DH Instruments
A Fluke Company

RPM4-AD™

Reference Pressure Monitor, Air Data Version

Operation and Maintenance Manual

High pressure liquids and gases are potentially hazardous. Energy stored in these liquids and gases can be released unexpectedly and with extreme force. High pressure systems should be assembled and operated only by personnel who have been instructed in proper safety practices.

This instrument is not to be operated in any other manner than that specified by the manufacturer.

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ABOUT THIS MANUAL

This manual is intended to provide the user with the basic information necessary to operate an RPM4-AD reference pressure monitor. It also includes a great deal of additional information provided to allow you to optimize RPM4-AD use and take full advantage of its many features and functions.

This manual is specific to the "-AD" configuration of RPM4 ("AD" in front panel configuration window). If you are not using an RPM4-AD, use the general RPM4 Operation and Maintenance Manual p/n 550129.

Before using the manual, take a moment to familiarize yourself with the Table of Contents structure: Sections 1, 2 and 3 should be read by all first time RPM4-AD users. Section 3 is most important for those using the local front panel interface but should be read over by all users to familiarize themselves with general RPM4-AD operating principles. Section 4 is for remote operation from an external computer. Section 5 provides maintenance and calibration information. Section 6 is a quick troubleshooting guide. Use it to troubleshoot unexpected RPM4-AD behavior based on the symptom of that behavior. Certain words and expressions have specific meaning as they pertain to RPM4-AD. The Glossary, Section 9, is useful as a quick reference for exact definition of specific words and expressions as they are used in the manual.

For those of you who "don't read manuals", go directly to Section 2.3 to set up your RPM4-AD and then go to Section 2.4 for power-up and verification. This will get you up and running quickly with a minimal risk of causing damage to yourself or your RPM4-AD. THEN... when you have questions or start to wonder about all the great features you might be missing, get into the manual!

Manual Conventions

(CAUTION) is used in throughout the manual to identify user warnings and cautions.

(NOTE) is used throughout the manual to identify operating and applications advice and additional explanations.

[ ] indicates direct function keys (e.g., **[RANGE]**).
< > indicates RPM4-AD screen displays (e.g., **<1yes>**).

NOTES

1. INTRODUCTION

1.1 PRODUCT OVERVIEW

RPM4-AD is a stand-alone, microprocessor driven, reference pressure monitor intended to precisely measure gas pressure in the range of air data instruments. It is designed to provide very high performance and extensive features combined with maximum versatility and ease of use. It is particularly well suited as a reference air data measurement device used to validate or calibrate air data test sets.

RPM4-AD uses two quartz reference pressure transducer (Q-RPT) modules and a barometer to measure pressure. There are two configurations. RPM4 A160Ka/A160Ka covers the altitude and airspeed range typically appropriate for rotary winged aircraft. RPM4 A350Ka/A160Ka covers the range of altitude and airspeed typically appropriate for fixed wing aircraft.

RPM4-AD can be controlled locally by the operator using its front panel display and keypad or remotely by a computer using ASCII character command strings transmitted over its standard RS232 or IEEE-488.2 interface.

RPM4-AD is a specialized air data version of the RPM4 Reference Pressure Monitor. The RPM4 Reference Pressure Monitor is available in a very wide variety of other configurations covering pressure ranges from as low as - 3 to 3 kPa (0.4 psi) to as high as 280 MPa (40 000 psi) in absolute, gauge, compound gauge and differential measurement modes.

1.2 SPECIFICATIONS

1.2.1 GENERAL SPECIFICATIONS

Power Requirements	85 to 264 VAC, 50/60 Hz, 25 VA max consumption and 12VDC, 1.2 A
Operating Temperature Range	15 to 35 °C
Ventilation	To prevent product overheating, provide proper ventilation. Allow 10 cm (4 in.) clearance from rear panel cooling fan.
Storage Temperature Range	- 20 to 70 °C
Vibration	Meets MIL-T-28800D
Weight	5 kg (11 lb)
Dimensions	10 cm H x 22.7 cm W x 24 cm D (3.9 in. x 9.3 in. x 9.5 in.)
Microprocessors	Motorola 68302, 16 MHz
Communication Ports	RS232 (COM1, COM2), IEEE-488.2
Fuses	1 A, 250 VAC fuse, 5 x 20 mm, time lag type fuse Internal power supply fuse not replaceable by operator: 2.5A, 250 VAC

Pressure Ranges	Lo Q-RPT	Hi Q-RPT	Qc (sea level)
A160K/A160K	160 kPa abs (23 psi)	160 kPa abs (23 psi)	60 kPa (8.7 psi)
A160K/A350K	160 kPa abs (23 psi)	350 kPa abs (51 psi)	250 kPa (36 psi)

Altitude Range	
A160K/A160K	- 4 000 to 20 000 m (- 13 000 to 66 000 ft)
A160K/A350K	- 4 000 to 30 000 m (- 13 000 to 100 000 ft)
Airspeed Range (sea level)	
A160K/A160K	0 to 1020 km/hr (550 kts)
A160K/A350K	0 to 2040 km/hr (1100 kts)
Operating Medium	Clean, dry, non-corrosive gas
Pressure Connections	
Ps , Pt	AN-4 (37º flare) male
VENT, ATM	10-32 UNF
Self Defense System (SDS™)	Included. Isolates Q-RPTs from **Ps** and **Pt** test ports and vents Q-RPTs to atmosphere.

Pressure Limits	A160K Q-RPT	A350K Q-RPT
Maximum working pressure	160 kPa abs (23 psi)	350 kPa abs (51 psi)
Maximum pressure without damage	200 kPa abs (29 ipsi)	370 kPa abs (54 psi)
Maximum SDS protection	10 MPa (1500 psi)	

CE Mark	Available, must be specified

1.2.2 PRESSURE MEASUREMENT SPECIFICATIONS

1.2.2.1 QUARTZ REFERENCE PRESSURE TRANSDUCERS (Q-RPT)

RPM4-AD includes two quartz reference pressure transducers (Q-RPT). Both are of the absolute (Axxx) type using an evacuated, permanently sealed reference. Axxx Q-RPTs are used to measure absolute, gauge and negative gauge pressure. Gauge pressure is defined by offsetting atmospheric pressure and applying dynamic compensation for atmospheric changes using the on-board barometer (see Section 3.2.2). Airspeed is calculated from the differential pressure between the Hi (Pt) and Lo (Ps) Q-RPTs or from gauge pressure (differential from current atmospheric pressure). See Section 3.3.3 for additional information on RPM4-AD measurement modes

In RPM4-AD A160K/A160K, the two Q-RPTs are sometimes used together in parallel measurement mode (//m™) to measure altitude or airspeed at altitude corresponding to ambient atmospheric pressure, reducing the uncertainty on the measurement (see Section 3.2.5).

Table 1. Quartz Reference Pressure Transducer (Q-RPT) module designations and ranges

Q-RPT DESIGNATION	MAXIMUM PRESSURE [kPa]		MAXIMUM PRESSURE [psi]	
	Absolute	Gauge	Absolute	Gauge
A350Ka[1] (Pt)	350	250	51	36
A160Ka[1](Ps or Pt)	160	60	23	8.7

GENERAL

Pressure Ranges	Lo Q-RPT	Hi Q-RPT	Qc (sea level)
A160K/A160K	160 kPa abs (23 psi)	160 kPa abs (23 psi)	60 kPa (8.7 psi)
A160K/A350K	160 kPa abs (23 psi)	350 kPa abs (51 psi)	250 kPa (36 psi)
Altitude Range			
A160K/A160K	- 4 000 to 20 000 m (- 13 000 to 66 000 ft)		
A160K/A350K	- 4 000 to 30 000 m (- 13 000 to 100 000 ft)		
Airspeed Range (sea level)			
A160K/A160K	0 to 1020 km/hr (550 kts)		
A160K/A350K	0 to 2040 km/hr (1100 kts)		
Resolution	To 1 ppm, user adjustable		
Warm Up Time	30 minute temperature stabilization recommended from cold power up for optimum performance.		
Operating Temperature Range	15 to 35 °C		
Acceleration Affect	± 0.008 % /g maximum, worst axis Allows operation ± 20° from reference plane without significant effect		
Predicted Stability[1]	± 0.005% of reading Note: the two Q-RPTs in RPM4-AD A160K/A160K can be compared one to the other to assist in identifying Q-RPT drift between calibrations		

RPM4-AD A160K/A160K (rotary wing)

	HL Q-RPT (absolute, gauge) Used for: altitude with best uncertainty; airspeed at ground altitude only	HI or LO Q-RPT (absolute, gauge) Used for: Not normally used for air data measurements	HI Q-RPT (differential) Used for: airspeed at varying altitude
Precision[2]	± 0.004 % of reading or 2 Pa, whichever is greater[4]	± 0.005 % of reading or 2.4 Pa, whichever is greater[4]	± 0.005 % of reading or 2.4 Pa, whichever is greater[4]
Measurement Uncertainty[3]	± 0.006% of reading or 3 Pa, whichever is greater[4]	± 0.008% of reading or 3.8 Pa, whichever is greater[4]	± 0.008% of reading or 3 Pa, whichever is greater

1. Predicted Q-RPT measurement stability limit (k=2) over one year assuming regular use of AutoZero function. AutoZero is performed by the operator: against zero pressure when vented in gauge mode, by direct comparison of one Q-RPT to the other at the line pressure in differential mode, by comparison with a barometric reference in absolute mode. Absolute mode predicted one year stability without AutoZ is ± (0.005 % Q-RPT span + 0.005 % of reading).
2. Combined linearity, hysteresis, repeatability. Add + 1 Pa (0.00015 psi) in gauge mode for the resolution and short term stability of the on-board barometer.
3. Maximum deviation of the Q-RPT indication from the true value of applied pressure including precision, predicted one year stability limit, temperature effect and calibration uncertainty, combined and expanded (k=2) following the ISO "Guide to the Expression of Uncertainty in Measurement." Add + 1 Pa (0.00015 psi) when measuring airspeed and using the Lo Q-RPT to display altitude.
4. % of reading applies to 30 to 100 % of Q-RPT span. Under 30 % of Q-RPT span, the value is a constant which is the % of reading value times 30 %.

RPM4-AD A350K/A160K (fixed wing)

	LO Q-RPT (absolute, gauge) Used for: altitude	HI Q-RPT (absolute, gauge) Used for: airspeed at ground altitude only	HI Q-RPT (differential) Used for: airspeed at varying altitude
Precision[2]	± 0.005 % of reading or 2.4 Pa, whichever is greater[4]	± 0.005 % of reading or 5.25 Pa, whichever is greater[4]	± 0.005 % of reading or 5.25 Pa, whichever is greater[4]
Measurement Uncertainty[3]	± 0.008% of reading or 3.8 Pa, whichever is greater[4]	± 0.008% of reading or 8.4 Pa, whichever is greater[4]	± 0.008% of reading or 6.6 Pa, whichever is greater

1. Predicted Q-RPT measurement stability limit (k=2) over one year assuming regular use of AutoZero function. AutoZero is performed by the operator: against zero pressure when vented in gauge mode, by direct comparison of one Q-RPT to the other at the line pressure in differential mode, by comparison with a barometric reference in absolute mode. Absolute mode predicted one year stability without AutoZ is ± (0.005 % Q-RPT span + 0.005 % of reading).
2. Combined linearity, hysteresis, repeatability. Add + 1 Pa (0.00015 psi) in gauge mode for the resolution and short term stability of the on-board barometer.
3. Maximum deviation of the Q-RPT indication from the true value of applied pressure including precision, predicted one year stability limit, temperature effect and calibration uncertainty, combined and expanded (k=2) following the ISO "Guide to the Expression of Uncertainty in Measurement." Add + 1 Pa (0.00015 psi) when measuring airspeed and using the Lo Q-RPT to display altitude.
4. % of reading applies to 30 to 100 % of Q-RPT span. Under 30 % of Q-RPT span, the value is a constant which is the % of reading value times 30 %.

1.2.2.2 ON-BOARD BAROMETER

The on-board barometer is used only to measure changes in atmospheric pressure to provide dynamic compensation of the Q-RPT's atmospheric pressure offset when making gauge pressure measurements and when displaying altitude while measuring airspeed.

1.2.3 BATTERY AND CHARGER PACK

Power Requirements	100 to 240 VAC, 50/60 Hz, 15 W max consumption
Operating Temperature Range	0 to 50 °C
Storage Temperature Range	- 20 to 50 °C
Vibration	Meets MIL-T-28800D
Weight	2 kg (4.4 lb)
Dimensions	8 cm H x 22.5 cm W x 20 cm D (3.1 in. x 8.9 in. x 7.9 in.)
Battery Type	Nickel Metal-Hydride
Battery Voltage	12 VDC
Battery Capacity	Typical: 9000 mAh Min: 8200 mAh
Charge Time	Full charge from empty, 14 to 16 hours approx.
Approx. Run Time, Full Charge	8 to 12 hours

2. INSTALLATION

2.1 UNPACKING AND INSPECTION

2.1.1 REMOVING FROM PACKAGING

RPM4-AD is delivered in a corrugated container with polyethylene inserts to hold it in place; or in the optional molded, medium density polyethylene shipping case with a custom foam insert for holding the RPM4-AD.

Remove the RPM4-AD and its accessories from the shipping container and remove each element from its protective plastic bag.

2.1.2 INSPECTING CONTENTS

Check that all items are present and have no visible damage.

A standard RPM4-AD includes all items indicated in Table 2.

Table 2. RPM4-AD packing list

DESCRIPTION		PART #
1 ea.	RPM4-AD Reference Pressure Monitor	FAM008
1 ea.	Calibration Report	550100
ACCESSORIES:		**402294 (402294-CE)**
1 ea.	Operation and Maintenance Manual	550148
1 ea.	Power Cord (7.5 ft.)	100770 (100770-CE)
1 ea.	Ferrite sleeve (snap on to COM2 cable for CE)	103303
1 ea.	General Accessories Disk (white CD)	102987
OPTIONAL BATTERY/CHARGER PACK		**401904 (401904-CE)**
1 ea.	Battery/charger pack	401980
1 ea.	Battery/charger pack to RPM4-AD cable	401979
1 ea.	Power Cord (7.5 ft.)	100770 (100770-CE)
1 ea.	Instruction Sheet	560062

2.2 SITE REQUIREMENTS

Install RPM4-AD on a flat, stable surface at a convenient height. The front feet can be extended so that the unit can be inclined for easier viewing. The RPM4-AD can also be mounted in a standard 19 in. rack using the optional rack mount kit.

2.3 SETUP

2.3.1 PREPARING FOR OPERATION

To prepare RPM4-AD for check out and operation:

❶ Remove the plastic caps from the RPM4-AD rear panel pressure connections.

❷ Remove the protective plastic sheet from the front panel display.

❸ Familiarize yourself briefly with the front and rear panels (see Section 2.3.2).

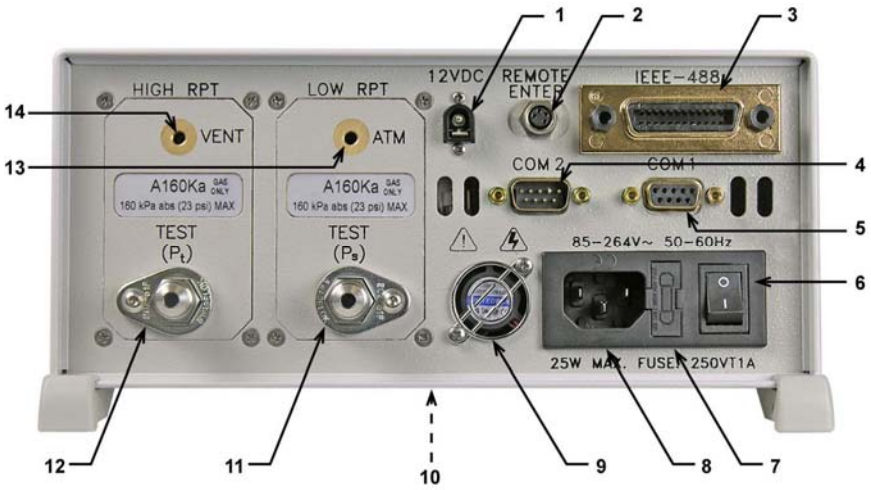
2.3.2 FRONT AND REAR PANELS

2.3.2.1 FRONT PANEL

1. Ready/not ready indicator
2. Display
3. Remote activity indicator
4. Cursor control keys
5. Multi-function keypad

Figure 1. Front panel

2.3.2.2 REAR PANEL



1. 12VDC power supply connection
2. Remote **[ENT]** connector
3. IEEE-488 connector
4. COM2 connector
5. COM1 connector
6. Power switch
7. Fuse
8. Electrical power connector (IEC-320-C13)
9. Fan
10. Product label (bottom of case)
11. **TEST (Ps)**, low Q-RPT
12. **TEST (Pt)**, high Q-RPT
13. **ATM** port
14. **VENT** port

Figure 2. Rear panel

2.3.3 POWER CONNECTION

2.3.3.1 85 TO 264 VAC, 50/60 HZ VAC POWER

❶ Check that the RPM4-AD power switch is OFF.

❷ Connect the supplied power cable to the rear panel power module.

❸ Connect the other end of the power cable to an electrical supply of 85 to 264 VAC, 50/60 Hz.

2.3.3.2 BATTERY PACK

❶ Charge the battery pack fully (see Section 3.2.9).

❷ Connect the RPM4-AD 12VDC power connection on the rear panel of the RPM4-AD to the 12 VDC power connection on the battery/charge pack using the cable supplied with the pack.

See Section 3.2.9 for additional information on battery/charger pack operation and maintenance.

2.3.4 REMOTE [ENT] CONNECTION (FOOTSWITCH OR OTHER SWITCH)

Connect the optional remote ENTER footswitch, if available or a user supplied switch fitted to the optional cable (see Section 7.1). Connect the cable to the RPM4-AD rear panel connection labeled **REMOTE ENTER**. Closing the switch is equivalent to pressing the **[ENT]** key on the front panel (see Section 3.1.3).

2.3.5 CONNECTING TO MEASURE PRESSURE (PS AND PT PORTS)

Using a pressure connecting hose or tube of appropriate pressure rating, connect the device or system to be tested to the RPM4-AD **TEST (Pt)** and/or **TEST (Ps)** ports.

The RPM4-AD **TEST (Pt)** and **TEST (Ps)** connections are **AN4 (1/4 in.) male**.

See Table 3 for instructions on how to connect to the RPM4-AD **TEST** ports depending on what is to be measured. See Section 5.6 for schematics of RPM4-AD **TEST** ports, Q-RPTs and internal valve configurations. Typically, when testing an air data device, the air data device **Ps** port is connected to the RPM4-AD **Ps** port and the air data device **Pt** port is connected to the RPM4-AD **Pt** port.

Table 3. Making pressure connections to RPM4-AD

TYPE OF MEASUREMENT	RPM4-AD A160K/A160K			RPM4-AD A350K/A160K		
	TEST(Pt)	TEST(Ps)	VENT	TEST(Pt)	TEST(Ps)	VENT
Airspeed at varying altitude (true Ps and Pt differential operation)	Connect to DUT **Pt** port	Connect to DUT **Ps** or **altitude** port	Not used	Connect to DUT **Pt** port	Connect to DUT **Ps** or **altitude** port	Not used
Altitude only, best uncertainty and absolute pressure	Not used. May be connected to DUT **Pt** port	Connect to DUT **Ps**, **altitude** or **abs** port	Not used	Not used. May be connected to DUT **Pt** port	Connect to DUT **Ps**, **altitude** or **abs** port	Not used
Airspeed at ground altitude only (A160K/A160) and gauge pressure	Connect to DUT **Pt** port	Not used. May be connected to DUT or **Ps** port	Not used. May be connected to DUT or **Ps** port	Connect to DUT **Pt** port	Not used. May be connected to DUT or **Ps** port	Not used
Gauge pressure or negative gauge pressure	Connect to DUT **(+)** or **gauge** port	Not used	Connect to DUT **(-)** port (optional)	Connect to DUT **(+)**or **gauge** port to measure with Hi Q-RPT	Connect to DUT **(+)**or **gauge** port to measure with Lo Q-RPT	Connect to DUT **(-)** port (optional)

RPM4-AD includes the SDS Self Defense System on both of its Q-RPTs. SDS, operated properly, allows a the Q-RPT TEST port to be left connected to a pressure up to 10 MPa (1 500 psi) without damage to the Q-RPT. Do NOT attempt to use SDS in this manner without first becoming thoroughly familiar with its operation and limitations (see Sections 3.2.8, 3.3.8, 3.5.4).

Using the RPM4-AD connected to a system with liquid contaminants without taking proper precautions to purge the system and test line may cause contamination of the RPM4-AD that will require non-warranty service.

2.3.6 THE VENT AND ATM PORTS

The RPM4-AD Hi Q-RPT module has a **VENT** port. The **VENT** port is connected to the Q-RPT Self Defense System (SDS) Q-RPT vent valves. The **VENT** port should always be left completely unobstructed and open to ambient atmospheric pressure.

RPM4-AD Lo Q-RPT module has an **ATM** port. The **ATM** port is connected to the RPM-AD internal barometer. The **VENT** port should always be left completely unobstructed and open to ambient atmospheric pressure. When operating RPM4-AD A160K/A160K in parallel gauge pressure mode to measure airspeed, the vent port may be connected to the DUT Ps or altitude port to assure that the RPM4 and the DUT are at the same altitude setting. In this case, altitude must remain between -700 and 3000 m (110 to 70 kPa abs).

See Section 5.6 for schematics of RPM4-AD **TEST** and **VENT** ports, Q-RPT and internal valve configurations.

NEVER plug, obstruct or connect a supply pressure to an RPM4-AD VENT port. This will adversely affect GAUGE mode operation and AutoZeroing functions.

2.3.7 CHECK/SET SECURITY LEVEL

RPM4-AD has a security system based on user levels. By default, the security system is set to “low”, which includes access restriction to internal calibration coefficients, and there is no password required to change the security level. See Section 3.5.5.5 for information on the security level system. As part of the RPM4-AD startup, determine the security level that is appropriate for the RPM4-AD and set a password if desired.

RPM4-AD is delivered with the security level set to “low” to avoid inadvertent altering of critical internal settings but with access to changing security levels unrestricted. It is recommended that the low security level be maintained at all times and password protection be implemented if control over setting of security levels is desired.

2.3.8 SDS FULL TIME OFF

RPM4-AD includes the SDS Self Defense System on both its **TEST** ports to shut them off from a pressure connected to them when they are not in use. If this function is not desired, SDS can be turned full time off so that in regular operation, SDS is not present. With SDS full time off, the SDS overpressure protection is still active.

See Section 3.5.4.2 for instructions on turning SDS full time off if desired.

2.4 POWER-UP AND VERIFICATION

2.4.1 SWITCH POWER ON

Actuate the power switch on the RPM4-AD rear panel (if a 12 VDC power supply is already connected to the **12 VDC** connection, RPM4-AD power is already on). Observe the front panel display as RPM4-AD initializes, error checks and goes to the MAIN RUN screen (see 3.1.1).

If the RPM4-AD fails to reach the MAIN RUN screen, service is required. Record the sequence of operations and displays observed.

SDS is CLOSED at power up and the TEST ports are shut off. This causes <SDS CLOSED> to be flash periodically in the MAIN RUN screen in place of the measured pressure value.

2.4.2 CHECK PRESSURE MEASUREMENT OPERATION

2.4.2.1 CHECKING ABSOLUTE MODE PRESSURE MEASUREMENT

Check the RPM4-AD operates properly in **absolute** mode.

Make sure that the **TEST (Ps)** and **TEST (Pt)** ports are vented to atmosphere.

Press the **[MODE]** function key and select **<absolute>** mode (see Section 3.3.3). Use **[UNIT]** to select a **pressure** unit of measure (not altitude) (see Section 3.3.2).

If SDS is CLOSED (**<SDS CLOSED>** flashes over the display of pressure on the top line of the display), Press **[SDS]**, **<2yes>** to OPEN SDS (see Section 3.3.8).

Do NOT OPEN SDS with a pressure higher than the maximum pressure of the Q-RPT applied to the TEST port. Damage to the Q-RPT may result.

The RPM4-AD should be measuring the current value of atmospheric pressure. Check that the value agrees with the local value of atmospheric pressure within measurement tolerances (see Section 1.2.2.1). If RPM4-AD does not agree within tolerance, it may need to be AutoZeroed (see Section 3.3.9), calibrated (see Section 5.2) or repaired.

2.4.2.2 CHECKING GAUGE MODE PRESSURE MEASUREMENT

Check the RPM4-AD operates properly in **gauge** mode.

Make sure that the **TEST (Ps)** and **TEST (Pt)** ports are vented to atmosphere.

Press the **[MODE]** function key and select **<gauge>** mode. Use **[UNIT]** to select a **pressure** unit of measure (not airspeed) (see Section 3.3.2).

If SDS is CLOSED (**<SDS CLOSED>** flashes over the display of pressure on the top line of the display), OPEN SDS. Press **[SDS]**, **<2yes>** to OPEN SDS.

Do NOT OPEN SDS with a pressure higher than the maximum pressure of the Q-RPT applied to the TEST port. Damage to the Q-RPT may result.

The value indicated should be near zero. It is normal for RPM4-AD to indicate a value other than zero when vented when **gauge** mode is first entered or the range is changed. Press **[AutoZ]**. This runs AutoZ to zero the Q-RPT reading (see Section 3.3.9.1). Upon return to the MAIN RUN screen, observe that the indication of measured pressure has zeroed.

If the display fails to zero properly, RPM4-AD may need repair.

2.5 SHORT TERM STORAGE

The following is recommended for short term storage of RPM4:

❶ Remove pressure from the RPM4-AD TEST ports.

❷ Switch power OFF.

NOTES

3. OPERATION

3.1 USER INTERFACE

RPM4-AD is designed to offer a balance between simple, straight forward operation and the availability of a wide variety of advanced functions with a high level of operator discretion. The local operator interface is through a 2 x 20 character alphanumeric display, a function/data keypad, a cursor control pad and a *Ready/Not Ready* indicator.

Remote communications are by RS232 (COM1) and IEEE-488. See Section 4 for information on remote communication.

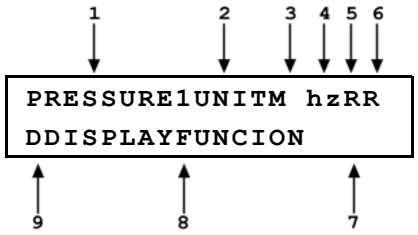
3.1.1 MAIN RUN SCREEN

The RPM4-AD MAIN RUN screen is its home display that is reached on power-up and from which other functions and menus are accessed. It is the very top level of all menu structures.

The MAIN RUN screen is where RPM4-AD is left in normal operation. It displays the current measured pressure, altitude and/or airspeed as well as a variety of additional information if desired.

Figure 3 and its legend summarize the RPM4-AD MAIN RUN screen fields and their functions.

RPM4-AD has a screen saver function which causes the display to dim if no key is pressed for 10 minutes. Pressing a key restores full power to the display. The screen saver time can be changed or screen saving can be completely suppressed (see Section 3.5.5.1).

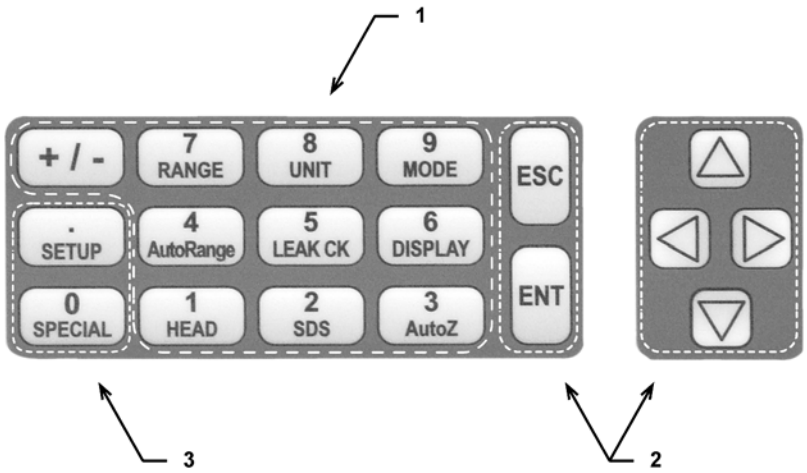


DISPLAY FIELD	NAME	PURPOSE	CONTENTS	SECTION
1. PRESSURE1	Measured pressure, altitude or airspeed	Displays value measured by the active Q-RPT(s)	Numerical pressure value and sign. Intermittently flashes **<SDS CLOSED>** when the Q-RPT is shut off from the **TEST** port by SDS.	3.2.8
2. UNIT	Unit of measure	Identifies unit of measure in which pressure or pressure derived values are displayed	Unit of measure abbreviation	3.3.2
3. M	Measurement mode	Identifies measurement mode of displayed pressure or air data value	**<a>** absolute **<g>** gauge or negative gauge **<d>** differential	3.3.3
4. h	Head indicator	Indicates whether a fluid head correction is applied to PRESSURE1	**<h>** the fluid head is not zero **<blank>** fluid head is zero	3.3.7
5. z	AutoZero indicator	Indicates whether the AutoZero function is ON or OFF for the active Q-RPT and measurement mode	**<z>** AutoZ is ON **<blank>** AutoZ is OFF	3.5.1
6. RR	Active Q-RPT indicator	Indicates the active Q-RPT in the RPM4. The active Q-RPT measurement is displayed on the RPM4 top line.	**<Hi>** Hi Q-RPT **<Lo>** Lo Q-RPT **<HL>** Hi and Lo Q-RPTs together in parallel measurement mode (A160K/A160K only) **<Hd>** Hi and Lo Q-RPTs together in differential measurement mode	3.2.1
8. DISPLAY FUNCTION	Information specific to the DISPLAY mode	Pressure indication depending on current RPM4-AD DISPLAY function. Leading character identifies the value	Numerical pressure value and sign.	3.3.6
9. D	Pressure information indicator	Pressure information indicator depending on current RPM4-AD DISPLAY function.	**<σ>** Display mode is AVERAGE and value is standard deviation **<R>** Display mode is RATE and value is pressure or air data unit rate of change per second **</s>** or per minute **</m>** **<H>** Display mode is HI/LO and values high (left), low (right) **<D>** Display mode is DEVIATION and value is difference from current target None Display mode is RPT and value is measurement of inactive RPT (**<Lo>** or **<Hi>** to right) **<F>** Display mode is FREEZE and value is last captured reading **Blank, no character** Current display mode is CLEAN	3.3.6

Figure 3. MAIN RUN screen display fields

3.1.2 FUNCTION / DATA KEYPAD LAYOUT AND PROTOCOL

The RPM4-AD has a function/data keypad for local operator access to direct functions, function menus and for data entry.



1. The **Function/Data keys** allow very commonly used functions to be accessed directly by a single keystroke when pressed from the MAIN RUN screen (see Section 3.1.1). The name of the function is on the bottom half of the key. These keys enter numerical values when editing.
2. The **Editing and Execution keys** are for starting and suspending command execution, cursor control in menus and editing entries.
3. The **Menu/Data keys** provide access to function menus when pressed from the MAIN RUN screen. The menu name is on the bottom half of the key. The SETUP menu is for more frequently used functions (see Section 3.4). The SPECIAL menu is for functions that are not generally used as a part of day to day operation (see Section 3.5). These keys enter numerical values when editing.

Figure 4. Keypad layout

Pressing the **[ENT]** key generally causes execution or forward movement in the menu tree.

Pressing the **[ESC]** key moves back in the menu tree and/or causes execution to cease or suspend. Pressing **[ESC]** repeatedly eventually returns to the MAIN RUN screen and, from there, allows momentary viewing of the RPM4-AD introduction screen.

Pressing the **[+/-]** key changes a numerical sign when editing. It also toggles through multiple screens when available and, from some run screens, is a shortcut to a momentary display of active RANGE.

Pressing the **[△]**, **[▽]**, **[◁]** and **[▷]** keys allows up, down, reverse and forward cursor movement when editing data **entry** or moving in menus.

Some screens go beyond the two lines provided by the display. This is indicated by a flashing arrow in the second line of the display. Press the cursor control keys to move the cursor to access the lines that are not visible or directly enter the number of the hidden menu choice if you know it.

3.1.3 REMOTE [ENT] (ENTER) FOOTSWITCH

The optional remote ENTER function is a switch that duplicates the function of the front panel **[ENT]** key. The remote ENTER function is serviced by a connector on the RPM4-AD rear panel. An optional footswitch is available to activate remote entry hands free or a different switch may be used. See Section 7.1 for information on remote ENTER switch wiring.

3.1.4 SOUNDS

RPM4-AD is equipped with a variable frequency tone device to provide audible feedback and alarms. The beeper is used for the following indications.

Valid key press	Brief beep. Choice between three frequencies or NO sound is available (see Section 3.5.5.2).
Invalid key press	Descending two tone “blurp”
Leak check completed	Three two second beeps (see Section 3.3.5).
Upper or lower limit exceeded	Intermittent one second beeps (see Section 3.4.4).
Pmax! (overpressure limit) exceeded	Eight second high frequency beep (see Section 3.4.4.1).
Possible disconnect between the Hi and Lo Q-RPTs in parallel measurement mode	Rapid beeps for 8 seconds (3.2.5).

3.2 GENERAL OPERATING PRINCIPLES

3.2.1 Q-RPTS AND Q-RPT SELECTION

RPM4-AD has two Q-RPTs. In RPM4-AD A160K/A160K the two Q-RPTs have of the same range of 160 kPa absolute (23 psi). In RPM4-AD A350K/A160K the Hi Q-RPT has a range of 350 kPa (51 psi) and the Lo Q-RPT has a range of 160 kPa (23 psi). Position indication of the currently active Q-RPT is continuously displayed in the upper right hand corner of the MAIN RUN screen and most other screens. See Section 5.6 for a schematic of the RPM4-AD pneumatic system and Q-RPTs. See Table 4 for position designation protocol for the Q-RPTs in an RPM4-AD.

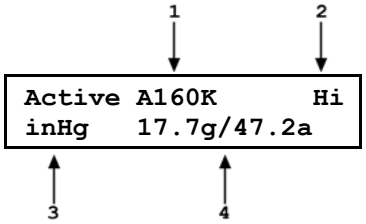
Table 4. Position designators of Q-RPTs in an RPM4-AD system

Q-RPT POSITION	DISPLAY SYMBOL*
A160K/A160K: A160K Q-RPT installed in **HIGH RPT** (Pt) position. A350K/A160K: A350K Q-RPT installed in **HIGH RPT** (Pt) position.	**<Hi>**
Hi Q-RPT when used in differential measurement mode (Hi – Lo)	**<Hd>**
A160K/A160K: A160K Q-RPT installed in **LOW RPT** (Ps) position. A350K/A160K: A160K Q-RPT installed in **LOW RPT** (Ps) position.	**<Lo>**
Both Q-RPTs being used simultaneously in parallel measurement mode (RPM4-AD A160K/A160K only)	**<HL>**

* The display symbol is included in the upper, right hand corner of most RPM4-AD menu displays as a convenient indicator of the active Q-RPT.

AN RPM4-AD Q-RPT is identified by a range screen identifying the Q-RPT, its current unit of measure and its full scale pressure in gauge and absolute measurement modes or in an air data unit. The Q-RPT screen is:

1. Q-RPT designator.
2. Q-RPT position designator.
3. Current pressure unit of measure.
4. Full scale pressure in current unit of measure in gauge (**<g>**) and/or absolute (**<a>**) measurement mode.



The Q-RPTs available on an RPM4-AD and short cuts to specific air data measurement modes are accessed using **[RANGE]**.

Most settings made when an RPM4-AD Q-RPT is active, such as unit of measure, measurement mode, display resolution, and stability setting are specific to the Q-RPT. Generally, settings selected while one Q-RPT is active apply to that Q-RPT and not to the other Q-RPT. The Q-RPT specific settings are stored with the Q-RPT and recalled whenever the Q-RPT is made active. See Table 5 for a listing of RPM4-AD settings and to what level of RPM4-AD operation they are specific.

Table 5. Settings and what they are specific to (range, measurement mode, Q-RPT, system)

SETTING	PURPOSE	SPECIFIC TO	SECTION
[Unit]	Set pressure unit of measure	Q-RPT and measurement mode	3.3.2
[Mode]	Set pressure measurement mode (absolute, gauge, negative gauge)	Q-RPT	3.3.3
[Display]	Set bottom line display function	System	3.3.6
[Head]	Set fluid head correction height, fluid, unit of measure	System	3.3.7
[SDS]	Open and close SDS	Q-RPT	3.3.8
[AutoZ]	Run AutoZ	Q-RPT and measurement mode	3.3.9
Resolution	Set pressure display resolution	Q-RPT	3.4.2
Stability	Set *Ready/Not Ready* stability test.	Q-RPT	3.4.3
Upper Limit	Set upper and lower pressure limit alarm	Q-RPT and measurement mode	3.4.4
AutoZ	AutoZ ON/OFF, set and view values	Q-RPT and measurement mode	3.5.1
Screen Saver, Sound, Time, ID, Level	Set system user preferences	System	3.5.5
ReadRate	Automated read rate adjustment ON/OFF	System	3.5.7.2
Cal	Q-RPT and barometer calibration coefficient and date viewing and editing	Q-RPT or barometer	3.5.7.5

3.2.2 GAUGE AND NEGATIVE GAUGE MEASUREMENT, DYNAMIC COMPENSATION FOR ATMOSPHERIC PRESSURE

RPM4-AD Q-RPTs are intrinsically absolute but they are also used for gauge and negative gauge measurement modes (see Section 3.3.3, ❍ PRINCIPLE). Gauge measurement modes are achieved by subtracting the value of atmospheric pressure, $\mathbf{P_{offset,G}}$, from the Q-RPT's absolute reading using AutoZ (see Section 3.2.2). The AutoZ routine that measures $\mathbf{P_{offset,G}}$, is run by pressing **[AutoZ]** whenever RPM4-AD is in the vented condition. This assures the continuous

updating of the $\mathbf{P_{offset,G}}$ value corresponding to atmospheric pressure. Gauge pressure is the measured absolute pressure, $\mathbf{P_u}$, minus the atmospheric offset.

$$\mathbf{P_{gauge} = P_u - P_{offset,G}}$$

However, atmospheric pressure may change between opportunities to run AutoZ and update the value of $\mathbf{P_{offset,G}}$, for example when running an extended test without venting. RPM4-AD uses ***dynamic compensation for atmospheric pressure*** to correct for changes in atmospheric pressure between opportunities to run AutoZ and update $\mathbf{P_{offset,G}}$. When AutoZ runs, and $\mathbf{P_{offset,G}}$ is determined, the reading of RPM4's on board barometer, $\mathbf{P_{atm,0}}$, is also recorded. Later, when no longer vented, the change in atmospheric pressure, $\mathbf{\Delta P_{atm}}$, since $\mathbf{P_{offset,G}}$ was updated, is the difference between the current barometer reading, $\mathbf{P_{atm}}$, and the barometer reading at the time of AutoZ execution, $\mathbf{P_{atm,0}}$:

$$\mathbf{\Delta P_{atm} = P_{atm} - P_{atm,0}}$$

Dynamic compensation for atmospheric pressure uses $\mathbf{\Delta P_{atm}}$ to correct the value of $\mathbf{P_{offset,G}}$, thus always compensating real time for changes in atmospheric pressure:

$$\mathbf{P_{gauge} = P_u - P_{offset,G} - \Delta P_{atm}}$$

Gauge pressure measurement on an Axxx (absolute) Q-RPT allows instantaneous switching between gauge and absolute measurements modes. The additional uncertainty in gauge pressure mode due to the dynamic compensation for atmospheric pressure technique is a function of the resolution and short term stability of the on-board barometer, not its absolute measurement uncertainty. This additional uncertainty is ± 1 Pa (0.00015 psi).

In RPM4-AD A160K/A160K the two A160K Q-RPTs are used in parallel measurement mode in gauge mode to reduce measurement uncertainty (see Section 3.2.5). Gauge mode can be used to measure airspeed in parallel measurement mode. This provides airspeed measurement but only at ground altitude corresponding to the current value of atmospheric pressure (see Section 3.2.3.1).

3.2.3 ALTITUDE AND AIRSPEED MEASUREMENT

RPM4-AD is designed to support the measurement of altitude and airspeed with minimal uncertainty. See Section 3.2.3.1 for information on altitude and airspeed measurement with RPM4-AD A160K/A160K (rotary wing) and Section 3.2.3.2 for information on RPM4-AD A350K/A160K (fixed wing).

3.2.3.1 RPM4-AD A160K/A160K (ROTARY WING)

RPM4-AD A160K/A160K has two 160 kPa absolute Q-RPTs, one in the HIGH RPT (Pt) position and one in the LOW RPT (Ps) position.

Air data measurements can be made in three different conditions.

The two Q-RPTs measuring two absolute pressures (Ps and Pt) separately: airspeed at varying altitude

In differential mode, the two Q-RPTs are separated internally. One is connected to the **TEST (Ps)** port and the other is connected to the **TEST (Pt)** port (see Section 3.2.6).

RPM4 measures the absolute pressures applied to the **TEST (Ps)** and **TEST (Pt)** ports. The absolute pressure measured on the **TEST (Ps)** port is converted to altitude. The difference between the **TEST (Pt)** and **TEST (Ps)** pressure (Pt - Ps) is converted to airspeed (see Section 7.2.3). If a true airspeed unit of measure has been selected, altitude and entered temperature are also used in the airspeed calculation.

To measure airspeed and altitude using this mode, use **[RANGE]** (see Section 3.3.1.1) to select the **<Hi>** Q-RPT or the **<airspeed & altitude>** shortcut. If the shortcut is not used, once the Q-RPT has been selected, use **[MODE]** (see Section 3.3.3) to set absolute and differential measurement mode and **[UNIT]** (see Section 3.3.2) to set the desired airspeed unit. Use **[DISPLAY]**, **<4RPT>** to change the altitude unit if desired.

The two Q-RPTs measuring absolute pressure in parallel: Altitude only, with lowest uncertainty

In parallel mode (//m™), the two Q-RPTs are connected together internally, the **TEST (Ps)** port is opened and the **TEST (Pt)** port is closed using the SDS valves.

RPM4 measures the absolute pressure applied to the **TEST (Ps)** port with both Q-RPTs and averages the two (see Section 3.2.5). The absolute pressure is converted to altitude (see Section 7.2.2).

