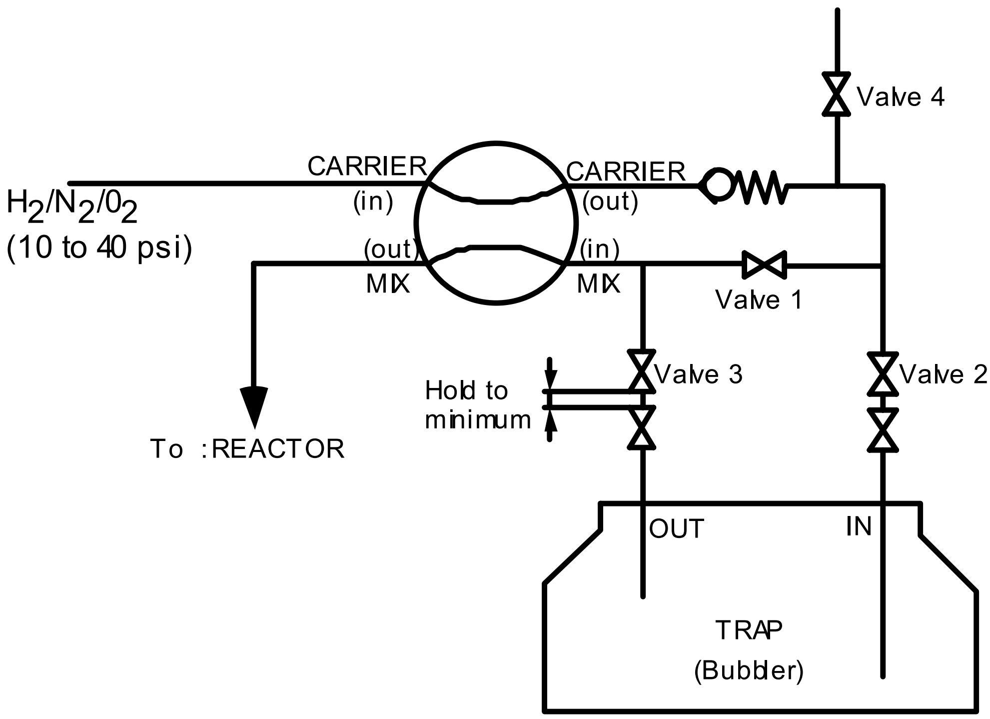
2. Sufficient volume to maintain dopant vapor saturation. A rule of thumb is carrier flow in SCCM equals the volume of the tank.
3. Vaporizer tube design is important to insure vapor saturation up to maximum carrier flow. The tube should be designed as a spray head that will blanket the cross section of the bubbler with small bubbles. The open tube design which is common in many commercial bubblers does not maintain saturation except at low carrier flows. Qualiflow provides custom bubblers on request.

2.5. SYSTEM EFFICIENCY

The following conditions should be considered to optimise system efficiency :

1. Operate the LVC at minimum back pressure. The lower the vaporizer pressure the higher the concentration.
2. Size bubbler for system.
3. Minimize plumbing pressure drops and dead volume by using correct tubing size. Use short plumbing runs where possible.
4. Prevent vapor condensation in system by proper plumbing temperatures (i.e. plumbing temperatures equal or greater than bubbler).
5. Most source materials when combined with air (which contains moisture) will form acid and a residue. Therefore, proper purging procedures must be followed to avoid system contamination during installation or removal.
6. Use check valve on outlet side of LVC to prevent liquid backing into line. Use a low cracking pressure type check valve (1/3-2 psi).
7. Since vaporizing will tend to decrease bubbler temperature, care should be taken to minimize this effect since concentration will decrease.
8. Use HI-Purity materials for minimum contamination.

2.6. CONNECTION PROCEDURE



N O T E : Allow enough time between each sequence to permit proper purging of the system. (15 to 20 minutes).