To measure altitude using this mode, use **[RANGE]** (see Section 3.3.1) to select the **<HL>** Q-RPT or the **<altitude, parallel>** shortcut. If the shortcut is not used, once the Q-RPT has been selected, use **[MODE]** (see Section 3.3.3) to set absolute measurement mode and **[UNIT]** (see Section 3.3.2) to set the desired altitude unit.

The two Q-RPTs measuring gauge pressure in parallel: Airspeed at ground altitude only

In parallel mode, the two Q-RPTs are connected together internally, the **TEST (Pt)** port is opened and the **TEST (Ps)** port is closed using the SDS valves.

RPM4 measures the gauge pressure applied to the **TEST (Pt)** port with both Q-RPTs and averages the two (see Section 3.2.5). Since the gauge pressure is the difference from atmospheric pressure, it directly provides the differential pressure used to calculate airspeed. The value of static pressure, Ps, is the current value of atmospheric pressure. The gauge pressure is converted to airspeed (see Section 7.2.3). The value of ground altitude corresponding to ambient atmospheric pressure can also be displayed. If a true airspeed unit of measure has been selected, altitude and entered temperature are also used in the airspeed calculation.

To measure airspeed using this mode, use **[RANGE]** (see Section 3.3.1.1) to select the **<HL>** Q-RPT or the **<airspeed, parallel>** shortcut. If the shortcut is not used, once the Q-RPT has been selected, use **[MODE]** (see Section 3.3.3) to set gauge measurement mode and **[UNIT]** (see Section 3.3.2) to set the desired airspeed unit.

3.2.3.2 RPM4-AD A350K/A160K (FIXED WING)

RPM4-AD A350K/A160K has two Q-RPTs. A 350 kPa absolute Q-RPTs is in the HIGH RPT (Pt) position and a 160 kPa absolute is in the LOW RPT (Ps) position.

Air data measurements are normally made in the following conditions:

The two Q-RPTs are separated internally. One is connected to the **TEST (Ps)** port and the other is connected to the **TEST (Pt)** port.

RPM4 measures the absolute pressures applied to the **TEST (Ps)** and **TEST (Pt)** ports. The absolute pressure measured on the **TEST (Ps)** port is converted to altitude. The difference between the **TEST (Pt)** and **TEST (Ps)** pressure (Pt – Ps) is converted to airspeed (see Section 7.2.3). If a true airspeed unit of measure has been selected, altitude and entered temperature are also used in the airspeed calculation.

To measure airspeed and altitude using this mode, use **[RANGE]** (see Section 3.3.1.2) to select the **<Hi>** Q-RPT or the **<airspeed & altitude>** shortcut. If the shortcut is not used, once the Q-RPT has been selected, use **[MODE]** (see Section 3.3.3) to set absolute and differential measurement mode and **[UNIT]** (see Section 3.3.2) to set the desired airspeed unit. Use **[DISPLAY]**, **<4RPT>** to change the altitude unit if desired (see Section 3.3.6.4).

3.2.4 PRESSURE READY/NOT READY

There is a *Ready/Not Ready* indication LED on the RPM4-AD front panel. This indication is intended to provide the user with an objective indication of when a stable pressure has been achieved. *Ready* is indicated when the current stability (rate of change) of pressure is less than the stability limit. The user can set the stability limit (see Section 3.4.3). The ready indication is often used when comparing the RPM4-AD and a test device to indicate when a valid reading can be made.

The *Ready/Not Ready* indication always applies to the active Q-RPT, whose pressure measurement is displayed on the top line of the RPM4-AD display.

The *Ready/Not Ready* LED indications are:

<Green >	Pressure ***Ready***	The pressure stability is within the stability limit.
<Red>	Pressure ***Not Ready***	The pressure stability is NOT within the stability limit.

In differential measurement mode (see Section 3.2.6), the LED *Ready/Not Ready* indication applies to the differential pressures.

In parallel measurement mode (see Section 3.2.5), the LED *Ready/Not Ready* indication applies to the average pressure read by the <HL> Q-RPT.

The *Ready/Not Ready* LED indications are:

<Green >	Pressure ***Ready***	The pressure stability is within the stability limit.
<Red>	Pressure ***Not Ready***	The pressure stability is NOT within the stability limit.

The default stability limit criteria for the *Ready/Not Ready* determination is:

Absolute measurement mode: ± 0.001875% of absolute mode span

Gauge measurement mode: ± 0.005% of gauge mode span

3.2.5 PARALLEL MEASUREMENT MODE (//M™) (RPM4-AD A160K/A160K ONLY)

RPM4-AD A160K/A160K can be set to operate in parallel measurement mode. Parallel measurement mode is used to measure altitude with the lowest uncertainty (see Section 3.2.3.1).

Parallel measurement mode is intended to improve measurement reliability and reduce measurement uncertainty by using the measurements of two Q-RPTs together. In parallel measurement mode, the measured pressure is the average of the readings of the two Q-RPTs.

Parallel measurement mode is considered a Q-RPT designated **<HL>** (combination of Hi and Lo). The HL Q-RPT can be selected using the **[RANGE]** (see Section 3.3.1.1) key and operated with all the features of a Hi or Lo Q-RPT.

In parallel measurement mode the active **TEST** port depends upon the measurement mode. In absolute measurement mode the **TEST(Ps)** port is active and the **TEST(Pt)** port is shutoff. In gauge measurement mode the **TEST(Pt)** port is active and the **TEST(Ps)** port is shutoff.

3.2.6 DIFFERENTIAL MEASUREMENT MODE

RPM4-AD can be set to operate in differential measurement mode. Differential measurement mode is used to measure airspeed and varying altitude (see Section 3.2.3).

In differential measurement mode, the measured pressure is the difference between measurements of the two Q-RPTs (Hi – Lo, Pt – Ps).

To set up differential measurement mode, use **[RANGE]** (see Section 3.3.1) to select the **<Hi>** Q-RPT or the **<airspeed & altitude>** shortcut. If the shortcut is not used, once the Q-RPT has been selected, use **[MODE]** (see Section 3.3.3) to set absolute and differential measurement mode.

3.2.7 AUTOZERO FUNCTION

RPM-AD includes an AutoZero function. This function is used to rezero the Q-RPT readings in gauge and differential modes and to offset the Q-RPT relative to a reference standard in absolute mode.

See Section 3.5.1 for complete information on the AutoZ function.

In **gauge measurement mode**, AutoZ should be run when the mode is first selected and any time RPM4-AD is vented (zero gauge pressure applied) (see Section 3.3.9.1).

In **differential measurement mode**, the AutoZ function should be run when the mode is first selected and any time zero differential is set or the line pressure (altitude) is changed (see Section 3.3.9.3).

In **absolute measurement mode**, it is recommended that AutoZ be run every 30 days or when RPM4-AD has been exposed to temperature changes exceeding 15 ºC (36 ºF) (see Section 3.3.9.2).

3.2.8 SDS SELF DEFENSE SYSTEM

The RPM4-AD Q-RPTs modules are equipped with the SDS self defense system. The SDS system includes hardware and embedded software to isolate Q-RPTs from overpressure. When SDS is CLOSED for a Q-RPT module, the Q-RPT is isolated from the module's **TEST** port and opened to the module's **VENT** port (See Section 5.6, Figure 8, Figure 9).

SDS can be OPENED and CLOSED from the front panel using **[SDS]**. SDS can also be controlled using functions under **[SPECIAL]**, **<4SDS>**. The SDS "temp open/close" function allows SDS on both Q-RPTs and **TEST** ports, whether active or inactive, to be opened and closed directly (see Section 3.5.4.1). The SDS "full time on/off" function allows SDS to be opened permanently so the RPM4-AD can be operated as if SDS were not installed (see Section 3.5.4.2).

SDS is normally used to isolate an RPM4-AD Q-RPT from a test system which may sometimes be subjected to pressures higher than the Q-RPT's maximum pressure. When configuring a multi-range system, this can eliminate the need for external valving or connecting and disconnecting RPM4s. For example, two Q-RPTs of different ranges might be connected to a single calibration system. When the Hi Q-RPT is in use, SDS is closed on the Lo Q-RPT to protect it from overpressure. When used in this manner, SDS should be CLOSED prior to applying pressure. Automatic SDS closing in response to overpressure should only be used in an emergency overpressure situation.

SDS also attempts to protect Q-RPTs from accidental overpressure. Whenever RPM4-AD is powered ON it continuously monitors the pressure read by its Q-RPT(s). If the pressure reaches the maximum pressure limit for a Q-RPT, SDS CLOSES to isolate the Q-RPT from the **TEST** port and vent it to atmosphere. This is not a fail safe overpressure system. It does not protect against very rapid overpressure or pressure exceeding 10 MPa (1 500 psi).

See Section 5.6 for schematics of the RPM4-AD Q-RPTs and pneumatic system and indication of internal valve states for SDS open and closed.

The maximum pressure that should be applied to an RPM4-AD TEST port when SDS is CLOSED is 10 MPa (1 500 psi).

Though the SDS self defense system includes features to automatically protect Q-RPTs against accidental overpressure, SDS should NOT be considered a fail-safe overpressure protection system. SDS cannot guarantee that overpressure damage will NOT occur. Conventional measures for overpressure protection should also always be used. Damage to Q-RPTs due to overpressure is NOT covered by the RPM4-AD product warranty even when SDS is present and ON.

3.2.9 USE OF THE 12VDC BATTERY/CHARGER PACK

An optional 12VDC battery/charger pack is available to supply power to RPM4-AD's **12VDC** power connection.

The battery/charger pack combines the battery and the battery charger.

To Charge the Battery

The battery may be charged while the battery/charge pack is connected to the RPM4-AD.

To charge the battery, connect the battery/charger pack to a 100 to 240 V, 50/60 Hz power supply using the supplied power cable and turn on the charger power switch. The green CHARGE indicator light goes on to indicate that battery charging is in progress. Allow 14 to 16 hours for the battery to charge fully. When the battery is fully charged, the CHARGE indicator light flashes.

When the battery charger power switch is in the ON, the battery is connected to the charger, not the 12VDC output. When the battery charger switch is in the OFF position, the CHARGE indicator light goes off, and 12VDC is supplied on the 12VDC connection.

To Use the Battery/Charger Pack to Supply RPM4

After charging the battery, connect the 12VDC connection of the battery/charger pack to the 12VDC connection on the RPM4-AD rear panel.

Turn the battery/charger pack power switch to OFF (when AC power is connected to the battery/charger pack, the power switch must be OFF for 12VDC power to be output).

When RPM4-AD is connected to **both** a 12 VDC source and an AC source, if the RPM4-AD power switch is OFF, the 12VDC source supplies the RPM4; if the RPM4-AD power switch is ON, the 12 VDC source is disconnected and the AC source supplies the RPM4-AD.

To Check the Battery Charge Level

To check the current charge level of the battery, press the toggle switch on the battery/charger pack front panel. Observe the BATTERY CHECK indicator lights. All three lights are lit when battery is fully charged. If no light or one light is on, the battery should be recharged.

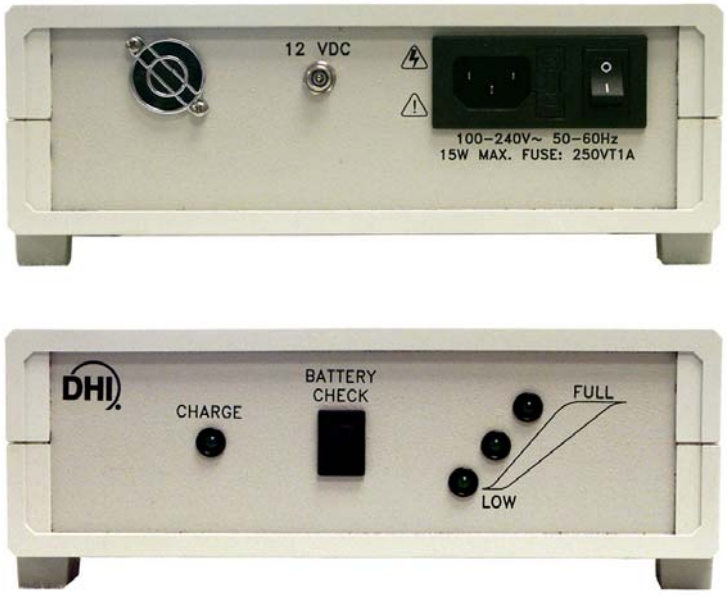


Figure 5. Battery pack/charger

3.2.10 USING RPM4-AD WITH A PPC3 CONTROLLER/CALIBRATOR

Certain RPM4 models can be used as an external measurement device for a PPC3 pressure controller/calibration.

RPM4-AD cannot be used as a PPC3 external measurement device.

3.2.11 DIRECT FUNCTION KEYS SUMMARY

Table 6 provides a brief summary of direct function key operation. It may be useful to keep a copy of this summary near the RPM4-AD, especially when first becoming acquainted with its operation.

Local operation of RPM4-AD is through the front panel keypad. To minimize multi-layered menu structures, the keypad numerical keys also provide direct access to the most commonly used functions. The function accessed is labeled on the bottom half of the key. Direct function keys are active whenever RPM4-AD is in its MAIN RUN screen. Table 6 summarizes the operation of the direct function keys.

Table 6. Summary of RPM4-AD function key operation

DIRECT FUNCTION KEYS ARE ACTIVE FROM THE MAIN RUN SCREEN See corresponding manual sections for full detail.			
1 HEAD	Adjust height of fluid head correction. Set to zero to defeat correction.	7 RANGE	View and toggle through active Q-RPT and setup shortcuts. **[ENT]** on a Q-RPT or shortcut activates it.
2 SDS	SDS controls the connection of the Q-RPT to the **TEST(Pt)** and/or **TEST(Ps)** port. Closes any open SDS. Opens SDS of active Q-RPT if closed.	8 UNIT	Select pressure unit of measure for the active range. Choice of units available in this menu depends on current measurement mode. Choice of units can be customized.
3 AutoZ	Run the AutoZ function to AutoZero the active Q-RPT and measurement mode.	9 MODE	Select the pressure measurement mode for the active Q-RPT (absolute, gauge, negative gauge, differential).
4 AutoRange	This function is not used in RPM4-AD models.	0 SPECIAL	Menu of less commonly used internal functions and settings.
5 LEAK CK	Run automated leak checking routine, also used for average rate measurements (e.g. ascent, descent).	. SETUP	Menu of commonly used setup features including set display resolution, set stability limit.
6 DISPLAY	Select the display function for the bottom line of the RPM4-AD display.	ENT	Start or set functions such as Leak Check and Freeze. ENTER values when editing.

3.3 DIRECT FUNCTION KEYS

3.3.1 [RANGE]

❍ PURPOSE

To view and/or change the active Q-RPT and associated settings. Includes direct shortcuts to air data measurement modes.

❍ PRINCIPLE

RPM4-AD has two Q-RPTs.

In RPM4 A160K/A160K, the two Q-RPTs may be used in parallel (**<HL>**) or the Hi Q-RPT may be used alone (**<Hi>**) or in true differential mode with the Lo Q-RPT (**<Hd>**).

In RPM4 A350K/A160K, the Hi Q-RPT (**<Hi>**) or the Lo Q-RPT (**<Lo>**) may be used individually. Differential use of the two Q-RPTs is accessed by selecting the Hi Q-RPT (**<Hd>**). Parallel mode of the two Q-RPTs is not supported.

The **[RANGE]** function key is used to specify which Q-RPT (and associated range and settings) is active.

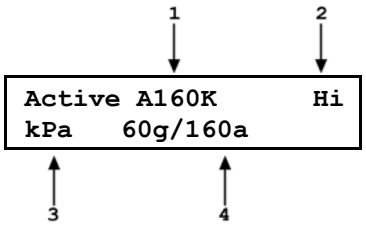
To streamline RPM4-AD operation, the **[RANGE]** key also provides simple shortcuts to the RPM4-AD configurations that support air data measurements.

See Section 4.4.5 for procedures to accomplish the same air data setups as [RANGE] shortcuts using remote commands.

❍ OPERATION

Pressing the **[RANGE]** function key activates the Q-RPT viewing and selecting function. When the **[RANGE]** function key is first pressed, the active Q-RPT is displayed. For example:

1. Q-RPT designator.
2. Q-RPT position designator (**<Hi>**, **<Lo>**, **<HL>** for both Q-RPTs in parallel mode, **<Hd>** for Hi Q-RPT in differential mode with the Lo Q-RPT).
3. Current unit of measure.
4. Full scale pressure of Q-RPT in current unit of measure in gauge (**<g>**) and absolute (**<a>**) measurement modes for pressure unit of measure or in air data unit.



Pressing the **[RANGE]** key again while in the RANGE functions toggles through displays of the other available Q-RPTs and shortcuts to air data measurement configurations (see below for RPM4-AD A160K/A160K and RPM4-AD A350K/A160K **[RANGE]** key choice details). The **[◁]** and **[▷]** keys can also be used to move forwards or backwards through the selections.

To select a Q-RPT or shortcut, press **[ENT]** when it is displayed.

Pressing **[ESC]** while in the RANGE function returns to the MAIN RUN screen without making any change.

Q-RPT specific RPM4-AD operating settings are saved with the Q-RPT when another Q-RPT is made active (see Section 3.2.1, Table 5). When the Q-RPT is selected again, it has the same settings as it was left with. The air data measurement shortcuts always return to the Q-RPT and measurement mode necessary for the air data measurement. They retain all other user settings.

3.3.1.1 RPM4-AD A160K/A160K (ROTARY WING)

Pressing **[RANGE]** always displays the active Q-RPT information. Pressing **[RANGE]** again toggles through the other Q-RPT choices available and the three air data shortcuts. There are a total of five **[RANGE]** displays.

The first time **[RANGE]** is pressed, the active range is displayed. Pressing **[RANGE]** again displays the next range choice. Pressing **[ENT]** activates the displayed selection and returns to the main run screen.

The sequence of selections when **[RANGE]** is pressed is:

FIRST [RANGE] SELECTION: HI Q-RPT

Selects Hi Q-RPT with all previous settings (measurement mode, unit of measure, etc) for that Q-RPT.

```
Select A160K      Hi
kPa   60g/160a
```

SECOND [RANGE] SELECTION: HL (PARALLEL MODE) Q-RPT

Selects HL Q-RPT (Hi and Lo Q-RPTs in parallel) with all previous settings (measurement mode, unit of measure, etc) for that Q-RPT.

```
Active A160K      HL
kPa   60g/160a
```

THIRD [RANGE] SELECTION: HI Q-RPT, SHORTCUT TO AIRSPEED AT VARYING ALTITUDE

Selects Hi Q-RPT in absolute, differential measurement mode (**<Hd>**) in which Hi – Lo Q-RPT differential pressure (airspeed) is displayed on top line and Lo Q-RPT absolute pressure (altitude) on the bottom line. Units of measure are default or last selected airspeed and altitude units.

```
Select A160K  dif Hd
airspeed & altitude
```

FOURTH [RANGE] SELECTION: HL Q-RPT, SHORTCUT TO ALTITUDE, BEST UNCERTAINTY

Selects HL Q-RPT (Hi and Lo Q-RPTs in parallel) with altitude displayed on top line and rate of change on the bottom line. SDS is set so that the **TEST(Ps)** port is active. Unit of measure is default or last selected altitude unit.

```
Select A160K  abs HL
altitude, parallel
```

FIFTH [RANGE] SELECTION: HL Q-RPT, SHORTCUT TO AIRSPEED, BEST UNCERTAINTY

Selects HL Q-RPT (Hi and Lo Q-RPTs in parallel) with airspeed displayed on top line and altitude corresponding to local atmospheric pressure on bottom line. Altitude cannot be changed. SDS is set so that the **TEST(Pt)** port is active. Unit of measure is default or last selected airspeed and altitude units.

```
Select A160K gage HL
airspeed, parallel
```

From the fifth **[RANGE]** display, pressing **[RANGE]** again returns to the first display.

3.3.1.2 RPM4-AD A350K/A160K (FIXED WING)

Pressing **[RANGE]** always displays the active Q-RPT information. Pressing **[RANGE]** again toggles through the other Q-RPT choices available and an air data shortcut. There are a total of three **[RANGE]** displays.

The sequence of selections when **[RANGE]** is pressed is:

FIRST [RANGE] SELECTION: LO Q-RPT

Selects Lo Q-RPT with all previous settings for that Q-RPT.

```
Active A160K      Lo
kPa   60g/160a
```

SECOND [RANGE] SELECTION: HI Q-RPT

Selects Hi Q-RPT with all previous user settings for that Q-RPT.

```
Active A160K      Hi
kPa   60g/160a
```


THIRD [RANGE] SELECTION: SHORTCUT TO AIRSPEED AT VARYING ALTITUDE

Selects Hi Q-RPT in absolute, differential measurement mode (**<Hd>**) with RPT display in which differential pressure (Qc) is displayed on top line and Lo Q-RPT (Ps) on bottom line. Unit of measure is default or last selected airspeed and altitude units.

```
Shortcut to airspeed
& varying altitude
```

From the third **[RANGE]** display, pressing **[RANGE]** again returns to the first display.

Q-RPT full scale limits are given in the pressure or air data unit that is currently active for that range.

Pressing [+/-] from the MAIN RUN screen provides a shortcut to a momentary view of the active Q-RPT.

Many RPM4-AD settings and functions are Q-RPT specific. See Table 5 for identification of Q-RPT specific settings.

For best metrological performance, vent the RPM4-AD Q-RPT before changing active Q-RPT.

3.3.2 [UNIT]

❍ PURPOSE

To select the unit of measure in which RPM4-AD displays measured values.

The units of measure available under the [UNIT] key depend upon the active Q-RPT and measurement mode. Seen Section for 3.3.1 information on selecting the active-Q-RPT and Section 3.3.3 for information on setting measurement mode (absolute, gauge, differential)

To change the unit of altitude displayed on the RPM4-AD bottom line with HL, absolute or Hi, absolute + differential (Hd) Q-RPT active, select [DISPLAY], <4PRT> to select the altitude unit for the bottom line display with HL, absolute or Hi, absolute + differential Q-RP Tactive. 3.3.6.4.

❍ PRINCIPLE

RPM4-AD allows the unit of measure in which measured values are displayed to be changed.

RPM4-AD supports a variety of standard pressure units of measure, air data scaling factors and user defined units. To simplify operation, quick access to six units is made available under the **[UNIT]** key. The default units and the units that are supported depend on which

RPM4 Q-RPT is active and the active measurement mode. See Table 7 or Table 8 for definition of the types of units of measure are available by Q-RPT and measurement mode. The choice of six units displayed by the **[UNIT]** function can be customized by the user (see Section 3.5.6).

Table 7. Available unit of measure types by active Q-RPT and measurement mode, RPM4-AD A160K/A160K (rotary wing)

-RPT	MEASUREMENT MODE	UNIT TYPE			
		PRESSURE	ALTITUDE	AIRSPEED	USER
Hi and Lo parallel **<HL>**	Absolute **<a>**	Yes[1]	**Yes**[1]	No	Yes[1]
	Gauge, negative gauge **<g>**	Yes[1]	No[2]	**Yes**[1,2]	Yes[1]
Hi **<Hi>, <Hd>**	Absolute **<a>**	Yes	No	No	Yes
	Gauge, negative gauge **<g>**, differential **<d>**	Yes	No[2]	**Yes**[2]	Yes

1. Best measurement uncertainty .
2. Altitude measured by Lo Q-RPT can be displayed while measuring airspeed.

Table 8. Available unit of measure types by active Q-RPT and measurement mode, RPM4-AD A350K/A160K (fixed wing)

Q-RPT	MEASUREMENT MODE	UNIT TYPE			
		PRESSURE	ALTITUDE	AIRSPEED	USER
Lo **<Lo>**	Absolute **<a>**	Yes	**Yes**	No	Yes
	Gauge, negative gauge **<g>**	Yes	No	No	Yes
Hi **<Hi>, <Hd>**	Absolute **<a>**	Yes	No	No	Yes
	Gauge, negative gauge **<g>**, differential **<d>**	Yes	No[1]	**Yes**[1]	Yes

1. Altitude measured by Lo Q-RPT can be displayed while measuring airspeed.

Internally, RPM4-AD always operates in Pascal (Pa), the SI unit of pressure. Values expressed in other units of measure are obtained by applying conversion or scaling factors to Pascal. (see Section 7.2).

❍ OPERATION

To change the active unit of measure for a Q-RPT and measurement mode, press **[UNIT]** from the MAIN RUN screen while the Q-RPT and measurement mode is active (see Table 9 or Table 10 for default units of measure by active Q-RPT and measurement mode). The display is (actual units shown specific to Q-RPT and measurement mode):

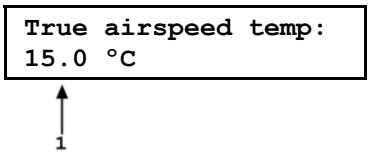
```
1kPa 2inHg 3psi
4mbar 5m   6ft
```

The cursor is on the number corresponding to the active pressure unit of measure for the active range.

To change the pressure unit of measure, select the desired unit. Making the selection returns to the MAIN RUN screen with the selected unit active.

If the unit of measure selected is a true airspeed (unit label in upper case, e.g. KTS), the temperature used in airspeed calculation must be specified. When the unit is selected, the display is:

1. Entry field for temperature to be used in true airspeed calculation.



Enter the desired temperature value. The default value for true airspeed air temperature is set in **[SPECIAL]**, **<6Punit>** when the unit is set up (see Section 3.5.6).

In RPM4-AD displays, calibrated airspeed units are represented in lower case (e.g. kts) and true airspeed units are represented in upper case (e.g. KTS).

Table 9. Default **[UNIT]** choices by active Q-RPT and measurement mode, RPM4 A160K/A160K (rotary wing)

Q-RPT	MEASUREMENT MODE	UNIT					
		#1	#2	#3	#4	#5	#6
Hi and Lo parallel **<HL>**	Absolute **<a>**	kPa	inHg	psi	mbar	m	ft
	Gauge, negative gauge **<g>**	kPa	inHg	psi	inWa	kts	km/h
Hi **<Hi>, <Hd>**	Absolute **<a>**	kPa	inHg	psi	mbar	hPa	mmHg
	Gauge, negative gauge **<g>**, differential **<d>**[1]	kPa	inHg	psi	inWa	kts	km/h

1. Altitude measured by Lo Q-RPT can be displayed while measuring airspeed.

Table 10. Default **[UNIT]** choices by active Q-RPT and measurement mode, RPM4 A350K/A160K (rotary wing)

X	MEASUREMENT MODE	UNIT					
		#1	#2	#3	#4	#5	#6
Lo **<Lo>**	Absolute **<a>**	kPa	inHg	psi	mbar	m	ft
	Gauge, negative gauge **<g>**	kPa	inHg	psi	inWa	mbar	hPa
Hi **<Hi>, <Hd>**	Absolute **<a>**	kPa	inHg	psi	mbar	m	ft
	Gauge, negative gauge **<g>**, differential **<d>**[1]	kPa	inHg	psi	inWa	kts	km/h

1. Altitude measured by Lo Q-RPT can be displayed while measuring airspeed.

The pressure unit of measure selected is Q-RPT and measurement mode specific. For that Q-RPT and measurement mode, all functions and settings are represented in the current unit of measure for that range. However, certain internal and/or metrological functions (e.g., Q-RPT calibration coefficients) are always represented in Pa regardless of the current unit selection.

See Section 7.2 for information on the unit of measure conversion factors used by RPM4-AD.

If the pressure unit selected is inWa (inches of water), the reference temperature for water density must we specified in a separate menu (choices are 4°C, 20°C 60°F). No reference temperature selection is necessary for the unit mmWa as the only reference temperature commonly used for mmWa is 4 °C.

The default units of measure available under the UNIT function depend on the active Q-RPT and measurement mode (see Tables Table 9 and Table 10). The choice of six units available under the UNIT function can be customized from a wider selection by the user (see Section 3.5.6). The units available under the UNIT function can be reset to default (see Section 3.5.9.2).

3.3.3 [MODE]

❍ PURPOSE

To set the measurement mode (absolute, gauge, negative gauge or differential) for the active Q-RPT.

For information on selecting the active Q-RPT, see Section 3.3.1. For selecting the unit of measure, see Section 3.3.2.

❍ PRINCIPLE

RPM4-AD supports simple, one-step switching between different measurement modes:

Absolute — Measures pressure relative to vacuum (zero is hard vacuum). Range is from zero absolute to full scale.

Absolute mode is used to measure altitude, without airspeed (see Section 3.2.3).

Gauge — Measures pressure relative to atmosphere (zero is ambient pressure). Range is from zero gauge to full scale, full scale must be greater than zero.

Gauge mode is used to measure airspeed at altitude corresponding to ambient atmospheric pressure (see Section 3.2.3).

Negative Gauge — Measures pressure relative to atmosphere (zero is ambient pressure). Range is positive and negative from zero, negative to minus one atmosphere and positive to full scale.

Negative gauge mode does not support air data measurements.

Differential — Measures the difference between the Hi and the Lo Q-RPT (Differential = Hi – Lo). Differential measurement mode is only available when the Hi Q-RPT (**<Hi>**) is active and the measurement mode is absolute. Differential mode is selected "on top of" the Hi Q-RPT absolute measurement mode.

Differential mode is selected to measure airspeed and altitude simultaneously with varying altitude. Differential mode allows true Ps and Pt operation (see Section 3.2.3).

Measurement mode selection is Q-RPT specific.

❍ OPERATION

See Section 3.2.6 for information on differential mode operation (airspeed at varying altitude). Differential mode operation is only available when the Hi Q-RPT is active and already in absolute measurement mode.

To change the measurement mode for the active Q-RPT, press **[MODE]** from the MAIN RUN screen. The display depends upon the Q-RPT that is active.

If the Hi Q-RPT (**<Hi>**) is active, all four measurement modes are visible. Use **<1abs>** + **<4dif>** to measure altitude and airspeed simultaneously (see Section 3.2.3).

```
Meas mode: 1abs
2gage 3neg gage 4dif
```

If the parallel mode Q-RPT (**<HL>**) (RPM4-AD 160K/A160K only) or the Lo Q-QRPT (**<Lo>**) (RPM4-AD 350K/A160K only) is active, differential mode is not available. Use **<1abs>** to measure altitude only or **<2gage>** to measure airspeed at altitude corresponding to current atmospheric pressure (see Section 3.2.3.1).

```
Measurement mode:
1abs 2gage 3neg gage
```

Certain RPM4-AD settings, including AutoZ ON/OFF (see Section 3.5.1) are Q-RPT AND measurement mode specific. See Table 5 for a listing of settings and what they are specific to.

3.3.3.1 DIFFERENTIAL MEASUREMENT MODE OPERATION

Differential mode operation is only available with the Hi Q-RPT (<Hi>) active (see Section 3.2.1) in absolute measurement mode. Differential mode supports simultaneous measurement of air speed and altitude with varying altitude (Ps, Pt, Qc) (see Section 3.2.3).

See Section 3.2.6 for differential measurement mode principle of operation.

To activate differential measurement mode, first be sure the Hi Q-RPT is active and in absolute measurement mode. If necessary, use **[RANGE]** to select the **<Hi>** Q-RPT (see Section 3.3.1) and **[MODE]** to select absolute measurement mode. Then, with the Hi Q-RPT active, press **[MODE]** from the MAIN RUN screen.

The cursor is on the base measurement mode, which should be **<1abs>**. If differential mode is already active, the cursor is on **<1abs>** and **<4dif>**.

```
Meas mode: 1abs
2gage 3neg gage 4dif
```

The base pressure measurement mode, absolute, is the line pressure mode for the differential pressure (altitude when differential unit is airspeed). If necessary, change the base pressure measurement mode to **<1abs>**.

To activate differential measurement mode, select **<4dif>**. Operation returns to the MAIN RUN screen. The Q-RPT identifier in the top right hand corner of the MAIN RUN screen changes from **<Hi>** to **<Hd>**. AutoZero should always be run when differential measurement mode is initiated (see Section 3.3.9.3) or when the line pressure (pressure on the Lo Q-RPT (Ps) is changed.

When differential mode is activated, AutoZ should be run at the line pressure (altitude) with zero differential pressure applied to eliminate the zero error on differential pressure due to the initial disagreement of the Hi and Lo Q-RPTs (see Section 3.3.9.3).

When differential mode is active, the Q-RPT position indicator in the upper right hand corner of the MAIN RUN screen and other displays is <Hd> instead of <Hi> (see Section 3.2.1, Table 4).

The following operating conditions are specific to differential mode:

MAIN RUN screen measured pressure display The display of measured pressure in the MAIN RUN screen, top line, is the difference between the Hi and the Lo Q-RPTs (Hi – Lo) with a differential mode AutoZ correction (see Section 3.5.1). The measurement mode indicator is **<d>**. The Q-RPT position indicator is **<Hd>**.

Default DISPLAY function The default display function is RPT with the Lo Q-RPT displayed on the bottom display line (see Section 3.3.6.4). This allows the line pressure (Lo Q-RPT indication) to be viewed simultaneously with the differential pressure, and altitude measured by the Lo Q-RPT to be viewed while displaying air speed. The Lo Q-RPT altitude unit of measure is set in the RPT DISPLAY function (see Section 3.3.6.4). All other DISPLAY functions (Average, Rate, Deviation, HiLo, Freeze) apply to the differential pressure.

SDS function [SDS] key operation to OPEN SDS opens SDS of both the Hi and Lo Q-RPTs simultaneously (see Section 3.3.8.1). Overpressure is driven by the pressure range of the Lo Q-RPT.

AutoZ function AutoZ manages zeroing of differential mode and is intended to “tare” the two Q-RPTs at a common line pressure (see Section 3.3.9.3). In air data measurements, the line pressure is the altitude. AutoZ should always be run when the altitude is changed.

Leak Check function The leak check function uses the differential mode measurement (see Section 3.3.5).

Head function The head function applies to the differential pressure (see Section 3.3.7).

UL function The UL limits apply to positive and negative differential pressure (see Section 3.4.4) and the default is the maximum value of the differential pressure. Both the Lo and Hi Q-RPT based measurement mode ULs also remain active. The Hi Q-RPT UL provides an upper limit for the maximum pressure on the Hi side of the differential pressure. Exceeding the differential and/or absolute mode Hi Q-RPT UL causes the display of differential pressure to flash. The Lo Q-RPT UL provides an upper limit for the line pressure.

3.3.4 [AUTORANGE]

This feature is not used in RPM4-AD models.

3.3.5 [LEAK CK]/RATE OF CHANGE MEASUREMENT

❍ PURPOSE

To run an automated leak check routine that measures the leak rate of the system connected to the RPM4-AD active **TEST** port(s). Also used to measure average rate of change over a specified time period as required to evaluate the rate of change of altitude set by an air data test set.

❍ PRINCIPLE

The LEAK CHECK function is provided as a means of checking and quantifying the leaks that may be present in the system connected to the RPM4's active Q-RPT **TEST** port(s). It is also used to measure rate of change of altitude over a specified time period (rate of climb).

The principle of the LEAK CHECK function for measurement of a leak is the measurement of the natural decrease or increase of pressure in a fixed volume over time. The LEAK CHECK function allows a leak check time to be set. The total pressure change and the average rate of change over the leak check time are calculated and displayed.

The LEAK CHECK function also measures average rate as required to evaluate the rate of change of altitude set by an air data test set. To use the function in this way, set the desired rate measurement time period, then set the rate with the air data test set. When ready, press **[ENT]** on the RPM4-AD to start the measurement.

In differential pressure measurement mode (see Section 3.2.6), the leak check measurement is based on the measurement of the differential pressure.

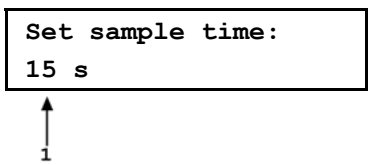
❍ OPERATION

To run a leak check, first set the pressure to the desired pressure. To verify a rate of change set by another device (such as an air data test set), first set the rate of change on the device.

Changing the pressure in a test system causes adiabatic temperature changes in the pressurized medium that need to have dissipated before a valid leak measurement can be made. In general, a 0.5 to 1 minute wait before running a leak check is adequate to allow the adiabatic temperature change to dissipate and valid leak measurements to be made. However, stabilization time may be longer as volume and pressure increases.

To access the LEAK CHECK function, press **[LEAK CHECK]** from the MAIN RUN screen. Select **<1run>** to run a leak test or rate of change measurement. The display is:

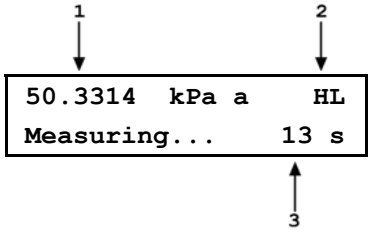
1. Edit field for the time over which the rate will be determined, in seconds.



Edit the rate measurement time if desired (minimum 1, maximum 999 seconds) and press **[ENT]**.

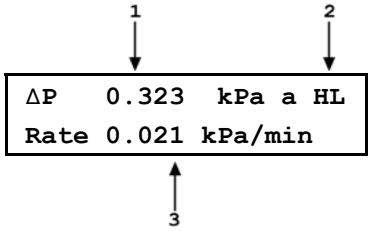
Press **[ENT]** again when ready to start the test. The test display is:

1. Standard MAIN RUN screen first line showing measured pressure.
2. Active Q-RPT position indicator
3. Indication that rate measurement test is running and countdown of time remaining.



[ESC] can be used to abort the test. **[ENT]** while the test is running restarts the measurement timer. When the timer countdown has completed, RPM4-AD beeps three times and the leak results screen is displayed:

1. Total pressure change from start to finish of measurement time.
2. Indicator of Q-RPT used to run the test.
3. Average rate of change of pressure over the leak check time period (ΔP/time in minutes).



From the test results screen, press **[ENT]** to restart the timer and repeat the test.

Press **[ESC]** to return to leak check main menu and exit to the MAIN RUN screen.

To view the results of the most recently completed test, press **<2view>**. If NO test data is stored (i.e., if the RPM4-AD has never run a leak test or a reset has cleared previous results), the results screen displays **<Data NOT available>** briefly and returns to MAIN RUN screen. Press **[ENT]** or **[ESC]** to return to the MAIN RUN screen.

Leak check is Q-RPT specific in the sense that a leak check is run using the active Q-RPT. However, only one set of leak check results is maintained in memory and each leak test completed overwrites the memory. View leak check always shows the results of the last test run regardless of the Q-RPT that is now active. The results screen includes the Q-RPT indicator to indicate the Q-RPT with which the test was run.

3.3.6 [DISPLAY]

❍ PURPOSE

To select, from a variety of choices, the information that is displayed on the second line of the RPM4-AD main run screen.

❍ PRINCIPLE

RPM4-AD supports a variety of advanced measurement functions that are displayed on the second (bottom) line of the RPM4-AD main run screen. In summary, the available display functions are:

AVERAGE Calculates the average measurement over a user specified period of time and displays the average, the standard deviation about the mean and a countdown in seconds to the next average (see Section 3.3.6.1). This function is often used to filter out pressure noise in an unstable system. The magnitude of the noise is quantified by the standard deviation about the mean. A second Avg screen allows the instantaneous pressure values to be viewed during an averaging cycle.

RATE Calculates and displays the current rate of change of pressure, altitude or airspeed in current unit of measure per second or per minute (see Section 3.3.6.2). This function is a useful indication of the stability of the pressure being measured. It is often used as an indication of positive or negative leak rate and as a go/no go criterion of when to take data when comparing RPM4-AD and a device under test, for example in a calibration. Rate is used by the Ready/Not Ready function to determine when a Ready condition exists (see Section 3.2.4). To measure rate of change over a period of time, use the LEAK CHECK function (see Section 3.3.5).

DEVIATION Continuously calculates and displays the difference between the value measured by RPM4-AD and a target value entered by the user (see Section 3.3.6.3). This function is useful in monitoring the evolution of pressure around and/or away from a desired set point.

RPT Allows measurement from the two Q-RPTs to be displayed simultaneously (see Section 3.3.6.4). This function can be used to monitor two separate pressures simultaneously. It is particularly useful when the measurement unit is airspeed to simultaneously observe the value of altitude measured by the Lo Q-RPT.

HI/LO Records and displays maximum and minimum values measured (see Section 3.3.6.5). This function is used to keep track of the minimum and maximum pressure observed in a system over a period of time or to monitor if a pressure min/max limit has been exceeded..

FREEZE Captures and displays the value measured by the active Q-RPT of RPM4-AD when the **[ENT]** key is pressed (see Section 3.3.6.6). This function is useful to record the pressure present at the time of an operator observed trigger event, for example when the needle of an analog indicator was on the nominal point or when a switch activates.

CLEAN Blanks out the second line of the display (see Section 3.3.6.7). This function is used when a simple display of pressure measured by the RPM4-AD active Q-RPT with minimal additional information is desired.

❍ OPERATION

To set the DISPLAY function press **[DISPLAY]** from the MAIN RUN screen.

The display is:

```
1avg 2rate 3dev 4RPT
5HiLo 6freeze 7clean
```

The cursor is on the active DISPLAY function. Selecting a display function returns to the MAIN RUN screen with the selected function active.

Display menu choices include:

<1avg> Display average pressure and standard deviation. Specify averaging time period (see Section 3.3.6.1).

<2rate> Display rate of change of measured value (see Section 3.3.6.2).

<3dev> Display deviation of the measured value from a target value and specify the target value (see Section 3.3.6.3).

<4RPT> Display the measurement of a Q-RPT other than the active Q-RPT (see Section 3.3.6.4).

<5HiLo> Display the maximum and minimum values measured by the active Q-RPT since HiLo reset (see Section 3.3.6.5).

<6freeze> Capture and display the value measured by the active Q-RPT when **[ENT]** is pressed
(see Section 3.3.6.6).

<7clean> Leave the second line of the display blank (see Section 3.3.6.7).

The DISPLAY selection is Q-RPT specific. A DISPLAY selection made in one Q-RPT does not apply to other Q-RPTs.

The default DISPLAY function is Rate which causes the second line of the display to show "R" followed by the current rate of change of pressure in current pressure units per minute or per second. In differential mode (<Hd>), the default DISPLAY function is RPT which shows the measurement of the Lo Q-RPT .

3.3.6.1 AVG (AVERAGE)

❍ PURPOSE

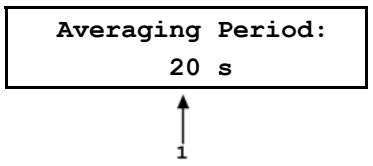
To activate the Average DISPLAY and/or adjust the period of time over which averaging occurs.

See Section 3.3.6. ❍ Principle.

❍ OPERATION

To access the Average DISPLAY, press **[DISPLAY], <1Avg>.** The display is:

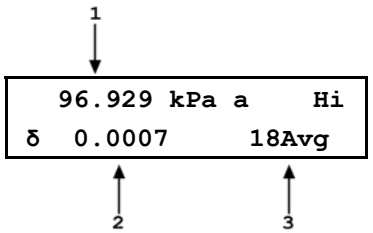
1. Edit field for averaging period in seconds. Default is 20. Minimum 1, maximum 999.



Edit the averaging time period if desired. Pressing **[ENT]** returns to the MAIN RUN screen with the Average DISPLAY active.

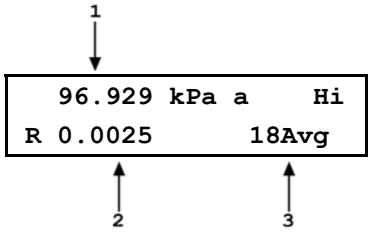
With the Average DISPLAY active the MAIN RUN screen is:

1. Average measured over last completed averaging period.
2. Standard deviation of last completed averaging period.
3. Countdown in seconds until completion of on-going averaging period.



The Average DISPLAY has a second screen that allows the instantaneous pressure readings to be viewed while an averaging cycle is running. The instantaneous Average screen is:

1. Instantaneous pressure values at RPM4's normal update rate.
2. Current rate of change of pressure in pressure units/second.
3. Countdown in seconds until completion of on-going averaging period.



The **[+/-]** key toggles between the MAIN RUN Average screen and the instantaneous values Average screen.

Pressing [ENT] while in the Average DISPLAY aborts the current averaging period and causes a new one to begin. [ENT] can thus be use to trigger a new averaging period on demand.

In the Average DISPLAY the Ready/Not Ready indication applies to the result of the previous averaging period (see Section 3.2.4). <Ready> indicates that all readings during the previous averaging period met the stability criterion. <Not Ready> indicates that one or more readings were outside of the stability criterion.

Changing the pressure unit of measure, measurement mode or range while the averaging screen is active, starts a new averaging period.

To go to a DISPLAY other than Average, press [DISPLAY] and make a new DISPLAY choice (see Section 3.3.6).

3.3.6.2 Rate

❍ **PURPOSE**

To activate the Rate DISPLAY.

See Section 3.3.6 [DISPLAY], ❍ Principle.

❍ **OPERATION**

To activate the Rate DISPLAY press **[DISPLAY]**, **.** The display is:

Select whether the rate should be displayed in unit per minute or unit per second. The default is per minute.

```
Display rate per:
1minute 2second
```

When the selection is made, operation returns to the MAIN RUN screen with the Rate DISPLAY active.

With the Rate DISPLAY active the MAIN RUN screen is:

1. Current rate of change of in current unit of measure per minute (**</m>**) or second (**</s>**). The default is per minute.

```
  20473.6 ft a    HL
R 378.3 /m
```

1

The Rate DISPLAY is different and separate from the stability setting which is used to set the stability criterion on which the Ready/Not Ready indication is based (see Sections 3.4.3 and 3.2.4). The Rate DISPLAY only causes the current rate of change to be displayed and has NO affect on the stability setting or the Ready/Not Ready condition.

The Rate DISPLAY is the default display except in differential measurement mode in which the default DISPLAY is RPT so the measurement of the Lo Q-RPT is displayed.

To go to a DISPLAY other than Rate, press [DISPLAY] and make a new DISPLAY choice (see Section 3.3.6).

3.3.6.3 Dev (Deviation)

❍ **PURPOSE**

To activate the Deviation DISPLAY and/or set the deviation target value.

See Section 3.3.6 [DISPLAY], ❍ Principle.

❍ **OPERATION**

To activate the Deviation DISPLAY press **[DISPLAY]**, **<3Dev>**. The display is:

```
Target:
100.000 kPa a
```

Edit the desired target value. Pressing **[ENT]** returns to the MAIN RUN screen with the Deviation DISPLAY active using the entered target value.

The target value is the value from which deviations (D) are measured by the Deviation DISPLAY following:

D = current value - target value

With the Deviation DISPLAY active the MAIN RUN screen is:

1. Deviation of current measured value from the target value.
2. Target value.

```
  99.1135 kPa a  zHL
D -0.8865  T100.000
```

1 2

Pressing [ENT] from the MAIN RUN screen when the Deviation DISPLAY is active goes directly to the Target editing screen. This allows the target value to be changed without going through the DISPLAY menu.

If the pressure measurement unit or mode is changed while the Deviation DISPLAY is active the target value remains at the same numerical value. It is NOT converted.

To go to a DISPLAY other than Deviation, press [DISPLAY] and make a new DISPLAY choice (see Section 3.3.6).

3.3.6.4 RPT

❍ PURPOSE

To activate the RPT DISPLAY.

See Section 3.3.6, ❍ Principle.

The RPT DISPLAY is the default DISPLAY in differential measurement mode (<Hd>) (see Section 3.2.6).

❍ OPERATION

For the sake of clarity, when describing the RPT DISPLAY, the Q-RPT displayed on the top line of the display when the RPT function is selected is referred to as the "active" Q-RPT. The other Q-RPT to be displayed on the second (bottom) line of the RPM4-AD display is referred to as the "inactive" Q-RPT. It is "inactive" in the sense that all RPM4-AD functions and settings such as UNIT and RES still apply to the "active" Q-RPT. In differential pressure measurement mode (<Hd>), the Lo Q-RPT is always the "inactive" Q-RPT. In parallel measurement (<HL>), the Hi or the Lo Q-RPT may be the "inactive" Q-RPT.

To activate the RPT DISPLAY, press **[DISPLAY]**, **<4RPT>**.

If the active measurement unit is NOT an airspeed unit, operation returns to the MAIN RUN screen with the inactive Q-RPT displayed on the display's bottom line and the settings (unit of measure, resolution) of the inactive Q-RPT are the same as for the active Q-RPT.

If the active measurement unit IS an airspeed unit, the display on the bottom line is altitude so that airspeed and altitude can be viewed simultaneously. When **<4RPT>** is selected, the altitude unit must be specified. The display is:

Select the desired unit for the second line display of altitude.

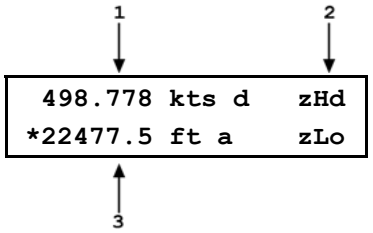
```
Lo Q-RPT altitude
unit: 1ft 2m
```

After the altitude unit selection, operation returns to the main run screen with the RPT display active.

When RPM4-AD A160K/A160K is in parallel (<HL>) mode in which both Q-RPTs measure the same pressure in parallel, if the active unit is airspeed the bottom line display of altitude is obtained using the last measurement of atmospheric pressure made by the Lo Q-RPT corrected by the change in atmospheric pressure since the last measurement as measured by the on-board barometer. If the active unit is NOT airspeed, the Q-RPT to display on the lower display line (<Hi> or <Lo>) must be specified.

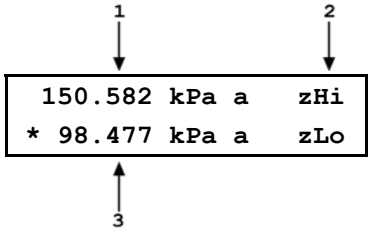
When the RPT DISPLAY is active and the unit of measure for the active Q-RPT IS an airspeed unit, the MAIN RUN screen is:

1. Active Q-RPT measurement.
2. Active Q-RPT indicator.
3. Altitude at which airspeed is being measured.



When the RPT DISPLAY is active and the unit of measure for the active Q-RPT is NOT an airspeed unit, the MAIN RUN screen is:

1. Active Q-RPT measurement.
2. Active Q-RPT indicator.
3. Inactive Q-RPT measurement.



If SDS Self Defense System (see Section 3.2.8) is CLOSED on the inactive Q-RPT when the RPT DISPLAY is activated, SDS can be OPENED on the inactive Q-RPT using [SPECIAL], <4SDS>, <1temp open/close> (see Section 3.5.4). In differential measurement mode, SDS is be opened simultaneously on both Q-RPTs using [SDS] (see Section 3.3.8).

The RPT DISPLAY is the default display in differential measurement mode.

When the RPT display is active, executing a Q-RPT change to the inactive Q-RPT makes the inactive Q-RPT the active Q-RPT. The DISPLAY defaults back to Rate (Section 3.3.6.2).

To go to a DISPLAY other than RPT, press [DISPLAY] and make a new DISPLAY choice (see Section 3.3.6).

3.3.6.5 Hi/Lo

❍ PURPOSE

To activate the Hi/Lo DISPLAY.

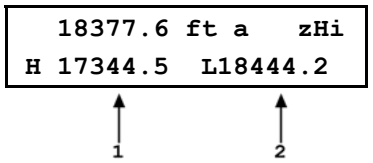
See Section 3.3.6, ❍ Principle..

❍ OPERATION

To activate the Hi/Lo DISPLAY press **[DISPLAY]**, **<5Hi/Lo>**. Pressing **<5Hi/Lo>** resets the Hi/Lo values and returns to the MAIN RUN screen with the Hi/Lo DISPLAY active.

With the Hi/Lo DISPLAY active the MAIN RUN screen is:

1. Highest measurement observed since Hi/Lo reset.
2. Lowest measurement observed since Hi/Lo reset.



The Hi/Lo values change each time a new Hi or Lo pressure is observed.

The Hi/Lo record can be reset at any time by pressing [ENT]. This allows a Hi/Lo reset without going back through the DISPLAY menu.

If the measurement unit or mode is changed while the Hi/Lo DISPLAY is active, Hi/Lo resets.

To go to a DISPLAY other than Hi/Lo, press [DISPLAY] and make a new DISPLAY choice (see Section 3.3.6).

3.3.6.6 Freeze

❍ **PURPOSE**

To activate the Freeze DISPLAY.

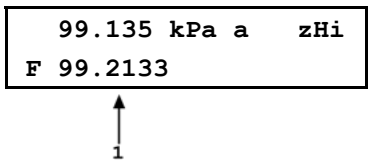
See Section 3.3.6, ❍ Principle.

❍ **OPERATION**

To activate the Freeze DISPLAY press **[DISPLAY]**, **<6Freeze>**. Pressing **<6Freeze>** returns to the MAIN RUN screen with the Freeze DISPLAY active.

With the Freeze DISPLAY active the MAIN RUN screen is:

1. Pressure measured by active Q-RPT when [ENT] was pressed (displays 0.00 by default when Freeze DISPLAY is first activated).



Pressing **[ENT]** causes the current measurement of the active RPM4-AD Q-RPT to be captured and displayed.

If the measurement unit or mode is changed while the Freeze DISPLAY is active, the Freeze value defaults back to zero.

To go to a DISPLAY other than Freeze, press [DISPLAY] and make a new DISPLAY choice (see Section 3.3.6).

3.3.6.7 Clean

❍ **PURPOSE**

To activate the Clean DISPLAY.

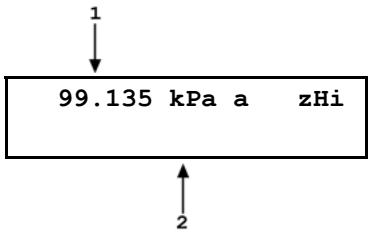
See Section 3.3.6, ❍ Principle.

❍ **OPERATION**

To activate the Clean DISPLAY press **[DISPLAY]**, **<7Clean>**. Pressing **<7Clean>** returns to the MAIN RUN screen with the Clean DISPLAY active.

With the Clean DISPLAY active the MAIN RUN screen is:

1. Conventional MAIN RUN screen first line.
2. "Clean" second line.



To go to a DISPLAY other than Clean, press [DISPLAY] and make a new DISPLAY choice (see Section 3.3.6).

3.3.7 [HEAD]

❍ **PURPOSE**

To cause a pressure head correction to be added to or subtracted from the pressure measured by the RPM4-AD in order to predict the pressure at a height other than the RPM4's reference level.

❍ **PRINCIPLE**

RPM4-AD measures gauge, absolute or differential pressure at the height of the rear panel **TEST** ports. Frequently, when performing a calibration or test, the device or system under test is at a different height than the RPM4's **TEST** ports. This difference in height, frequently called **head**, can cause a significant difference between the pressure measured by the RPM4-AD at the height of its **TEST** ports and the pressure at the device under test which is at a different height. In this case, it is useful to make a head correction to the pressure measured by the RPM4-AD in order to predict the pressure actually applied present a different height.

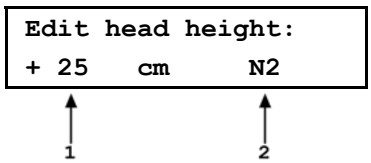
RPM4-AD can accurately determine "head" pressures for nitrogen, helium and air as the pressurized medium. In calculating the head value, standard gravity (9.80665 m/s^2) is used. Gas densities are calculated from the selected gas's standard density correcting for temperature of 20°C and the measured pressure using the gas's compressibility factor

The **[HEAD]** function key is used to specify the height difference between the RPM4-AD **TEST** ports and another height. Entering a height of zero turns the function off. The height unit and the test gas are specified by pressing **[SPECIAL]**, **<3Head>** (see Section 3.5.3).

Specifying the head height within ± 2.5 cm (1 in.) is adequate to assure that, even in the worst case, the uncertainty on the head correction will be insignificant relative to the tolerance on the pressure measurement.

❍ OPERATION

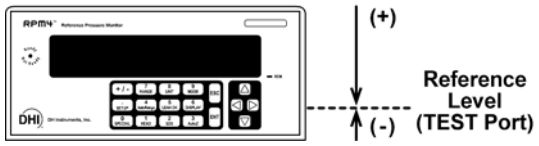
To access the HEAD function, press **[HEAD]**. The display is:



1. Edit field for head height.
2. Test gas currently specified for the head correction.

Edit the head height to the desired value. Press **[ENT]** to return to the MAIN RUN screen with the new head correction active. Press **[ESC]** to return with no changes.

The reference height of the RPM4-AD pressure measurement is the middle of the RPM4-AD TEST ports. The head height should be entered as a positive value if the device or system under test is higher than the RPM4-AD and negative if it is lower.



The HEAD function is NOT Q-RPT specific. The HEAD ON or OFF status and settings remain the same as active Q-RPT is changed.

When a head correction is being applied, it is indicated by <h> in the top line of the MAIN RUN screen (see Section 3.1.1). When the head correction is zero, the <h> is not shown.

To change units of head height between inches and centimeters and to change the test gas species, use [SPECIAL], <3head> (see Section 3.5.3).

3.3.8 [SDS] (SELF DEFENSE SYSTEM)

❍ PURPOSE

To CLOSE SDS on all reference pressure transducers (Q-RPTs). To OPEN SDS on the active Q-RPT/**TEST** port.

The [SDS] key should be used with care to avoid accidentally over pressuring a Q-RPT. Always double check to ensure that the pressure applied to the Q-RPT's TEST port is lower than the Q-RPT's maximum pressure before OPENING SDS.

SDS can be set to permanently be OPEN as if no SDS were installed (see Section 3.5.4.2).

❍ PRINCIPLE

SDS is a self defense system to protect RPM4-AD Q-RPTs from overpressure. SDS CLOSES automatically to protect a Q-RPT that is not active. Activating an individual Q-RPT automatically CLOSES SDS on the other Q-RPT. Powering down the RPM4-AD or energizing it also CLOSES SDS on all Q-RPTs.

When SDS is CLOSED, the Q-RPT(s) is (are) isolated from the active **TEST** port and opened to the **VENT** port. SDS must be OPENED for the pressure applied to the **TEST** port to be measured. The **[SDS]** key is used to OPEN SDS.

The SDS function can also be used to CLOSE SDS as might be desired when leaving RPM4-AD at rest, when a possible overpressure situation is anticipated or anytime it is desirable to shut off the **TEST** port and vent the Q-RPT. Pressing **[SDS]** always CLOSES SDS.

See Sections 3.3.8.1 and 3.3.8.2 for information specific to SDS operation in differential and parallel measurement modes which are frequently used by RPM4-AD.

See Section 3.2.8 for general information on SDS and its principles and Section 5.6, for Q-RPT module schematics and valve states with SDS open and closed.

SDS closed is indicated by <SDS CLOSED> flashing in the current measured pressure display field. When SDS is closed, the Q-RPT is isolated from the TEST port and connected to the VENT port.

❍ OPERATION

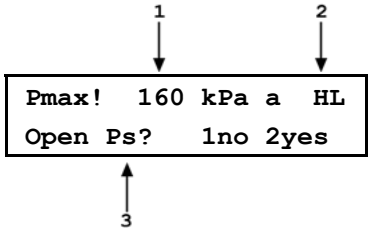
Though the SDS self defense system includes features to protect Q-RPTs against overpressure, SDS should NOT be considered a fail-safe overpressure protection system. SDS cannot guarantee that overpressure damage will NOT occur. SDS closing automatically may protect a Q-RPT in case of accidental overpressure but conventional measures for overpressure protection should always be used. Damage to Q-RPTs due to overpressure is NOT covered by the RPM4-AD product warranty even when SDS is present and ON.

The maximum pressure that should be applied to an RPM4-AD TEST(+) port when SDS is CLOSED is 10 MPa (1 500 psi).

Use **[SDS]** to OPEN SDS if it is CLOSED for the active Q-RPT(s) and/or to CLOSE SDS for the active and inactive Q-RPT.

When **[SDS]** is pressed, there are three possible results, depending on whether SDS is ON (see Section 3.5.4.2), and whether SDS of the active Q-RPT is OPEN or CLOSED.

1. If the active **Q-RPT's SDS is "full time OFF"** (see Section 3.5.4.2): **<SDS is OFF and OPEN>** is displayed for 5 seconds and operation returns to the MAIN RUN screen.
2. If the **SDS on the active RPT is OPEN**: SDS is CLOSED and operation returns to the MAIN RUN screen.
3. If the **SDS on the active Q-RPT is CLOSED**: The OPEN SDS routine is presented. The display is :



1. Maximum acceptable pressure of active Q-RPT(s) (always absolute).
2. Position designator of Q-RPT for which SDS will be opened.
3. Indication of which **TEST** port(s) will be open-end when SDS is opened.

Check that the pressure applied to the indicated **TEST** port does NOT exceed the maximum acceptable value for the Q-RPT. Select **<1no>** to return to the MAIN RUN

screen without OPENING SDS, select **<2yes>** to OPEN SDS and return to the MAIN RUN screen with SDS OPEN (the active **TEST** port open).

Opening SDS with a pressure greater than Pmax! applied to the test port may cause overpressure damage to the Q-RPT(s).

In differential measurement mode, opening SDS acts simultaneously on BOTH the Ps and Pt TEST ports (see Sections 3.3.8.1).

In parallel measurement mode (HL Q-RPT), the active TEST port is the TEST(Ps) port in absolute measurement mode and the TEST(Pt) port in gauge measurement mode. Normal SDS operation using [SDS] opens and closes the active TEST port while the inactive test port is always closed. SDS temp open/close can be used to open SDS on the inactive TEST port.

The [SDS] key is also the [2] key which is pressed to select <2Yes> to OPEN SDS. Thus, SDS can be OPENED by two rapid presses of [SDS]. Use this feature to conveniently OPEN SDS but always check that the pressure connected the active TEST port does NOT exceed the Q-RPT(s) Pmax! before doing so.

When changing active Q-RPT, SDS is automatically CLOSED for the Q-RPT that is being changed from, leaving the inactive Q-RPT with SDS CLOSED.

The SDS valves can be controlled directly regardless of which Q-RPT is currently active (see Section 3.5.4).

SDS can be permanently opened so regular operation is as if SDS were not present (see Section 3.5.4.2).

3.3.8.1 SDS IN DIFFERENTIAL MEASUREMENT MODE

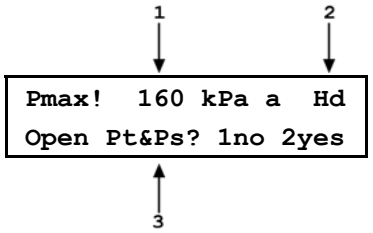
In differential measurement mode, opening SDS opens SDS for BOTH the Hi and Lo Q-RPTs (Ps and Pt TEST ports). Before opening SDS, be certain that the pressure applied to both the Ps and Pt TEST ports is less than the maximum pressure of TEST port's Q-RPT.

Differential measurement mode (see Section 3.2.6) makes measurements using the RPM4-AD's two Q-RPTs independently. In this mode, the function of the **[SDS]** key is adapted to facilitate dual Q-RPT operation. **[SDS]** can OPENS SDS on both the active an inactive Q-RPTs at the same time.

Pressing **[SDS]** always CLOSES any OPEN SDS, as it does in single Q-RPT mode operation. If both SDS are CLOSED, pressing SDS goes to the usual OPEN SDS routine which OPENS SDS for both Q-RPTs.

The display is :

1. Maximum acceptable pressure of the **Lo** Q-RPT (always absolute).
2. Position designator of active Q-RPT (**<Hd>** for differential mode).
3. Indication that opening SDS will open both the **Pt** and **Ps TEST** ports.



Check that the pressure applied to BOTH the **TEST** ports does NOT exceed the maximum acceptable value. Select **<1no>** to return to the MAIN RUN screen without OPENING SDS, select **<2yes>** to OPEN SDS for both Q-RPTs and return to the MAIN RUN screen with SDS OPEN (both Q-RPTs open to their **TEST** ports).

3.3.8.2 SDS IN PARALLEL MEASUREMENT MODE, RPM4-AD A160K/A160K ONLY

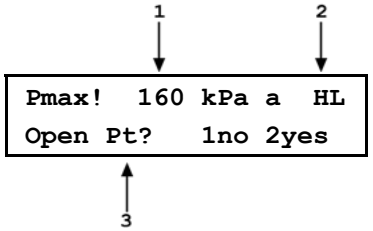
In parallel mode both Q-RPTs are connected together internally by the RPM4-AD's internal bypass valve (see Section 3.2.5). For gauge measurement mode, the active TEST port is the TEST(Pt) port. For absolute measurement mode, the active TEST port is the TEST(Ps) port. Opening SDS opens SDS for the TEST port that is used for the active measurement mode.

In parallel measurement mode (see Section 3.2.5), the RPM4-AD's two RPTs are connected to one **TEST** port by the internal bypass valve. Only one **TEST** port is used depending on the measurement mode. The **(Ps) TEST** port is used for absolute mode, the **(Pt) TEST** port is used for gauge mode. **[SDS]** OPENS and CLOSES SDS on the test port that is used, the other port is always kept CLOSED.

Pressing **[SDS]** always CLOSES any ON and OPEN SDS, as it does in single Q-RPT mode operation. However, if SDS for the active **TEST** port is CLOSED, pressing SDS goes to the usual OPEN SDS routine which will OPEN SDS for active **TEST** port.

The display is :

1. Maximum acceptable pressure of the **HL** Q-RPT (always absolute).
2. Position designator of active Q-RPT (**<HL>** in parallel mode.
3. Active **TEST** port on which SDS will be opened (**Pt** in gauge measurement mode, **Ps** in absolute measurement mode).



Check that the pressure applied to the active **TEST** port does NOT exceed the maximum acceptable value. Select **<1no>** to return to the MAIN RUN screen without OPENING SDS, select **<2yes>** to OPEN SDS and return to the MAIN RUN screen with SDS OPEN (both Q-RPTs open to the active **TEST** port).

3.3.9 [AUTOZ]

❍ PURPOSE

To run the AutoZ function that rezeros the active Q-RPT between full calibrations.

See Section 3.5.1, ❍ Principle for a full explanation of the AutoZ function.

❍ PRINCIPLE

Run AutoZ is the function by which the current Q-RPT reading is compared to a reference, $\mathbf{P_{std,0}}$, at atmospheric pressure to determine a new value of $\mathbf{P_{offset}}$. The value of $\mathbf{P_{offset}}$ is then used by AutoZ to automatically correct the Q-RPT for possible changes in zero over time (see Section 3.5.1, ❍ PRINCIPLE).

Running AutoZ in parallel mode (see Section 3.2.5) autozeros the Hi and Lo Q-RPTs simultaneously and independently. There are no Zoffset values specific to the HL Q-RPT.

See Section 3.3.9.1 to run AutoZ in gauge in negative gauge modes.

See Section 3.3.9.2 to run AutoZ in absolute mode.

See Section 3.3.9.3 to run AutoZ in differential mode.

3.3.9.1 [AUTOZ] IN GAUGE AND NEGATIVE GAUGE MODE

❍ PURPOSE

To “rezero” the active Q-RPT in gauge measurement mode.

See Section 3.5.1, ❍ Principle for a full explanation of the AutoZ function.

❍ OPERATION

For the AutoZ function key to run AutoZ, AutoZ must be turned ON for the active Q-RPT and measurement mode. AutoZ ON is indicated by <z> to the left of the Q-RPT designator on the first line of the MAIN RUN screen. AutoZ ON and OFF is set using [SPECIAL], <1AutoZ> (see Section 3.5.1). If AutoZ is OFF for the active Q-RPT, and measurement mode, <AutoZ is off…> is displayed when [AutoZ] is pressed.

Running AutoZ in or parallel mode (see Section 3.2.5) autozeros both the Hi and Lo Q-RPTs simultaneously.

To run AutoZ in gauge measurement mode, set gauge or negative gauge as the measurement mode (see Section 3.3.3) and press **[AutoZ]** from the MAIN RUN screen. **<Running gauge AutoZ>** is displayed briefly before returning to the MAIN RUN screen. To be sure the Q-RPTs are really open to zero gauge pressure, SDS may be closed to shut the Q-RPTs off from the **TEST** ports and open vent them to atmosphere.

Before running AutoZ in gauge mode, ensure that the pressure applied to the Q-RPT is truly zero gauge (atmospheric pressure). If running AutoZ in gauge mode results in a zero offset that RPM4-AD considers unusually large, <Confirm 0 gauge P!> is displayed when AutoZ is pressed. Check that zero gauge pressure is applied to the TEST port(s) and press ENTER to continue or ESCAPE to abort. To be sure the Q-RPTs are really open to zero gauge pressure, SDS may be closed to shut the Q-RPTs off from the TEST ports and open vent them to atmosphere.

Allow the RPM4-AD to stabilize at atmospheric pressure and ambient temperature for 1 to 2 minutes before running AutoZ in gauge mode.

3.3.9.2 [AUTOZ] IN ABSOLUTE MODE

❍ PURPOSE

To “rezero” the active Q-RPT in absolute measurement mode.

See Section 3.5.1, ❍ Principle for a full explanation of the AutoZ function.

❍ OPERATION

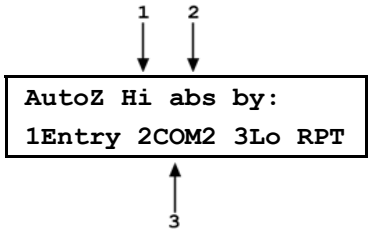
For the AutoZ function key to run AutoZ, AutoZ must be turned ON for the active Q-RPT and measurement mode. AutoZ ON is indicated by <z> to the left of the range designator on the first line of the MAIN RUN screen. AutoZ ON and OFF is set using [SPECIAL], <1AutoZ> (see Section 3.5.1). If AutoZ is OFF for the active range, and measurement mode, <AutoZ is off...> is displayed when [AutoZ] is pressed.

Running AutoZ in or parallel mode (see Section 3.2.5) autozeros both the Hi and Lo Q-RPTs simultaneously.

AutoZ cannot be run when the active unit of measure is an altitude unit.

To run AutoZ in absolute measurement mode, set absolute measurement mode (see Section 3.3.3) and press **[AutoZ]** from the MAIN RUN screen. The display is:

1. Active Q-RPT designator.
2. Current measurement mode (absolute).
3. Selection of source of $\mathbf{P_{std,0}}$ reference to which to AutoZ.



Selecting **<1Entry>** allows the value of $\mathbf{P_{std,0}}$ to be entered from the front panel keypad.

Selecting **<2COM2>** allows the value of $\mathbf{P_{std,0}}$ to be read automatically from another **DHI** RPMx connected to RPM4’s COM2 communications port.

Selecting **<3Lo RPT>** is shown only if the active Q-RPT is Hi. This selection allows the value of $\mathbf{P_{std,0}}$ for the Hi Q-RPT to be read automatically from the RPM4s Lo Q-RPT.

Allow the RPM4-AD to stabilize at atmospheric pressure and ambient temperature for 10 to 15 minutes before running AutoZ in absolute mode.

If running AutoZ results in a value of P_{offset} that is greater than ± 0.005 % FS of the span of the Q-RPT that is being AutoZeroed, the Q-RPT and/or the reference used as the source of $P_{std,0}$ may be out of tolerance or the AutoZ process may have been faulty. Before activating a new P_{offset} greater than ± 0.005 % FS of the active Q-RPT, check to be sure that both the Q-RPT and the reference were in good working order, properly vented to stable atmospheric pressure, at the same height, and reading in the same pressure units when AutoZ was run.

When the run AutoZ selection is made, if a HEAD correction is currently active (see Section 3.3.7) the head correction is momentarily disabled while running AutoZ to avoid "zeroing out" the head value.

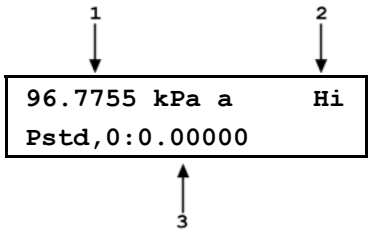
The value of P_{offset} is always displayed and entered in Pascal (Pa).

Run AutoZ by Entry

AutoZ by entry allows the value of $\mathbf{P_{std,0}}$ (see Section 3.5.1, ❍ PRINCIPLE) to be entered directly from the RPM4-AD front panel. This provides a simple way of AutoZeroing relative to an independent reference device such as a house barometer that does not interface directly with RPM4-AD.

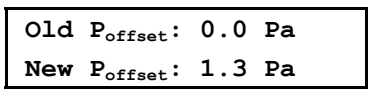
To access run AutoZ by entry press **[AutoZ]**, **<1entry>**. The display is:

1. Real time pressure reading (without head correction), pressure unit of measure and measurement mode of the active Q-RPT.
2. Active Q-RPT position designator.
3. Entry field for the value of $\mathbf{P_{std,0}}$. in the current pressure unit of measure.



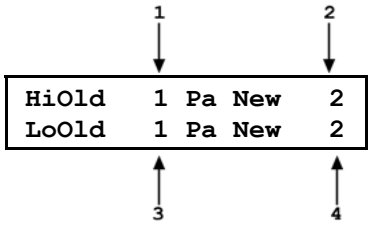
Enter the value of the AutoZ reference ($\mathbf{P_{std,0}}$) in the same unit of measure as the top line display and press **[ENT]**. RPM4-AD logs the reading and calculates a new AutoZ offset value. The next display is:

Press **[ENT]** to activate the new value of $\mathbf{P_{offset}}$ or **[ESC]** to start over with entry of a new AutoZ reference ($\mathbf{P_{std,0}}$) value.



If AutoZeroing the HL (parallel mode) Q-RPT the Old P_{offset}/New P_{offset} display shows the values for both Q-RPTs simultaneously:

1. Old value of **P_{offset}** in Pascal for the Hi Q-RPT. This is the value RPM4-AD is currently using.
2. New value of **P_{offset}** just determined for the Hi Q-RPT. This is the value RPM4-AD will use if it is activated.
3. Old value of **P_{offset}** in Pascal for the Lo Q-RPT. This is the value RPM4-AD is currently using.
4. New value of **P_{offset}** just determined for the Lo Q-RPT. This is the value RPM4-AD will use if it is activated.



The value of P_{offset} is always in Pascal (Pa). The value of $P_{std,0}$ is entered in the current pressure unit of measure.

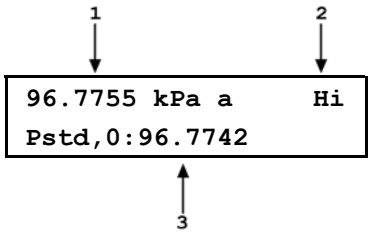
Run AutoZ by COM2

AutoZ by COM2 allows the value of **$P_{std,0}$** (see Section 3.5.1 ❍ Principle) to be read automatically from a **DHI** RPMx connected to the RPM4-AD COM2 communications port. The RPMx is read and the new **P_{offset}** is calculated automatically.

Before running AutoZ by COM2, if the AutoZ reference is another RPM4, the RPM4 must be set up so that the active Q-RPT, measurement mode (absolute) and unit of measure are compatible. RPM4 AutoZ by COM2 reads the reference RPM4 "as is" and will use whatever pressure value it responds with to a simple pressure request command.

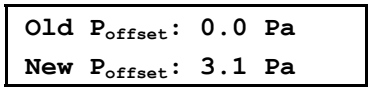
To access run AutoZ by COM2 press **[AutoZ]**, **<2COM2>**. The display is:

1. Real time pressure reading (without head correction), pressure unit of measure and measurement mode of the active Q-RPT.
2. Active Q-RPT position designator.
3. Real time reading from the RPMx connected to RPM4's COM2 communications port.



Observe the displayed pressures and verify that they are stable. When ready, press **[ENT]** to cause AutoZ to run. RPM4-AD logs both readings and calculates a new AutoZ offset value. The display is:

Press **[ENT]** to activate the new value of **P_{offset}** or **[ESC]** to start over.



When AutoZeroing the HL Q-RPT in absolute measurement mode (see Section 3.2.5), the Old P_{offset}/New P_{offset} screen display shows both Q-RPTs simultaneously.

For RPM4-AD to communicate with an RPMx connected to its COM2 port, the RPM4-AD and the RPMx RS-232 interfaces must be set up properly (see Section 3.5.2.1). If, the RPM4-AD is unable to communicate with an RPMx via COM2 when running AutoZ by COM2, it times out after 6 seconds and displays <RPM NOT detected>.

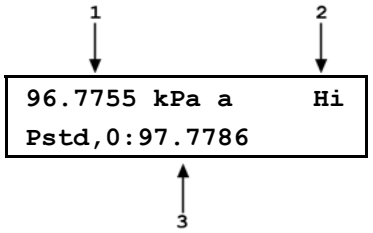
The value of P_{offset} is always displayed and entered in Pascal (Pa).

Run AutoZ by Lo RPT

AutoZ by Lo RPT is available only if the active Q-RPT is the Hi Q-RPT. AutoZ by Lo RPT allows the Lo Q-RPT in an RPM4-AD to serve as the AutoZ reference (source of $\mathbf{P_{std,0}}$) (see Section 3.5.1, ❍ PRINCIPLE). The Lo Q-RPT is read and the new $\mathbf{P_{offset}}$ is calculated automatically.

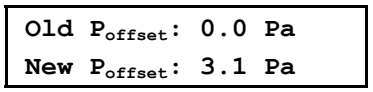
To access run AutoZ by Lo RPT, first be sure that both Q-RPTs are at atmospheric pressure. This can be accomplished by using SDS to isolate them from the **TEST** ports and vent them. Press **[AutoZ]**, **<3Lo RPT>**. The display is:

1. Real time pressure reading (without head correction), pressure unit of measure and measurement mode of the active Q-RPT.
2. Active Q-RPT position designator.
3. Real time reading from the Lo Q-RPT.



Observe the displayed pressures and verify that they are stable. When ready, press **[ENT]** to cause AutoZ to run. RPM4-AD logs both readings and calculates a new AutoZ offset value. The display is:

Press **[ENT]** to activate the new value of $\mathbf{P_{offset}}$ or **[ESC]** to start over.



The value of P_{offset} is always displayed and entered in Pascal (Pa).

3.3.9.3 AUTOZ IN DIFFERENTIAL MODE

❍ PURPOSE

To compensate for the offset between the Hi Q-RPT and the Lo Q-RPT at the operating “line pressure” in differential measurement mode.

See Section 3.5.1, ❍ Principle for a full explanation of the AutoZ function.

❍ OPERATION

For the AutoZ function key to run AutoZ, AutoZ must be turned ON for the active range and measurement mode. AutoZ ON is indicated by <z> to the left of the Q-RPT designator on the first line of the MAIN RUN screen. AutoZ ON and OFF is set using [SPECIAL], <1AutoZ> (see Section 3.5.1). If AutoZ is OFF for the active Q-RPT, and measurement mode, <AutoZ is off > is displayed when [AutoZ] is pressed.

To run AutoZ in differential measurement mode, set differential as the measurement mode (see Section 3.3.3) and OPEN SDS if SDS is CLOSED (see Section 3.3.8.1).

Press **[AutoZ]** from the MAIN RUN screen.

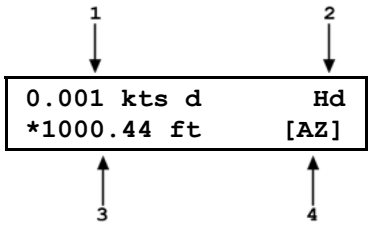
If the pressure on the Hi Q-RPT is higher than the maximum pressure of the Lo Q-RPT, the display is:

Press **[ESC]** to return to the run screen. Reduce the pressure on the Hi Q-RPT TEST port and try again.

```
Reduce Hi Q-RPT P
for bypass to open
```

If the pressure on the Hi Q-RPT is lower than the maximum pressure of the Lo Q-RPT, the RPM4-AD internal bypass valve opens (see Section 5.6 for RPM4-AD A160K/A160K pneumatic schematic) and the display is:

1. Differential measurement (Hi – Lo).
2. Active Q-RPT position designator.
3. Lo Q-RPT measurement.
4. Prompt that RPM-AD is in differential AutoZ mode and to press **[AutoZ]** when ready.



Note that the RPM4-AD bypass valve is open so the two Q-RPTs are exposed to the same pressure. Adjust the pressure to the desired line pressure value (in the case of airspeed measurement, adjust the pressure to the desired altitude value, this is the altitude at which airspeed will be measured after AutoZ). The line pressure or altitude is displayed on the bottom line of the RPM4-AD display.

Once the pressure has been adjusted to the desired line pressure, allow the pressure to stabilize for at least 60 seconds.

After pressure stabilization, press **[AutoZ]** or **[ENT]** to proceed with the AutoZero process.

<Running dif AutoZ> displays for about 7 seconds and operation returns to the MAIN RUN screen. The bypass valve is closed and normal operation in differential mode may resume. The differential measurement value should be very near zero.

Before running AutoZ in differential mode, be sure the pressure applied to the Hi Q-RPT (TEST (Pt) port) is not higher than the maximum pressure of the Lo Q-RPT (160 kPa abs (23 psia)). When running AutoZ, the RPM4-AD internal bypass valve connects the Hi and Lo Q-RPTs together so the pressure on the Hi Q-RPT must be safe for the Lo Q-RPT. If running AutoZ in differential mode results in a zero offset that RPM4-AD considers unusually large, <Confirm 0 DP> is displayed when AutoZ is pressed. Check that the pressure applied to the TEST ports is stable and leak free and try to AutoZ again.

Allow the RPM4-AD to stabilize at the line pressure (altitude) for at least 60 seconds before running AutoZ in differential mode.

3.3.10 [ENT]

❍ PURPOSE

Purpose depends on active DISPLAY mode (see Section 3.3.6).

3.4 [SETUP]

❍ PURPOSE

[SETUP] accesses a menu of functions and features commonly used in setting up and using RPM4-AD.

❍ OPERATION

To access the SETUP menu, press **[SETUP]** from the MAIN RUN screen. The display is:

```
1range 2res 3stab
4UL 5ATest
```

SETUP menu choices include:

<1range> This function is not used in RPM4-AD models.

<2res> Adjust the resolution of measurement displays (see Section 3.4.2).

<3stab> Adjust the pressure stability test that is the criterion for the *Ready/Not Ready* indication (see Section 3.4.3).

<4UL> Adjust upper and lower pressure limit alarms (see Section 3.4.4).

<5ATest> This function is not used in RPM4-AD models.

3.4.1 <1RANGE>

This function is not used in RPM4-AD models.

3.4.2 <2RES> (RESOLUTION)

❍ PURPOSE

To set the resolution with which various measured values and settings are displayed.

❍ PRINCIPLE

The resolution with which RPM4-AD displays pressure values can be adjusted.

The resolution setting determines the number of digits with which pressure is displayed. The resolution is calculated based on the span of the range and then rounded to the furthest digit to the right. For example, resolution of 0.001 % on a range of 150 kPa is 150 X 0.001 % = 0.0015 which is rounded down to 0.001 kPa.

When the displaying units of altitude, the resolution is adjusted as follows:

1, 0.1, 0.01% resolution: display 1 m or ft.
0.001% resolution: display 0.1 m or ft.
0.0001% resolution: display 0.01 m or ft.

Default resolution is 0.001% of active range span.

❍ OPERATION

To access the resolution function, press **[SETUP]**, **<2res>**. The display is:

```
Display resltn:   Hi
0.0010 %FS   < and >
```

Use the cursor control keys to set the desired level of resolution. Press **[ENT]** to return to the MAIN RUN screen with the new resolution setting active or **[ESC]** to make no changes.

The resolution setting is Q-RPT specific. A resolution setting made on one Q-RPT does NOT affect other Q-RPTs.

The displayed resolution is fixed for altitude units at "1" for 1, 0.1 and 0.01% resolution; 0.1 for 0.001% resolution; 0.01 for 0.0001% resolution.

3.4.3 <3STAB>

❍ PURPOSE

To view and/or adjust the stability test that is the Ready/Not Ready criterion for the active RPT and range.

See Section 3.2.4 Pressure Ready/Not Ready Indication.

❍ PRINCIPLE

RPM4-AD continuously monitors the rate of change of pressure measured by the active Q-RPT and compares this rate to the stability limit to make a Ready/Not Ready determination (see Section 3.2.4 Pressure Ready/Not Ready Indication). The stability function allows the stability limit to be adjusted by the user to increase or decrease the stability required for a Ready condition to occur.

Default stability limits are:

RPM4-AD A160K/A160K, all Q-RPTs

Absolute and gauge measurement modes: +/- 3 Pa (0.00044 psi) or air data equivalent.

RPM4-AD A350K/A160K, A160K (Lo) Q-RPT

Absolute and gauge measurement modes: +/- 3 Pa (0.00044 psi) or air data equivalent.

RPM4-AD A350K/A160K, A350K (Hi) Q-RPT

Absolute, gauge and absolute differential measurement modes: +/- 6 Pa (0.00088 psi) or air data equivalent.

The stability limit is separate and different from the Rate DISPLAY function (see Section 3.3.6.2) which allows the current rate of change of pressure to be displayed.