1. After plumbing and cleaning system, purge with N2 by opening valves 4, 1, 2 and 3 with trap not connected and reactor line closed. Then close valve 1, 2 and 3. This action will fill all lines with N2 and remove all air, etc. from plumbing system. Be sure that N2 has purged through the LVC and the reactor long enough to purge the lines.
2. Trap connection procedure.
    a. Open valve 2. While N2 is still flowing through the valve 2 line connect the trap inlet side. Close valve 2. Open valves 1 and 3. While N2 is still flowing through the valve 3 line connect the trap outlet side. Open valve 2 and thoroughly leak check all possible places where leaks could occur while system is pressurized. After leak-check, open reactor line.
    b. Purge with N2 for 15 to 20 minutes.
    c. Shut off valve 4.
    d. Turn on H2 and purge with H2 for 15 minutes minimum.
    e. Open valves on trap slowly. (OUT valve first).
    f. Slowly close valve 1.

The Liquid Source System is now properly plumbed and ready for operation.

3. Trap connection procedures.
    a. Open valve 1.
    b. Shut off valves on trap. (IN valve first).
    c. Shut off valves 2 and 3.
    d. Purge with H2 for 30 minutes or longer.
    e. Turn off H2 and open valve 4.
    f. Purge with N2 for 20 to 30 minutes. longer if lines are long. Close reactor line.
    g. Open valve 3.
    h. Remove outlet side of trap, cap line and trap while N2 is still flowing through the line. Close valves 1 and 3. Open valve 2. While N2 is still flowing through the line remove inlet side of trap and cap line and trap.
    Close valves 2 and 4.

NOTE 1: On most traps valves are included by supplier. Valves 2 and 3 are still required.

NOTE 2: All plumbing should be 316 stainless steel.

NOTE 3: Valve 1 to 4 are ball-valves or bellow-valves and should be either 316 stainless steel or Kel-F. All types of valves can be supplied by Qualiflow.

NOTE 4: Mixture flow can be in either direction through the LVC.

SECTION 3 TROUBLE SHOOTING

3.1. PRELIMINARY

In order to trouble shoot the LVC it must be connected so that all three parameters can be read :
C = Carrier, 0 - 5 vdc, pins A (+) and H (-)
R = Ratio, 0 - 5 vdc, pins K (+) and H (-)
S = Source, 0 - 5 vdc, pins N (+) and H (-)

Note that C and R are measured parameters, while S is computed in the controller as the product of C and R in consistent units:
K x S = C x R

where S,R,C are in volts and K is a dimensional constant (values shown are for **room temperature 21°C** calibrations).

Doping Compound	K
SiCl4	2.640
SiHCl3	2.067
POCl3	3.653
GeCl4	3.484
BBr3	2.980

By operating the vaporizer and observing each of the three parameters the problem can usually be isolated to one of the three variables or to an external cause. Field experience has shown that most problems encountered in initial connection and use of the vaporizer controllers are caused by either the bubbler or electrical connections.