❍ OPERATION

To access the stability setting adjustment, press **[SETUP]**, **<3stab>**. The display is:

The stability limit is always displayed in the current unit of measure if the unit of measure is a pressure unit. If the unit is an airdata unit, the stability limit is expressed in Pascal (Pa), the SI unit of pressure.

```
Stability:      Hi
3 Pa
```

Edit the desired stability limit setting if desired. **[ENT]** activates the stability limit for the active Q-RPT and returns to the MAIN RUN screen Press **[ESC]** to return to the MAIN RUN screen with no change to the stability limit.

The default stability limit is ± 3 Pa (0.00044 psi) for A160K Q-RPTs in all measurement modes and ± 6 Pa (0.00088 psi) for the A350K Q-RPT in all measurement modes.

The stability setting is Q-RPT specific. A stability setting made for one Q-RPT does NOT affect other Q-RPTs.

3.4.4 <4UL> (UPPER LIMIT)

❍ PURPOSE

To set the upper and lower pressure limit values for a pressure range and measurement mode.

❍ PRINCIPLE

The UPPER LIMIT function provides the user with settable pressure limits at which an alarm sounds. Absolute and gauge measurement modes (see Section 3.3.3, ❍ PRINCIPLE) have upper limits only. Differential and negative gauge modes have a lower limit.

When the limit is reached, RPM4's beeper sounds intermittently as long as pressure is outside the limit.

The UPPER LIMIT function has two purposes. First, when UL is set to its default value, it serves as a warning that the maximum pressure of the active Q-RPT is about to be exceeded. Second, UL can be set by the user to a value other than the default value to provide an alarm that a specific pressure limit has been exceeded. This feature is often used to help protect an external device or system on which RPM4-AD is being used to measure pressure. For example, it might be set just over the full scale of a device under test (DUT) that is being calibrated.

The default upper limit is 102 % of Q-RPT maximum working pressure. The default lower limit (negative gauge mode only) is – 110 kPa (- 16 psi).

In differential measurement mode (see Section 3.2.6), UL has upper and lower limits. If the measurement unit is an airspeed unit, there is no lower limit.

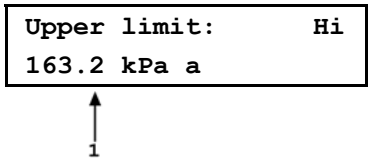
In differential measurement mode, the ULs on the Lo Q-RPT and Hi Q-RPT default range are also active so that line pressure (Lo Q-RPT) and total pressure (Hi Q-RPT) upper limit can be set and monitored in addition to a differential limit.

❍ OPERATION

To view or edit upper and lower limits press **[SETUP]**, **<4UL>**.

If the current measurement mode is absolute or gauge or if the active unit of measure is an airspeed unit, there is an upper limit only. The display is:

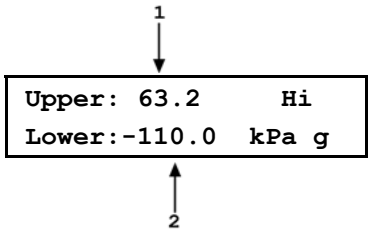
1. Entry field for upper limit value in active pressure unit of measure and measurement mode.



Edit the upper limit value as desired. The maximum upper limit is 102 % of default Q-RPT full scale. Press **[ENT]** to return to the MAN RUN screen with the new upper limit active. Press **[ESC]** to return to the MAIN RUN screen with no change to the upper limit.

If the current measurement mode is negative gauge or differential and the unit of measure is not an airspeed unit, there is an upper limit and a lower limit. The display is:

1. Entry field for upper limit value.
2. Entry field for lower limit value and active range pressure unit of measure and measurement mode indication.



Edit the upper and lower limit values as desired. Use the cursor control keys to move between the two edit fields. The lower limit must be a negative value. Press **[ENT]** to return to the MAIN RUN screen with the new upper and/or lower limit active. Press **[ESC]** to return to the MAIN RUN screen with no change to the limits.

When the upper or lower limit has been exceeded, the display of current pressure flashes and a buzzer sounds for 3 seconds on/2 seconds off intervals. Change the pressure applied to RPM4-AD so that it is within the upper and/or lower limit to return to normal operation.

Upper limit values are specific to each range and measurement mode. Be careful not to assume that the upper limit set in one measurement mode will apply to the other. For example, if you change the upper limit in gauge mode, the upper limit will not be changed in negative gauge mode.

3.4.4.1 OVER PRESSURE FUNCTION

In addition to the UL function, RPM4-AD has an over pressure function.

The over pressure function executes when a Q-RPT measures a pressure that is 104 % of its maximum working pressure.

The over pressure function causes the measured pressure display to flash. SDS closes shutting off the **TEST** port (see Section 3.2.8). The overpressure function also logs the time and date of the overpressure condition in both user and factory logs to assist in incident diagnosis (see Section **Error! Reference source not found.**).

To recover from an overpressure condition, cycle RPM4-AD power. Be sure to correct the condition that caused the overpressure before cycling power.

3.4.5 <5ATEST>

This function is not used in RPM4-AD models.

3.5 [SPECIAL]

❍ PURPOSE

[SPECIAL] accesses a menu of RPM4-AD functions and features that are less commonly used or not normally used in regular operation.

❍ OPERATION

Press **[SPECIAL]** from the MAIN RUN screen to access the SPECIAL menu. The display is:

```
1AutoZ 2remote 3head
4SDS 5prefs 6Punit↓
7intern 8cal 9reset
```

Some screens, such as the SPECIAL menu, go beyond the two lines provided by the display. This is indicated by a flashing arrow in the second line of the display. Press the cursor control keys to move the cursor to access the lines that are not visible or directly enter the number of the hidden menu choice if you know it.

SPECIAL menu choices include:

<1AutoZ> Manage AutoZero function for the active Q-RPT (see Section 3.5.1).

<2remote> View and edit COM port (RS-232) and IEEE-488 interface settings. Select remote syntax style (see Section 3.5.2).

<3head> Set HEAD function gas and height unit of measure (see Section 3.5.3).

<4SDS> View and set the temporary and full time ON/OFF and OPEN/CLOSED status of SDS for Q-RPTs.

<5prefs> View and set screen saver time, keypad sound frequency, unit ID number, time/date, security protection level (see Section 3.5.5).

<6Punit> Customize the **[UNIT]** key unit of measure selections (see section 3.5.6).

<7intern> Access internal functions including on-board barometer viewing, read rate adjustment, incident log viewing (see Section 3.5.7).

<8cal> View and adjust RPM4, Q-RPT and barometer calibration coefficients (see Sections 3.5.7.5, 5.2, 5.3).

<9reset> Access RPM4's various reset functions (see Section 3.5.9).

3.5.1 <1AUTOZ>

❍ PURPOSE

To offset the RPM4-AD Q-RPTs readings relative to a reference value in order to compensate for possible changes in Q-RPT zero between full recalibrations. In differential measurement mode, to compensate for the difference between the reading of the Hi and Lo Q-RPTs at the "line pressure" at which differential measurements are made.

To assure operation within measurement uncertainty specifications (see Section 1.2.2.1), it is recommended that AutoZ be run (the value of P_{offset} updated) whenever vented in gauge mode, whenever the line pressure is changed in differential mode and at least every 30 days or when RPM4-AD has been exposed to temperature changes exceeding 15 °C (36 °F) in absolute mode.

❍ PRINCIPLE

AutoZ Purpose and Principle

The main component of the change over time of the RPM4-AD Q-RPTs is change in zero or offset, independent of span. Offsetting or "rezeroing" RPM4-AD Q-RPTs relative to a reference between recalibrations allows measurement uncertainty specifications to be maintained with less frequent full calibrations. AutoZ is also used to compensate for the difference between the Hi and Lo Q-RPT at the "line pressure" at which differential measurements are made. The RPM4-AD AutoZero function (AutoZ) provides full on-board support for the rezeroing process to simplify its application by the user.

The AutoZero function uses three values:

1. **$P_{std,0}$:** The pressure value indicated by the AutoZ reference, the device that is acting as the reference relative to which to offset the RPM4-AD Q-RPT.

   In absolute measurement mode, the pressure at which AutoZ is performed is normally atmospheric pressure and the **$P_{std,0}$** value can be obtained by RPM4-AD a) by manual entry, b) automatically from a **DHI** RPMx connected to RPM4-AD COM2 communications port, or automatically from the Lo Q-RPT.

   In gauge measurement mode, **$P_{std,0}$** is always zero (atmospheric pressure) which is supplied by definition when the Q-RPT is vented to atmosphere.

   In differential measurement mode, **$P_{std,0}$** is the pressure indicated by the Lo Q-RPT when the Hi and Lo Q-RPTs are connected to a common pressure.

2. **$P_{u,0}$:** The pressure reading of the Q-RPT, with no AutoZ offset, at the time AutoZ is performed.

3. **$P_{offset,G}$, $P_{offset,A}$ and $P_{offset,D}$:** The difference between the reading of the Q-RPT with no AutoZ offset ($P_{u,0}$) and the indication of the AutoZ reference ($P_{std,0}$) for gauge ($_G$), absolute($_A$) or differential ($_D$) measurement mode:

$$P_{offset} = P_{u,0} - P_{std,0}$$

P_{offset} represents the difference between the Q-RPT reading ($P_{u,0}$) and the AutoZ standard ($P_{std,0}$). This value is used to correct the RPM4-AD Q-RPT so it agrees with the AutoZ standard. The AutoZ function manages the determination, storage and application of P_{offset} to correct the Q-RPT in absolute, gauge and differential measurement modes.

When the Q-RPT is calibrated, P_{offset} is set to zero. P_{offset} is then redetermined at regular intervals using the AutoZ function. The most recent value of P_{offset} is applied to the Q-RPT reading to correct for change in zero.

The AutoZ function can be turned ON and OFF. Table 11 summarizes the effect of AutoZ ON and OFF.

AutoZ in absolute measurement mode

RPM4-AD Q-RPTs are intrinsically absolute. They have an evacuated and sealed reference.

In absolute measurement mode, the source of $P_{std,0}$ must be an absolute pressure, nominally atmospheric pressure, with uncertainty significantly better than that of the Q-RPT that is being AutoZeroed.

When a Q-RPT is in absolute measurement mode with AutoZ ON, absolute pressure is calculated as:

$$P_{abs} = P_u - P_{offset,A}$$

In absolute measurement mode, running the AutoZ function to update the AutoZ value ($P_{offset,A}$), is initiated by the operator using **[AutoZ]** (see Section 3.3.9.2).

AutoZ in gauge and negative gauge measurement modes, dynamic compensation for atmospheric pressure

RPM4-AD Q-RPTs are intrinsically absolute but they are also used in gauge and negative gauge (difference from atmosphere) measurement modes (see Section 3.3.3, ❍ PRINCIPLE). Gauge measurement mode is achieved by subtracting the value of atmospheric pressure from the Q-RPT's absolute reading using AutoZ and by dynamically compensating for changes in atmospheric pressure between opportunities for AutoZ to execute (see Section 3.2.2).

In gauge measurement modes, the value of $P_{std,0}$ is always zero gauge pressure. Zero gauge pressure, by definition, is applied to the Q-RPT when it is vented to atmosphere. Gauge pressure is the measured absolute pressure, P_u, minus $P_{offset,G}$.

$$P_{gauge} = P_u - P_{offset,G}$$

When AutoZ is ON, dynamic compensation for atmospheric pressure is also applied to compensate for changes in atmospheric pressure as measured by a barometer (ΔP_{atm}) between AutoZ updates (see Section 3.2.2). The measured gauge pressure is calculated using ΔP_{atm} to correct the value of $P_{offset.G}$.

$$P_{gauge} = P_u - P_{offset.G} - \Delta P_{atm}$$

In gauge measurement mode, running the AutoZ function to update the value of $P_{atm,0}$, is initiated by the operator using **[AutoZ]** (see Section 3.3.9.1). ΔP_{atm} resets when AutoZ is run is then updated continuously as new atmospheric pressure measurements are made by the barometer.

When gauge or negative gauge mode is first activated, the value of $P_{offset,G}$ subtracted from the absolute pressure reading to achieve gauge pressure is standard atmosphere of 101.325 kPa. This can cause a large zero error when gauge mode is activated if atmospheric pressure is significantly different from standard atmospheric pressure. When gauge mode is activated, always press [AutoZ] to run AutoZ and obtain an actual value of $P_{offset,G}$.

AutoZ in differential measurement mode

RPM4-AD supports differential measurement mode (see Section 3.2.6) in which the measured pressure is the difference between the pressure measured by the Hi Q-RPT (Pt) and the Lo Q-RPT (Ps) (Hi – Lo, Pt – Ps).

In differential measurement mode, the purpose of AutoZ is to compensate for the offset between the Hi and Lo Q-RPT indications at the "line pressure" at which the differential pressure is being measured. In differential measurement mode, when the active unit of measure is an airspeed unit, the line pressure is altitude. The value of $\mathbf{P_{std,0}}$ is the pressure measured by the Lo Q-RPT at the time of AutoZ.

In differential measurement mode, with AutoZ ON, differential pressure is calculated as:

$$\mathbf{P_{differential} = P_{Hi} - P_{Lo} - P_{offset,D}}$$

In differential measurement mode, AutoZ is run when initiated by the operator pressing **[AutoZ]**. RPM4-AD's differential mode AutoZ function connects both RPTs together internally to the **TEST (Ps)** port to be sure they are exposed to the same pressure.

AutoZ ON/OFF

The AutoZ function can be turned ON and OFF, separately for gauge, absolute and differential measurement modes and for each Q-RPT. Table 11 summarizes the effect of AutoZ ON and OFF.

Table 11. AutoZ ON and OFF

MEASUREMENT MODE	AutoZ STATUS	P_{offset} APPLIED	ΔP_{atm} APPLIED	AutoZ ROUTINE RUNS
Absolute	ON	YES	Not Applicable	When initiated by operator
	OFF	NO		Not available
Gauge or negative gauge	ON	YES	YES	When initiated by operator
	OFF		NO	
Differential	ON	YES	Not Applicable	When initiated by operator
	OFF	NO		Not available

Recommendations for the Use of the AutoZ Function

The AutoZ function provides a powerful and easy to use tool for improving the stability over time of RPM4-AD Q-RPTs and maximizing the recalibration interval by compensating for zero drift between full recalibrations. In differential measurement mode, it minimizes the uncertainty in the differential pressure due to the offset between the Hi and Lo Q-RPTs at the "line pressure" (altitude in air data measurement). The following simple recommendations will help assure that you use the AutoZ feature to best advantage.

- In **gauge and differential measurement** mode: Always leave AutoZ ON when operating.
- In **absolute measurement** mode: Always leave AutoZ ON when operating if the AutoZ routine has been run regularly using a valid atmospheric reference.

- To assure operation within measurement uncertainty specifications (see Section 1.2.2.1), run AutoZ whenever vented in gauge mode, whenever the line pressure is changed in differential mode and at least every 30 days or when RPM4-AD has been exposed to temperature changes exceeding 15 ºC (36 ºF) in absolute mode.
- In **absolute measurement** mode**:** Run AutoZ only when a reference whose measurement uncertainty is known to be significantly better than that of the Q-RPT to be AutoZeroed is available. The best possible reference with which to run AutoZ in absolute measurement mode is a gas operated piston gauge (such as a **DHI** PG7601) applying atmospheric pressure to the RPM4-AD **TEST** port. The best day to day reference is a properly calibrated **DHI** RPM4 BA100K/BA100K interfaced directly as an external device to the RPM4-AD COM2 port.
- In **absolute measurement modes:** Allow the RPM4-AD to stabilize at atmospheric pressure and ambient temperature for 10 to 15 minutes before running AutoZ.

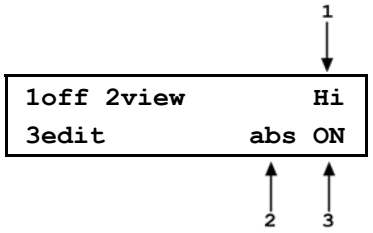
❍ **OPERATION**

The AutoZ function and values are Q-RPT AND measurement mode (absolute, gauge or differential) specific.

[SPECIAL], <1AutoZ> is to perform AutoZ management functions such as turning AutoZ ON and OFF. In day to day operation, to RUN the AutoZ routine that rezeroes the Q-RPTs, use [AutoZ] (see Section 3.3.9).

To access the RPM4-AD AutoZ function press **[SPECIAL]**, **<1AutoZ>**. The display is:

1. Active Q-RPT designator.
2. Indication of active measurement mode (**<abs>** for absolute, **<gage>** for gauge and negative gauge, **<dif>** for differential).
3. Indication of whether AutoZ is currently ON or OFF for this Q-RPT and measurement mode.



Select **<1off>** (or **<1on>**) to change the AutoZ status for the current Q-RPT and measurement mode from ON to OFF or vice versa.

AutoZ ON is indicated by a <z> in the MAIN RUN screen, top line, fourth character from the right. When AutoZ is OFF, the character is blank.

Select **<2view>** to view the current value of $\mathbf{P_{offset}}$ for the active Q-RPT(s) and measurement mode.

P_{offset} should be zero when the RPM4-AD is new or has just been calibrated. P_{offset} should be roughly equal to atmospheric pressure when operating in gauge mode.

Select **<3edit>** to edit the value of $\mathbf{P_{offset}}$ for the active Q-RPT and measurement mode (see Section 3.5.1.1). This function is not normally used. In normal operation, **[AutoZ]** should be used to obtain the value of $\mathbf{P_{offset}}$ (see Section 3.3.9).

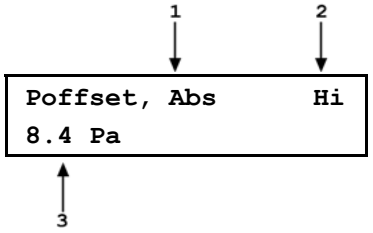
The value of P_{offset} is always displayed and entered in Pascal (Pa).

3.5.1.1 EDIT AUTOZ

The edit AutoZ function should be used with great caution as entering inappropriate values and turning AutoZ ON may result in out of tolerance measurements. In normal operation, the value of the AutoZ offset, P_{offset}, should be changed by running AutoZ using [AutoZ] (seen Section 3.3.9). Before editing P_{offset}, see Section 3.5.1, ❍ PRINCIPLE.

To edit the current **P_{offset}** value for the active Q-RPT and measurement mode, press **[SPECIAL]**, **<1AutoZ>**, **<3edit>**. The display is:

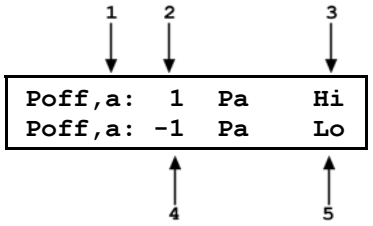
1. Indication of active measurement mode (**<abs>** for absolute, **<gage>** for gauge and negative gauge, **<dif>** for differential).
2. Active Q-RPT for which **P_{offset}** is being edited.
3. Edit field for value of **P_{offset}**.



Edit **P_{offset}** as desired and press **[ENT]** to activate the new value. Press **[ESC]** to abandon changes.

If editing the HL (parallel mode) **P_{offset}** values, the editing display shows the values for both Q-RPTs simultaneously:

1. Indication of measurement mode for which this is **P_{offset}** (**<a>** for absolute, **<g>** for gauge).
2. Edit field for value of Hi Q-RPT **P_{offset}**.
3. Indication that this is the Hi Q-RPT **P_{offset}**.
4. Edit field for value of Lo Q-RPT **P_{offset}**.
5. Indication that this is the Lo Q-RPT **P_{offset}**.



The value of P_{offset} is always in Pascal (Pa). The value of $P_{std,0}$ is entered in the current pressure unit of measure.

3.5.2 <2REMOTE>

❍ PURPOSE

To configure the RPM4-AD COM1, COM2 and IEEE-488 (GPIB) communication ports. To test COM1 and COM2 communications. To select the remote programming communications format.

❍ PRINCIPLE

The RPM4-AD has two RS-232 communications ports referred to as COM1 and COM2 and a single IEEE-488 (GPIB) port. COM1 or the IEEE-488 port is for communicating with a host computer (see Section 4), and COM2 is reserved for communicating with an external device (e.g. an RPMx, a multimeter, etc.). These ports' settings can be viewed and changed using **[SPECIAL]**, **<2remote>**.

RPM4-AD has two remote communications formats, classic and enhanced (see Section 4.3). Which of these is active can be selected.

A self test is supplied for RS-232 communications. The self test allows verification that the RPM4-AD RS232 ports (COM1 and COM2) are operating properly and that a valid interface cable is being used.

❍ OPERATION

To access the communications settings, press **[SPECIAL]**, **<2Remote>**.

- Select **<1COM1>** to view and edit COM1 settings (see Section 3.5.2.1.).
- Select **<2COM2>** to view and edit COM2 settings (see Section 3.5.2.1.).
- Select **<3IEEE>** to view and edit IEEE-488 settings (see Section 3.5.2.2).
- Select **<4format>** to select the remote communications command format (see Section 3.5.2.3).
- Select **<5RS232test>** to run the COM1 and COM2 communications test (see Section 3.5.2.4).

3.5.2.1 <1COM1, 2COM2>

The COMx ports can be set for specific communications settings. The settings are baud rate, parity, data bits and stop bits. The available options are:

Baud 300, 600, 1 200, 2 400, 4 800, 9 600, 19 200, 28 800, 38 400

Parity NONE, ODD or EVEN

Length 7 or 8

Stop Bit 1 or 2

The default is <2 400, E, 7,1> for both COM1 and COM2.

The user can also specify one or two termination characters as well as define these characters. These are referred to as “Term1” and “Term2”. These define the characters that mark the end of commands that are sent to the RPM4-AD. The RPM4-AD looks for an ASCII(13) (carriage return) to terminate a received command but responds with both and ASCII(13) (carriage return) and an ASCII(10) (line feed). There are no other options.

3.5.2.2 <3IEEE-488>

The IEEE-488 port’s primary address can be set from 1 to 31 in this screen. The factory default value is 10. Secondary addressing is not used or supported. This address must not conflict with the address of any other device on the same IEEE-488 bus.

The receiving terminating character must be a line feed and EOI. Carriage returns are ignored if received. The RPM4-AD sends a line feed and asserts the EOI line to terminate a reply. These settings are fixed to agree with IEEE Std. 488.2. If you change the address, the IEEE interface will reset (PON) and become idle.

3.5.2.3 <4FORMAT>

The RPM4-AD has two different syntax formats available for the remote program commands.

The **classic** remote command format is highly intuitive and conforms with previous **DHI** PPC and RPM products.

The **enhanced** remote command format generally uses the same commands as the **classic** format, but in addition it follows the syntax, format, and status reporting features of IEEE Std 488.2.

The details of each format are covered in Section 4.3.

[SPECIAL], **<2remote>**, **<4format>** allows the remote program command syntax to be selected. The cursor is on the active format. Select **<1classic>** or **<2enhanced>** as desired.

3.5.2.4 <5RS232 SELF-TEST>

The RS232 self-test is provided to check the RPM4-AD COM ports and the interface cable independently of an external device or computer.

If you are having difficulty communicating with RPM4-AD from a host computer using RS232, the RS232 self test can help establish that the RPM4-AD COM1 port you are trying to communicate with and the interface cable you are using are good.

To run a self test of the RS232 ports (COM1 and COM2), press **[SPECIAL]**, **<2remote>**, **<5RS232test>**.

The display prompts you to connect COM1 to COM2 using a standard pin-to-pin DB-9F to DB-9M RS232 cable (see Section 4.2.1.1, 4.2.1.3).

Once the cable has been installed, press **[ENT]** to run the self-test. The test is first executed in the COM1→COM2 direction and then in the COM2→COM1 direction.

If the COM1→COM2 test passes:	**<PASSED>** displays briefly and the test proceeds to COM2→COM1.
If COM2→COM1 passes:	**<PASSED>** is displayed briefly followed by the conclusion, **<The RS232 test has PASSED>**.
If a test fails:	Execution is suspended until **[ENT]** is pressed.

The RPM4-AD RS232 test can fail for three reasons:

1. The RS232 cable being used is incorrect (Section 4.2.1.1, 4.2.1.3 for information on the correct cable).
2. COM1 and COM2 do NOT have the same serial communications settings and therefore cannot communicate together (see Section 3.5.2.1 to set the COM ports).
3. COM1 or COM2 is defective.

The reason for failed communications is almost always a cable or incorrect RS232 interface settings. Be sure that these are correct before concluding that a COM port is defective.

3.5.3 <3HEAD>

- **PURPOSE**

To view or change the properties of the HEAD function (see Section 3.3.7) including the unit of measure of length for head height entry and the test gas species for density calculations.

- **OPERATION**

From the MAIN RUN screen, pressure **[SPECIAL]**, **<3Head>**.

Select the desired height unit of measure and press **[ENT]**.

Select the gas species and press **[ENT]**.

Use **[HEAD]** to set a head height if desired (see Section 3.3.7).

3.5.4 <4SDS>

❍ PURPOSE

To open and close SDS temporarily or to turn the SDS function ON and OFF full time.

See Section 3.2.8 for complete information on RPM4's SDS (Self Defense System) feature.

❍ PRINCIPLE

SDS is a self defense system to protect RPM4-AD Q-RPTs from overpressure (see Section 3.2.8). Normally, opening and closing SDS is performed automatically by the RPM4-AD or by the operator using the **[SDS]** key.

[SPECIAL], **<4SDS>** gives further control over the SDS function. This includes: a) temporarily opening or closing SDS on either the Hi or Lo Q-RPT (see Section 3.5.4.1), and; b) turning OFF SDS so that it is open full time and RPM4-AD can be operated as if SDS were not installed (see Section 3.5.4.2).

The temporary opening or closing of SDS allows the SDS open/closed state to be set to the desired state immediately. Following the change, normal automated operation of SDS and control using the **[SDS]** continues. This function is often used to open SDS on the inactive Q-RPT.

Setting the SDS function to full time OFF eliminates the SDS function completely for both Q-RPTs (except for reaction to an overpressure condition) until SDS is set to full time ON again.

3.5.4.1 <1TEMP OPEN/CLOSE>

❍ OPERATION

See Section 3.2.8 for complete information on RPM4's SDS (Self Defense System) feature.

To temporarily open or close the SDS of the Hi or Lo Q-RPT press **[SPECIAL]**, **<4SDS>**, **<1temp open/close>**. Select the Hi or Lo Q-RPT. The next display is:

The cursor is on the current state of SDS for the designated Q-RPT. Select **<1close>** to close SDS or **<2open>** to open SDS and return to the MAIN RUN screen. Press **[ESC]** to return without making changes.

```
SDS temporary:     Hi
1close 2open
```

If **<2open>** is selected and SDS for the Q-RPT is not already open, the SDS opening screen with indication of the maximum pressure of the Q-RPT is displayed. This is the same screen used when opening SDS using the **[SDS]** key (see Section 3.3.8). Check that the pressure applied to the Q-RPT module **TEST** port does not exceed the Q-RPT's Pmax! value before confirming that SDS should be opened.

SDS temporary open and close in parallel measurement mode (HL)

In parallel measurement mode (HL Q-RPT), the active **TEST** port is the **TEST(Ps)** port in absolute measurement mode and the **TEST(Pt)** port in gauge measurement mode. Opening SDS using **[SDS]** opens the active **TEST** port and the internal bypass valve between the two Q-RPTs (see Section 5.6 for schematics and valve states) while the inactive **TEST** port is left closed. Closing SDS using **[SDS]** closes the active **TEST** port amd the internal Q-RPT bypass valve. When SDS is open, SDS temporary open can be used to open the

inactive **TEST** port. When SDS is open, SDS temporary close can be used to isolate and vent the specified Q-RPT.

Opening SDS with a pressure greater than Pmax! applied to the test port may cause overpressure damage to the Q-RPT.

3.5.4.2 <2FULL TIME ON/OFF>

❍ **OPERATION**

See Section 3.2.8 for complete information on RPM4's SDS (Self Defense System) feature.

Turning SDS "full time OFF" eliminates normal SDS operation so that the active TEST port remains open. However, the SDS overpressure function (see Section 3.4.4.1) remains active.

To turn SDS full time ON/OFF, press **[SPECIAL]**, **<4SDS>**, **<2full time on/off >**. The next display is:

The cursor is on the current state of SDS ON/OFF. Select **<1on>** to set SDS for normal operation and return to the MAIN RUN screen. Select **<2off>** to open SDS permanently so operation is as if SDS were not installed. Press **[ESC]** to return without making changes.

```
SDS full time:
1on 2off
```

If **<2off>** is selected and SDS is not already open, the SDS opening screen with indication of the maximum pressure of the Q-RPT is displayed. This is the same screen used when opening SDS using the **[SDS]** key (see Section 3.3.8). Check that the pressure applied to the Q-RPT module **TEST** port does not exceed the Pmax! value before confirming that SDS should be opened.

Opening SDS with a pressure greater than Pmax! applied to the TEST port may cause overpressure damage to the Q-RPT.

With SDS "full time OFF", when using parallel measurement, the active TEST port is still switched between the Ps and Pt port depending upon measurement mode (see Section 3.2.5).

3.5.5 <5PREFS>

❍ **PURPOSE**

To access a menu of RPM4-AD operational preferences and functions.

❍ **OPERATION**

To access the PREFS menu press **[SPECIAL]**, **<5prefs>**. The display is:

```
1ScrSvr 2sound 3time
4ID 5level
```

The PREFS menu includes:

<1ScrSvr> View and change the screen saver activation time (see Section 3.5.5.1).

<2sound> View and change the key press sounds (see Section 3.5.5.2).

<3time> View and edit the internal time and date settings (see Section 3.5.5.3).

<4ID> View the RPM4-AD serial number (SN) and view or edit the ID number (see Section 3.5.5.4).

<4level> View and set user security level and/or password (see Section 3.5.5.5).

3.5.5.1 <1SCRSVR>

- **PURPOSE**

To adjust the idle time after which RPM4's SCREEN SAVER activates.

- **PRINCIPLE**

RPM4-AD has a SCREEN SAVER function which causes the display to dim after a front panel key is NOT pressed for a certain amount of time. The default is for the screen saver to activate after 10 idle minutes. The screen saver activation time can be adjusted by the user or screen saving can be completely eliminated.

Setting screen saver time to zero eliminates the SCREEN SAVER function so that the display permanently remains at full brightness.

- **OPERATION**

To access the SCREEN SAVER function, press **[SPECIAL]**, **<5prefs>**, **<1ScrSav>**. Edit, in minutes, the idle time after which screen saver will activate to dim the screen. Set the time to zero to eliminate the SCREEN SAVER function.

3.5.5.2 <2SOUND>

- **PURPOSE**

To adjust or suppress the RPM4-AD valid key press sound.

- **PRINCIPLE**

RPM4-AD provides audible feedback by a brief "beep" when a valid key press is made. The tone frequency of this beep may be selected from three choices or it may be completely suppressed. Invalid key presses are indicated by a descending two tone "blurp" which cannot be suppressed.

- **OPERATION**

To access the keypad sound adjustment function press **[SPECIAL]**, **<5prefs>**, **<2sound>**.

Select between **<2lo>**, **<3mid>** or **<4hi>** to adjust the valid key press tone frequency.

Select **<1none>** to suppress the valid key press tone.

The sound function only affects the valid key press tone. The invalid key press tone and other RPM4-AD sounds cannot be adjusted or suppressed.

3.5.5.3 <3TIME>

- **PURPOSE**

To view and edit the RPM4-AD internal time and date settings.

- **OPERATION**

To access the TIME function press **[SPECIAL]**, **<5prefs>**, **<3time>**. The display is:

```
Edit:  1time 2date
08:32:11 am 20030125
```

Select **<1time>** to edit the time. Edit hours, then minutes, then am/pm by pressing **[ENT]** after each entry. Seconds go to zero when minutes are entered. This can be used to synchronize the time with a time standard.

Select **<2date>** to edit the date. The date must be specified in YYYYMMDD format.

The RPM4-AD date and time are set to United States Mountain Standard Time in the final test and inspection process at the factory. If desired, use the TIME and DATE function to set your local time and date.

3.5.5.4 <4ID>

- **PURPOSE**

To view or edit the RPM4-AD user ID and to view the RPM4-AD serial number.

- **OPERATION**

To access the ID function press **[SPECIAL]** and select **<5prefs>**, **<2ID>**.

Select **<1view>** to view the current ID.

Select **<2edit>** to edit the ID.

The ID has twelve characters. When the edit screen is opened, the cursor is on the first character. Numerical values can be entered directly from the keypad. In addition, the cursor control keys can be used to toggle through a list of available alphanumeric characters. Holding the key slews through the characters. Character order going up is: blank space, symbols, lower case letters, upper case letters, numbers. After selecting a character, press **[ENT]** to activate it and move to the next character field.

When a character is selected the cursor moves to the next character. To leave a blank character, press **[ENT]** with the field for that character blank. Use this for the trailing characters if the ID being entered is less than twelve characters.

After the last of the twelve characters has been entered, the **<Save ID?>** option is offered. Select **<1no>** to return to the ID edit screen. Select **<2yes>** to save the edited ID.

The ID can be set remotely from a computer which is quite a bit more convenient than entering characters from the keyboard (see Section 4.4.4, ID command). The ID is not cleared or reset by any RESET function (see Section 3.5.9).

3.5.5.5 <5LEVEL> (SECURITY)

❍ **PURPOSE**

To set user protection levels to restrict access to certain functions and to edit the password required for changing user levels.

❍ **PRINCIPLE**

RPM4's front panel user interface provides the means to access all RPM4-AD user defined data, settings and functions including calibration data. Inadvertent, uninformed or unauthorized altering or deleting of data, settings and functions could require extensive reconfiguration by the user and might cause invalid readings and behavior. For these reasons, depending upon the application in which RPM4-AD is being used, it may be desirable to restrict access to some functions. The user level function provides a means of restricting access to certain functions. Four different levels of security are available.

Access to changing security levels can be left open, or be protected by a password.

Security Levels

The security levels are structured to support typical operating environments as follows:

None This level is intended for use only by the system manager and/or calibration facility. It allows access and editing in all areas including critical metrological information.

Low Low security is designed to protect the specific metrological information and SYSTEM DIAGNOSTIC AND MAINTENANCE functions of the system against accidental alteration. It is intended for an advanced operator performing many different tasks. Low security is the default user level setting.

Medium Medium security is designed to protect specific metrological information in the system and to assure that the RPM4-AD is operated using consistent operational parameters.

High High security is designed to protect all operating parameters. It is intended to minimize operator choices, for example to perform repeated identical calibrations under consistent conditions.

RPM4-AD is delivered with the security level set at low to avoid inadvertent altering of critical internal settings but with access to changing security levels unrestricted. It is recommended that the low security level be maintained at all times. If there is a risk of unauthorized changing of the security level, changing authority should be password protected (see ❍ OPERATION of this section).

The security levels are structured to support typical levels of operation as shown in Table 12. Specifically, the security levels prevent execution of the functions accessed by the key strokes marked by "•":

Table 12. Security levels

FUNCTION	LOW	MEDIUM	HIGH
[RANGE]			•
[ENT]			•
[UNIT]			•
[MODE]			•
[AutoRange]		•	•
[LEAK CK]			•
[DISPLAY]		•	•
[HEAD]			•
[SDS]			•
[AutoZ] (in absolute mode)		•	•
[SETUP]			•
[SETUP], <1range>		•	•
[SETUP], <2res>		•	•
[SETUP], <4UL>		•	•
[SPECIAL]			•
[SPECIAL], <1AutoZ>		•	•
[SPECIAL], <1AutoZ>, <1on/1off>	•	•	•
[SPECIAL], <1AutoZ>, <3edit>	•	•	•
[SPECIAL], <2remote>			•
[SPECIAL], <2remote>, make changes		•	•
[SPECIAL], <3head>		•	•
[SPECIAL], <4SDS>		•	•
[SPECIAL], <5pref>, <1ScrSvr>		•	•
[SPECIAL], <5pref>, <2sound>		•	•
[SPECIAL], <5pref>, <3time>		•	•
[SPECIAL], <5pref>, <3time>, make changes	•	•	•
SPECIAL], <5pref>, <4ID>, <2edit>	•	•	•
[SPECIAL], <6Punit>		•	•
[SPECIAL], <7internal>		•	•
[SPECIAL], <7internal>, <3RPT2x>	•	•	•
[SPECIAL], <7interrnal>, <5log>, clear log	•	•	•
[SPECIAL], <8cal>		•	•
[SPECIAL], <8cal>, <2edit> under any selection	•	•	•
[SPECIAL], <4reset>		•	•
[SPECIAL], <4reset>, <4cal>	•	•	•
[SPECIAL], <4reset>, <5all>	•	•	•
Remote communications disabled			•

"•" indicates the function/menu is NOT accessible.

❍ OPERATION

RPM4-AD is delivered with no active password and access to the User Level menu is open. The user level is set to **<1Low>**. User levels can be changed freely until a password has been created.

To access the LEVEL function press **[SPECIAL]**, **<5prefs>**, **<5level>**. The display is:

```
1change user level
2edit password
```

Selecting **<1change user level>** brings up the restriction menu:

```
Restrictions: 1none
2low 3medium 4high
```

The cursor is on the current restriction level. Select a different level or or **[ESC]** back to the MAIN RUN screen.

If no password is active, selecting **<2edit password>** displays the user password and allows it to be edited.

```
Password: pppppp
0 disables password
```

Once a password has been entered, the user level cannot be changed without reentering the password.

Passwords can be up to six numbers in length and cannot start with a zero. If **<0>** is entered, the password is made inactive and the user will not be required to enter a password to access the user level menu. This condition, with a security level of **<2low>**, is the factory default.

If there is an active password, the RPM4-AD password entry screen appears. The user must enter the user defined password or the factory secondary password to proceed further:

```
RPM4      SNnnnn-xx
Password: pppppp
```

The first field, **<nnnn>**, is the serial number of the RPM4, followed by a second field, **<xx>**, that represents the number of times that a secondary password has been used. The second field, **<xx>**, increments each time a secondary password is used. The third field, **<pppppp>** is for user entry of the normal password.

The factory secondary password is available in case the user's password has been misplaced or forgotten. It can be obtained by contacting a DHI Authorized Service Center (see Table 34). The factory secondary password is different for all RPM4's and changes each time it is used.

3.5.6 <6PUNIT>

❍ PURPOSE

To customize the choice of units of measure available in the **[UNIT]** key menus.

❍ PRINCIPLE

The **[UNIT]** function key makes available a choice of six default units of measure depending on the active Q-RPT and measurement mode (see Section 3.3.2 and Table 9, Table 10). RPM4-AD also supports many commonly used units that are not included in the default set up. These units can be made available for active selection by customizing the UNIT function using **[SPECIAL]**, **<6PresU>**. The typical user customizes the **[UNIT]** function key displays

to support his/her six most commonly used units. This allows RPM4-AD to offer a very wide selection of units without having to deal with a long unit list in day to day operation.

❍ OPERATION WITH RPM4 A160K/A160K

To customize the **[UNIT]** function key, press **[SPECIAL]**, **<6PresU>** from the MAIN RUN screen. The display is:

Select the Q-RPT and measurement modes for which the UNIT function menu is being customized. The <other> selection covers the measurement modes other than absolute (gauge, negative gauge, differential) when applicable.

```
Setup unit for Q-RPT
1Hi abs 2Hi other ↓
3HL abs 4HL other
```

The next display is:

1. Entry field to specify which unit position (1 to 6) of the UNIT function menu is to be changed.

```
        1
        ↓
Set up unit #6
for Hi absolute mode
```

Enter the number of the unit position on the UNIT function menu that you would like to change.

The next display lists the types of measurement unit supported by RPM4-AD.

Select the unit type. **<SI>** and **<other>** are pressure units. Not all unit types are available for all Q-RPTs and measurement modes.

```
Unit#6  1SI 2other
3altitude 4airspeed ↓
5user
```

See Table 13 for definition of unit type availability by Q-RPT and measurement mode. If the measurement unit type selected is not available for the selected Q-RPT and/or measurement mode, **<Not available on [Q-RPT], [measurement mode]>** is displayed. Press **[ESC]** to return to the unit type selection screen and select a valid unit type.

Table 13. Available unit of measure types by active Q-RPT and measurement mode, RPM4-AD A160K/A160K (rotary wing)

Q-RPT	MEASUREMENT MODE	UNIT TYPE			
		PRESSURE	ALTITUDE	AIRSPEED	USER
Hi and Lo parallel **<HL>**	Absolute **<a>**	Yes[1]	**Yes[1]**	No	Yes[1]
	Gauge, negative gauge **<g>**	Yes[1]	No[2]	**Yes[2]**	Yes[1]
Hi **<Hi>, <Hd>**	Absolute **<a>**	Yes	No	No	Yes
	Gauge, negative gauge **<g>**, differential **<d>**	Yes	No[2]	**Yes[2]**	Yes

1. Best measurement uncertainty .
2. Altitude measured by Lo Q-RPT can be displayed while measuring airspeed.

After selecting the unit type, select the unit. Table 14 lists the unit selection menus by unit type.

Table 14. UNIT function - available units of measure

<1SI>[1]	<2OTHER>	<3ALTITUDE>	<4AIRSPEED>		<4USER>
			<1calibrated>	<2true>	
<1Pa> <2hPa> <3kPa> <4MPa> <5mbar> <6bar> <7mmHg> <8mmWa>	<1psi> <2psf> <3inHg> <4inWa> <5kcm2> <6Torr> <7mTor>	<1feet> <2meters>	<1kts> <2mph> <3km/h> <4mach>	<1KTS> <2MPT> <3KM/H> <4MACH>	

1. SI pressure units include certain units based on SI such as mmWa.

If **<3airspeed>** is selected, the type of airspeed unit must be selected. The display is:

Select **<1calibrated>** for airspeed calculated from the differential pressure (Qc) assuming a fixed altitude and air temperature (see Section 7.2 for information on RPM4-AD unit conversions). This is the most commonly used air speed unit. Select **<2true>** for airspeed calculated from differential pressure (Qc) taking into consideration altitude (Ps) and a user entered temperature value.

```
Airspeed type:
1calibrated 2true
```

If **<2true>** is selected, the default air temperature to be used in calculating airspeed must be entered. The display is:

1. Entry field for default temperature to be used in true airspeed calculation. The default value is 15 ºC.

```
True airspeed
default T: 15.0 °C
           ↑
           1
```

Enter the default temperature value. This value can be edited when a true airspeed unit is selected in the **[UNIT]** menu. Changing this value changes the default temperature value for any true airspeed units that have already been setup.

In RPM4-AD displays, calibrated airspeed units are represented in lower case (e.g. kts) and true airspeed units are represented in upper case (e.g. KTS).