3.2. INITIAL TESTS

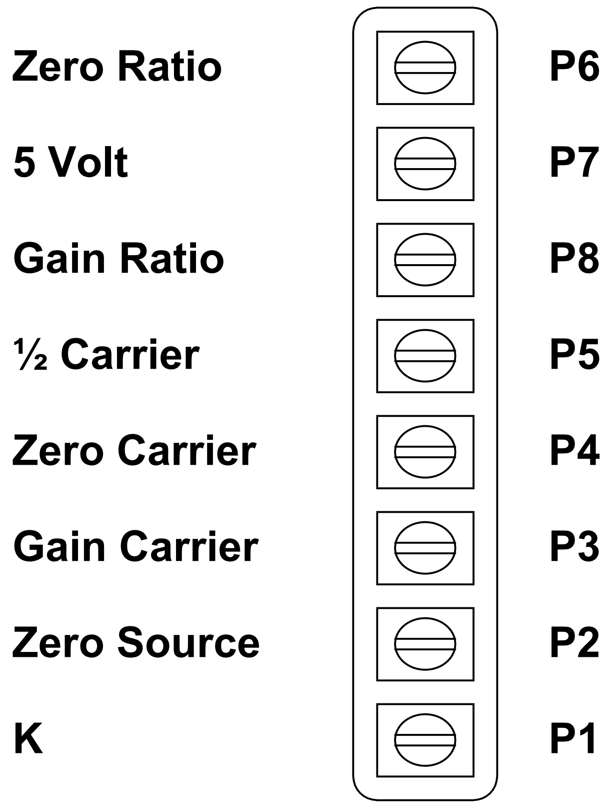
1. Check set-up and procedure against the connection instructions. PERMANENT DAMAGE TO THE UNIT MAY RESULT IF PURGING PROCEDURES ARE NOT FOLLOWED. OR IF LINE POWER IS ACCIDENTALLY APPLIED TO ANY SIGNAL LEADS.
2. Test line cord for compliance with pin assignments shown on case, and continuity from all wires to correct pins. Use hipot tester to check for any pin to pin shorts; during this test, flex the able coming out of the connector to find intermittent shorts.
3. Check insulation resistance from pin E to case, pin H to case, and pin E to pin H. All should exceed 50 megohms at 50 vdc.
4. If possible, operate LVC on pure carrier with bubbler bypassed to isolate problem (ratio and source readings should be less than 4% of full scale if carrier flow is less than 100% of full flow.
5. Connect a dc power supply between connector pins K (+) and H (-). Set a voltage equal to constant K given above (e.g. 2.64 volts for SiC14). With bubbler bypassed, check that source output signal and carrier signal both follow command (i.e., 50% of full scale when command is at 2.5 vdc or midpoint setting).
6. Source Setpoint set to 0 will fully open the thermal valve. The valve can be damaged. So do not have 0 Source Setpoint.

SECTION 4 ADJUSTMENTS

CAUTION :

No adjustments should be attempted unless adequate facilities are available to make the required measurements with adequate accuracy. Rotameters do not have adequate accuracy for flow measurement calibration.

During adjustment remove the cover to give access to the electronics and the base section. Be very careful not to break wires or create short circuits while the instrument is open. Do not stress flow sensor.



4.1. VALVE ADJUSTMENT

1. Plumb the carrier side of the LVC-414 with a regulated supply of the correct gas. Connect a reference flowmeter on the carrier output flow, or monitor the carrier flow measured by the LVC.
2. With the case removed to permit access to the valve assembly on the base gently adjust the hex nut on the top of the valve to give 100% rated carrier flow with 8-10 psig inlet and the valve electrically disconnected. (unplug one lead wire).
3. Check that carrier flow will shut off to less than 4°/0 of rated flow at all pressures from 8 to 40 psig input. (Reconnect valve wire. Command voltage set to zero).
4. If the valve does not close adequately, check valve heater voltage; this may be increased to a maximum of approximately 10 vdc (LVC-414) by reducing R41 if valve still exhibits excessive leakage, seat may be contaminated or damaged; clean or replace valve.

   CAUTION: Do not use less than 30 ohms.
5. The valve may be replaced by disconnecting the valve heater wires from the printed circuit board and removing the two mounting screws which hold the valve in the base. Care should be taken to not pull on the sensor leads attached to the circuit board. Before replacing the valve, check the "O" ring seal for nicks, cuts or damage and replace if

necessary to ensure an adequate seal between the valve flange and the base. Connect the heater wires of the new valve to the printed circuit board and adjust the valve per steps 2 and 3.

4.2. FLOWMETER ADJUSTMENT

1. Plumb the carrier side of the LVC with a regulated supply of the correct gas. connect a reference flowmeter in series to measure the actual flow. NOTE: Rotameters do not have adequate accuracy. Remove cover for access and disconnect valve wires from P.C. board.
2. Adjust P4 to give a zero indication of carrier flow (connector pins M(+) to (H) when actual flow is tightly shut off.
3. Adjust P3 to give 5.00 vdc output for full scale flow.
4. Check that the output is 2.5 at exactly one-half of full scale flow. If not, adjust with PS and repeat other adjustments.

4.3. RATIO ADJUSTMENT

1. Plumb the LVC so a low purge flow of the correct gas is flowing through both CARRIER and MIXTURE sides (Source container bypassed). Allow to purge until it is certain that the unit is well purged.
2. Adjust P6 to get ratio signal = 0V (connector pins K (+) to H). If P6 does not have enough adjustment adjust P6 to half way (approx. 10 turns from end. Put a resistance decade box across either R35 or R36 (the two 35-ohm bridge completion resistors). Adjust the decade box (lK to l00K) to get ratio signal = 0V (connector pin K (+) to H). Replace decade box with fixed resistor soldered in place when correct value is determined. Fine adjust P6 as required.
3. To adjust gain, operate at one-half of full scale mixture ratio as measured by a reference thermal conductivity cell bridge or by timed weight loss of a vaporizer. Adjust P8 to give 2.50 +0.10 volts ratio signal output.

4.4. MULTIPLIER ADJUSTMENT

1. Short-circuit both the carrier and ration outputs by placing jumpers between connector pins M and H, and between K and M. Adjust P2 to get source signal = 0V, connector pin N to H.
2. Jumper connector pin K to M and connect a d.c. power supply between KM (+) and H (-). Set the voltage at one of the following voltages, depending upon the type of source :

SiCl4	2.640
SiHCl3	2.067
POCl3	3.653
GeCl4	3.484
BBr3	2.980

Those K values are for calibration at **room temperature (21°C).**

Adjust P1 so that the output source signal equals the set power supply voltage.

4.5. CLEANING

Should the LVC show symptoms of contamination (see Trouble Shooting) the unit should be purged or flushed.

1. Remove the LVC from the system.

2. Remove carrier inlet filter fitting - clean separately. Carrier out and mix have screens omitted. DO NOT remove carrier inlet screen.
3. Since it is possible to distort the thermal conductivity helix elements with liquid due to surface tension, the first attempt should be a nitrogen or hydrogen purge for 1 - 4 hours.
4. If step three is not successful then flush (back and forward) with isopropyl alcohol, then water several times. Final flush should be with isopropyl alcohol.
5. Purge with Hydrogen or Nitrogen for 4 hours minimum with the LVC 414 at 160° to 180° F. This should remove trapped liquid from cavities in the base
6. Re-install cleaned filter fittings.

4.6. SENSOR REPLACEMENT

If it is determined that either of the sensor elements is open or shorted to case, or that the sensor tube is plugged, it will be necessary to replace the sensor assembly. This can be done by unsoldering the sensor leads from the P.C. board and removing the two screws which attach the sensor assembly to the base. The sensor assembly can then be removed and replaced. CAUTION: Before replacing the sensor assembly, the sensor element resistance should be checked and should measure as follows :

Upstream	Ru = 175 ohms + 5 ohms
green to red Downstream	Rd = 175 ohms + 5 ohms
	Check that Ru – Rd < +-1 ohms
yellow to red Isolation (all leads to sensor tube)	100 mega ohms

Examine the sensor seals (replace if necessary with new ones) and make sure they are seated with the open side toward the bottom of the assembly; pressurize the base and check for leakage. Resolder the sensor leads to the circuit board.

4.7. DYNAMIC RESPONSE ADJUSTMENT

After replacement of a valve it may be necessary to readjust the feedback control circuit in order to optimize the dynamic response and stability performance of the controller. This entails reselecting R13 and R40 during transient tests to optimise the performance. While the steady state gain of the controller is essentially infinite (holding the error between the command setting and tag flowmeter output signal to zero over the entire operating range), the gain during a flow and/or command setting transient is reduced to a low value determined by R40 and provides a slowly changing valve control voltage, whose rate of change is determined by the time constant of C14, R37 and R40.
This provides gradual change in flow rate, which is sensed, compared to the command and readjusted before the valve has a chance to overshoot or become oscillatory.
Since the sensor and valve response times depend highly on mechanical tolerances, flow rate, gas properties and electrical component values and tolerances, it is necessary to individually optimize the response of each unit by selecting values of R13 and R40 during actual test. This is accomplished best by setting the inlet pressure to 20 psi (or the known operating pressure), switching the command setting from 50 to 100% full flow and/or vice versa, and noting the response of the output signal to this change in command.