If **<4user>** is selected, the user unit must be defined. The display is:

1. Entry field.

```
Define user unit:
1.000000 unit/Pa
↑
1
```

Enter the number of user units per Pascal (Pa) in the entry field. Pressing **[ENT]** defines the user unit and returns to the **<Set up unit #n>** screen.

The user defined unit label can be customized to any alphanumeric, four character label using the remote command "UDU" (see Section 4.4.4).

See Section 7.2 for information on the unit of measure conversions used by RPM4-AD.

❍ OPERATION WITH RPM4 A350K/A160K

To customize the **[UNIT]** function key, press **[SPECIAL]**, **<6PresU>** from the MAIN RUN screen. The display is:

Select the Q-RPT for which the UNIT function menu is being customized.

```
Setup UNIT for Q-RPT
1Hi 2Lo
```

The next display is:

1. Q-RPT for which UNIT function menu is being customized.

```
                    1
                    ↓
Measurement mode: Hi
1absolute 2other
```

Select the measurement mode for which the UNIT function key menu is being customized.

1. Entry field to specify which unit position (1 to 6) of the UNIT function menu is to be changed.

```
                1
                ↓
Set up unit #6
for Hi absolute mode
```

Enter the number of the unit position on the UNIT function menu that you would like to change.

The next display lists the type of measurement units supported by RPM4-AD.

Select the unit type. **<SI>** and **<other>** are pressure units.

```
Unit#6  1SI 2other
3altitude 4airspeed ↓
5user
```

See Table 15 for definition of unit type availability by Q-RPT and measurement mode. If the measurement unit type selected is not available for the selected Q-RPT and/or measurement mode, **<Not available on [Q-RPT], [measurement mode]>** is displayed. Press **[ESC]** to return to the unit type selection screen and select a valid unit type.

Table 15. Available unit of measure types by active Q-RPT and measurement mode, RPM4-AD A350K/A160K (fixed wing)

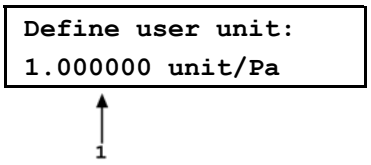
Q-RPT	MEASUREMENT MODE	UNIT TYPE			
		PRESSURE	ALTITUDE	AIRSPEED	USER
Lo **<Lo>**	Absolute **<a>**	Yes	**Yes**	No	Yes
	Gauge, negative gauge **<g>**	Yes	No	No	Yes
Hi **<Hi>, <Hd>**	Absolute **<a>**	Yes	No	No	Yes
	Gauge, negative gauge **<g>**, differential **<d>**	Yes	No[1]	**Yes**[1]	Yes

1. Altitude measured by Lo Q-RPT can be displayed while measuring airspeed.

After selecting the unit type, select the unit. Table 14 lists the unit selection menus by unit type.

If **<user>** is selected, the user unit must be defined. The display is:

1. Entry field.



Enter the number of user units per Pascal (Pa) in the entry field. Pressing **[ENT]** defines the user unit and returns to the **<Set up unit #n>** screen.

The user defined unit label can be customized to any alphanumeric, four character label using the remote command "UDU" (see Section 4.4.4).

See Section 7.2 for information on the unit of measure conversions used by RPM4-AD.

3.5.7 <7INTERNAL>

❍ PURPOSE

To view, set, adjust, and maintain various aspects of RPM4's internal operation.

❍ OPERATION

To access the internal selections press **[SPECIAL]**, **<7internal>**. The display is:

The INTERNAL menu choices include:

<1baro> View the real time output of the on-board barometer, if present (see Section 3.5.7.1).

<2ReadRt> Turn ON and OFF RPM4's automated, rate of change dependent, reading integration rate feature (see Section 3.5.7.2).

<3RPT2x> The ability to turn ON and OFF parallel measurement mode is not used in RPM4-AD.
Parallel measurement mode is always enabled in RPM4-AD A160K/A160K (rotary wing) (see Section 3.2.5).
Parallel mode is not available in RPM4 A350K/A160K (fixed wing).

<4lo vnt> This feature is not used in RPM4-AD models..

<5log> View the RPM4-AD incident log (see Section **Error! Reference source not found.**).

3.5.7.1 <1BARO>

❍ PURPOSE

To view the value of atmospheric pressure as measured by the RPM4-AD on-board barometer.

❍ PRINCIPLE

RPM4-AD is equipped with a separate, on-board barometer. The atmospheric pressure measurements made by the on-board barometer are used for dynamic compensation of atmospheric pressure when making gauge pressure measurements (see Sections 3.3.3, ❍ PRINCIPLE and 3.2.2).

See Section 5.5, Figure 7 and Section 5.6, Figure 8, Figure 9 for a photo and schematics showing the position of the on-board barometer in RPM4-AD.

The on-board barometer is a low accuracy sensor used only for measuring small changes in atmospheric pressure over short periods of time (see Section 3.2.2). RPM4-AD measurement uncertainty does not depend on the measurement uncertainty of the on-board barometer.

❍ **OPERATION**

To view the current reading of the on-board barometer press **[SPECIAL]**, **<7internal>**, **<1baro>**. The display is in the active pressure unit of measure (see Section 3.3.2). The display resolution is fixed to 0.01 Pa, or its equivalent.

The barometer pressure reading is displayed in the current unit of measure. If the current unit of measure is airspeed, the barometer pressure reading is displayed in the default or last selected altitude unit. To display the barometer in the a desired unit of pressure, return to the main run screen and use [UNIT] to set the desired unit (see Section 3.3.2).

3.5.7.2 <2READRT>

❍ **PURPOSE**

To turn ON and OFF RPM4's automated, rate of change dependent, reading integration rate feature.

❍ **PRINCIPLE**

To obtain maximum resolution from RPM4-AD Q-RPT pressure measurements, an integration time of about 1.2 second per reading is used. In most situations, maximum precision is needed when pressures are stable so a relatively slow display update rate presents no disadvantage. However, when pressure is changing quickly, more rapid pressure updates are usually more important than obtaining maximum precision on individual readings. The RPM4-AD read rate function automatically adjusts pressure measurement integration time depending on the rate of change of pressure. When pressure is changing rapidly, reading rate is increased. When pressure is evolving slowly, reading rate is decreased and maximum precision is obtained.

When the automated read rate function is ON, three pressure rate of change dependent read rates are used. The result is three display update rates:

Table 16. READRT - display update rates

PRESSURE RATE OF CHANGE	DISPLAY UPDATE
> 3 % of range span/s	≈ 0.2 s
> 0.5 and < 3 % of range span/s	≈ 0.6 s
< 0.5 % of range span/s	≈ 1.2 s

For situations in which maximum reading precision is desired regardless of pressure rate of change, the RPM4 automated read rate function can be turned

OFF. In this case, the reading rate is always the high resolution rate of about 1.2 seconds per reading.

❍ **OPERATION**

To turn the automated read rate function ON or OFF or check its current status, press **[SPECIAL]**, **<7internal>**, **<3ReadRt>**.

The display is:

```
Auto read rate:
1on 2off
```

The cursor is on the current selection.

Selecting **<1on>** activates the automated reading rate and returns to the MAIN RUN screen. Selecting **<2off>** turns OFF the automated reading rate and returns to the MAIN RUN screen.

The default RPM4-AD condition is auto read rate ON.

Auto read rate ON/OFF is Q-RPT specific. Turning auto read rate ON or OFF applies to all RPM4 measurements.

3.5.7.3 <3RPT2X>

❍ **PURPOSE**

To enable and disable the RPM4-AD parallel measurement mode in which two Q-RPT modules are used to measure in parallel and their readings are averaged.

The ability to turn ON and OFF parallel measurement mode is not used in RPM4-AD. Parallel measurement mode is always enabled in RPM4-AD A160K/A160K (rotary wing) (see Section 3.2.5). It is not available in RPM4 A350K/A160K (fixed wing).

3.5.7.4 <4LO VNT>

This function is not used in RPM4-AD models.

3.5.7.5 <5LOG>

❍ **PURPOSE**

To view and/or clear the RPM4-AD event log.

❍ **PRINCIPLE**

RPM4-AD records to a log each time one of the following events occurs:

- Pmax! of an internal RPM4-AD Q-RPT or utility sensor is exceeded (see Section 3.4.4.1).
- A memory fault occurs.

❍ **OPERATION**

To view the event log press **[SPECIAL]**, **<9Log>**.

Use **[◁]** and **[▷]** to move back and forth between older and newer log entries.

Each log entry has two screens, one with the event description and one with the even time and date. Use **[△]** and **[▽]** to toggle between the two screens. The oldest logged event appears.

After the last log has been viewed, the option to clear the log, **<1no>**, **<2yes>** is presented. Use **<2yes>** to remove all entries from the log. Use **<1no>** to continue without altering the log.

To leave the log, use **[ESC]**.

3.5.8 <8CAL>

❍ PURPOSE

To calibrate the RPM4-AD Hi and Lo Q-RPTs and adjust the on-board barometer. These functions are considered part of RPM4-AD maintenance and are covered in the maintenance section of this manual (see Sections 5.2, 5.3).

3.5.9 <9RESET>

❍ PURPOSE

To reset various RPM4-AD settings to default or factory values.

❍ PRINCIPLE

RPM4-AD stores its user definable settings in non-volatile memory. The reset menu allows the user to selectively or completely reset these settings to factory defaults. This clears any settings that the user has made, and should be used only to restore the RPM4-AD to a known state. RPM4-AD goes through its power up sequence after any type of reset is executed.

RPM4-AD reset functions will change current settings to factory defaults. These may include settings vital to RPM4-AD operation and affecting the calibration of the quartz reference pressure transducers (Q-RPTs). Reset functions should only be used by qualified personnel with knowledge of reset consequences. Reset functions should never be used "experimentally".

❍ OPERATION

To access the RESET menu, press **[SPECIAL]**, **<9reset>**. The display is:

```
1sets 2units 3ATest
4cal 5all
```

RESET menu choices include:

<1set> to reset general system operating parameters (see Section 3.5.9.1).

<2units> to reset unit of measure functions (see Section 3.5.9.2).

<3ATest> not used in RPM4-AD models.

<4cal> to reset internal calibration coefficients and modes (see Section 3.5.9.4).

<5all> to reset all settings except ID and security password to factory default values (see Section 3.5.9.5).

3.5.9.1 <1SETS>

❍ **PURPOSE**

Sets most general operating parameters back to default values. Does not affect calibration coefficients or remote interfaces. The Reset – Sets resets are itemized in Table 17.

Table 17. Reset – Sets

RESET	RESULT	SEE SECTION
Active Q-RPT	Hi	3.2.1, 3.3.1
[UNIT]	Pressure unit of measure to kts for Hd Q-RPT and ft for Lo Q-RPT	3.3.2
[MODE]	Measurement mode to absolute + differential..	3.3.3
[RANGE]	Hi Q-RPT in absolute + differential mode (Hd)	3.3.1
[HEAD]	0 cm height and Nitrogen medium	3.3
Stability Limit	3 Pa for A160K Q-RPT, 6 Pa for A350K Q-RPT	3.4.3
Upper Limit	102% of Hi Q-RPT range	3.4.4
Resolution	0.001 % FS of Hi Q-RPT default range	3.4.2
AutoZ	AutoZ ON for all Q-RPTs and measurement modes. Z_{offset} value not affected	3.5.1
AutoZ	$\mathbf{P_{atm,0}}$ set to 101.325 kPa a	3.5.1, 3.2.2
Leak Check	15 second run time. Clear logged results	3.3.5
Screen Saver	10 minutes to activation	3.5.5.1
Key Sounds	Medium tone valid key press sound	3.5.5.2
Lo Vnt	Not used in RPM4-AD models.	3.5.7.4
Display	RPT display	3.3.6.4
ReadRate	Automatic	3.5.7.2

3.5.9.2 <2 UNITS>

❍ **PURPOSE**

Sets the six pressure units available under the UNIT function for various measurement modes to the default selections (see Section 3.3.2, 3.5.6).

Sets the user defined unit to 1.000/Pa (see Section 3.5.6).

Sets the reference temperature for inWa unit to 20°C.

Sets the reference temperature for true airspeed units to 15°C.

3.5.9.3 <3ATEST>

This function is not used in RPM4-AD models.

3.5.9.4 <4 CAL>

❍ **PURPOSE**

The Reset - Cal function will reset Q-RPT, utility sensor and barometer calibration coefficients and settings and reset AutoZ values to zero. This will change the RPM4-AD calibration and could cause it to make out of tolerance measurements.

Clears all user values affecting the calibration of Q-RPTs and the on-board barometer. The Reset – Cal resets are itemized in Table 18.

Table 18. Reset – Cal

RESET	RESULT	SEE SECTION
All Q-RPT Calibration Coefficients	PA to zero, PM to 1	5.2.1.1, 5.2.7
On-board Barometer Calibration Coefficients	PA to zero, PM to 1	5.3
Calibration Date	Set all dates to 19800101	5.2.7, 5.3
AutoZ values	All P_{offset} values to zero for absolute mode and 101325 Pa for gauge and negative gauge modes	3.5.1
AutoZ function	ON, all Q-RPTs, all measurement modes	3.5.1

3.5.9.5 <5 ALL>

❍ **PURPOSE**

The reset - all function clears and deletes large amounts of user defined information including critical calibration data.

Combines all resets in one global reset command that clears the entire user section of non-volatile memory except the ID function (see Section 3.5.5.4) and the security level password (see Section 3.5.5.5) returning RPM4-AD to the "as delivered" condition. The Reset – All resets are itemized in Table 19.

Table 19. Reset – All

RESET	RESULT	SEE SECTION
Reset – Sets	All the resets of Reset - Sets	3.5.9.1
Reset – Units	All the resets of Reset - Units	3.5.9.2
Reset – Atest	All the resets of Reset - ATest	--
Reset – Cal	All the resets of Reset – Cal	3.5.9.4
Remote Interfaces	COM1, COM2 and IEEE-R88 interfaces to default settings.	3.5.2
Remote Communications	Remote command format to Classic	3.5.2.3
Level (Security)	Reset security level to low	3.5.5.5
SDS	All SDS full time ON	3.5.4.2

NOTES

4. REMOTE OPERATION

4.1 OVERVIEW

Most of the RPM4-AD front panel functions can also be executed by commands from a remote computer. The host computer can communicate to the RPM4-AD using the RPM4's COM1 RS232 port or it's IEEE-488 port.

Before writing test code using RPM4-AD remote commands, familiarize yourself with its operating principles by reading Section 3 of this manual.

4.2 INTERFACING

Sending a program message to the RPM4-AD places it into **remote** mode. The remote indicator to the right of the display window lights when the RPM4-AD is in **remote** mode. It also flickers when a program message is received. The menus usually accessed from the front panel are locked out while in remote. The **[ESC]** key returns the RPM4-AD to local operation unless the **<REMOTE>** program message, which locks out all keypad operation, was sent to the unit.

4.2.1 RS232 INTERFACE

4.2.1.1 COM1

The RPM4-AD COM1 RS232 interface is located on the back of the unit. It is a 9-pin male DB-9F connector configured as a DCE device. Data is transmitted out of the unit using pin 2, and is received on pin 3. This allows a normal pin-to-pin DB-9M to DB-9F RS232 cable to be used to connect to a DTE host.

Handshaking is not required or supported. The COM1 receive buffer is 80 bytes deep. If you overflow the buffer by sending too much data, the data will be lost. Because of this, you **must** send a single program message at a time and you **must** wait for the RPM4-AD to reply from the previous command before issuing another command.

Table 20. COM1 Pin Designations and Connections

RPM4-AD COM1 DB-9F PIN DESIGNATIONS		
PIN #	**FUNCTION**	**DESCRIPTION**
2	TxD	This pin transmits serial data from the RPM4-AD to the host.
3	RxD	This pin accepts serial data from the host computer.
5	Grn	This pin is the common return for the TxD and RxD signals.

IBM PC/XT DB-9F CONNECTIONS		IBM PC/XT DB-9M TO RPM4-AD DB9F CONNECTION	
DB-25M	**DB-9F**	**DB-9M**	**DB-9F**
2	3	3	3
3	2	2	2
7	5	5	5

4.2.1.2 IEEE-488

The RPM4-AD IEEE-488 interface is located on the back of the unit. The physical and electrical interface conforms to IEEE Std 488.1-1987 Subset E2 and IEEE Std. 488.2-1992. You should not attempt to communicate with the IEEE-488 interface while using the COM1 interface. The IEEE-488 receive buffer is 250 bytes deep. If you attempt to overflow the buffer, the RPM4-AD will hold off release of the NRFD handshake line until it can service and empty the receive buffer.
This keeps the buffer from overflowing. It is recommended that you check for errors using the "ERR?" query after sending a group of non-query program messages. When using queries, ensure that you wait for a reply to each query to ensue proper operation and order of command execution. Replies to queries remain in the reply queue until the host gets them, so they can "stack up", causing replies to appear out of sequence.

4.2.1.3 COM2

The RPM4-AD COM2 RS232 interface is located on the back of the unit. It can be used to allow the host computer to communicate with another device through the RPM4-AD. This allows the user to use one host COM port to communicate with the RPM4-AD and an additional RS232 device. Refer to the "**#**" remote program command for details.

COM2 is a 9-pin female DB-9F connector configured as a DTE device. Data is transmitted out of the RPM4-AD using pin 3, and is received on pin 2. This allows a normal pin-to-pin DB-9M to DB-9F RS232 cable to be used to connect to a DCE device.

Handshaking is not required or supported.

Table 21. COM2 DB-9F Pin Designations

PIN #	FUNCTION	DESCRIPTION
2	RxD	This pin transmits serial data from the RPM4-AD to a device.
3	TxD	This pin accepts serial data from the external device.
4	DTR	This pin is Data Terminal Ready (DTR) (held at + 5 V).
5	Grn	This pin is the common return for the TxD and RxD signals.

4.3 PROGRAMMING FORMATS

RPM4-AD supports two program message formats, the **"classic"**, and the **"enhanced"** formats. The user must select which format to use. Selection can be accomplished from the front panel (see Section 3.5.2.3) or remotely using the **"L2"** or **"L3"** program message (see Section 4.4.4). The **"MSGFMT"** command can also be used to select the format, but is not recommended for new designs.

The main difference between the "classic" and "enhanced" formats is that when using the IEEE-488 interface, a query operator **"?"** must be included in an enhanced command to yield a reply from the RPM4-AD. When using the COM1 port in classic or enhanced mode or using the IEEE-488 port in classic mode, every command has a reply which the host must wait for before continuing. In addition, the enhanced message format supports IEEE Std 488.2 syntax, format and status reporting. The default is the classic format.

In either format, it is recommended that you start out a command sequence with the **"*CLS"** command, which clears all of the communication and error queues. The basic commands are similar for both the classic and enhanced formats, but the usage, syntax, format and status reporting are different.

Many RPM4-AD classic and enhanced commands are common with RPM4 (non-AD), PPC2+, PPCK+ and PPC3 Pressure/Controller Calibrators.

4.3.1 CLASSIC PROGRAM MESSAGE FORMAT

Each program message sent is also a query. You can only send one program message to the RPM4-AD at time. After sending any program message, you must wait for the RPM4-AD to reply before sending another program message. This reply will contain data, or a numeric error message if the program message was invalid. You must wait for this reply before issuing another program message to the RPM4-AD. This insures that the RPM4-AD has completed the program message. Most remote program messages will return a reply within 500 ms except:

"PR?", **"PRR?"**, **"SR?"**, **"ATM?"**, **"RATE?"**: Up to 2 seconds.

"AUTOZERO=RUN": Up to 10 seconds

"MODE=", **"UNIT=", "RANGE="**: Up to 5 seconds

The syntax and format used for each program message in the classic mode is listed next to the keyword "Classic"' in each program message summary in Section 4.4.4.

4.3.2 ENHANCED PROGRAM MESSAGE FORMAT

The enhanced program message format uses the IEEE Std. 488.2 format, syntax and status reporting. Errors are reported using the IEEE Std. 488.2 status reporting model. If an error is reported, the error is put into an Error Queue and the **"ERR?"** query program message can be used to get a text description of the most recent error. If you are using the IEEE-488 port, the service request line can be setup to be asserted if this occurs (see Section 4.5.2). In the enhanced format, there are two possible program message types for every program message. Each of these two types starts with the same basic text referred to as the program message header. The two types are COMMAND type and QUERY type commands.

4.3.2.1 USING COMMAND TYPE COMMANDS

Enhanced format commands DO NOT reply when using the IEEE-488 interface unless a "?" is included in the command. Do not expect a response from the RPM4's IEEE-488 interface to non-query (no "?") commands as there is none. Remote software will time-out waiting for a response from RPM4-AD. However, in RS232 communications, there is always a response and the response MUST be read prior to issuing another command.

The COMMAND type of program message executes a process and can additionally send data to the RPM4-AD in the form of comma delimited arguments. This data is usually a setting of some sort that is stored in the RPM4-AD. If data is specified, it must be preceded by at least one white space from the program message header and be within the range and format described in the program message description. The keyword **"Command:"** appears to the left of the required syntax in each program message description in Section 4.4.4.

If you are using the IEEE-488 port, the Command type does not generate a reply unless you place a query operator **"?"** immediately after the command. You also may send multiple program messages at once by separating each program message with a semicolon. The commands are queued and executed in as received order after the entire message stream has been received, so care in determining order of execution is needed.

If you are using the RS232 port COM1, the Command type will always generate a reply so you **must** wait for a reply before issuing another program message. Because of this, you can only send one Command program message at a time while using the COM1 port.

Examples:

- **IEEE-488 enhanced mode command series using query operator:**

  "*CLS?" (Clear the error queue. Wait for reply)
  "MMODE? A" (Generates a reply. User must wait for reply before continuing)
  "UNIT? KPA" (Generates a reply. User must wait for reply before continuing)
  "PR?" (Generates a reply. User must wait for reply before continuing)

- **IEEE-488 enhanced mode commands without query operator:**

  "*CLS" (Clear the error queue. No reply)
  "MMODE A" (No reply)
  "UNIT KPA" (No reply)
  "ERR?" (Wait for reply. User should use **"ERR?"** query following a series of non query commands to check for errors that may have occurred)

- **IEEE-488 enhanced mode multiple commands without query operator:**

  "*CLS" (Clear the error queue. No reply)
  "MMODE A; UNIT KPA" (Two command at once. No reply)
  "ERR?" (Wait for reply. User should use **"ERR?"** query following a series of non query commands to check for errors that may have occurred)

- **COM1 enhanced mode command:**

  "*CLS" or **"*CLS?"** (Clear the error queue. Wait for reply)
  "UNIT KPA" or **"UNIT? KPA"** (Generates a reply. User must wait for reply before continuing)
  "MMODE A" or **"MMODE? A"** (Generates a reply. User must wait for reply before continuing)
  "PR" or **"PR?"** (Generates a reply. User must wait for reply before continuing)

4.3.2.2 USING QUERY TYPE COMMANDS

The QUERY type of program message just requests data from the RPM4-AD. Placing the query operator **"?"** immediately after the command creates a query. You **must** wait for a reply with a query. If you send any type of program message to the RPM4-AD after a query before receiving a reply, the program message is discarded and an error is generated. Errors are reported using the IEEE Std. 488.2 status reporting model. A Query program message always ends with a question mark. Most queries return a reply within 200 ms except:

"PR?", **"PRR?"**, **"SR?"**, **"ATM?"**, **"RATE?"**: Up to 2 seconds.

"RPT", **"AUTOZERO RUN"**: Up to 3 seconds

The syntax for using a QUERY program message is listed next to the keyword **"Query:"** in each program message summary in Section 4.4.4. Please note that queries in enhanced mode via the IEEE-488 port that results in an error will not result in a reply. You must check the error queue (use the "ERR" querie) to see if an error has occurred.

4.4 COMMANDS

4.4.1 PROGRAMMING MESSAGES

Some commands accept an optional suffix. This suffix can be used to specify the explicit Q-RPT to address (HI, LO or HL). Only the HI or HL RPT can be the "active" Q-RPT at any time. If the suffix is not specified, then the "Active" Q-RPT ("HI" or "HL") is assumed. The "LO" Q-RPT cannot be made the "active" RPT, but you can access it's measurement using a suffix of "2" in some commands. The "RANGE" command can be used to select the "Active" Q-RPT. There are some limitations to use of the suffix when the RPM4-AD is in differential mode (see Section 3.2.6) or the "HL" Q-RPT is active (see Section 3.2.5). See the program message descriptions for suffix use with a specific command.

Table 22. Program Message List

COMMAND '*n*' indicates an optional suffix	**DESCRIPTION**
#	Send a command string out of the RPM4-AD COM2 port.
ABORT	Stop pending operations
ARANGE*n*	Command not available in RPM4-AD models.
ATM	Read the current atmospheric pressure (on-board barometer).
AUTOZERO*n*	Read or set the status of the AutoZ automatic zeroing function.
AUTOZERO*n=RUN*	Run AutoZero.
CALAMB	Read or set the on-board barometer calibration
COM1	Read or set the configuration of the COM1 port.
COM2	Read or set the configuration of the COM2 port.
CONT*n*	Enable continuous measurements
DATE	Read or set the current date.
ERR	Read the last error message.
GPIB	Read or set the GPIB interface address.
HEAD	Read or set the fluid head settings.
ID	Read or set the RPM4-AD alphanumeric asset ID tag.
L2	Selects "classic" program message format
L3	Selects "enhanced" program message format
LL*n*	Read or set the lower limit for the current range (negative gauge and differential modes only).
LOCAL	Return control to the RPM4-AD front panel.
MEM	Read the power-up memory test status.
MMODE*n*	Read or change the active measurement mode.
MSGFMT	Read or set the type of program message format to use.
NVENT*n*	Command not available in RPM4-AD models.
PCAL*n*	Read or set the user Lo Q-RPT calibration information.
PCAL:*XX*	Read or set the user Lo Q-RPT calibration information (old command).
PR*n*	Read the next RPM4-AD pressure.
PRR*n*	Read the next RPM4-AD pressure, rate, and ATM.
QPRR*n*	Read the last RPM4-AD pressure, rate and ATM.
RANGE	Select a Q-RPT to be active
RATE*n*	Read the next available rate of change of pressure.
READRATE*n*	Read or set the Q-RPT measurement read rate and mode
READYCK*n*	Read or set a flag that is cleared by a *Not Ready* condition.
REMOTE	Enable remote local lockout operation.
RES*n*	Read or set the pressure display resolution.
RESET	Reset the RPM4-AD to default user parameters.
RPT*n*	Read the available Q-RPT data.
SCRSAV	Read or set the front panel screen saver period.
SDS*n*	Read or set the SDS state for a specific Q-RPT
SDSACT	Read or set the active Q-RPT SDS state
SDSAUTO	Read or set the SDS mode for both Q-RPTs
SN	Read the serial number of the RPM4-AD.
SR*n*	Read the next available pressure status (*Ready/Not Ready*).
SS*n*	Read or set the stability required for a *Ready* condition.
SS%*n*	Read or set the stability required for a *Ready* condition (% span/ s).
TIME	Read or set the current time of day.
UCOEF*n*	Convert a pressure in Pascal to pressure in the current units.

COMMAND '*n*' indicates an optional suffix	DESCRIPTION
UDU	Read or set the user defined pressure unit.
UL*n*	Read or set the upper limit for the current range.
UNIT*n*	Read or set the pressure unit of measure for the current range.
VER	Read the RPM4-AD software version.
ZOFFSET*n*	Read or set the AutoZero Z_{offset} for the specified Q-RPT.
ZOFFSET:*XX*	Read or set the AutoZ Z_{offset} for the specified Q-RPT (old command).

4.4.2 ERROR MESSAGESS

Table 23. Error #s and Descriptions

REPLY	DESCRIPTION
ERR# 0	"OK"
ERR# 2	"Text argument is too long"
ERR# 3	"Arguments cannot be 0"
ERR# 4	"External device not detected"
ERR# 5	Not used
ERR# 6	"Numeric argument missing or out of range"
ERR# 7	"Missing or improper command argument(s)"
ERR# 8	"External device time-out error"
ERR# 9	"Unknown command"
ERR# 10	"Missing or invalid command suffix"
ERR# 11	"Command missing argument"
ERR# 12	"System overpressured" or "overpressure may result"
ERR# 13	"Text queue overflow"
ERR# 14	"User unit not defined"
ERR# 17	Not used
ERR# 18	"Command not yet available"
ERR# 19	"Not available with absolute units"
ERR# 20	"Not available with gauge device"
ERR# 21	Not used
ERR# 22	"Pressure is not stable"
ERR# 23	"Option not available or installed"
ERR# 25	Not used
ERR# 26	"COM port failed to initialize"
ERR# 27	"Internal device failure"
ERR# 28	"Device failure"
ERR# 29	"Device not available"
ERR# 30	"Must be on range HI"
ERR# 31	"Exceeds upper or lower limit"
ERR# 32	"Not stable enough"
ERR# 37	"Data table is full"
ERR# 38	"Selected range is not available"
ERR# 39	"Data verify error"
ERR# 45	"Argument not allowed"
ERR #46	"Argument cannot be negative"
ERR #52	"Command obsolete"
ERR# 53	"Not Available"
ERR# 60	"Air data unit of measure not compatible with measurement mode" (e.g. airspeed in absolute mode, altitude in mode other than absolute)

4.4.3 PROGRAM MESSAGE DESCRIPTION OVERVIEW

Each program message description is separated into the following sections:

Purpose	A brief description of the programs message's function.
Command	This is the Enhanced program message syntax to send data to the RPM4-AD or to execute an RPM4-AD function. The RPM4-AD **must** be set to use the enhanced format (see Section 3.5.2.3) to use the syntax and style shown. It may be sent alone, or followed by at least one white space and additional argument(s) to show that arguments can be passed. If there are multiple arguments, then commas must separate them. If you are using the IEEE-488 port, multiple command type program messages can be sent in one message if you separate them with a semicolon. There will be no reply from the RPM4-AD using the IEEE-488 port unless the command is immediately followed by the query operator "?". If you are using the COM1 port, the PPC1 will reply and you **must** wait for this reply. If this field is not listed in the program message description, then the Command type is not supported when using the Enhanced format.
Query	This is the Enhanced program message syntax to request data from the RPM4-AD. The RPM4-AD **must** be set to use the enhanced format (see Section 3.5.2.3). The RPM4-AD will always reply to a query. You **must** wait for this reply before issuing another program message. If this field (Query) is not listed in the program message description, then the Query type for the program message is not supported when using the Enhanced format.
Classic	This is the Classic program message syntax to send data to the RPM4, to execute an RPM4-AD function, or to query for data. The RPM4-AD **must** be set to use the classic format (see Section 3.5.2.3). The command may be followed by a '(=)' and additional argument characters to show that argument(s) can be passed. If there are multiple arguments, then commas must separate them. The RPM4-AD will always reply to a Classic program message. You **must** wait for this reply before issuing another program message. If this field is not listed in the program message description, then it is not supported when using the classic format.
Suffix	Some commands support an optional suffix. This suffix is typically used to specify a Q-RPT to which the command applies, since many settings are Q-RPT specific: Suffix of '1' for Hi or HL Q-RPT access Suffix of '2' for Lo Q-RPT access If an optional suffix is allowed but not given, then the "Active Q-RPT" is addressed. The "Active Q-RPT" is the Q-RPT that is currently displayed on the top line of the front panel of the RPM4, and is identified by the text label in the upper right of the pressure display screen. The "active" Q-RPT can be the HI or the HL Q-RPT. The "RANGE" or "RPT" command query can be used to determine which Q-RPT is currently active. With the Hi Q-RPT In differential mode of operation or if the HL Q-RPT is active, there are some limitations on access to the Lo Q-RPT settings, and with the HL Q-RPT active, there are limitations on access to the Lo Q-RPTs measurements as well.
Arguments	If the program message can be used to set data inside the RPM4, then this section describes the arguments and their limits.
Default	If the program message can be used to set data inside the RPM4, then this line shows (using the enhanced format) the default setting from the factory.
Remarks	This field has the details and remarks about the command.
Example	Examples are given for the enhanced and classic methods. **Enhanced:** An example of the use of an enhanced format program message to be sent to the RPM4-AD is shown. The message sent to the RPM4-AD appears after the **"Cmd sent:"** label. If only a Query type exists, the **"Query sent:"** label is shown instead. Directly under this label, **"Query reply"** shows a typical reply to a query type. **"Reply:"** shows that a query format does not exist. It may have a short description next to it. **Classic:** An example of the use of a classic program message to be sent to the RPM4-AD is shown. The command sent to the RPM4-AD appears after the **"Cmd sent:"** label. The **"Reply"** label shows a typical reply to the **"Sent"** example. It may have a short description next to it.
Errors	If the program message can report an argument error, the types of errors are listed. If using the classic format or the COM1 port, the error message is replied after receiving the program message. If using the enhanced format via the IEEE-488 port, the error condition is handled by the status reporting model which stores the errors in an Error Queue and can be programmed to assert the IEEE-488 SRQ line to signal an error has occurred. In either case, the **"ERR"** or **"ERR?"** program message can be used to retrieve a text description of the error.
See Also	Indicates related commands (**"----"**) and refers to manual sections giving detail on RPM4-AD operation corresponding to the program message.

4.4.4 PROGRAM MESSAGE DESCRIPTIONS

#	
Purpose	To allow the host PC to communicate with a device connected to the RPM4-AD COM2 port.
Classic	*"#xx"*
Arguments	*xx:* The string to send out of the RPM4-AD COM2 port. It must be less than 40 characters long.
Remarks	The RPM4-AD COM2 port can be used to communicate to another RS232 device (such as another RPM4). This allows the user to use a single COM port or IEEE-488 port on the host computer to communicate with the RPM4-AD and another RS232 device. A carriage return and a line feed (**<CR><LF>**) are added to the string. After this program message is issued, the RPM4-AD will reply back every string received by the RPM4-AD COM2 port that is terminated with a carriage return. Line feeds are discarded. This will discontinue when the next query is sent to the RPM4-AD. There is no other reply from this program message. Prior to using this program message, you must ensure that the RPM4-AD COM2 port is correctly set up to communicate with the device on COM2. Refer to the **"COM2="** program message.
Example (classic)	Sent: "#VER" Reply: "DH INSTRUMENTS, INC RPM4-AD us A1000/A0015 Ver2.00 " This example assumes that a second RPM4's COM1 port is connected to the RPM4-AD COM2 port. This example gets the version of the second RPM4-AD.
See Also	"COM2" 3.5.2

ABORT	
Purpose	Cancels any pending data requests by the "PR", "PRR" "RATE", "SR" or "CONT" commands.
Command Classic	"ABORT" "ABORT"
Remarks	This program message is usually used to ensure the RPM4-AD is in an idle condition.
Example (enhanced)	Cmd sent: "ABORT" Reply: "ABORT" (no reply if IEEE-488)
Example (classic)	Sent: "ABORT" Reply: "ABORT"
See Also	"PR", "PRR" "RATE", "SR" or "CONT"

ARANGE*n*	
Purpose	Not used in RPM4-AD models
Errors	ERR# 53: Command not available.

ATM	
Purpose	Reads the next measured pressure from RPM4's on-board barometer (if present).
Query Classic	"ATM?" "ATM"
Remarks	The atmospheric pressure as measured by the RPM4-AD on-board barometer is returned in the current pressure units of the active Q-RPT (always absolute). This measurement is followed by the units text.
Example (enhanced)	Query sent: "ATM?" Query reply: "97.12348 kPa a"
Example (classic)	Sent: "ATM" Reply: "97.12384 kPa a"
Errors	ERR# 23: RPM4-AD is not equipped with a barometer.
See Also	3.5.7.1

AUTOZERO*n*	
Purpose	Read or set the ON/OFF status of the AutoZ function.
Command Query	"AUTOZERO*n state*" "AUTOZERO*n*?"
Classic	"AUTOZERO*n= state*" "AUTOZERO*n*"
Default	"AUTOZERO1"
Optional Suffix	*"n"* The active Q-RPT is assumed if no suffix is given. '1' Specify the Hi Q-RPT if the HL RPT is not active Specify the HL Q-RPT if the HL Q-RPT is active '2' Specify the Lo Q-RPT if the HL Q-RPT is not active '3' Specify the HL Q-RPT if the HL Q-RPT is active
Arguments	*'state'*: '0' Autozero OFF '1' Autozero ON

Remarks	The RPM4-AD AutoZ function can be turned ON and OFF. There is a separate AutoZ flag for the gauge, absolute, and differential measurement modes for each Q-RPT. This command sets the AutoZ status for the current mode of the specified or the active Q-RPT only. To set the state of AutoZ for a measurement mode, you must be in that mode.
Example (enhanced)	Cmd sent: "AUTOZERO 0" Query reply: "0" (No reply if GPIB-488)
Example (classic)	Sent: "AUTOZERO=0" Query reply: "AUTOZERO=0"
Errors	ERR# 7: The argument was other than '0' or '1'. ERR# 10: The suffix is invalid.
See Also	"ZOFFSET", "MMODE" 3.5.1

AUTOZERO*n*=RUN	
Purpose	Run the AutoZero routine.
Command Query	"AUTOZERO*n* RUN (,*Pref*)" "AUTOZERO*n*? RUN (,*Pref*)"
Classic	"AUTOZERO*n*= RUN (,*Pref*)"
Optional Suffix	*"n"* The active Q-RPT is assumed if no suffix is given. '1' Specify the Hi Q-RPT Specify the HL Q-RPT '2' Specify the Lo Q-RPT '3' Specify the HL Q-RPT if the HL Q-RPT is active
Arguments	*'Pref'*: The AutoZ reference pressure in Pa. Optional when the RPM4-AD is not in absolute measurement mode, as the reference is usually "0".
Remarks	The RPM4-AD AutoZ function can be remotely run with this command only if AutoZero is ON. You should ensure that the pressure is stable for valid determination of Z_{offset}. If in differential mode, the autozero function can take up to 10 seconds to complete. You cannot autozero while in an airspeed or altitude unit. Running AutoZ in differential measurement mode may take up to 10 seconds.
Example (enhanced)	Cmd sent: "AUTOZERO RUN" Query reply: "OK" (No reply if GPIB-488)
Example (enhanced)	Cmd sent: "AUTOZERO? RUN, 97283" (abs AutoZero to 97283 Paa) Query reply: "OK"
Example (classic)	Sent: "AUTOZERO=RUN" Query reply: "OK"
Errors	ERR# 6: An argument was not given for the AutoZ reference in absolute mode. ERR# 10: Invalid suffix ERR# 53 AutoZero is currently OFF or in airspeed or altitude unit.
See Also	"ZOFFSET", "MMODE", "AUTOZERO", "UNIT" 3.5.1

CALAMB	
Purpose	Read or set the on-board barometer calibration.
Command Query	"CALAMB *adder, mult, CalDate*" "CALAMB?"
Classic	"CALAMB=*adder, mult, CalDate*" "CALAMB"
Defaults	"CALAMB = 0.0, 1.0, 19800101"
Arguments	*Adder:* The Barometer calibration adder (PA), in Pascal. *Mult:* The Barometer calibration multiplier (PM) from 0.1 to 100. *CalDate:* The date of the calibration in the format "YYYYMMDD"
Remarks	The barometer calibration information can be accessed with this program message. Using this program message overwrites the current calibration coefficients, so caution must be used. Changes made take effect immediately.
Example (enhanced)	Cmd sent: "CALAMB? 2.1, 1.000021, 20011201" Query reply: " 2.10, 1.000021, 20011201"
Example (classic)	Sent: "CALAMB=2.1, 1.000021, 20011201" Reply: " 2.10, 1.000021, 20011201"
Errors	ERR# 6: One of the arguments is out of range.
See Also	3.5.7.1, 5.3

COM1	
Purpose	Read or set the RS232 settings for the COM1 port.
Command Query	"COM1 *baud, parity, data, stop*" "COM1?"
Classic	"COM1=*baud, parity, data, stop*" "COM1"
Arguments	*Baud:* The baud rate. This may be '300', '600','1200','2400','4800', '9600' or '19200'. *Parity:* The data parity. This may be 'O' for odd, 'E' for even, or 'N' for none. *Data:* The number of data bits. This may be '7' or '8'. *Stop:* The number of stop bits. This may be '1' or '2'.
Defaults	"COM1 2400,E,7,1"
Remarks	The COM1 port is used to communicate to the RPM4-AD. When the COM1 port configuration of the RPM4-AD is changed, the program message reply (COM1 use only) is sent at the old COM1 settings, but all subsequent communications are accomplished at the new COM1 settings. A 250ms or longer delay after receiving the reply to this command will ensure that the RPM4-AD has changed the COM port settings and is ready for communications at the new settings.
Example (enhanced)	Cmd sent: "COM1 9600,N,8,1" Query reply: "9600,N,8,1" (No reply if GPIB-488)
Example (enhanced)	Cmd sent: "COM1? 9600,N,8,1" Query reply: "9600,N,8,1"
Example (classic))	Sent: "COM1=9600,N,8,1" Reply: "9600,N,8,1"
Errors	ERR# 7: Missing or improper program message argument(s).
See Also	"COM2" 3.5.2.1

COM2	
Purpose	Read or set the RS232 settings for the COM2 port.
Command Query	"COM2 *baud,parity,data,stop*" "COM2?"
Classic	"COM2= *baud,parity,data,stop*" "COM2"
Arguments	*baud*: The baud rate. This may be '300', '600','1200','2400','4800', '9600' or '19200'. *parity*: The data parity. This may be 'O' for odd, 'E' for even, or 'N' for none. *Data:* The number of data bits. This may be '7' or '8'. *stop*: The number of stop bits. This may be '1' or '2'.
Defaults	"COM2 2400,E,7,1"
Remarks	COM2 is generally used to allow the host computer to communicate through the RPM4-AD to an additional device connected to COM2. This can be useful if the host computer does not have 2 serial ports available.
Example (enhanced)	Cmd sent: "COM2 9600,N,8,1" Query reply: "9600,N,8,1" (No reply if GPIB-488)
Example (enhanced)	Cmd sent: "COM2? 9600,N,8,1" Query reply: "9600,N,8,1"
Example (classic)	Sent: "COM2=9600,N,8,1" Reply: "9600,N,8,1"
Errors	ERR# 7: Missing or improper program message argument(s).
See Also	"COM1" 3.5.2.1

CONT*n*	
Purpose	Have the RPM4-AD reply continuously as each new measurement becomes available.
Query	"CONT*n*?"
Classic	"CONT*n*"
Optional Suffix	*"n"* The active Q-RPT is assumed if no suffix is given. '1' Specify the Hi Q-RPT if the HL RPT is not active Specify the HL Q-RPT if the HL Q-RPT is active '2' Specify the Lo Q-RPT if the HL Q-RPT is not active '3' Specify the HL Q-RPT if the HL Q-RPT is active
Remarks	This command is somewhat different than most as it enables the RPM4-AD to continuously output the selected Q-RPT's measurement without further queries. This continues until the next query is received by the RPM4, or if the ABORT" or "*CLS" command is received. The frequency of the measurements is determined by the readrate of the Q-RPT. The data returned includes the pressure of the specified or active Q-RPT, the Q-RPT's unit of measure and measurement mode.
Example (enhanced)	Query sent: "CONT1?" Query reply: "1936.72 kPa a" (repeats every measurement cycle)
Example (classic)	Query sent: "CONT" Reply: "1936.72 kPa a" (repeats every measurement cycle)
See Also	"PR", "READRATE"

DATE	
Purpose	Read or set the RPM4-AD date.
Command Query	"DATE *date*" "DATE?"
Classic	"DATE= *date*" "DATE"
Arguments	*date*: The date in the numerical only format "YYYYMMDD"
Remarks	The RPM4-AD has an internal real time calendar clock. The span of acceptable dates ranges from 19800101 to 20791231. The reply is always in the YYYYMMDD format.
Example (enhanced)	Cmd sent: "DATE 20030115" Query reply: "20030105" (No reply if GPIB-488)
Example (enhanced)	Cmd sent: "DATE? 20030105" Query reply: "20030105"
Example (classic)	Sent: "DATE=20021201" Reply: "20021201"
Errors	ERR# 6: Missing or improper program message argument(s).
See Also	"TIME" 3.5.5.3

ERR	
Purpose	Read the new available error message from the Error Queue.
Query	"ERR?"
Classic	"ERR"
Remarks	This program message obtains additional details about an error that has occurred. If the user receives an "ERR# nn" reply, or the enhanced mode is enabled using the IEEE-488 interface and an error has been detected, the error is put into a FIFO Error Queue. The "ERR" program message pulls and replies the oldest error message available. In "classic" mode only the most recent error can reside in the queue. "OK" is replied if there are no error messages left. If an error occurs in enhanced mode using the IEEE-488 interface, no reply is generated even if the command was a query.
Example (enhanced):	Query sent: "ERR?" Query reply: "Numeric argument missing or out of range"
Example (classic)	Sent: "ERR" Reply: "Numeric argument missing or out of range"
See Also	4.4.2

GPIB	
Purpose	Read or set the GPIB interface address.
Command *Query*	"GPIB *addr*" "GPIB?"
Classic	"GPIB=*addr*" "GPIB"
Defaults	"GPIB 10"
Arguments	*Addr:* The address of the IEEE-488 (GPIB) interface (1 to 30)
Remarks	The GPIB address is changed following the reply of this command. Each device on a GPIB interface bus requires a unique address.
Example *(enhanced)*	Cmd sent: "GPIB 21" Query reply "21" (No reply if GPIB-488)
Example *(enhanced)*	Cmd sent: "GPIB? 21" Query reply "21"
Example *(classic)*	Sent: "GPIB=21" Reply: "21"
Errors	ERR# 6: The argument is not within given limits.
See Also:	3.5.2.2

HEAD	
Purpose	Read or set the gas head settings.
Command Query	"HEAD *height, units, gas*" "HEAD?"
Classic	"HEAD=*height, units, gas* "HEAD"
Defaults	"HEAD 0, cm, N2"
Arguments	*height:* The height of the test in relation to the RPM4-AD. The value is positive if the test is above the RPM4, or negative if below the RPM4-AD. The value can be between - 9999 and 9999. Setting the value to '0' disables the head correction. *units:* The height units. This must be "in" or "cm". *gas:* The gas type. This must be "N2", "AIR" or "HE". Command is case sensitive.
Remarks	The RPM4-AD can make a gas head correction to allow it to display the pressure at a level other than the reference level of the RPM4-AD.
Example (enhanced)	Cmd sent: "HEAD? 10,in,N2" Query reply: "10, in, N2"
Example (classic)	Sent: "HEAD=10,in,N2" Reply: "10, in, N2"
Errors	ERR# 2: The gas text is too long ERR# 6: The height is not within given limits or the unit is invalid. ERR #7: The gas text is invalid
See Also:	3.3.7, 3.5.3

ID	
Purpose	Read or set the user defined instrument identification label.
Command *Query*	"ID *string*" "ID"
Classic	"ID=*string*" "ID"
Arguments	*String:* An alphanumeric string up to 12 characters long.
Remarks	The user defined ID label can be used to allow the user to "tag" the RPM4-AD with a unique identifier. This ID is stored in non-volatile memory and cannot be erased by a power failure, system fault or reset. The ID should not be changed frequently, as the non-volatile memory may fail after 100,000 write operations.
Example *(enhanced)*	Cmd sent: "ID RPM4-AD #A01" Query reply "RPM4-AD #A01" (No reply if GPIB-488)
Example *(enhanced)*	Cmd sent: "ID? RPM4-AD #A01" Query reply "RPM4-AD #A01"
Example *(classic)*	Sent: "ID=RPM4-AD #A01" Reply: "RPM4-AD #A01"
Errors	ERR# 2 Text argument is too long (more than 12 characters)
See Also	3.5.5.4

L2 / L3	
Purpose	Read or set the type of program command format to use (classic or enhanced).
Command	"L2"enables "classic" mode "L3"enables "enhanced" mode
Defaults	"L2" (Classic mode)
Remarks	The user can select the type of remote command format using these simplified commands. There is no query format. This format must agree with the format sent to the RPM4-AD. This command is a replacement for the "MSGFMT" command.
Example (enhanced)	Cmd sent: "L3" Query reply: "L3" (No reply if IEEE-488)
Example (classic)	Sent: "L2" Reply: "L2"
See Also	"MSGFMT" 4.3, 3.5.2.3

LL*n*	
Purpose	Read or set the lower pressure limit for the active range and measurement mode (negative gauge or differential measurement mode only).
Command	"LL*n limit*"
Classic	"LL*n =limit*"
Optional Suffix	*"n"* The active Q-RPT is assumed if no suffix is given. '1' Specify the Hi Q-RPT if the HL RPT is not active Specify the HL Q-RPT if the HL Q-RPT is active '2' Specify the Lo Q-RPT if the HL Q-RPT is not active and the measurement mode is not differential '3' Specify the HL Q-RPT if the HL Q-RPT is active
Arguments	*"limit":* The lower pressure limit for the current pressure range in the specified Q-RPT's current unit of measure unit and measurement mode. Value is always a negative value of gauge pressure.
Remarks	Negative gauge and differential modes in RPM4-AD each have a separate lower limit. If the pressure is less than the lower limit, the pressure display flashes. This feature can used to prevent accidental over (under) pressure of a device under test.
Example (enhanced)	Cmd sent: "LL -4" Reply: "-4 kPa g" (no reply if IEEE-488)
Example (enhanced)	Cmd sent: "LL? -4" Reply: "-4 kPa g"
Example (classic)	Sent: "LL=-4" Reply: "-4 kPa g"
Errors	ERR# 6: The *limit* argument is invalid. ERR# 10 The suffix is invalid ERR# 23 The mode must be negative gauge to specify a lower limit.
See Also	"UL", "MMODE" 3.4.4, 3.3.3

LOCAL	
Purpose	Returns control to the RPM4-AD front panel.
Command	"LOCAL"
Classic	"LOCAL"
Remark	The REMOTE program message can lock the front panel out completely. The user can return to local operation by sending the LOCAL program message, sending the IEEE-488 'GTL' command (if in enhanced format), or by cycling RPM4-AD power.
Example (enhanced)	Cmd sent: "LOCAL" Reply: "LOCAL" (no reply if IEEE-488)
Example (enhanced)	Cmd sent: "LOCAL?" Reply: "LOCAL"
Example (classic)	Sent: "LOCAL" Reply: "LOCAL"
See Also	"REMOTE"

MEM	
Purpose	Read the status from the power-up memory test.
Query	"MEM?"
Classic	"MEM"
Remarks	The RPM4-AD system memory stores the user settings (units, resolution) and retains them when the unit is OFF. On power-up, this memory is checked. If this memory is corrupted, all user settings are reset to default , and the MEM status is set to reflect this.
Example (enhanced)	Query sent: "MEM?" Reply: "0" RPM4-AD data corrupted and was set to factory defaults. "1" The memory was found to be OK on power-up.
Example (classic)	Sent: "MEM" Reply: "MEM=0" RPM4-AD data corrupted and was set to factory defaults. "MEM=1" The memory was found to be OK on power-up.
See Also	3.5.9, **Error! Reference source not found.**

MMODE*n*	
Purpose	Read or change the active measurement mode.
Command Query	"MMODE*n mode*" "MMODE*n*?"
Classic	"MMODE*n=mode*" "MMODE*n* "
Optional Suffix	*"n"* The active Q-RPT is assumed if no suffix is given. '1' Specify the Hi Q-RPT if the HL RPT is not active Specify the HL Q-RPT if the HL Q-RPT is active '2' Specify the Lo Q-RPT if the HL Q-RPT is not active and the measurement mode is not differential '3' Specify the HL Q-RPT if the HL Q-RPT is active
Arguments	*Mode:* "A" Absolute mode "G" Gauge mode "N" Negative gauge mode "D" Differential mode (available only for the Hi Q-RPT) Measured pressure values are returned with "g" to identify measurement mode for both gauge and negative gauge measurement modes. Differential mode restricts access to settings on the Lo Q-RPT.
Remarks	The measurement mode can also be set using the "UNIT" command but the "UNIT" command does not distinguish between gauge and negative gauge in it's reply, while the "MMODE" does. Measurement mode is range specific. Altitude units must use absolute mode and airspeed units cannot use absolute mode. Differential mode is always absolute differential so setting differential mode for the Hi Q-RPT automatically puts the Lo Q-RPT into absolute mode.
Example (enhanced)	Cmd sent: "MMODE A" Query reply: "A" (No reply if IEEE-488)
Example (enhanced)	Cmd sent: "MMODE? A" Query reply: "A"
Example (enhanced)	Cmd sent: "MMODE=G" Query reply: "G"
Errors	ERR# 6: Invalid argument text. ERR# 7: Abs mode only with altitude units or gauge mode only with gauge Q-RPT. ERR#10: The suffix indicating the Q-RPT is invalid for the current conditions. ERR# 20: Absolute or negative gauge mode not available with gauge Q-RPT. Absolute Q-RPT with an absolute and negative gauge OFF calibration. The current range cannot support gauge mode. ERR# 53: Gauge mode range would be negative. Lo Q-RPT not suitable for differential mode. Altitude units must use absolute mode. Airspeed units cannot use absolute mode
See Also	"UNIT" 3.3.3

MSGFMT	
Purpose	Read or set the type of program command format to use (enhanced or classic).
Command Query	"MSGFMT *mode* "MSGFMT?"
Classic	"MSGFMT= *mode* "MSGFMT"
Arguments	*mode:* '1' to use the enhanced command format. '0' to use the classic command format.
Defaults	"MSGFMT 0"
Remarks	The user can select the type of remote command format to use. This format must agree with the format sent to the RPM4 The enhanced query form of this command ("MSGFMT? *n*") should always be used to set the desired format, as it will be accepted regardless of the current format (classic or enhanced). It is recommended to use the "L2" and "L3" commands instead of this command for new designs.
Example (enhanced)	Cmd sent: "MSGFMT 1" Query reply: "1" (No reply if IEEE-488)
Example (enhanced)	Cmd sent: "MSGFMT? 1" Query reply: "1"
Example (classic)	Sent: "MSGFMT=1" Reply: "MSGFMT=1"
Errors	ERR# 6: Missing or improper program message argument(s).
See Also	"L2 / L3" 4.3, 3.5.2.3

NVENT*n*	
Purpose	Not used in RPM4-AD models
Errors	ERR# 53: Command not available!

PCAL*n*	
Purpose	Read or set the calibration information for the Hi or Lo Q-RPT.
Command Query	"PCAL*n adder, mult, CalDate*" "PCAL*n*?"
Classic	"PCAL*n= adder, mult, CalDate*" "PCAL*n*"
Defaults	"PCAL*n* = 0.0, 1.0, 19800101"
Optional Suffix	*"n"* The active Q-RPT is assumed if no suffix is given. The Hi Q-RPT is assumed if the HL Q-RPT is active and no suffix is given. '1' Specify the Hi Q-RPT '2' Specify the Lo Q-RPT
Arguments	*Adder:* The Q-RPT calibration adder (PA). In Pascal. *Mult:* The Q-RPT calibration multiplier (PM) from 0.1 to 100. *CalDate:* The date of the calibration in the format "YYYYMMDD" by default. Any other format up to 8 characters long is also accepted, and the replied format is in th previously entered format.
Remarks	The user defined pressure calibration information for the specified Q-RPT (Hi or Lo) can be accessed with this program message. The HL Q-RPT does not have it's own calibration information. Using this program message overwrites the current calibration coefficients, so caution must be used. Changes made using this program message take effect immediately. For compatibility with the obsolete style PPC3 "PCAL:HI" and "PCAL:LO" commands, ":HI" and ":LO" can be used in place of the suffix *"n"* but this is not recommended for new applications.
Example (enhanced)	Cmd sent: "PCAL2? 2.1, 1.000021, 20011201" Query reply: " 2.10 Pa, 1.000021, 20011201" (No reply if GPIB-488)
Example (enhanced)	Cmd sent: "PCAL? 2.1, 1.000021, 20011201" Query reply: " 2.10 Pa, 1.000021, 20011201"
Example (enhanced)	Cmd sent: "PCAL:HI? 2.1, 1.000021, 20011201" (PPC3 style is OK) Query reply: " 2.10 Pa, 1.000021, 20011201"
Example (classic)	Sent: "PCAL1=2.1, 1.000021, 20011201" Reply: " 2.10 Pa, 1.000021, 20011201"
Errors	ERR# 6: One of the arguments is out of range. ERR# 10: The suffix is invalid.
See Also	5.2

PR*n*	
Purpose	Read the next available pressure measurement.
Query	"PR*n*?"
Classic	"PR*n*"
Optional Suffix	*"n"* The active Q-RPT is assumed if no suffix is given. '1' Specify the Hi Q-RPT if the HL RPT is not active Specify the HL Q-RPT if the HL Q-RPT is active '2' Specify the Lo Q-RPT '3' Specify the HL Q-RPT if the HL Q-RPT is active
Remarks	The next available pressure value for the specified or active Q-RPT is read in the Q-RPT's current pressure units. The data returned also contains *Ready/Not Ready* information, and the pressure unit of measure and measurement mode. The reply field is always 20 characters long. The first 3 characters of the reply are reserved for the ready status. The ready status is described in the "SR" program message. The pressure value and pressure unit of measure are right justified in this field. After receiving this program message, the RPM4-AD replies back with the data after a new pressure measurement cycle is complete. This can take up to the current read rate period (1.2 seconds by default).
Example (enhanced)	Query sent: "PR?" Query reply: "R 1936.72 kPa a"
Example (classic)	Query sent: "PR" Reply: "R 1936.72 kPa a"
Errors	ERR# 60: The current Q-RPT unit of measure and measurement mode are not compatible. ERR# 10: The suffix is invalid.
See Also	"PRR", "QPRR", "SR", "ABORT", "READRATE", "MMODE", "UNIT" 3.1.1, 3.2.1, 3.5.7.2

PRR	
Purpose	Read the next available *Ready* condition, pressure measurement, rate and on-board barometer reading.
Query	"PRR?"
Classic	"PRR"
Optional Suffix	*"n"* The active Q-RPT is assumed if no suffix is given. '1' Specify the Hi Q-RPT if the HL RPT is not active Specify the HL Q-RPT if the HL Q-RPT is active '2' Specify the Lo Q-RPT '3' Specify the HL Q-RPT if the HL Q-RPT is active
Remarks	The next available *Ready* condition, Q-RPT pressure measurement, rate of pressure change, and barometric pressure is replied in the Q-RPT's current pressure unit of measure. . This can take up to the current read rate period (1.2 seconds by default). Each data field is separated by a comma, and is returned in the following order: ready, pressure UNITS, rate UNITS/s, atm UNITS Here are the field descriptions: ready: Three character ready status field. Refer to the "SR" command. pressure: The measured pressure for the active Q-RPT in the current pressure unit. This is followed by the current pressure unit. rate: The measured rate of pressure change for the active Q-RPT in the current pressure unit per second. This is followed by the current pressure unit of measure. atm: The pressure measured by the RPM4-AD on-board barometer in the current pressure unit (and always absolute). This is followed by the current active Q-RPT's pressure unit. If the current active Q-RPT pressure unit is an airspeed unit, then the barometer will be indicated in "feet" Not all RPM4s are equipped with an on-board barometer. This field is missing if the RPM4-AD is not equipped with an on-board barometer.
Example (enhanced)	Query sent: "PRR?" Query reply: "R,2306.265 kPaa,0.011 kPa/s,97.000 kPa a" "R,2306.265 kPaa,0.011 kPa/s" (no barometer)
Example (classic)	Query sent: "PRR" Reply: "R,2306.265 kPaa,0.011 kPa/s,97.000 kPa a"
Errors	ERR# 60: The current Q-RPT unit of measure and measurement mode are not compatible. ERR# 10: The suffix is invalid.
See Also	"PR", "QPRR", "SR" 3.1.1, 3.2.1, 3.5.7.1

QPRR	
Purpose	Read the last Q-RPT pressure measurement, pressure rate and on-board barometer output immediately.
Query	"QPRR?"
Classic	"QPRR"
Optional Suffix	*"n"* The active Q-RPT is assumed if no suffix is given. '1' Specify the Hi Q-RPT if the HL RPT is not active Specify the HL Q-RPT if the HL Q-RPT is active '2' Specify the Lo Q-RPT '3' Specify the HL Q-RPT if the HL Q-RPT is active
Remarks	The last measured *Ready/Not Ready* condition, active Q-RPT pressure measurement, rate of pressure change, and barometric pressure is replied in the Q-RPT's current pressure unit of measure immediately. This program message is useful when a rapid response of measured pressure is needed. It does not result in quicker pressure measurements. Each data field is separated by a comma, and is returned in the following order: Ready, pressure UNITS, rate UNITS/s, atm UNITS Here are the field descriptions: ready: Three character ready status field. Refer to the "SR" command. pressure: The measured pressure for the selected Q-RPT in the current pressure unit. This is followed by the current pressure unit and measurement mode. rate: The measured rate of pressure change for the active Q-RPT in the current unit of pressure per second. This is followed by the current pressure unit. atm: The pressure measured by the RPM4-AD on-board barometer in the current pressure unit (but always absolute). This is followed by the current active Q-RPT's pressure unit. If the current active Q-RPT pressure unit is an airspeed unit, then the barometer will be indicated in "feet" Not all RPM4s are equipped with an on-board barometer. This field is missing if the RPM4-AD is not equipped with a barometer. If the Q-RPT's measurement unit is in airspeed, then the barometer measurement is in ft
Example (enhanced)	Query sent: "QPRR?" Query reply: "R,2306.265 kPa a,0.011 kPa/s,97.000 kPa a" "R,2306.265 kPa a,0.011 kPa/s" (no barometer)
Example (classic)	Query sent: "QPRR" Reply: "R,2306.265 kPa a,0.011 kPa/s,97.000 kPa a"
Errors	ERR# 60: The current Q-RPT unit and measurement mode are not compatible. ERR# 10: The suffix is invalid.
See Also	"PR", "PRR", "SR" 3.1.1, 3.2.1, 3.5.7.1

RANGE	
Purpose	Change the active Q-RPT range to the default range of the Hi or HL Q-RPT. Replies the active range full scale, pressure unit and measurement mode.
Command Query	"RANGE *Rng*" "RANGE?"
Classic	"RANGE= *Rng*" "RANGE "
Default	"RANGE IH"
	Rng: "IH" for the Hi Q-RPT "HL" for the HL Q-RPT
Remarks	The active Q-RPT must be selected before making changes to settings that are dependent on the range. Q-RPTs selected with this command are used with their full default pressure range. The reply indicates the active range in kPa. Used as a simple query, the active range is returned.
Example (enhanced)	Cmd sent: "RANGE? HL" (select HL Q-RPT) Query reply: "160 kPa a,HL"
Example (classic)	Sent: "RANGE= IH" (select Hi Q-RPT) Reply: "350 kPa a, IH"
Example (classic)	Sent: "RANGE" (request current active Q-RPT range) Reply: "160 kPa a,IH"
Errors	ERR# 6: Invalid *Rng* argument. ERR# 29: The selected Q-RPT is not available.
See Also	"RPT" 3.2.1, 3.3.1

RATE*n*	
Purpose	Read the next available pressure rate of change.
Query	"RATE*n*?"
Classic	"RATE*n*"
Optional Suffix	*"n"* The active Q-RPT is assumed if no suffix is given. '1' Specify the Hi Q-RPT if the HL RPT is not active Specify the HL Q-RPT if the HL Q-RPT is active '2' Specify the Lo Q-RPT '3' Specify the HL Q-RPT if the HL Q-RPT is active
Remarks	The next available pressure rate of change in the current pressure unit per second is returned. Though the RPM4-AD can set locally to display rate per minute, the response to the "RATE" command is always rate per second. After receiving this program message, the RPM4-AD replies back with the data once a new pressure measurement cycle is complete. This can take up to the current read rate period (1.2 seconds by default).
Example (enhanced)	Query sent: "RATE?" Query reply: "0.01 kPa/s"
Example (classic)	Sent: "RATE2" Reply: "0.03 kPa/s"
See Also	"PRR", "QPRR"."READRATE" 3.3.6.2

READRATE*n*	
Purpose	Read or set the specified or active Q-RPT read rate or auto read rate mode.
Command Query	"READRATE*n period*" "READRATE*n*?"
Classic	"READRATE*n= period*" "READRATE*n*"
Optional Suffix	*"n"* The active Q-RPT is assumed if no suffix is given. '1' Specify the Hi Q-RPT if the HL RPT is not active Specify the HL Q-RPT if the HL Q-RPT is active '2' Specify the Lo Q-RPT if the HL Q-RPT is not active and the measurement mode is not differential '3' Specify the HL Q-RPT if the HL Q-RPT is active
Arguments	*"period ":* Period to integrate the measurement over (ms). Can be from 200 ms to 20000 ms. Set to '0' to enable automatic read rate.
Remarks	The RPM4-AD can have the speed in which it integrates each measurement ("read rate") automatically adjusted based on the rate, or it can manually set to a fixed period. Increasing the read rate increases the reply time for pressure and rate queries. In differential mode and when using the HL Q-RPT, the Lo Q-RPT read rate is always set to the same read rate as the Hi.
Example (enhanced)	Cmd sent: "READRATE 1000" Query reply: "1000" (No reply if GPIB-488)
Example (enhanced)	Cmd sent: "READRATE? 1000" Query reply: "1000"
Example (classic)	Sent: "READRATE=1000" Reply: "1000"
Errors	ERR# 6: The "*period*" argument is out of range. ERR#10: The suffix '*n*' is invalid
See Also	"PR", "PRR", "SR" 3.5.7.2

READYCK*n*	
Purpose	Read or set the *Ready* check flag.
Command Query	"READYCK*n* 1" "READYCK*n*?"
Classic	"READYCK*n*=1" "READYCK*n*"
Optional Suffix	*"n"* The active Q-RPT is assumed if no suffix is given. '1' Specify the Hi Q-RPT if the HL RPT is not active Specify the HL Q-RPT if the HL Q-RPT is active '2' Specify the Lo Q-RPT '3' Specify the HL Q-RPT if the HL Q-RPT is active
Remarks	The internal ready check flag is cleared whenever the specified or active Q-RPT reaches a *Not Ready* (NR) condition. The "READYCK" query returns the status of the flag. The flag is set by sending the "READYCK 1" program message while the Q-RPT is in a *Ready* condition. The "READYCK" program message query can then be used at a later time to determine whether a *Not Ready* condition has occurred since the ready check flag was set.
Example (enhanced)	Cmd sent: "READYCK1 1" Query reply: "1" (no reply if GPIB-488)
Example (enhanced)	Cmd sent: "READYCK1?" Query reply: "1"
Example (enhanced)	Cmd sent: "READYCK?" Query reply: "1" (if Q-RPT condition has stayed *Ready*) "0" (if Q-RPT condition has NOT stayed *Ready*)
Example (classic)	Sent: "READYCK=1" Query reply: "READYCK=1"
Example (classic)	Sent: "READYCK" Query reply: "READYCK=1" (if Q-RPT condition has stayed *Ready*) "READYCK=0" (if Q-RPT condition has NOT stayed *Ready*)
Errors	ERR# 6: Argument is not a '0' or a '1'.
See Also	"SR" 3.2.4

REMOTE	
Purpose	Lock out the front panel keypads during remote operation.
Command	"REMOTE"
Classic	"REMOTE"
Remarks	The RPM4-AD goes into remote mode whenever communications take place. The user can return to local operation by pressing the [ESC] key. The REMOTE program message locks out the front panel completely. The only way to unlock the front panel after the "REMOTE" command is using the "LOCAL" program message, the IEEE-488 "GTL" command, or by cycling the RPM4-AD power.
Example (enhanced)	Cmd sent: "REMOTE" Reply: "REMOTE" (no reply if IEEE-488)
Example (enhanced)	Cmd sent: "REMOTE?" Reply: "REMOTE"
Example (classic)	Sent: "REMOTE" Reply: "REMOTE"
See Also	"LOCAL"

RES*n*	
Purpose	To read or set the pressure display resolution for the active range.
Command Query	"RES*n res*" "RES*n*"
Classic	"RES*n= res*" "RES*n*"
Default	"RES*n*=0.001"
Optional Suffix	*"n"* The active Q-RPT is assumed if no suffix is given. '1' Specify the Hi Q-RPT if the HL RPT is not active Specify the HL Q-RPT if the HL Q-RPT is active '2' Specify the Lo Q-RPT '3' Specify the HL Q-RPT if the HL Q-RPT is active
Arguments	*res:* The pressure display resolution in % span of the specified Q-RPT range (0.0001 to 1 % FS).
Remarks	The pressure display resolution is defined as % span of the active range. The setting is separate for each range, and changes as the range is changed. If the Q-RPT's unit of measure is in altitude, then the displayed resolution is directly related to the resolution setting: 0.0001% & less results in 2 decimal places of resolution in altitude. 0.0010% results in 1 decimal place of resolution in altitude 0.0100% & greater results in an integer display altitude.
Example (enhanced)	Cmd sent: "RES .01" Query reply: "0.01" (No reply if GPIB-488)
Example (enhanced)	Cmd sent: "RES? .01" Query reply: "0.01"
Example (classic)	Sent: "RES=.01" Reply: "0.01"
Errors	ERR# 6 The argument is invalid.
See Also	3.4.2

RESET	
Purpose	Reset the user's settings to factory defaults.
Command	"RESET"
Classic	"RESET"
Remarks	The RPM4-AD has user settings (units, resolution, etc.) that can be reset to factory defaults. The remote "RESET" program message corresponds to the front panel "Reset - Sets". System calibration coefficients and communications settings are not affected. The reset cycle takes up to 3 seconds to complete. Remote communications should not take place during this period.
Example (enhanced)	Cmd sent: "RESET" Reply: "RESET" (no reply if IEEE-488)
Example (enhanced)	Cmd sent: "RESET?" Reply: "RESET"
Example (classic)	Sent: "RESET" Reply: "RESET"
See Also	3.5.9.1

RPT*n*	
Purpose	Read the available Q-RPT identification data.
Query	"RPT*n*"
Classic	"RPT*n*"
Optional Suffix	*"n"* The active Q-RPT is assumed if no suffix is given. '1' Specify the Hi Q-RPT if the HL RPT is not active Specify the HL Q-RPT if the HL Q-RPT is active '2' Specify the Lo Q-RPT '3' Specify the HL Q-RPT if the HL Q-RPT is active
Remarks	Up to two (three including the HL Q-RPT which is a combination of the Hi and Lo) internal Q-RPTs can be available for use in an RPM4-AD. You can query the RPM4-AD for information about each particular Q-RPT. The Q-RPT data is returned in the following format: *RPTLabel,* Q-RPTLocator, Serial#, RngGa, RngAbs, Q-RPTMode RngLabel: RPT type label. This label identifies the Q-RPT type and range. This is the same label used on the RPM4-AD front panel screen. RptLocator: Text field identifying the Q-RPT position in the RPM4-AD system. "IH" identifies this as an internal, Hi Q-RPT "IL" identifies this as an internal, Lo Q-RPT Serial#: The serial number of the Q-RPT. RngGa: The Q-RPT default gauge mode range in the current pressure unit. RngAbs: The Q-RPT default absolute mode range in the current pressure unit. "NONE" appears in the field if the Q-RPT is a Gxxx, BGxxx or Axxx with absolute and negative gauge modes OFF. RptMode: 'A' if Q-RPT is Axxx and supports absolute, gauge and negative gauge measurement modes. 'G' if Q-RPT is gauge Gxxx or Axxx with absolute and negative gauge modes OFF and supports only gauge measurement mode. 'N' if Q-RPT is BGxxx and supports gauge and negative gauge measurement modes.
Example (enhanced)	Cmd sent: "RPT2?" (Get information on the Lo Q-RPT) Query reply: "A160K, IL, 82345,60,160,A"
Example (classic)	Cmd sent: "RPT3" (Get information on the HL Q-RPT) Query reply: "A350K, HL, 82345,250,350,A"
Errors	ERR#4: External device not detected. ERR# 10: Invalid suffix.
See Also	3.2.1, 3.2.5

SDS*n*	
Purpose	Read or set the OPEN/CLOSE status for the specified or active Q-RPT SDS systems. This is equivalent to use of the SDS temporary OPEN/CLOSE function from the RPM4-AD front panel.
Command Query	"SDS*n close*" "SDS*n*"
Classic	"SDS*n*=*close*" "SDS*n*"
Default	"SDS*n*=1"
Optional Suffix	*"n"* The active Q-RPT is assumed if no suffix is given. '1' Specify the Hi Q-RPT '2' Specify the Lo Q-RPT
Arguments	"*close*": '0' to OPEN the SDS system. '1' to CLOSE the SDS system.
Remarks	Each Q-RPT has an "SDS" system, which can be either "OPEN" or "CLOSED". This command allows access to each one without affecting the other (unless the HL Q-RPT is active), regardless of whether SDS is currently full time "ON" or "OFF". Caution must be used in differential mode, as this command can allow you to have one Q-RPT open while the other Q-RPT is closed. If the HL Q-RPT is active, then the state of the Hi and Lo Q-RPT SDS is set as appropriate. This command does not affect the power up status of the SDS system.
Example (enhanced)	Cmd sent: "SDS2? 1" (close the Lo Q-RPT SDS) Query reply: "1"
Example (classic)	Cmd sent: "SDS1=0" (open the Hi Q-RPT SDS) Query reply: "SDS1=0"
Errors	ERR# 7: Argument not a '0' or a '1' ERR# 10: Invalid suffix.
See Also	"SDSAUTO", "SDSACT" 3.2.8, 3.3.8, 3.5.4

SDSACT	
Purpose	Read or set current SDS status. This is equivalent to use of the [SDS] key from the RPM4-AD front panel.
Command Query	"SDSACT *state*" "SDSACT"
Classic	"SDSACT=*state*" "SDSACT"
Default	"SDSACT=1"
Arguments	"state"*:* '0' OPEN the SDS system as appropriate for the current measurement mode and active Q-RPT, . '1' to CLOSE the SDS system on both Q-RPTs.
Remarks	This command can be used to select one Q-RPT at a time, ensuring that the "inactive" Q-RPT SDS is closed. If a Q-RPT's SDS is full time "OFF", then it is not be affected by this command. The status of the active Q-RPT's SDS system is replied. If the RPM4-AD is in differential mode then this command opens or close both the Hi and Lo SDS at the same time, unless the SDS is full time "off". If the HL Q-RPT is active, then the state of the SDS is set as appropriate for the current measurement mode.
Example (enhanced)	Cmd sent: "SDSACT? 1" Query reply: "1"
Example (classic)	Cmd sent: "SDSACT=0" Query reply: "SDSACT=0"
Errors	ERR# 7: Argument not a '0' or a '1' ERR# 10: Invalid suffix or command argument.
See Also	"SDSAUTO", "SDS" 3.2.8, 3.3.8, 3.5.4

SDSAUTO	
Purpose	Read or set the automatic full time ON/OFF status of the SDS system. This is equivalent to use of the SDS full time ON/OFF function from the RPM4-AD front panel.
Command Query	"SDSAUTO *on*" "SDSAUTO"
Classic	"SDSAUTO=*on*" "SDSAUTO"
Default	"SDSAUTO*n*=1"
Arguments	" *on*"*:* '0' to turn the SDS system OFF. '1' to turn the SDS system ON
Remarks	Turning an SDS system to full time "OFF" or "ON" affects how the remote command "SDSACT" and the front panel SDS button can affect each Q-RPT's SDS system. Turning SDS to full time "OFF" opens the SDS valves for both Q-RPTs or as appropriate for the current measurement mode if the HL Q-RPT is active.
Example (enhanced)	Cmd sent: "SDSAUTO? 1" Query reply: "1"
Example (classic)	Cmd sent: "SDSAUTO=0" Query reply: "SDSAUTO=0"
Errors	ERR# 7: Argument not a '0' or a '1'
See Also	"SDSACT", "SDS" 3.2.8, 3.3.8, 3.5.4

SCRSAV	
Purpose	Read or set the front panel display screen saver activation time.
Command Query	"SCRSAV *n*" "SCRSAV?"
Classic	"SCRSAV=*n*" "SCRSAV"
Arguments	*n:* The inactivity period (0 – 99 minutes) after which screen saver activates.
Default	"SCRSAV 10"
Remarks	The RPM4-AD front panel will dim after a period of keyboard and remote inactivity. Setting this value to '0' disables this feature.
Example (enhanced)	Cmd sent: "SCRSAV 30" Query reply: "30" (No reply if GPIB-488)
Example (enhanced)	Cmd sent: "SCRSAV? 30" Query reply: "30"
Example (classic)	Sent: "SCRSAV=30" Reply: "30"
Errors	ERR# 6 The argument was invalid.
See Also	3.5.5.1

SN	
Purpose	To read the serial number of the RPM4-AD.
Query	"SN?"
Classic	"SN"
Remarks	The RPM4-AD is serialized. The serial number can be read using this program message.
Example (enhanced)	Query sent: "SN?" Query reply: "321"
Example (classic)	Sent: "SN" Reply: "321"
See Also	3.5.5.4

SR	
Purpose	Read the next available *Ready/Not Ready* status.
Query	"SR?"
Classic	"SR"
Optional Suffix	*"n"* The active Q-RPT is assumed if no suffix is given. '1' Specify the Hi Q-RPT if the HL RPT is not active Specify the HL Q-RPT if the HL Q-RPT is active '2' Specify the Lo Q-RPT '3' Specify the HL Q-RPT if the HL Q-RPT is active
Remarks	The current *Ready* status can be read using this program message. Possible replies: "NR" The pressure is not ready within the limits defined by the stability criterion. "R " The pressure meets the ready criteria. The status is replied when the next pressure measurement is finished. "OL" The pressure of one of the active Q-RPTs has exceeded the user defined upper or lower limits. "OP" The pressure of one of the Q-RPTs has exceeded the Q-RPT's maximum limits. "ER" An internal device failure has occurred.
Example (enhanced)	Query sent: "SR?" Query reply: "NR"
Example (classic)	Sent: "SR" Reply: "NR"
See Also	"PR", "PRR", "HS", "SS", "UL", "LL" Commands 3.2.4, 3.4.4

SS%*n*	
Purpose	Read or set the current stability limit as a % of range.
Command Query	"SS% *limit*" "SS%?"
Classic	"SS%=*limit*" "SS%"
Optional Suffix	*"n"* The active Q-RPT is assumed if no suffix is given. '1' Specify the Hi Q-RPT if the HL RPT is not active Specify the HL Q-RPT if the HL Q-RPT is active '2' Specify the Lo Q-RPT '3' Specify the HL Q-RPT if the HL Q-RPT is active
Arguments	*limit:* The stability limit in %FS of the current active range.
Remarks	The stability limit can be read and set as a percent of the full scale range of the Q-RPT range.
Example (enhanced)	Cmd sent: "SS% .1" Query reply: "0.10 %"(No reply from GPIB-488)
Example (enhanced)	Cmd sent: "SS%? .1" Query reply: "0.10 %"
Example (classic)	Sent: "SS%=.1" Reply: "0.10 %"
Errors	ERR# 6: The argument was invalid. ERR# 10: Invalid or missing command suffix.
See Also	"SS" 3.4.3

SS*n*	
Purpose	Read or set the current pressure stability limit.
Command Query	"SS *limit*" "SS?"
Classic	"SS=*limit*" "SS"
Optional Suffix	*"n"* The active Q-RPT is assumed if no suffix is given. '1' Specify the Hi Q-RPT if the HL RPT is not active Specify the HL Q-RPT if the HL Q-RPT is active '2' Specify the Lo Q-RPT '3' Specify the HL Q-RPT if the HL Q-RPT is active
Arguments	*Limit:* The stability limit in the current pressure unit of measure.
Remarks	The stability limit can be read and set as a pressure. The stability limit is used as the *Ready/Not Ready* criteria. It the Q-RPT is in an altitude or airspeed unit, then the stability setting is represented in the pressure unit "Pa".
Example (enhanced)	Cmd sent: "SS .1" Query reply: "0.10 kPa/s" (No reply from GPIB-488)
Example (enhanced)	Cmd sent: "SS? .1" Query reply: "0.10 kPa/s"
Example (classic)	Sent: "SS=.1" Reply: "0.10 kPa/s"
Errors	ERR# 6: The argument was invalid. ERR# 10: Invalid or missing command suffix.
See Also	"SS%" 3.4.3

TIME	
Purpose	Read or set the RPM4-AD internal clock.
Command Query	"TIME *hh:mmXX*" "TIME?"
Classic	"TIME=*hh:mmXX*" "TIME"
Arguments	*hh:mm:* The time in a 12 hour format using a colon delimiter *XX:* "am" or "pm"
Example (enhanced)	Cmd sent: "TIME 12:52PM" Query reply: "12:52pm" (No reply if GPIB-488)
Example (enhanced)	Cmd sent: "TIME? 12:52PM" Query reply: "12:52pm"
Example (classic)	Sent: "TIME=12:52PM" Reply: "12:52pm"
Errors	ERR# 7: Missing or improper program message argument(s).
See Also	"DATE" 3.5.5.3

UCOEF*n*	
Purpose	To identify the coefficient used to convert 1 Pascal to the current pressure unit of measure.
Command Query	"UCOEF*n Pres*" "UCOEF*n Pres, Temp*" "UCOEF*n*?"
Classic	"UCOEF*n = Pres, Temp*" "UCOEF*n*"
Arguments	*Pres:* Pressure in Pa to convert to the Q-RPT's measurement units. *Temp:* Optional reference temperature in °C if the Q-RPT unit is a "True" airspeed.
Optional Suffix	*"n"* The active Q-RPT is assumed if no suffix is given. '1' Specify the Hi Q-RPT if the HL RPT is not active Specify the HL Q-RPT if the HL Q-RPT is active '2' Specify the Lo Q-RPT '3' Specify the HL Q-RPT if the HL Q-RPT is active
Remarks	The RPM4-AD handles all pressure values internally in Pascal. The coefficient replied is equivalent of *Pres* Pa in the current pressure unit of measure. If the optional argument *Pres* is not given, then 1Pa is assumed and converted. The *Temp* argument is only valid for True airspeed units.
Example (enhanced)	Query sent: "UCOEF?" (current units are kPa) Query reply: "0.0010000000"
Example (classic)	Sent: "UCOEF=100" (current units are kPa) Reply: "0.1000000000"
See Also	3.3.2, 3.5.6, 7.2

UDU	
Purpose	Read or set the user defined pressure unit.
Command Query	"UDU *label, ucoef*" "UDU?"
Classic	"UDU=*label, ucoef*" "UDU" *label:* User unit label (4 alphanumeric char maximum). It cannot be an already supported unit label. *Ucoef*: "User unit conversion coefficient (units/Pa).
Default	"UDU USER,1.0"
Remarks	The user defined unit must be set up with the program message prior to remote or local selection.
Example (enhanced)	Cmd Sent: "UDU MYUN, .001" Query reply: "MYUN, 0.001000" (No reply if GPIB-488)
Example (enhanced)	Cmd Sent: "UDU? MYUN, .001" Query reply: "MYUN, 0.001000"
Example (enhanced)	Sent: "UDU=MYUN, .001" Reply: "MYUN, 0.001000"
Errors	
See Also	**3.5.6**, **3.3.2**

Ul*n*	
Purpose	Read or set an upper limit for the specified or active Q-RPT.
Command Query	"Ul*n* *limit*" "Ul*n*?"
Classic	"Ul*n*=*limit*" "UL*n*"
Optional Suffix	*"n"* The active Q-RPT is assumed if no suffix is given. '1' Specify the Hi Q-RPT if the HL RPT is not active Specify the HL Q-RPT if the HL Q-RPT is active '2' Specify the Lo Q-RPT if the HL Q-RPT is not active and the measurement mode is not differential '3' Specify the HL Q-RPT if the HL Q-RPT is active
Arguments	*"limit":* The upper limit pressure in the specified Q-RPT's current pressure unit and measurement mode.
Remarks	The RPM4-AD has an upper limit for each range and for each measurement mode (gauge, absolute, and differential). If the pressure does exceed the upper limit, the pressure display flashes. This feature should always be used to prevent accidental over pressure of a device under test. Altitude units triggers an upper limit alarm if the altitude drops below the limit.
Example (enhanced)	Cmd sent: "UL 1000" Query reply: "1000.00 kPa a" (No reply if GPIB-488)
Example (enhanced)	Cmd sent: "UL? 1000" Query reply: "1000.00 kPa a"
Example (classic)	Sent: "UL=1000" Reply: "1000.00 kPa a"
Errors	ERR# 6: The "*limit*" argument is out of range.
See Also	"LL" **3.4.4**

UNIT*n*	
Purpose	Read or set the pressure unit of measure unit and measurement mode.
Command Query	"UNIT*n unit (, ref*)" "UNIT*n unit*n *(, ref*)" "UNIT*n unit*g *(, ref*)" "UNIT*n unit*a *(, ref*)" "UNIT*n unitd (, ref)"* "UNIT*n*?"
Classic	"UNIT*n=unit (, ref*)" "UNIT*n=unit*n *(, ref*)" "UNIT*n=unit*g *(, ref*)" "UNIT*n=unit*a *(, ref*)" "UNIT*n=unitd (,ref)"* "UNIT*n*"
Optional Suffix	*"n"* The active Q-RPT is assumed if no suffix is given. '1' Specify the Hi Q-RPT if the HL RPT is not active Specify the HL Q-RPT if the HL Q-RPT is active '2' Specify the Lo Q-RPT if the HL Q-RPT is not active and the measurement mode is not differential '3' Specify the HL Q-RPT if the HL Q-RPT is active
Arguments	*Unit:* The text corresponding to the pressure unit of measure. A unit mode character can optionally be added to the end of the units to change the measurement mode as wel as the units: 'a' for absolute measurement mode. 'g' for gauge measurement mode. 'n' for negative gauge measurement mode. 'd' for differential measurement mode (Hi Q-RPT only) *ref:* The optional unit reference temperature only if the unit is "InWa" or a true airspeed.
Remarks	This program message determines what unit of measure and what measurement mode is used to display pressure values. Refer to Table 13 for a detailed list of the units available and their labels. If the unit text is not followed by an explicit mode character ('a', 'g', 'n' or 'd') then the current mode is retained. There can be a space between the unit text and the 'a', 'g', 'n' or 'd'. If the unit specified is "InWa", an optional second argument "*ref"* can be set. The "ref" can be 4, 20, or 60 corresponding to InWa at 4 °C, 20 °C or 60 °F. If this second argument is not given when the unit is "InWa", then the reference temperature is assumed to be 20 °C. If the unit specified is a "true" airspeed unit, then an optional second argument "*ref"* can be set. The "ref" temperature is always in °C. If this second argument is not given, then the reference temperature is assumed to be 15 °C. The fifth character of the reply is always 'a' for absolute mode, 'g' for gauge/negative gauge mode or 'd' for differential mode. White spaces precede this character if needed. The temperature reference is added to the reply only if the unit is "InWa". Differential mode is always absolute differential. The reply includes the measurement mode character in the fifth position, with an 'a' indicating absolute mode, a 'g' indicating gauge or negative gauge mode or a 'd' indicating differential mode. The "MMODE" command can also be used to set the desired measurement mode only. Since pressure units are mode dependent, the mode desired should be established before the unit is set.
Example (enhanced)	Cmd sent: "UNIT? kPaa" Query reply: "kPaa" Sent: "UNIT? InWag, 4" Query reply: "inWag, 4" Sent: "UNIT? InWaa, 60" Query reply: "inWaa, 60" Sent: "UNIT? MACH, 18" Query reply: "MACH, 18.0"
Example (enhanced)	Cmd sent: "UNIT psi n" Query reply: "psi g" ('g' used to indicate both gauge & neg gauge modes)
Example (classic)	Sent: "UNIT=kPaa" Reply: "kPaa" Sent: "UNIT=InWag, 4" Reply: "inWag, 4"
Errors	ERR# 7: The *unit* is invalid. ERR# 6: The *ref* is invalid. ERR# 20: Absolute measurement mode and altitude units are not allowed with a gauge Q-RPT.
See Also	"MMODE", "MODE" 3.3.2, 3.3.3, 3.5.6, 7.2

VER	
Purpose	Identify the RPM4, US or SI units, the Q-RPT labels and the software version.
Query	"VER?"
Classic	"VER"
Remarks	The software version of the RPM4-AD can be read. This is useful for checking for the presence of the RPM4-AD and for reference purposes. It indicates the internal Q-RPT(s) and software version.
Example (enhanced)	Query sent: "VER?" Query reply: "DH INSTRUMENTS, INC RPM4-AD us A160K/A160K Ver1.00 "
Example (classic)	Query sent: "VER?" Query reply: "DH INSTRUMENTS, INC RPM4-AD us A160K/A160K Ver1.00 "
See Also	"ID", "*IDN?" None

ZOFFSET*n*	
Purpose	Read or set the AutoZ pressure offset (P_{offset}) for the specified or active Q-RPT in the current measurement mode.
Command Query	"ZOFFSET*n* *GaOffset , AbsOffset , DifOffset*" "ZOFFSET*n*?"
Classic	"ZOFFSET*n* =*GaOffset , AbsOffset , DifOffset"* "ZOFFSET*n*"
Defaults	"ZOFFSET*n* = 0.0, 0.0, 0.0" (Gauge Q-RPT) "ZOFFSET*n* = 101325, 0.0, 0.0" (Absolute Q-RPT)
Optional Suffix	*"n"* The active Q-RPT is assumed if no suffix is given. '1' Specify the Hi Q-RPT '2' Specify the Lo Q-RPT
Arguments	*GaOffset:* The Q-RPT pressure offset ("Poffset") for Gauge measurement mode (Pa). *AbsOffset:* The Q-RPT pressure offset for absolute measurement mode (Pa) *DifOffset:* The Q-RPT pressure offset for differential measurement mode (Pa)
Remarks	The pressure offset (P_{offset}) for the specified Q-RPT (Hi or Lo) can be accessed with this program message. There are separate offsets for gauge, absolute and differential measurement modes, but not all modes apply in all cases. Gauge Q-RPTs do not support "*AbsOffset*". "*DifOffset*" applies only to the "Hi" Q-RPT. Using this program message overwrites the current offset, so caution must be used. Changes made using this program message take effect immediately.
Example (enhanced)	Cmd sent: "ZOFFSET1 2.1, 0, 0" Query reply: " 2.10 Pa, 0.00 Pa, 0.00 Pa"
Example (classic)	Sent: "ZOFFSET=97293.1, 3.02, 0" Reply: " 97293.10, 3.02, 0.00"
Errors	ERR# 6: One of the arguments is out of range.
See Also	**3.5.1**

4.4.5 REMOTE AIRDATA SETUP PROCEDURES

Use the procedures below to set up RPM4-AD for airdata measurement.