The flowmeter section, valve and maximum valve voltage must have been previously set. Optimizing the response characteristics at this pressure gives the best trade-off in performance, since at lower pressure the response is slower while at higher pressure it is faster but more overshoot is present. Achieving optimum response is accomplished by the following procedure.

1. After calibrating the flowmeter section and selecting the proper R41 for good valve closure, install C14 (20 uF, 25 vdc) and temporarily install R40 (20K) and R13 (1K) with resistance substitution boxes.
2. Operate the unit as a controller and alternately command 100% full flow, then 50% flow and observe the output and response. Reducing R13 reduces the time constant of the sensor speedup circuit, which in turn reduces overshoot and more quickly dampens out oscillations following a step change in flow or pressure. Output ripple increases, however, due to the increased ac gain, and too low a value will result in output oscillation.
3. Once R13 has been selected and installed, increase R40 to as high a value as possible. Increasing R40 increases the dynamic gain of the controller circuit, thereby improving the dynamic response to changes in upstream pressure and/or command setting. Too high a value will result in output signal oscillation and instability. Typically, the lighter the gas the smaller R40 will have to be to prevent instability, but the response will be faster than on heavier gases. (e.g. a hydrogen controller may have a R40 of 30K and a response time of 1 second, while a nitrogen controller may have 300K and a response time of 4 seconds).
4. Increasing the maximum valve voltage (decreasing R41) provides more overdrive and speeds up the shutdown time, while mechanically opening the valve to pass more flow speeds up the opening time. Use of these two techniques should normally be avoided unless absolutely necessary.
5. Excessively high values of C14 and R40 should be avoided since the start-up time (time to achieve control after initial application of power and pressure) may be excessive. However, if stability or proper overshoot cannot be obtained by adjusting R13 and R40, increase C14 Use 25 vdc or higher.
6. Solder the resistors, determined in the preceding steps, in place and recheck stability.

4.8. BYPASS ADJUSTMENT

If it is desired to change the range of the unit beyond the electronics' adjustment capabilities, it will be necessary to replace the bypass assembly to produce the nominal sensor output of 125 +- 25 mV +20 mV at fullscale flow. In addition, the valve may have to be replaced. Range change of the LVC in the field is not recommended since other considerations exist.

The bypass is a preadjusted assembly which can be removed and reinstalled with the use of a screwdriver (Note: Be careful not to damage the fitting threads). Each assembly is stamped with a coded number which identifies the range for which it was calibrated. After replacement or removal for cleaning of this assembly, the flowmeter section should be recalibrated per the FLOWMETER ADJUSTMENT section, since a calibration shift of as much as 10% may occur during this operation depending on the flow range and gas.

TABLE II VALUES OF R41

Valve Closing Voltage (Note 1 and Note 4)	R41 (1 Watt)
UP to 6 vdc	100 ohms
6 - 7 vdc	75 ohms
7 - 8 vdc	62 ohms
8 - 9 vdc	39 ohms
9 - 10 vdc CAUTION! NOTE 3	30 ohms

NOTE 1: Measured voltage across valve required to close to less than 4% of rated flow at 40 psig inlet pressure.

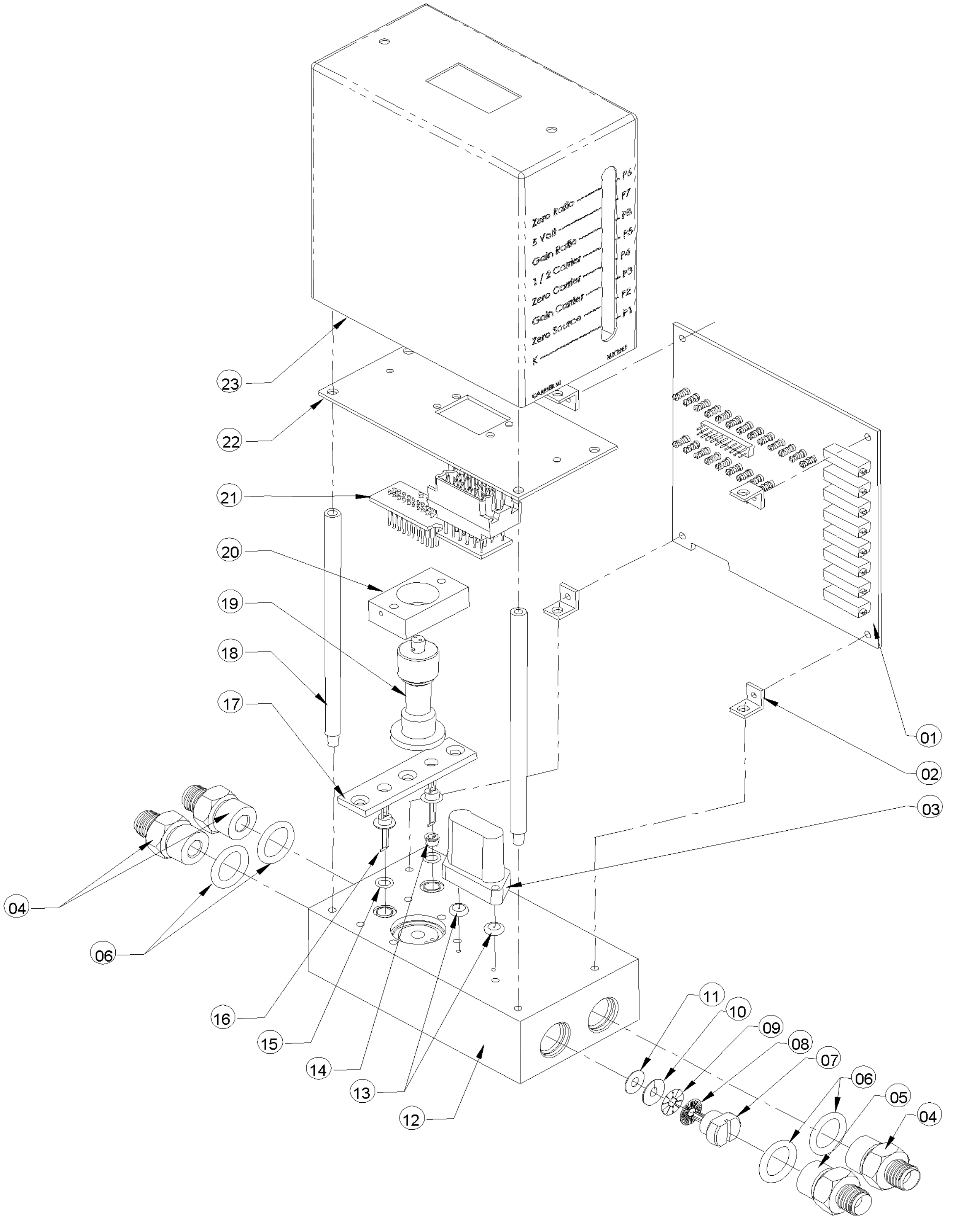
NOTE 2: Resistor values give approximately 20% power margin for valve closure.

NOTE 3: CAUTION! Do not exceed 10 vdc on the LVC-414 valve. R41 must be 30 ohms or greater to prevent severe valve damage (distortion or burn-out). Overpowering the valve unnecessarily may reduce its life and reliability.

NOTE 4: CAUTION! When the gas supply has been shut off or when purging a hydrogen controller with another gas such as nitrogen, do not command less than 10% full flow as severe damage to the control valve may result.