Reading airspeed at varying altitude in differential mode (RPM4-AD A350K/A160K and RPM4-AD A160K/A160K)

This sequence sets up RPM4-AD in the same manner as the **[RANGE]**, **<airspeed & altitude>** shortcut (see Section 3.4.1).

In "classic" command format (see Section 3.5.2.3) send the following sequence of commands.

range=hi (makes Hi Q-RPT active)

mmode=a (sets Hi Q-RPT to absolute measurement mode)

mmode2=a (sets Lo Q-RPT to absolute measurement mode)

unit2=ft [or m] (sets Lo Q-RPT to indicate altitude unit)

mmode=d (sets Hi Q-RPT to differential measurement mode)

unit=kts [or desired airspeed unit] (sets Hi Q-RPT to indicate airspeed unit)

sdsact=0 (opens SDS so pressure can reach Hi and Lo Q-RPTs through **TEST(Ps)** and **TEST(Pt)** ports. Send this command only if certain pressure applied to TEST ports is lower than maximum pressure rating of the Q-RPTs.

Reading altitude only in parallel mode (RPM4-AD A160K/A160K only)

This sequence sets up RPM4-AD in the same manner as the **[RANGE]**, **<altitude, parallel>** shortcut (see Section 3.4.1).

In "classic" command format (see Section 3.5.2.3) send the following sequence of commands.

range=hl (makes HL (parallel mode) Q-RPT active)

mmode=a (sets HL (both Hi and Lo) Q-RPT to absolute measurement mode)

unit=ft [or m] (sets HL Q-RPT to indicate altitude unit)

sdsact=0 (opens SDS so pressure can reach Hi and Lo Q-RPTs simultaneously through **TEST(Ps)** port. Send this command only if certain pressure applied to **TEST(Ps)** port is lower than maximum pressure rating of the Q-RPTs.

Reading airspeed at ground altitude only in parallel mode (RPM4-AD A160K/A160K only)

This sequence sets up RPM4-AD in the same manner as the **[RANGE]**, **<airspeed, parallel>** shortcut (see Section 3.4.1).

In "classic" command format (see Section 3.5.2.3) send the following sequence of commands.

range=hl (makes HL (parallel mode) Q-RPT active)

mmode=g (sets HL (both Hi and Lo) Q-RPT to gauge measurement mode)

unit=kts [or other airspeed unit] (sets HL Q-RPT to indicate airspeed unit)

sdsact=0 (opens SDS so pressure can reach Hi and Lo Q-RPTs simultaneously through **TEST(Pt)** port. Send this command only if certain pressure applied to **TEST(Pt)** port is lower than maximum pressure rating of the Q-RPTs.

4.5 STATUS REPORTING SYSTEM

The RPM4-AD status reporting system is used to track and report system status and errors. It follows the model of the IEEE Std 488.2 and works for the COM1 and the IEEE-488 port with slight differences. The RPM4-AD can be programmed to respond to various status conditions by asserting the SRQ of the IEEE-488 interface. The COM1 port cannot be supported in such a way, so polling must be used.

4.5.1 ERROR QUEUE

The RPM4-AD keeps track of remote errors by using an error queue. If an error occurs, it is pushed onto the Error Queue. If you are using the COM1 port, the error number is immediately replied in the form "ERR#nn where nn is the error code from 0 to 99. The "ERR?" (or "ERR") query can then be used to pull the error from the Error Queue in it's descriptive text format. If you are using the enhanced program message format, the Error Queue will accumulate errors until full unless they are pulled from the queue. If you are using the classic program format, the Error Queue is cleared every time a new program message is received.

4.5.2 STATUS BYTE REGISTER

The RPM4-AD contains an 8 bit Status Byte Register that reflects the general status of the RPM4-AD.

Table 24. 8 bit status byte register

OPER (128)	RQS/MSS (64)	ESB (32)	MAV (16)	N/A (8)	ERROR (4)	N/A (2)	RSR (1)

This register is affected by the RPM4-AD reply output queue, the Error Queue, the Standard Event Status register and the *Ready Event* Status register.

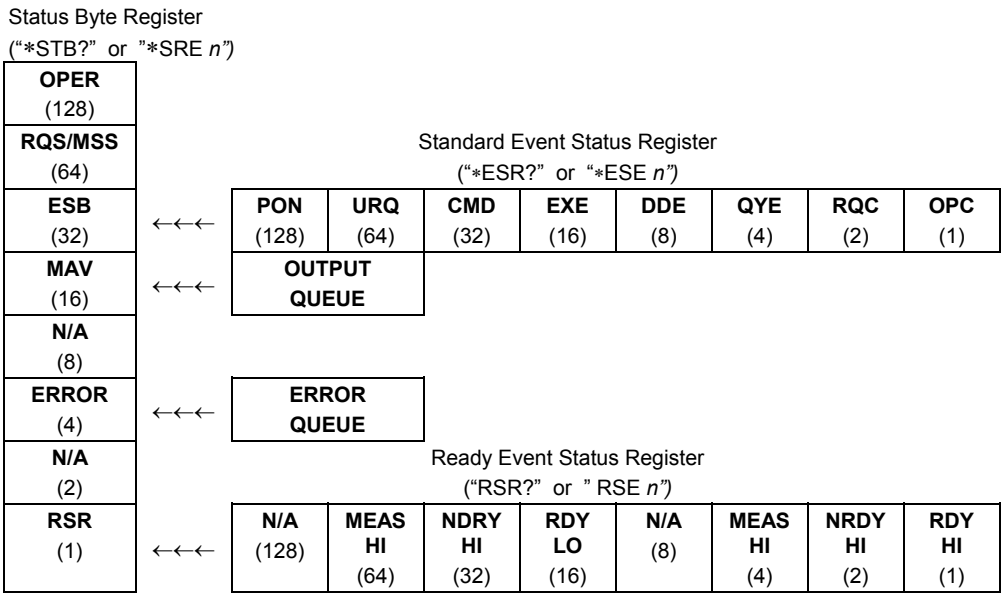


Figure 6. Status register schematic

The Status Byte Register can be read using the **"*STB?"** query, or by performing a serial poll on the IEEE-488 bus. If you read this using a serial poll then Bit 6 is the RQS. If the **"*STB?"** query is used, then bit 6 is the MSS bit. All of the other bits are common to both types of query.

Each of these status bits can cause a SRQ to occur. The Service Request Enable Register (**"*SRE"** program message) determines which of these flags are able to assert the SRQ line. This enable register has a matching set of bits that each will enable the designated bit to cause a SRQ, except for the RQS/MSS bit(s) which cannot cause a SRQ. If you set this register to 20 ($14 hex), an SRQ will occur if the MAV or the ERROR bit are set. The description of these bits are given as:

OPER N/A Bit 7 (128)

RQS Requested Service Bit 6 (64)

Indicates that the SRQ line of the IEEE-488 interface has been asserted by the RPM4-AD. This bit is cleared when a serial poll is performed on the RPM4, and is a part of the Status Byte Register when read using a serial poll. This bit does not apply if the COM1 port is being used.

MSS Master Summary Status Bit 6 (64)

Indicates that an event or events occurred that caused the RPM4-AD to request service from the Host, much like the RQS bit. Unlike the RQS bit, it is READ ONLY and can be only cleared when the event(s) that caused the service request are cleared.

ESB Event Summary Bit 5 (32)

Indicates if an enabled bit in the Standard Event Status Register became set (see Section 4.5.3).

MAV Message Available Bit 4 (16)

Indicates that at least one reply message is waiting in the RPM4-AD IEEE-488 output queue.

ERROR Error Queue Not Empty Bit 2 (4)

Indicates that at least one command error message is waiting in the RPM4-AD IEEE-488 error message queue. Use the **"ERR?"** query to get this message.

RSR Ready Summary Bit 0 (1)

Indicates that an enabled bit in the Ready Status Register became set.

4.5.3 STANDARD EVENT REGISTER

The RPM4-AD contains an 8 bit Standard event register that reflects specific RPM4-AD events. Enabled events in this register will set or clear the ESB bit of the Status Byte Register.

Table 25. 8 bit standard event register

PON	URQ	CMD	EXE	DDE	QYE	RQC	OPC
(128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)

This register can be read using the "*ESR?" query, Each of these status bits can set the ESB bit of the Status Byte Register, causing a SRQ to occur IF the ESB bit is enabled to do so. The Standard Event Status Enable Register ("*ESE" program message) determines which of these flags are able to assert the ESB bit. The description of these bits are given as:

PON Power On Bit 7 (128)

Indicates that the RPM4-AD power has been cycled since the last time this bit was read or cleared.

URQ User Request Bit 6 (64)

Indicates that the RPM4-AD was set to local operation manually from the front panel by the user (pressing the **[ESC]** key).

CMD Command Error Bit 5 (32)

Indicates that a remote command error has occurred. A command error is typically a syntax error in the use of a correct program message.

EXE Execution Error Bit 4 (16)

Indicates if a remote program message cannot be processed due to device related condition.

DDE Device Dependent Error Bit 3 (8)

Indicates that an internal error has occurred in the RPM4-AD such as a transducer time-out.

QYE Query Error Bit 2 (4)

Indicates that an error has occurred in the protocol for program message communications. This is typically caused by a program message being sent to the RPM4-AD without reading a waiting reply.

RQC Request Control Bit 1 (2)

This bit is not supported as the RPM4-AD cannot become the active controller in charge.

OPC Operation Complete Bit 0 (1)

Indicates that the RPM4-AD has completed all requested functions.

4.5.4 READY STATUS REGISTER

The RPM4-AD contains an 8 bit Ready Status Register that reflects specific RPM4-AD Q-RPT measurement ready events. Enabled events in this register will set or clear the RSB bit of the Status Byte Register.

Table 26. 8 bit ready status register

N/A (128)	**MEAS LO** (64)	**NRDY LO** (32)	**RDY LO** (16)	**N/A** (8)	**MEAS HI** (4)	**NRDY HI** (2)	**RDY HI** (1)

This register can be read using the **"*RSR?"** query, Each of these status bits can set the RSB bit of the Status Byte Register, causing a SRQ to occur IF the RSB bit is enabled to do so. The Standard Event Status Enable Register (**"*RSE"** program message) determines which of these flags are able to assert the RSB bit. The description of these bits are given as:

MEAS LO Lo-RPT measurement ready Bit 6 (64)

Indicates that the Hi Q-RPT has completed a Q-RPT measurement.

NRDY LO Lo Q-RPT pressure Not Ready Bit 5 (32)

Indicates that the Hi Q-RPT made a transition from *Ready* to *Not Ready* as defined by the stability settings (see Section 3.2.4).

RDY LO Lo Q-RPT pressure Ready Bit 4 (16)

Indicates that the Hi Q-RPT is *Ready* as defined by the stability settings (see Section 3.2.4).

MEAS HI Hi Q-RPT measurement ready Bit 2 (4)

Indicates that the Hi Q-RPT has completed a Q-RPT measurement.

NRDY HI Hi Q-RPT pressure Not Ready Bit 1 (2)

Indicates that the Hi Q-RPT made a transition from *Ready* to *Not Ready* as defined by the stability settings (see Section 3.2.4).

RDY HI Hi Q-RPT pressure Ready Bit 0 (1)

Indicates that the Hi Q-RPT is *Ready* as defined by the stability settings (see Section 3.2.4).

4.6 IEEE STD. 488.2 COMMON AND STATUS PROGRAM MESSAGES

The RPM4-AD supports a set of commands that are common to all instruments conforming to IEEE Std. 488.2. These commands make it easy to perform basic function for any device that supports these commands.

These commands also cover the status reporting commands. See Section 4.1 for details on the status registers mentioned in these commands.

Table 27. IEEE-488.2 common and status program message list

∗CLS	Clear all of the status & event structures.
∗ESE	Read or set the Standard Event Status Enable Register.
∗ESR	Read the Standard Event Status Register.
∗IDN	Identify the RPM4-AD version, range, and serial number.
∗OPC	Set the operation complete bit when all operations have completed.
∗OPT	Read the list of installed RPM4-AD options.
∗RST	Reset the RPM4-AD settings to factory settings.
∗TST	Read the power on self test status.
∗SRE	Read or set the Service Request Enable Register.
∗STB	Read the Status Byte Register.
∗RSE	Read or set the Ready Status Enable Register.
∗RSR	Read the Ready Status Register.

4.6.1 PROGRAM MESSAGE DESCRIPTIONS

∗CLS	
Purpose	Clear all of the status & event structures.
Command	"∗CLS"
Remarks	This program message clears the following events and status registers: Standard Byte Register (STB) Standard Event Status Register (ESR) Error Queue Pending OPC operations
Example	Sent: "∗CLS" Reply: none

∗ESE		
Purpose	Read or set the Standard Event Status Enable Register.	
Command Query	"∗ESE *n*" "∗ESE?"	
Default	"∗ESE 0"	
Arguments	*n:*	'0 to 255' This is the decimal representation of the bit(s) to enable. To enable the PON and QYE bits, the argument would be 128 + 4 = 132.
Remarks	The Standard Event Status Enable register determines which bits in the standard Event Status Register are enabled and included in the Status Byte Register (ESB bit), and can assert the SRQ line. The reply is in decimal numeric form.	
Example (enhanced)	Sent: Query reply:	"∗ESE=128"(enables the PON bit) "128" (no reply if IEEE-488)
Errors	ERR# 6:	*n* is not valid.

∗ESR	
Purpose	Read the Standard Event Register.
Command	"∗ESR?"
Remarks	The Standard Event Register contents are cleared after reading. The reply is in decimal numeric form.
Example (enhanced)	Sent: "∗ESR?" Reply: "20" (the QYE and EXE bits are set)

∗IDN	
Purpose	Identify the RPM4-AD version, range, and serial number.
Query	"∗IDN?"
Remarks	The identification reply is made up of the manufacture, the model, the serial number and the software version. Each is separated by a comma.
Example (enhanced)	Sent:"∗IDN?" Reply:"DH INSTRUMENTS INC, RPM4-AD A0100/A0015, 1234, Ver2.00 -dhf"

∗OPC	
Purpose	Sets the operation complete bit when all operations have completed.
Command Query	"∗OPC" "∗OPC?"
Remarks	This Command enables the RPM4-AD to set the OPC bit in the Standard Event Status Register when it has completed all pending functions. The Query replies with a "1" when all functions are complete.
Example (enhanced)	Sent: "∗OPC" Query reply: "1"

∗OPT	
Purpose	Reads the list of installed RPM4-AD options.
Query	"∗OPT?"
Remarks	This Query returns any registered option(s) installed in the RPM4-AD. Each option is separated by a comma. Possible options: "IEEE-488:0" The IEEE-488 option is installed,
Example (enhanced)	Sent: "∗OPT?" Reply: "IEEE-488:0"

∗RST	
Purpose	Resets the RPM4-AD settings to factory settings.
Command	"∗RST""
Remarks	This Command sets the RPM4-AD settings to factory settings. This equivalent to a front panel executed RESET/SET. This does not affect the communications settings.
Example (enhanced)	Sent: "∗RST" Reply: "∗RST" (no reply if IEEE-488)
See Also	3.5.9.1

∗SRE	
Purpose	Read or set the Service Request Enable Register.
Command Query	"∗SRE *n*" "∗SRE?"
Default	"∗SRE 0"
Arguments	*n:* '0 to 255' This is the decimal representation of the bit(s) to enable. To allow the MAV and ESB bits to assert the SRQ line, the argument would be 32 + 16 = 48. Bit 6 (64) is reserved and cannot be set.
Remarks	The Service Request Enable Register determines which bits of the Status Byte can set the MSS bit of the Status Byte and request service by asserting the SRQ line of the IEEE-488 interface.
Example (enhanced)	Sent: "∗SRE=48" (enables the MAV and ESB bits) Query reply: "48" (no reply if IEEE-488)
Errors	ERR# 6: *n* is not valid.

∗STB	
Purpose	Read the Status Byte Register.
Command	"∗STB?"
Remarks	The Status Byte Register reflects the general status of the RPM4-AD. The 'MSS' bit state is represented by bit 6.
Example (enhanced)	Sent: "∗STB?" Reply: "80" (The MSS and MAV bits are set)

∗TST	
Purpose	Read the power on self test status.
Query	"∗TST?""
Remarks	The RPM4-AD system memory stores the user settings (units, resolution) and retains them when the unit if OFF. On power-up, this memory is checked. If this memory is corrupted, all user settings are reset to default (as if the "∗RST" program message was executed), and the ∗TST query will return a non zero value. If the RPM4-AD passed the test on power-up OR if the ∗TST query was used at least once since the RPM4-AD was powered up the reply will be a '0'.
Example (enhanced)	Sent: "∗RST?" Reply: "1"

***RSE**	
Purpose	Read or set the Ready Status Enable Register.
Command Query	"RSE *n*" "RSE?"
Default	"RSE 0"
Arguments	*n:* '0 to 255' This is the decimal representation of the bit(s) to enable. To enable the RDY bit, the argument would be 1.
Remarks	The Ready Status Enable Register determines which bits in the Ready Status Register are enabled and included in the Status Byte Register (RSR bit), and can assert the SRQ line. The reply is in decimal numeric form.
Example (enhanced)	Sent: "∗RSE=1" (enables the RDY bit) Query reply: "1" (no reply if IEEE-488)
Errors	ERR# 6: *n* is not valid.

***RSR**	
Purpose	Read the Ready Status Register.
Command	"RSR?"
Remarks	The Ready Status Register contents are cleared after reading. The reply is in decimal numeric form.
Example (enhanced)	Sent: "RSR?" Reply: "6" (The MEAS and NRDY)

5. MAINTENANCE, ADJUSTMENTS AND CALIBRATION

5.1 OVERVIEW

RPM4-AD was designed for maintenance free operation. No maintenance is required other than:

- Regular AutoZeroing of quartz reference pressure transducer(s) (Q-RPT) (see Section 3.5.1).
- Periodic calibration of Q-RPT(s) (see Section 5.2).
- Adjustment of the on-board barometer, if present (see Sections 5.3).

This section provides information on calibration and adjustment procedures.

RPM4-AD is a sophisticated pressure measuring instrument with advanced on-board features and functions. Before assuming that unexpected behavior is caused by a system defect or breakdown, use this manual and other training facilities to become thoroughly familiar with RPM4-AD operation.

For rapid assistance in specific situations see Chapter 6 for troubleshooting information.

RPM4-AD is covered by a limited one (1) year warranty. Unauthorized service or repair during the warranty period is undertaken at the owner's risk and may cause damage that is not covered under warranty and/or may void the warranty. For warranty service, contact a DHI Authorized Service Provide (see Table 34). RPM4-AD units delivered under certain US government contracts with extended warranties have a warranty period sticker on their rear panel.

5.2 CALIBRATION OF QUARTZ REFERENCE PRESSURE TRANSDUCERS (Q-RPT)

5.2.1 PRINCIPLE

RPM4-AD is equipped with two quartz reference pressure transducers (Q-RPTs) used for low uncertainty pressure measurement.

To calibrate the Q-RPTs, pressures from a reference standard are applied to the Q-RPTs at ascending and descending pressure increments over the range. The pressure defined by the standard and the corresponding Q-RPT readings are recorded at each point. After all of the pressures have been applied and recorded, adjustments are made to fit the Q-RPT pressure readings to the standard. Fitting the readings means performing a linear regression to arrive at the lowest value of the residuals of errors of the Q-RPT relative to the standard. The Q-RPT output is adjusted by user settable coefficients: PA (an adder or offset) and PM (a multiplier or span set) (see Section 5.2.1.1).

The calibration process is performed independently on each Q-RPT to arrive at its optimal fit. As RPM4-AD 160K/A160K has two identical Q-RPTs, the calibration sequence may be run on both of them simultaneously but they are adjusted independently.

CalTool for RPTs software provided with the RPM4-AD supports the calibration process of RPM4-AD Q-RPTs. CalTool and its documentation are provided on a General Accessories Disk with a new RPM4-AD and can be downloaded from www.dhinstruments.com. Most users should use CalTool software to assist in the calibration of RPM4-AD.

RPM4-AD is delivered with an interactive Q-RPT calibration utility that steps the operator through the complete Q-RPT calibration procedure including applying the necessary pressures, collecting data automatically, calculating new PA and PM values, previewing the results of the new calibration and activating the results of the new calibration (see the CalTool for RPTs manual on the RPM4 General Accessories Disk). RPM4-AD also provides complete front panel and remote access to Q-RPT calibration parameters so that Q-RPT calibrations can be performed without using CalTool software (see Section 5.2.8).

5.2.1.1 PA AND PM COEFFICIENTS

The coefficients used to adjust Q-RPT readings are designated PA (an adder or offset) and PM (a multiplier or span set). The coefficients affect the Q-RPT reading following:

Corrected reading = (uncorrected reading • PM) + PA

PA is expressed in units of pressure (always the SI unit, Pascal).

PM is dimensionless.

Each Q-RPT has its own unique PA and PM values. The PA and PM values currently in use can be viewed and edited from the front panel in the RPM4-AD CAL function (see Section 5.2.7). PA and PM values are automatically edited when CalTool software results are activated.

As editing PA and PM values changes the Q-RPT calibration, they should only be edited by qualified personnel as part of the calibration process. Caution should be taken to avoid accidental editing and a security system is available to prevent access (see Section 3.5.5.5). Incorrect editing of PA and PM values can cause out of tolerance measurements.

A new RPM4-AD is delivered with PA and PM values set to zero for both Q-RPTs. This does not mean that the RPM4-AD has not been calibrated. In the original factory calibration, privileged factory coefficients are used for calibration with the user PA and PM set to zero and 1.

5.2.1.2 AS RECEIVED AND AS LEFT DATA

Frequently, calibration procedures require reporting as received and as left data. The necessary information to report as received and as left data on the calibration of RPM4-AD Q-RPTs can be obtained in several ways.

When the RPM4-AD CalTool calibration assistance software is used, as received data is displayed while running the calibration and is automatically recorded and reported if desired. As left data is also calculated and presented.

At any time, a) reference pressures applied; b) associated Q-RPT readings; c) PA and PM and P_{offset} values, can be used to calculate as received and as left values. For example, backing out PA and PM on the as left data yields the Q-RPT readings with PA = 0 and PM = 1. Then applying the as received PA and PM and P_{offset} values to the readings calculates *as received* readings (the readings that the transducer would have made with the old PA, PM and P_{offset}). P_{offset} is the offset applied between full calibrations by the AutoZero function (see Section 3.5.1).

It is recommended that "as received" values of PA, PM and P_{offset} be recorded for each Q-RPT prior to running the calibration. The current PA, PM and P_{offset} can be viewed by pressing [SPECIAL], <8cal>, <1view>.

5.2.2 EQUIPMENT REQUIRED

The recommended calibration standard for RPM4-AD Q-RPTs is a DHI PG7601 gas piston gauge or ADCS-601 air data calibration standard. Contact DHI for additional information.

Gas operated piston gauge (deadweight tester), with the following characteristics:

- **Measurement uncertainty of ± 0.0025 % of reading**. A standard with higher measurement uncertainty may be used but RPM4-AD measurement uncertainty may be degraded proportionally from published specifications.
- **Able to supply the recommended sequence of absolute pressure points in the range to be calibrated:** See Section 5.2.4 for information on the recommended calibration point sequence for RPM4-AD A160K and A350K Q-RPTs.

5.2.3 SET-UP AND PREPARATION

5.2.3.1 RPM4 A160K/A160K (ROTARY WING)

To set-up and prepare an RPM4-AD A160K/A160K for calibration of its Q-RPTs:

❶ Set the RPM4-AD on a stable surface near the calibration standard at a height as close as possible to the calibration standard's reference height. Consider the connections that may need to be made to the rear panel and access to the front panel display and keypad.

❷ Tee the calibration standard output to the **TEST(Pt)** and **TEST(Ps)** ports so that it can apply the reference pressure to both ports simultaneously. **TEST** port connection is AN4 M.

❸ Use **[RANGE]** to set the active Q-RPT to **<Hi>** (see Section 3.3.1.1).

❹ Use **[MODE]** to set the measurement mode to absolute (see Section 3.3.3).

❺ Use **[UNIT]** to set the unit of measure to a pressure unit (not an air data unit) (see Section 3.3.2).

❻ Use **[DISPLAY]**, (**<4RPT>**) to set the display to RPT (see Section 3.3.6.4) so the Lo Q-RPT measurement is displayed on the display's bottom line.

❼ Use **[SDS]** to open SDS (Self Defense System) on the Hi Q-RPT (**TEST (Pt)** port) (see Section 3.3.8) so that the pressure applied by the standard will reach the Hi Q-RPT.

Use **[SPECIAL]**, **<4SDS>**, **<1temp open/close>**, **<2Lo RPT>** to OPEN SDS temporarily on the Lo Q-RPT (**TEST (Ps)** port) (see Section 3.5.4.1) so that the pressure applied by the standard will reach the Lo Q-RPT.

Note: If RPM4-AD indicates **<SDS CLOSED>**, the Q-RPT's **TEST** port is closed and pressure from the reference standard will not be able to reach it until SDS is opened.

Opening SDS with a pressure greater than Pmax! applied to the test port may cause overpressure damage to the Q-RPT.

5.2.3.2 RPM4 A350K/A160K (FIXED WING)

To set-up and prepare an RPM4-AD A350K/A160K for calibration of its Q-RPTs:

❶ Set the RPM4-AD on a stable surface near the calibration standard at a height as close as possible to the calibration standard's reference height. Consider the connections that may need to be made to the rear panel and access to the front panel display and keypad.

❷ Connect the calibration standard output to the **TEST** port of the Q-RPT to be calibrated.

Use the **TEST(Ps)** port for the A160K (23 psia) Q-RPT.

Use the **TEST(Pt)** port for the A350K (50 psia) Q-RPT.

The **TEST** port connections are is AN4 M.

❸ Use **[RANGE]** to set the active Q-RPT to **<Lo>** for the A160K Q-RPT or **<Hi>** for the A350K Q-RPT(see Section 3.3.1.2).

❹ Use **[MODE]** to set the measurement mode to absolute (see Section 3.3.3).

❺ Use **[UNIT]** to set the unit of measure to a pressure unit (not an air data unit) (see Section 3.3.2).

❻ Use **[SDS]** to open SDS (Self Defense System) on the selected Q-RPT (see Section 3.3.8) so that the pressure applied by the standard will reach the Q-RPT.

Opening SDS with a pressure greater than Pmax! applied to the test port may cause overpressure damage to the Q-RPT.

5.2.4 RECOMMENDED CALIBRATION POINT SEQUENCE

Calibration adjustments to RPM4-AD Q-RPTs are made by altering calibration coefficients, PA and PM (see Section 5.2.1.1). To adjust these coefficients to optimum values giving the best results over the Q-RPTs complete operating range, specific calibration point sequences are recommended.

See Section 5.2.4.1 for the calibration sequence of RPM4-AD A160K Q-RPT.

See Section 5.2.4.2 for the calibration sequence of RPM4-AD A350K Q-RPT.

5.2.4.1 A160K Q-RPT CALIBRATION SEQUENCE

The calibration sequence starts with exercising of the Q-RPT(s):

a) Apply vacuum (very low absolute pressure).

b) Dwell for five minutes.

c) Set full scale absolute pressure.

d) Dwell for five minutes.

Repeat the exercising sequence twice then proceed with the calibration sequence defined in Table 28 (pressure is already at the first point).

All pressure points are absolute pressure.

A dwell time of at least 60 seconds after setting the pressure is recommended before taking data at each point.

Table 28. Calibration point sequence, A160K Q-RPT

CALIBRATION SEGMENT	POINT NO.	POINT [kPA (PSI)]
Descending	1	160 (23.2)
	2	120 (17.4)
	3	80 (11.6)
	4	40 (5.8)
	5	6 (0.9)
Ascending	6	40 (5.8)
	7	80 (11.6)
	8	120 (17.4)
	9	160 (23.2)

It is not required that the calibration pressure standard apply precisely the nominal pressure value of each calibration point as long as the exact value of the applied pressure is known. Best results are obtained if the actual applied pressure is within 2 % of the recommended nominal point.

5.2.4.2 A350K Q-RPT CALIBRATION SEQUENCE

The calibration sequence starts with exercising of the Q-RPT:

a) Set full scale absolute pressure.

b) Dwell for five minutes.

c) Apply vacuum (very low absolute pressure)

d) Dwell for five minutes.

Repeat the exercising sequence twice then proceed with the calibration sequence defined in Table 29.

All pressure points are absolute pressure.

A dwell time of at least 60 seconds after setting the pressure is recommended before taking data at each point.

Table 29. Calibration point sequence, A350K Q-RPT

CALIBRATION SEGMENT	POINT NO.	POINT [kPA (PSI)]
Descending	1	Lowest pressure[1]
	2	87.5 (12.7)
	3	175 (25.4)
	4	262.5 (38.1)
	5	350 (50.8)
Ascending	6	262.5 (38.1)
	7	175 (25.4)
	8	87.5 (12.7)
	9	Lowest pressure[1]

1. 1 kPa (0.15 psi) or the lowest point that can be set reliably by the reference piston gauge .

5.2.5 TURNING OFF ABSOLUTE AND NEGATIVE GAUGE MEASUREMENT MODES

This function is not used in RPM4-AD models.

5.2.6 Q-RPT CALIBRATION USING CALTOOL FOR RPTS SOFTWARE

To calibrate RPM4-AD Q-RPTs using CalTool software, refer to Sections 5.2.1, ❍ PRINCIPLE, 5.2.2, and 5.2.3 in this manual and then refer to the CalTool for RPTs Software Manual.

CalTool for RPTs software and manual are supplied on the RPM4-AD General Accessories Disk and can be downloaded from **www.dhinstruments.com**.

5.2.7 EDITING AND VIEWING Q-RPT CALIBRATION INFORMATION

❍ **PURPOSE**

View and/or edit Q-RPT calibration information fields including:

- **The calibration date** – This field is normally used to record the date on which the Q-RPT is calibrated.
- **The value of absolute mode AutoZero P_{offset}** – See Section 3.5.1 for complete AutoZero information. This value is normally set to zero following calibration a Q-RPT.
- **The value of PA** – The pressure adder for the selected Q-RPT (see Sections 5.2.1.1).
- **The value of PM** – The pressure multiplier for the selected Q-RPT (see Sections 5.2.1.1).

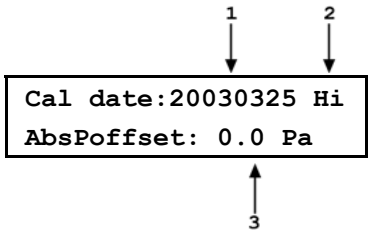
❍ **OPERATION**

As editing PA and PM values changes the calibration of the Q-RPTs, the edit function should only be used by qualified personnel as part of the calibration process. Caution should be taken to avoid accidental editing. A user level security system is available to control access (see Section 3.5.5.5).

A new RPM4-AD is delivered with PA and PM values set to zero and 1 for all ranges. This does not mean that the RPM4-AD has not been calibrated. In the original factory calibration, privileged factory coefficients are used for calibration with the user PA and PM set to zero and 1.

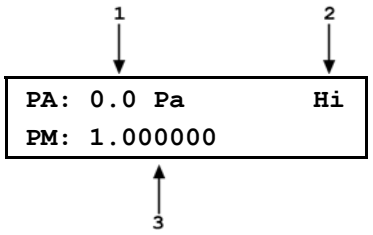
To view or edit Q-RPT calibration information press **[SPECIAL]**, **<8Cal>**. Select the desired Q-RPT. The **<1view>** selection displays the calibration information fields. The **<2edit>** function displays the fields and allows them to be edited. The display is:

1. Date of last calibration in YYYYMMDD format.
2. Position designator of the Q-RPT being viewed.
3. Current value of absolute mode P_{offset}.



If in **edit** mode, the calibration information fields can be edited. Edits to P_{offset} are common with changes made in the AutoZ edit or run function (see Section 3.5.1). Pressing **[ENT]** on the last field goes to the next view/edit screen:

1. Value of PA.
2. Position designator of the Q-RPT being viewed.
3. Value of PM.



If in **edit** mode, the calibration fields can be edited.

[ENT] in view mode returns to the view/edit screen. **[ENT]** in edit mode goes to confirmation of change activation if changes have been made in any of the calibration screens. Pressing **[ESC]** in any edit screen exits the edit screen without activating any changes.

The value of PA is always in Pascal (Pa). The value of PM is dimensionless but should be very near 1.

5.2.8 Q-RPT CALIBRATION/ADJUSTMENT WITHOUT CALTOOL FOR RPTS SOFTWARE

❍ PRINCIPLE

The RPM4-AD Q-RPTs can be calibrated and adjustments made without using CalTool for RPTs software. This requires:

- Applying pressures with a calibration standard and recording the pressures measured by RPM4-AD.
- Calculating new PA and PM values and entering them.
- Setting P_{offset} to zero.

Before proceeding to calibrate a reference pressure transducer without using CalTool for RPTs software, Sections 5.2, Calibration of Reference Pressure Transducers, 5.2.1 ❍ PRINCIPLE, 5.2.2 Equipment Required, 5.2.3 Setup and Preparation should be reviewed thoroughly.

The Q-RPTs of RPM4-AD A160K/A160K that are used in parallel measurement mode (see Section 3.2.5) may be run through the calibration sequence simultaneously but must be adjusted separately. PA and PM for the Hi and Lo Q-RPT need to be determined and set individually. Therefore, data to be used in determining calibration coefficients cannot be taken in parallel mode since parallel mode displays the average measurement of the two Q-RPTs. To calibrate the Q-RPTs of RPM4-AD A160K/A160K simultaneously, make the Hi Q-RPT active, use the [RPT], <4RPT> (see Section 3.3.6.4) function to display the Lo Q-RPT measurement on the display bottom line and use [SPECIAL], <4SDS> to OPEN SDS on the Lo Q-RPT (see Section 3.5.4.1).

OPERATION

The typical procedure for calibrating a Q-RPT is:

❶ Set-up and prepare the RPM4-AD for calibration (see Sections 5.2.2, 5.2.3).

❷ Use the **[RANGE]** function key to select the Q-RPT to be calibrated (see Section 3.3.1).

RPM4-AD A160K/A160K: the Q-RPTs of the RPM4-AD A160K/A160K have the same range and can be calibrated simultaneously. To do so, make the Hi Q-RPT active, use **[RPT], <4RPT>** to display the Lo Q-RPT measurement on the display bottom line (see Section 3.3.6.4) and use **[SPECIAL]**, **<4SDS>**, **<1temp open/close>** to OPEN SDS on the Lo Q-RPT (see Section 3.5.4.1).

RPM4-AD A350K/A160K: the Hi and Lo Q-RPT must be calibrated completely separately.

❸ Use **[HEAD]** to set the HEAD to zero (see Section 3.3.7).

Use **[UNIT]** to set the desired pressure unit of measure (not an air data unit) (see Section 3.3.2).

Use **[MODE]** to set absolute pressure measurement mode (see Section 3.3.3).

❹ Use **[SPECIAL]**, **<1AutoZ>** to access the AutoZ function (see Section 3.5.1).

Turn AutoZ ON if it is left ON in normal RPM4-AD operation.

❺ Use **[SPECIAL]**, **<8cal>**, **<1Hi RPT>** or **<2Lo RPT>**, **<1view>**, to read and record the current values of PA, PM and P_{offset} for the Q-RPT to be calibrated.

❻ Exercise the Q-RPT(s) and run the recommended calibration point sequence (see Section 5.2.4). Record the pressure applied by the standard and the RPM4-AD Q-RPT reading at each calibration point (record output of both Hi and Lo Q-RPT is calibrating both Q-RPTs of RPM4 A160K/A160K simultaneously. Dwell at least 60 seconds at each point after setting the reference pressure to allow full stabilization. The data recorded is the "as received" data for this calibration.

❼ Enter the calibration pressures and RPM4-AD readings into a spreadsheet. Calculate the "non-corrected" RPM4-AD readings by backing out the PA, PM and P_{offset} recorded in Steps ❸ and ❹ above, following:

$$\textbf{non-corrected reading} = ((\textbf{corrected reading} - PA)/PM) + P_{offset}$$

❽ Perform a linear regression to find the offset and slope that best fit the non-corrected RPM4-AD readings to the calibration standard pressures. The offset is the new value of PA, the slope is the new value of PM.

❾ Press **[SPECIAL]**, **<8Cal>**, **<1Hi RPT>** or **<2Lo RPT>**, **<2edit>** and write the new calibration date and the new values of PA and PM for the Q-RPT(s) calibrated. Set the value of P_{offset} to zero (see Section 5.2.7).

❿ Calculate as left data for the calibration if desired following:

$$\textbf{as left reading} = (\textbf{non-corrected reading} \bullet \textbf{new PM}) + \textbf{new PA}$$

⓫ Perform additional verification pressure runs as desired.