SECTION 5 PART LIST

5.1. MECHANICAL



1	LVC 414 BOARD	Q532810020-00
2	PLATINE LVC HOOK	Q580410072-11
3	SENSOR ASSEMBLY	Q997200000
4	SWG MALE CONNECTOR	Q580211150-11
5	INLET FITTING SW 1/4	Q2017970-02
6	O-RING VITON 11.90*1.98	Q808092032
7	BYPASS	Q2017997-01
8	40 GROOVES WASHER	Q580110211-13
9	10 GROOVES WASHER	Q580110211-12
10	1 GROOVE WASHER	Q580110211-11
11	INTERMEDIATE WASHER	Q580110211-10
12	LVC 414 BASE	Q580410011-11
13	SENSOR RUBBER SEAL	Q580212030
14	FLOW RATE ADAPTATOR	Q2052075-XX
15	O-RING VITON 4,0*1,5	Q600162800
16	TC CELLS	Q500600004
17	CELLS PLATE	Q580410032-11
18	LVC SUPPORT BASE	580410041-11
19	VALVE ASSEMBLY	Q580210020
20	VALVE PLATE	Q580410023-11
21	LVC INTERFACE BOARD	Q2080680-10
22	UPPER PLATE LVC	Q580410061-11
23	COVER LVC	Q580410082-12

SECTION 6 WARRANTY AND SERVICES

6.1. PRODUCT WARRANTY

1. Qualiflow products are guaranteed against defects in materials and workmanship for a period of one year from the date of shipment, if used in accordance with specifications and not subject to physical damage, contamination, alteration or retrofit.

2. Buyers undertake to check and inspect the goods and to notify Qualiflow of shipment incidents by fax, phone or e-mail as soon as possible after receipting the goods.

3. During the warranty period, products must only be repaired by authorized Qualiflow service centers; otherwise, the Qualiflow product warranty will be invalidated.

4. Repairs will be performed free of charge during the one-year warranty period. If MFCs are out of warranty, Qualiflow will notify the owner of replacement or repair costs before proceeding. Factory service and repairs are guaranteed 90 days. The warranty excludes consumable materials and wear parts (in teflon, viton, etc.).

5. No MFC will be accepted for repair or warranty without a decontamination and purge certificate.

6. Each MFC is individually checked (visual inspection of fittings, helium leak test and flow calibration). Qualiflow shall not be responsible for any damage caused by gas leakage or the use of a dangerous gas. Users are responsible for following the safety rules applicable to each gas they use. Improper use of a Qualiflow MFC will void the warranty, and MFCs that have been damaged as a result of improper use will not be replaced by Qualiflow.

7. Specific warranty requirements are as follows :

    a. Gas must be clean and particle-free, which means a filter must be fitted in the gas line upstream of the MFC.
    b. Gas must comply with the following pressure specifications:
        i. Gas pressure must never exceed 10 bars.
        ii. Differential pressure must be more than 500 mbar for full-scale flow through the MFC valve.
        iii. Differential pressure must be less than 3 bars for the MFC valve to regulate without gas-flow oscillation.
        iv. Pressure at the mass-flow inlet must be regulated by an accurate pressure regulator to prevent gas-flow oscillation.
    c. Electrical connection requirements are as follows:
        i. The system must be wired carefully: non-observance of the pinout may irreversibly damage the electronic board inside the MFC, in which case the warranty will be invalidated.
        ii. A stable power supply is required, with ripple below 5mV.
    d. Gas connections: the VCR gland must be handled carefully. Qualiflow guarantees that all glands have been individually inspected and are scratch-free.
    e. Fitting procedure: the fitting procedure set out in the manual must be followed meticulously. Specifically, the purge procedure is very important if corrosive gases or toxic gases are used.

f. The mass-flow must not be dismounted: the MFC warranty will be invalidated if the seal between the MFC block and cover is torn.

6.2. SERVICES

QUALIFLOW Products Engineers will help you to solve your problems regarding operation, calibration, connection, gas flows, gas mixture, etc…

We deliver technical support or maintenance within 24 hours.

QUALIFLOW offers factory training on mass flow controllers.

Visit www.qualiflow.com and find your nearest repair and calibration center.

APPENDIX   SELECTION CHART