5.3 ADJUSTMENT OF ON-BOARD BAROMETER

❍ PURPOSE

To adjust the output of the on-board barometer.

❍ PRINCIPLE

The on-board barometer output can be adjusted using PA and PM values in the same manner as Q-RPTs (see Section 5.2.1.1).

The on-board barometer is a low accuracy sensor used only for measuring changes in atmospheric pressure over short periods of time (see Section 3.2.2). RPM4-AD measurement uncertainty does not depend on the measurement uncertainty of the on-board barometer.

❍ OPERATION

To edit the values of PA and PM for the barometer, press **[SPECIAL]**, **<8cal>**, **<3barometer>**. Pressing **[ENT]** steps through displays of the calibration date (YYYYMMDD) and PA and PM. In **edit** mode, the values can be edited. Pressing **[ENT]** after the last screen activates the edited values.

To view the current output of the on-board barometer, press [SPECIAL], <7Internal>, <3baro>.

The on-board barometer reading is indicated in the current unit of measure. To change the unit of measure, return to the main run screen and use [UNIT].

5.4 RELOADING EMBEDDED SOFTWARE INTO FLASH MEMORY

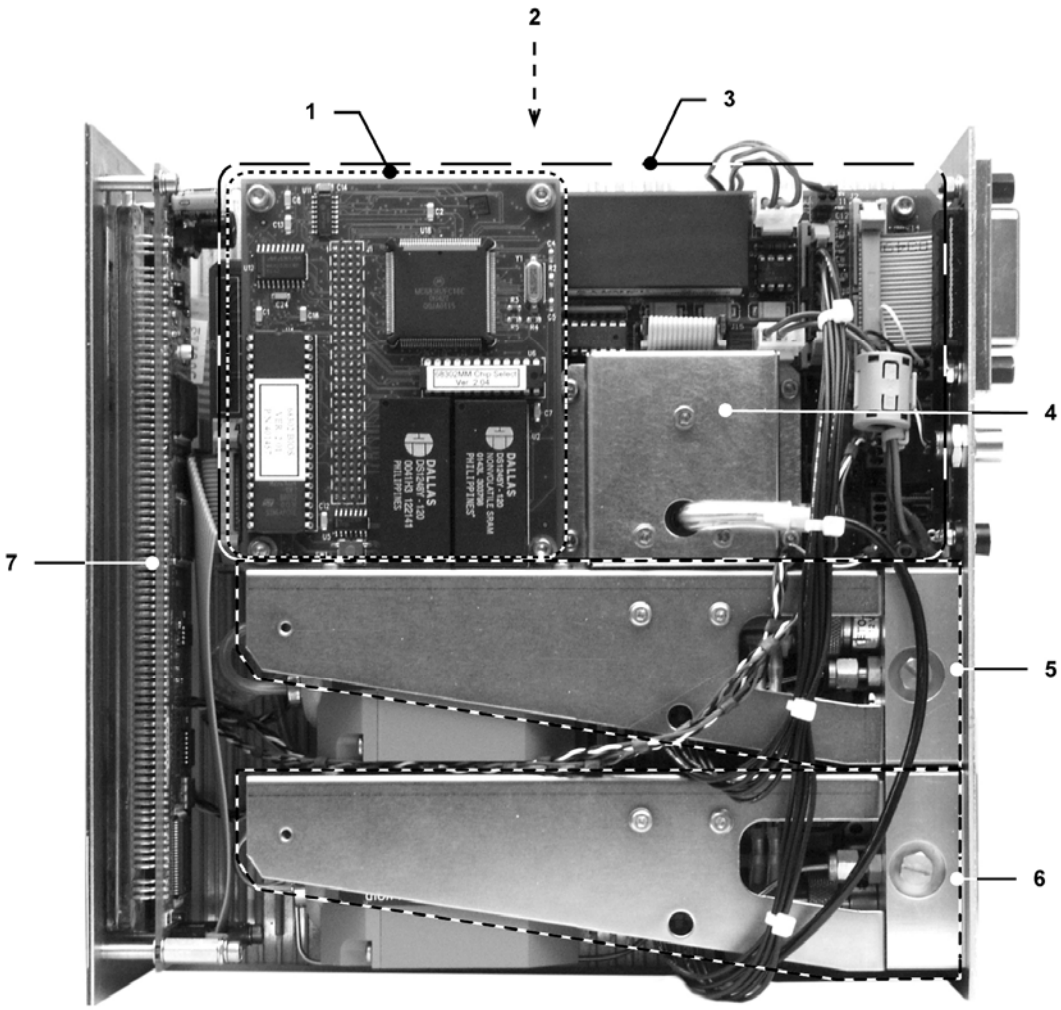
RPM4-AD uses FLASH memory. This allows the embedded software that controls RPM4-AD operations and functions to be loaded into RPM4-AD over its COM1 port from a computer with a simple FLASH loading utility program.

To replace corrupted software or upgrade your software, access the **DHI** worldwide web site at **www.dhinstruments.com** and go to **SOFTWARE**. A FLASH loading utility and the latest RPM4-AD software are available for download at no charge. If you do not have access to the web or have difficulty downloading or loading software, contact your **DHI** representative or a **DHI** Authorized Service Provider (see Table 34) for assistance.

If you believe you have discovered an error or "bug" in RPM4-AD software, please report it with complete details by email to **cal.repair@dhinstruments.com** or submit an on-line **Quality Feedback Report** under **CALIBRATION & REPAIR** at **www.dhinstruments.com**.

The DHI flash software loading utility and RPM4-AD embedded software are available for download from www.dhinstruments.com in the SOFTWARE page.

5.5 SUBASSEMBLY DESCRIPTION AND LOCATION



1. Micro card
2. Power supply module (beneath driver board)
3. Driver board
4. On-board barometer
5. Lo Q-RPT module
6. Hi Q-RPT module
7. Display

Figure 7. Internal view

5.5.1 MINI MICRO BOARD

The micro board supports a Motorola 68302 micro-controller, EPROM, EEPROM, 128k x 16 bit NVRAM, 8 Mbit flash memory; RS-232 and IEEE-488.2 communications; keypad and display control. An I/O port controls other ports and devices in RPM4-AD.

5.5.2 POWER SUPPLY MODULE

+ 12 V DC (± 2 %) @ 2.1 Amps

5.5.3 DRIVER BOARD

The driver board is controlled by the mini micro board (see Section 5.5.1). It supports:

- 12 V drivers for internal solenoid valve actuation
- Frequency counters (2) for reading Q-RPTs (see Section 5.5.5)
- On-board barometer power and output (see Section 5.5.4)
- Power to the system cooling fan
- Remote **[ENT]**
- Keypad and display
- Beeper

5.5.4 ON-BOARD BAROMETER

The on-board barometer supports a board mounted, barometric range, micro machined silicon sensor and an ambient temperature sensor. The barometer readings are used for dynamic atmospheric pressure compensation when measuring gauge pressure (see Section 3.2.2). The temperature sensor is used for temperature compensation of the barometric sensor.

5.5.5 Q-RPT MODULE

The Q-RPT module is an integrated Quartz Reference Pressure Transducer (Q-RPT) assembly. The module includes a Q-RPT, brackets to hold the transducer, interconnecting tubing.

RPM4-AD models use a single interconnection manifold for the two Q-RPT modules. The manifold includes the **TEST(Ps)**, **TEST(Pt)**, **VENT ATM** ports. The SDS (Self Defense System) and Hi Q-RPT/Lo Q-RPT bypass solenoid valves are mounted on the manifold.

A Q-RPT provides very high precision, low uncertainty pressure measurement. The basic sensing principle is the measurement of the change in the natural oscillating frequency of a quartz tuning fork in response to changes in temperature and mechanical stress resulting from the change in pressure applied to a connecting bellows or bourdon tube. Two independent quartz elements are used. One quartz element is subjected to pressure related stress. The other quartz element is used only to monitor temperature. See Section 1.2.2.1 for Q-RPT specifications.

See Section 5.6 for pneumatic schematics Q-RPT module configuration and valve states.

5.5.5.1 HI Q-RPT MODULE

RPM4-AD is always equipped with a Hi Q-RPT module. In RPM4-AD A160K/A160K (rotary wing), the Hi Q-RPT is designated A160K and has a range of 160 kPa absolute (23 psi). In RPM4-AD A350K/A160K (fixed wing) the Hi Q-RPT is designated A350K and has a range of 350 kPa absolute (51 psi).

5.5.5.2 LO Q-RPT MODULE

RPM4-AD is always equipped with a Lo Q-RPT module. In both RPM4-AD A160K/A160K (rotary wing) and RPM4-AD A350K/A160K (fixed wing) the Lo Q-RPT is designated A160K and has a range of 160 kPa absolute (23 psi).

5.5.6 DISPLAY

2 x 20 character vacuum fluorescent display.

5.6 Q-RPT MODULE PNEUMATIC SCHEMATIC AND VALVE STATES

5.6.1 RPM4-AD A160K/A160K (ROTARY WING)

Table 30. Q-RPT module valve states, RPM4-AD A160K/A160K

HL Q-RPT ACTIVE ABSOLUTE MODE (altitude with best uncertainty, no airspeed)

CONDITION	VALVE STATE				
	A	B	C	D	E
SDS Open	O	C	C	C	O
SDS Closed	C	C	O	O	C

HL Q-RPT ACTIVE GAUGE MODE (airspeed with best uncertainty, only at ambient pressure altitude)

CONDITION	VALVE STATE				
	A	B	C	D	E
SDS Open	C	O	C	C	O
SDS Closed	C	C	O	O	C

Hi Q-RPT ACTIVE ABSOLUTE AND GAUGE MODES

CONDITION	VALVE STATE				
	A	B	C	D	E
SDS Open	C	O	C	O	C
SDS Closed	C	C	O	O	C
Power off	C	C	O	O	C

Hi Q-RPT ACTIVE DIFFERENTIAL MODE (airspeed at varying altitude)

CONDITION	VALVE STATE				
	A	B	C	D	E
SDS Open	O	O	C	C	C
SDS Closed	C	C	O	O	C
Run AutoZ	O	C	C	C	O

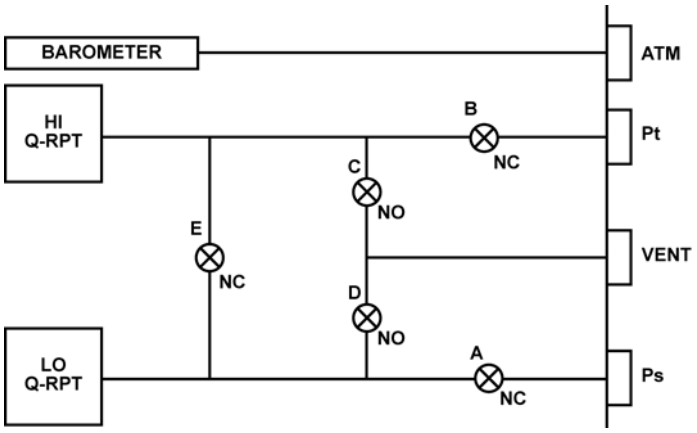


Figure 8. Pneumatic schematic and valve states, RPM4-AD A160K/A160K (rotary wing)

5.6.2 RPM4-AD A350K/A160K (FIXED WING)

Table 31. Q-RPT module valve states, RPM4-AD A350K/A160K

LO Q-RPT ACTIVE ABSOLUTE AND GAUGE MODES (altitude, no airspeed)

CONDITION	VALVE STATE				
	A	B	C	D	E
SDS Open	O	C	O	C	C
SDS Closed	C	C	O	O	C
Power off	C	C	O	O	C

HI Q-RPT ACTIVE ABSOLUTE AND GAUGE MODES (airspeed, at ambient pressure altitude only)

CONDITION	VALVE STATE				
	A	B	C	D	E
SDS Open	C	O	C	O	C
SDS Closed	C	C	O	O	C
Power off	C	C	O	O	C

HI Q-RPT ACTIVE DIFFERENTIAL MODE (airspeed and any altitude)

CONDITION	VALVE STATE				
	A	B	C	D	E
SDS Open	O	O	C	C	C
SDS Closed	C	C	O	O	C
Run AutoZ	O	C	C	C	O

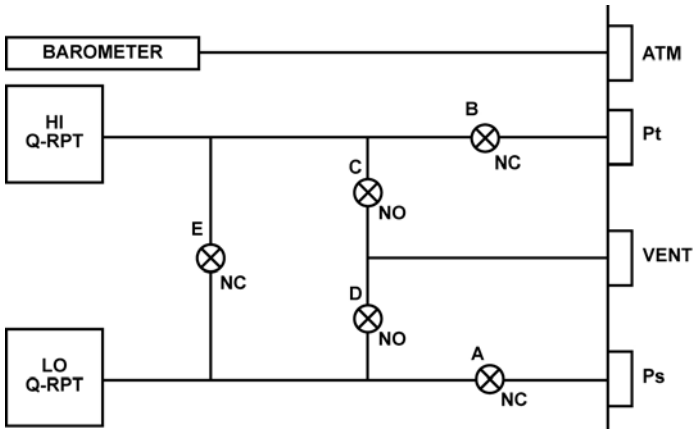


Figure 9. Pneumatic schematic and valve states, RPM4-AD A350K/A160K (fixed wing)

NOTES

6. TROUBLESHOOTING

RPM4-AD is a sophisticated pressure setting and measuring instrument with advanced on-board features and functions. Before assuming that unexpected behavior is caused by a system defect or breakdown, the operator should use this manual and other training facilities to become thoroughly familiar with RPM4-AD operation. This troubleshooting guide is intended as an aid in identifying the reason for RPM4-D behavior and determining whether the behavior is due to normal operation or an internal or external problem.

Identify the symptom or unexpected behavior you are observing from the **SYMPTOM** list below. A **PROBABLE CAUSE** is provided and a **SOLUTION** is proposed including references to manual sections that provide information that may be of assistance.

Table 32. Troubleshooting guide

SYMPTOM	PROBABLE CAUSE	SOLUTION
Will not power up.	Blown fuse.	Replace fuse.
Cannot access certain functions **>ACCESS RESTRICTED<**	User level has been set that restrict access to certain functions.	Change user level or consult system manager. 3.5.5.5
Displays **<FATAL ERROR>** or **<FATAL FAULT>**.	Encountered unresolved internal software conflict.	Cycle power to clear. Please record conditions leading up to event including the numbers displayed when **[ENT]** is pressed and report to your **DHI** Authorized Service Provider. Table 34
Displays **<ERR# 60>**.	Unit of measure and measurement mode are not compatible. Can only occur when unit and measurement mode are set by remote commands and unit of measure is an air data unit (altitude in a mode other than absolute or airspeed in absolute mode are nonsensical).	Use front panel or remote commands to change measurement mode or unit of measure to a valid combination. 3.3.2, 3.3.3, **Error! Reference source not found.**
Front panel keys seem to be disabled.	**<remote>** command has been sent from a host computer.	Send **<local>** command from host computer or cycle RPM4-AD power. 4, 4.4.4
Measured pressure display or other displays have too much/not enough resolution.	Resolution setting needs to be changed.	Change resolution setting. 3.4.2
Values that should be non-zero are displayed as zero.	Resolution setting needs to be increased to view significant digits.	Change resolution setting. 3.4.2
Keypad presses make undesired sounds or NO sounds.	Keypad sound settings are incorrect.	Use keypad function to set keypad sounds as desired. 3.5.5.2
Bottom line of display has changed and you want to change it back.	The DISPLAY function has been used to change the display.	Use **[DISPLAY]** to set bottom line to desired display. 3.3.6
Bottom line of display is blank.	DISPLAY mode is “clean”.	Operation is normal. Use **[DISPLAY]** to change bottom line display if desired. 3.3.6
Cannot get to air data units measurements	Not selecting correct Q-RPT and/or measurement mode.	Use a and airdata shortcut under **[RANGE]**. 3.3.1
Cannot change altitude unit of measure on bottom line of display.	Not using correct feature.	Select [DISPLAY], <4PRT> to select the altitude unit for the bottom line display with HL, absolute or Hi, absolute + differential Q-RP Tactive. 3.3.6.4
The pressure units available under the **[UNIT]** function key are	UNIT function needs to be customized.	Use PresU function to customize the UNIT function or reset units to default. 3.5.6

SYMPTOM	PROBABLE CAUSE	SOLUTION
not the ones you want.	Units available under UNIT function is Q-RPT and measurement mode specific and current selections do not support desired unit.	Change active Q-RPT with **[RANGE]** and/or measurement mode with **[MODE]**. 3.3.1, 3.3.3
Front panel display is dim.	Screen saver option has activated.	Operation is normal. Press any key to resume full screen power. Adjust screen saver time, if desired. 3.5.5.1
Cannot change active Q-RPT. Displays "Pressure on Hi (or Lo) RPT exceeds RR upper limit".	The pressure currently applied to the Q-RPT that is being selected exceeds the UL (upper limit) set for that range.	Reduce pressure applied to test port to less than UL of target range. 3.4.4
Pressure display is flashing and beeper is sounding intermittently.	Current upper limit of active Q-RPT has been exceeded.	Reduce pressure. Change UL and/or active Q-RPT if needed. 3.4.4
Pressure display is flashing and beeper is sounding intermittently while operating in differential mode.	Differential pressure upper limit OR Hi Q-RPT upper limit is exceeded.	Reduce differential pressure and/or pressure on Hi Q-RPT to be less than upper limit values or change upper limit value(s). 3.4.4, 3.2.6
Pressure display is NOT flashing and beeper is sounding intermittently while operating in differential mode.	Lo Q-RPT upper limit is exceeded. If Lo Q-RPT measurement is displayed on second line, its measured pressures is flashing.	Reduce pressure on Lo Q-RPT or change its upper limit. 3.4.4, 3.2.6
"Hi (or Lo) RPT EXCEEDED PMAX" displays alternating with normal display.	RPM4-AD Q-RPT has been overpressured (Pmax! exceeded).	Correct the overpressure condition and cycle power ON and OFF to clear. 0
Rapid beeping for 8 seconds and **<Check RPT connection>** displayed in second line.	RPM4-AD is in parallel measurement mode and the disagreement in pressure measured by the two Q-RPTs indicates they may not be connected in parallel.	If parallel measurement mode is not desired, change active Q-RPT. If parallel measurement is desired, check that the Hi and Lo Q-RPTs are connected to the same pressure. Ignore if having the two Q-RPTs on two different pressures is intentional. 3.2.5
A *Ready* (green *Ready/Not Ready* indicator) indication is never achieved.	Stability settings is too tight and/or existing conditions will not allow *Ready* to be achieved.	Adjust stability setting or correct other conditions. 3.4.3, 3.2.4
Display update rate of indicated pressure changes when changing pressure.	RPM4-AD automated read rate function is ON to automatically adjust read rate depending upon rate of change of pressure.	Operation is normal. Turn automated read rate function OFF if desired. 3.5.7.2
Display update of indicated pressure is too slow when pressure is changing quickly.	RPM4-AD automated read rate function is OFF.	Turn automated read rate function ON to automatically adjust read rate depending on pressure rate of change. 3.5.7.2
Pressure is changing but display of pressure is NOT and the bottom right hand corner of the display is a numerical countdown followed by **<avg>.**	Average DISPLAY function is ON and pressure display is updating only with the average value at the end of each averaging cycle.	Go to a DISPLAY function other than average or press **[+/-]** to get the instantaneous value Average DISPLAY. 3.3.6
Pressure measurement seems erratic when measuring gas pressure.	The RPM4-AD and/or the connection to the test system is contaminated with liquids.	Purge and clean affected systems. Contact **DHI** Authorized Service Provider if RPM4-AD is contaminated internally. Table 34
Pressure indicated by RPM4-AD never becomes stable.	These is a leak in the pressure system to which RPM4-AD is connected.	Find and correct leak. Consider using RPM4-AD leak check function. 3.3.5
Disagreement between two Q-RPTs in system appears excessive.	Difference is actually within tolerance and acceptable disagreement.	Compare differences observed to tolerances on Q-RPT measurements. 1.2.2.1
Apparently inaccurate pressure measurement and little or no response from Q-RPT:	Reference transducer destroyed by overpressure.	Contact **DHI** Authorized Service Provider. Table 34
Apparent inaccurate pressure measurement.	Incorrect pressure units and/or measurement mode (gauge or absolute).	Set desired pressure units and/or measurement mode. Consider reference temperature if unit is inWa. 3.3.2, 3.3.3
	Q-RPT calibration coefficients have been altered.	Check and correct calibration coefficients if needed. 5.2
	AutoZ has been run and turned ON with an incorrect standard for zero.	Check value of P_{offset}. Rerun AutoZ with a valid reference. 3.5.1

SYMPTOM	PROBABLE CAUSE	SOLUTION
Apparent inaccurate pressure measurement and **<h>** is displayed on top line of screen.	An unplanned "head" correction is active or head height or fluid is incorrect.	Operation is normal. Remove or change "head" correction. 3.3.7
Pressure applied is zero gauge but reading is NOT zero.	Need to run AutoZ to rezero in gauge mode.	Run AutoZ. 3.3.9
	Current measurement mode is absolute and RPM4-AD is indicating atmospheric pressure.	Check measurement mode setting and set to gauge if gauge pressure measurements are desired. 3.3.3
Pressure applied is atmospheric but RPM4-AD indicates near zero.	Current measurement mode is gauge and RPM4-AD is indicating zero gauge pressure.	Operation is normal. Check measurement mode setting and set to absolute if absolute pressure measurements are desired. 3.3.3
NOT reading pressure applied to the test port and **<SDS CLOSED>** is flashing over the pressure indication.	SDS is CLOSED for the active Q-RPT so the pressure applied to the test port is NOT getting to the Q-RPT.	After taking precautions to assure that pressure applied to test port is safe for the RPT, OPEN SDS. 3.2.8, 3.3.8
Is NOT reading pressure applied to the **TEST** port.	RPM4-AD has two **TEST** ports and the pressure to be measured is connected to the wrong port.	Familiarize yourself with your RPM4-AD configuration. Connect pressure to be measured to correct **TEST** port. 3.2.1, 5.6
	RPM4-AD has two **TEST** ports and pressure to be measured is connected to correct port but active Q-RPT is NOT the Q-RPT on that TEST port.	Familiarize yourself with your RPM4-AD configuration. Select active Q-RPT to be the Q-RPT to which the pressure to be measured is corrected. 5.6, 3.3.1, 3.2.5
<SDS CLOSED> is displayed alternating with the measured pressure.	SDS is CLOSED for the active Q-RPT.	Operation is normal. OPEN SDS if desired. 3.3.8
SDS should be present on a Q-RPT but does not seem to be active.	SDS has been turned full time OFF for the Q-RPT.	Turn SDS full time ON. 3.5.4.2
Opening SDS is not causing both the **TEST(Pt)** and **TEST(Ps)** ports to open	The active Q-RPT is the HL (parallel mode) Q-RPT.	Operation is normal. In parallel mode, normal opening of SDS opens only the active TEST port which is the **TEST(Ps)** port in absolute measurement mode and **TEST(Pt)** port in gauge measurement mode. 3.2.5, 3.3.8.2
SDS will not OPEN for the Q-RPT shown on the second line in the Q-RPT DISPLAY function.	When not in differential or parallel measurement mode, SDS on the inactive Q-RPT can only be OPENED using direct SDS control.	Use direct SDS direct control to OPEN SDS on the inactive Q-RPT. 3.5.4.1
SDS was left OPEN on one Q-RPT when the active Q-RPT was changed. When you come back to it, its CLOSED again.	When the active Q-RPT is changed, SDS is always CLOSED for the Q-RPT that becomes inactive.	Operation is normal. 3.2.8
You would like to eliminate the SDS function.	Set SDS to be inactive except for an overpressure situation.	Turn SDS full time OFF. 3.5.4.2

NOTES

7. APPENDIX

7.1 REMOTE [ENT]

The RPM4-AD remote ENTER function operates by detecting the open or closed status of the REMOTE ENTER switch.

The normal status of the ENTER switch is OPEN. When RPM4-AD detects a CLOSED condition held for 300 ms, it is interpreted as equivalent to a press of the **[ENT]** key.

Any switch may be used to accomplish the remote ENTER function. The switch should be installed on the optional remote ENTER cable (**DHI** P/N 103128). Install the switch by connecting its two terminals to the black and white wires of the remote ENTER cable.

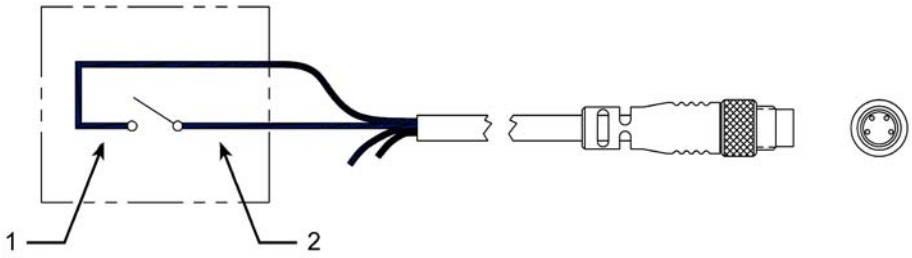


Figure 10. Remote [ENT] connector schematic

1. Black wire 2. White wire

7.2 UNIT CONVERSION

7.2.1 PRESSURE

RPM4-AD performs all internal calculations in SI units. Numerical values input or output in other units are converted to SI immediately after entry and back to other units just before output as needed.

Table 33 provides the conversion coefficients used by RPM4-AD to convert numerical values expressed in SI units to corresponding values expressed in other units.

Table 33. Pressure unit of measure conversion coefficients

TO CONVERT FROM Pa To		MULTIPLY BY
Pa	*Pascal*	1.0
mbar	*millibar*	1.0 E-02
hPa	□*ector Pascal*	1.0 E-02
kPa	*kilo Pascal*	1.0 E-03
bar	*Bar*	1.0 E-05
mmWa @ 4°C	*millimeter of water*	1.019716 E-01
mmHg @ 0°C	*millimeter of mercury*	7.50063 E-03
psi	*pound per square inch*	1.450377 E-04
psf	*pound per square foot*	1.007206 E-06
inWa @ 4°C	*inch of water*	4.014649 E-03
inWa @ 20°C	*inch of water*	4.021732 E-03
inWa @ 60°F	*inch of water*	4.018429 E-03
inHg @ 0°C	*inch of mercury*	2.953 E-04
kcm^2	*kilogram force per centimeter square*	1.019716 E-05
mTorr	*milliTorr (micron of mercury*	7.50063
Torr	*Torr (millimeter of mercury)*	7.50063 E-3
user	*User*	User defined coefficient
ft	*feet of altitude*	see Section 7.2.2
m	*meter of altitude*	see Section 7.2.2
kts	*knots*	see Section 7.2.3
km/h	*kilometers per hour*	see Section 7.2.3
mph	*miles per hour*	see Section 7.2.3
mach	*mach number*	see Section 7.2.3

7.2.2 ALTITUDE

Quantities expressed in units of altitude follow MIL-STD-859A "Static Pressure, p, in Inches of Mercury for Values of Pressure Altitude, H, in Geopotential Feet." MIL-STD-859A provides tables of pressure in inches of mercury as a function of altitude in feet. RPM4-AD uses a set of equations to model the pressure/altitude relationship. The worst case deviation between the MIL-STD-859A table and the calculated pressure is 0.0001 inches of mercury (0.3 Pa). The pressure quantity expressed in inches of mercury is converted to Pascal following Table 33 above. For altitude expressed in meters, meters are converted to feet using 1 m = 3.28084 ft.

The following formulas are used to convert altitude in ft (H) into pressure (P) in inHg and from pressure to altitude. There are three different equations depending on the range.

Low Altitude: H < 36089 ft and P > 6.6832426 inHg

$$P = \left(29.92126^{0.190255} - 1.3125214 \times 10^{-5} \times H\right)^{\frac{1}{0.190255}}$$

$$H = \frac{29.92126^{0.190255} - P^{0.190255}}{1.3125214 \times 10^{-5}}$$

Mid Altitude: 65617ft ≥ H ≥ 36089 ft and 1.6167295 inHg ≤ P ≤ 6.6832426 inHg

$$P = 6.6832426 \times e^{1.7345726 - 4.806353 \times 10^{-5} \times H}$$

$$H = \frac{1.7345726 - \ln\left(\frac{P}{6.6832426}\right)}{4.806353 \times 10^{-5}}$$

High Altitude: H >65617ft and P < 1.6167295 inHg

$$P = 1.6167295 \times \left(\frac{H + 645177.16}{710793.96}\right)^{-34.163156}$$

$$H = \left(710793.96 \times \left(\frac{P}{1.6167295}\right)^{\frac{-1}{34.163156}}\right) - 645177.16$$

7.2.3 AIRSPEED

RPM-AD has the ability to determine true airspeed, calibrated air speed and the Mach number. True airspeed unit selections are indicated by using upper case for the unit symbol (e.g. KTS, MPH). Mach and true airspeed unit of measure are dependent on static pressure and/or temperature. Calibrated airspeed is a function of differential pressure only. All airspeed calculations are based on the international standard **ISO 1151-5**.

Calibrated Airspeed

Calibrated airspeed is the expected airspeed at sea level atmospheric conditions. Some texts refer to this version of airspeed as “calibrated” airspeed because the value is corrected for specific atmospheric conditions. Other texts refer to it as “indicated airspeed” since the displayed value is what one would expect to see on a mechanical airspeed indicator in a plane.

The equations below are used to determine calibrated airspeed from a given differential pressure. There are two cases: 1) when the calculated airspeed is less than the speed of sound at sea level, 2) when the calculated airspeed is greater than the speed of sound at sea level. For the second case, the Mach number is determined assuming atmospheric static pressure. The Mach number times the speed of sound is the resultant air speed. In both cases, the resultant airspeed value is in meters per second. Length and time unit conversions are applied to yield all cases of airspeed units.

True Airspeed

True airspeed is the airspeed adjusted for the current altitude and specified temperature. The measured static pressure and input temperature impact the final air speed value. The fundamental equations and process are identical to the calibrated airspeed case. The exception is that the P and T values are the current static pressure and temperature instead of standard pressure (101325 Pa) and temperature (15 ºC by convention) at sea level.

$$q_c = P_t - P$$

Subsonic speeds ($V<a_t$)

$$f = \frac{2\gamma R}{\gamma - 1} = 2009.37009$$

$$\frac{q_c}{P} = \left(1 + \frac{V^2}{fT}\right)^{3.5} - 1$$

$$V = \sqrt{fT\left[\left(\frac{q_c}{P} + 1\right)^{\frac{1}{3.5}} - 1\right]}$$

Supersonic speeds ($V \geq a_t$)

$$a_t = \sqrt{\gamma RT}$$

$$V = Ma_t$$

Airspeed variable definitions

VARIABLE	DESCRIPTION
V_c	Calculated airspeed in meters per second assuming sea level atmospheric conditions. P = 101325 Pa and T = 288.15K
V_t	Calculated true airspeed in meters per second. The measured value for static pressure and user input value for temperature are used to determine V.
V	Calculated air speed in meters per second. The input P and T conditions determine true or calibrated air speed.
a_t	Speed of sound as a function of static temperature.
q_c	The differential pressure in Pa.
P	Static pressure in Pa. For calibrated airspeed, 101325Pa is always used.
T	Static temperature in K. For calibrated airspeed, 288.15K (15 ºC) is always used.
P_t	The optionally input total pressure in Pa. This pressure is also referred to as the dynamic pressure.
R	Gas constant. 287.05287 j/(Kkg)
γ	Constant ratio of specific heats of air (1.400).
M	Calculated Mach number as a function of static pressure.
q_c	The input or calculated differential pressure converted into Pa.

Airspeed dimension/time corrections

AIRSPEED UNIT	CORRECTION FACTOR MULTIPLY V_C BY
m/s	1.0
ft/s	1/0 .3048
mph	2.236936292054
km/h	3.6
knot	1.9438444924

Mach Number

The Mach number is defined as the ratio of true airspeed to the local speed of sound. Mach number is converted based on the international standard **ISO 1151-5**. The conversion of Mach number requires two pressure inputs: differential pressure and static pressure.

The equations below are used to determine the Mach number. There are two cases: 1)when the Mach number is less than 1; 2) when the Mach number is greater than 1. For the second case, an iteration is performed on the Mach number starting with the Mach number calculated for the subsonic case. The iteration continues until the change in calculated Mach number between iteration cycles is less than 0.01 parts per million.

For M<1

$$q_c = P_t - P$$

$$\frac{q_c}{P} = \left(1 + \frac{\gamma - 1}{2} M^2\right)^{\frac{\gamma}{\gamma - 1}} - 1$$

$$\frac{q_c}{P} = \left(1 + .2M^2\right)^{3.5} - 1$$

$$M = \sqrt{5\left[\left(\frac{q_c}{P_s} + 1\right)^{\frac{1}{3.5}} - 1\right]}$$

For M≥1

Start with **M** for the case in which **M<1**

$$\frac{q_c}{P} = \frac{1+\gamma}{2} M^2 \left(\frac{(1+\gamma)^2 M^2}{4\gamma M^2 - 2(\gamma - 1)} \right)^{\frac{1}{\gamma - 1}} - 1$$

$$\frac{q_c}{P} = 1.2 M^2 \left(\frac{5.76 M^2}{5.6 M^2 - 0.8} \right)^{2.5} - 1$$

$$M = \sqrt{\frac{\left(\frac{q_c}{P} + 1 \right)}{1.2 \left(\frac{5.76}{5.6 - \frac{0.8}{M^2}} \right)^{2.5}}}$$

8. WARRANTY

8.1 OVERVIEW

Except to the extent limited or otherwise provided herein, **DH Instruments, a Fluke Company** warrants for one year from purchase, each new product sold by it or one of its authorized distributors, only against defects in workmanship and/or materials under normal service and use. Products which have been changed or altered in any manner from their original design, or which are improperly or defectively installed, serviced or used are not covered by this warranty.

DH Instruments, a Fluke Company and any of its Authorized Service Providers' obligations with respect to this warranty are limited to the repair or replacement of defective products after their inspection and verification of such defects. All products to be considered for repair or replacement are to be returned to **DH Instruments** or its Authorized Service Provider after receiving authorization from **DH Instruments** or its Authorized Service Provider. The purchaser assumes all liability vis a vis third parties in respect of its acts or omissions involving use of the products. In no event shall **DH Instruments** be liable to purchaser for any unforeseeable or indirect damage, it being expressly stated that, for the purpose of this warranty, such indirect damage includes, but is not limited to, loss of production, profits, revenue, or goodwill, even if **DH Instruments** has been advised of the possibility thereof, and regardless of whether such products are used individually or as components in other products.

The provisions of this warranty and limitation may not be modified in any respect except in writing signed by a duly authorized officer of **DH Instruments, a Fluke Company**

The above warranty and the obligations and liability **of DH Instruments, a Fluke Company** and its Authorized Service Providers exclude any other warranties or liabilities of any kind.

RPM4-AD units delivered under certain US government contracts have extended warranties. In this case, the warranty period is listed on a sticker on the rear panel. The extended warranty extends the standard 1 year warranty, providing for remedy of defects in materials, workmanship and manufacturing. The extended warranty is not an extended service contract. Items returned for service not covered under the warranty terms are subject to standard service charges including charges for evaluation and/or analysis when no defect is found.

Table 34. DHI Authorized Service Providers

DH INSTRUMENTS, A FLUKE COMPANY AUTHORIZED SERVICE PROVIDERS			
COMPANY	**ADDRESS**	**TELEPHONE, FAX & EMAIL**	**NORMAL SUPPORT REGION**
DH Instruments, a Fluke Company	4765 East Beautiful Lane Phoenix AZ 85044-5318 USA	Tel 602.431.9100 Fax 602.431.9559 cal.repair@dhinstruments.com	Worldwide
Minerva Meettechniek B.V.	Chrysantstraat 1 3812 WX Amersfoort the NETHERLANDS	Tel (+31) 33.46.22.000 Fax (+31) 33.46.22.218 info@minervaipm.com	European Union
Ohte Giken, Inc. Technology Center	258-1, Nakadai Kasumigaura-machi, Niihari-Gun, Ibaraki 300-0133	Tel 81/29.840.9111 Fax 81/29.840.9100 tech@ohtegiken.co.jp	Japan/Asia
DH Products Technical Service Division	National Institute of Metrology Heat Division Pressure & Vacuum Lab NO. 18, Bei San Huan Donglu Beijing 100013 PR CHINA	Tel 010.64291994 ext 5 Tel 010.64218637 ext 5 Fax 010.64218703 cxcen@mx.cei.gov.cn	Peoples Republic of China

9. GLOSSARY

Axxx	A type of Q-RPT with a built-in vacuum reference that is intrinsically absolute (e.g. A10M). Axxx Q-RPTs support absolute, gauge and negative gauge measurement modes.
Absolute Mode	Measurement mode in which the Q-RPT indicates absolute pressure (difference from vacuum).
Active Q-RPT	The Q-RPT that is currently selected to be displayed on the top line of the RPM4-AD display. Most function selections affect the active Q-RPT.
AutoRange	A function that optimizes RPM4-AD measurement and control for a specific, user defined range of operation.
AutoRanged Range	An RPM4-AD pressure measurement range created using the AutoRange function.
AutoZero or AutoZ	A process by which a Q-RPT and measurement mode is rezeroed (offset) relative to a standard.
Barometer	RPM4's on-board atmospheric pressure measuring sensor. Also referred to as on-board barometer.
BGxxx	A type of Q-RPT that is intrinsically gauge and is capable of operating bi-directionally, above and below atmosphere, through zero. BGxxx Q-RPTs support gauge and negative gauge measurement modes.
Default Range (DF)	A Q-RPT's maximum range that is always available using **[RANGE]** and cannot be deleted.
Deviation	A DISPLAY function in which the deviation of the current pressure from a target pressure is displayed.
DUT	Device Under Test. The device or devices pneumatically connected to the RPM4-AD **TEST(+)** port that the RPM4-AD is being used to test or calibrate.
Differential mode	Measurement mode in which the measured pressure is the different between the Hi and Lo Q-RPT (Hi – Lo).
FS	Abbreviation of "full scale". The full scale value is the maximum pressure of a measurement range. Limits and specifications are often expressed as % FS. Also see span.
Gxxx	A type of Q-RPT that is intrinsically gauge but only measures pressure greater than atmosphere. Gxxx Q-RPTs support gauge measurement mode only.
Gauge Mode	Measurement mode in which the Q-RPT indicates gauge pressure (difference from atmospheric pressure), but only in the positive direction (above atmosphere).
Ground	Altitude at pressure corresponding to current atmospheric pressure at measurement location. When vented and displaying in altitude unit of measure, RPM4-AD displays "ground" altitude.
Head	A difference in height between the RPM4-AD reference level and the DUT.
HiLo	A DISPLAY function in which the highest and lowest pressure measurements since reset are recorded and displayed.
Hi Q-RPT	The designation of a single Q-RPT in an RPM4, or, if there are two, the one that has the highest full scale default range.
HL Q-RPT	The designation of the pseudo Q-RPT that results from the combination of using two Q-RPTs simultaneously in parallel measurement mode.
Inactive Q-RPT	In an RPM4-AD with two Q-RPTs, the Q-RPT that is not currently displayed on the top line of the display. The inactive Q-RPT may be displayed on the second line of the RPM4-AD display using the RPT DISPLAY function.
Lo Q-RPT	The designation of a the Q-RPT with the lower full scale default range in RPM4s with two Q-RPTs.
Measurement Mode	Whether pressure is being measured relative to absolute zero or vacuum (absolute mode) or relative to atmospheric pressure (gauge mode).
Negative gauge or compound gauge	Measurement mode in which the Q-RPT indicates gauge pressure (difference from atmospheric pressure), in both positive and negative directions (above and below atmosphere).
P_{offset}	The difference between a Q-RPT reading and the AutoZero reference at the time AutoZ is run. Used by the AutoZ function when Auto Z is ON to compensate Q-RPT readings for changes in zero over time.
$P_{std,0}$	AutoZero reference value. Value indicated by the device against which the Q-RPT is zeroed by AutoZ.
PA	Pressure adder, used to offset a Q-RPT or barometer to calibrate it.

PM	Pressure multiplier, used to adjust span of a Q-RPT or barometer to calibrate it.
Parallel Measurement Mode	Operating mode of RPM4s with two Q-RPTs in which both Q-RPTs are used to measure together in parallel and the indicated pressure is the average of their readings. This creates a pseudo Q-RPT designated HL.
Pmax!	The maximum pressure limit of a Q-RPT. If the pressure measured by the Q-RPT exceeds Pmax!, an overpressure condition occurs.
PPC3	Pressure controller calibrator manufactured by **DHI**. RPM4-AD can be used as an external reference device for a PPC3. PPC3 automates RPM4-AD pressure control.
Q-RPT (Quartz Reference Pressure Transducer)	The transducer used by RPM4-AD for low uncertainty pressure measurement. May be designated as Hi, Lo or HL depending on its position and role in t he RPM4-AD. Q-RPTs are designated by a leading A, G or BG (absolute, gauge or bi-directional gauge) followed by three numbers and a letter indicating the maximum range of the Q-RPT in kPa (nnnK) or MPa (nnnM).
Rate	A DISPLAY function in which the rate of change of pressure in pressure unit/second is displayed.
Ready/Not Ready	Front panel LED indication of when the pressure measured by RPM4's active Q-RPT is stable within the stability limit. Leading character of the second line when the inactive Q-RPT is displayed on the second line in RPT DISPLAY mode.
RPT2x	Parallel measurement mode in which both Q-RPTs of an RPM4-AD with two Q-RPTs are used together and the indicated pressure is the average of their measurements.
SDS (Self Defense System)	A system to protect Q-RPTs from overpressure made up of isolation and vent valves and internal operating logic. Applies only to Q-RPTs designated A7M or lower.
Span	The difference between FS and the lowest point in a range. For example, the span of a 100 kPa FS range in negative gauge mode is nominally 200 kPa (from - 100 kPa to 100 kPa).
Stability Limit	A limit expressed in units of pressure per second (e.g., kPa/second). The stability limit is used as the *Ready/Not Ready* criterion. *Ready* if rate of change is less than stability limit. *Not Ready* if rate of change is greater than stability limit.
Target	The value from which deviations are measured in the Deviation DISPLAY function.
UL (Upper Limit)	A user settable maximum pressure limit. When pressure exceeds UL, RPM4-AD beeps intermittently. In negative gauge measurement mode, there is also a user settable lower limit.
User Level	Levels of security that can be set to protect certain RPM4-AD functions from being accessed.
QDUT	On-board automated test sequence that AutoRanges RPM4-AD based on characteristics of the Device Under Test (DUT).

