

Hardware Guide



4000 QTRAP® System

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AB SCIEX

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The 4000 QTRAP® system includes a hybrid triple quadrupole/LIT (linear ion trap) mass spectrometer, a Turbo V™ ion source, a computer, and the Analyst® software.



WARNING! If you need to move the system, contact an FSE to assist you. Risk of personal injury or instrument damage



Note: Before you operate the instrument, make sure you have read the Safety Practices guide.

Principles of the System

The 4000 QTRAP® system includes a hybrid triple quadrupole LIT (linear ion trap) mass spectrometer designed specifically for quantitative and qualitative applications.

The Q3 region can be operated as either a standard quadrupole mass spectrometer, or as a linear ion trap mass spectrometer. The unique scan modes of both configurations can be linked to provide more and higher quality data than either technique alone.

Applications for the System

The 4000 QTRAP® system is best suited to three specific applications:

- Quantitative analysis of small molecules
- Qualitative analysis of small molecules
- Qualitative analysis of proteins and peptides

Quantitative Analysis of Small Molecules

This application involves measurement of specific molecular weight compounds (usually a drug or metabolite in urine or other bodily fluid) and their resulting fragment ions for determining the exact quantity of the compound in the sample of interest. Quantitation is performed using a standard curve of mass spectrometer signal intensity for various known concentrations of the compound. The signal in the test sample is compared to the standard curve to determine the concentration.

The typical scan type used for this application in the 4000 QTRAP system (as well as all triple quadrupole instruments) is MRM (Multiple Reaction Monitoring).

Qualitative Analysis of Small Molecules

This application involves MS analysis of low molecular weight (typically less than 1000 amu) compounds such as drugs and their metabolites. This is for the purpose of identification and structural characterization of the chemical compounds in a sample such as urine or other bodily fluid. In addition, this general application is used when the researcher wants to know what molecular weight species are in the sample.

The typical scan type used for this application in the 4000 QTRAP system is an EMS (Enhanced MS) scan for intact molecular weight analysis. For more detailed structural analysis using tandem mass spectrometry, EPI (Enhanced Product Ion) and MS3 (MS/MS/MS) scans are performed.

Qualitative Analysis of Proteins and Peptides

This application involves determination of molecular weights and sequences of protein and peptide samples. This is for the purposes of identification of the compounds and structural characterization. This general application is used when the researcher wants to know what molecular weight species and what sequences of peptides or proteins are in the sample.

The typical scan types used for this application in the 4000 QTRAP system are EMS (Enhanced MS) and EMC (Enhanced Multi-Charge) scans for intact molecular weight analysis. ER (Enhanced Resolution) scans are used to obtain higher resolution molecular weight information such as determining the charge state of a multiply charged peptide ion. This allows for more accurate identification of the sample using protein database searching. For more detailed structural analysis using tandem mass spectrometry (MS/MS), EPI (Enhanced Product Ion) scans are performed.

How the System Works

The 4000 QTRAP® system has a number of enhanced modes of operation. A common feature of the enhanced modes is that ions are trapped in the Q3 quadrupole region and then scanned out to produce full spectrum data. Many spectra are rapidly collected in a short period of time and are significantly more intense than spectra collected in a comparable standard quadrupole mode of operation.

During the collection phase, ions pass through the Q2 collision cell, where CAD gas focuses the ions into the Q3 region. The Q3 quadrupole is operated with only the main RF voltage applied. Ions are prevented from passing through the Q3 quadrupole rod set and are reflected back by an exit lens to which a DC barrier voltage is applied. After the fill time elapses (a time defined by the user, or determined by the Dynamic Fill Time feature), a DC barrier voltage is applied to a Q3 entrance lens (ST3). This confines the collected ions in Q3 and stops further ions from entering. The entrance and exit lens DC voltage barriers and the RF voltage applied to the quadrupole rods confine the ions within Q3.

During the scan out phase, the voltage on the exit lens and the auxiliary RF voltage are ramped simultaneously with the main RF voltage for increased resolution and sensitivity. An auxiliary AC frequency is applied to the Q3 quadrupole. The main RF voltage amplitude is ramped from low to high values, which sequentially brings masses into resonance with the auxiliary AC frequency. When ions are brought into resonance with the AC frequency, they acquire

enough axial velocity to overcome the exit lens barrier and are axially ejected towards the mass spectrometer ion detector. Full spectra data can be acquired from the ions collected in Q3 by rapidly scanning the main RF voltage.

Features of the System

The unique scan modes of both configurations can be linked to provide more and higher quality data than either instrument alone. For example, a precursor ion scan in transmission mode can be used as a survey scan in order to target specific ions to be used in an EPI scan (in LIT mode). Conversion between the two modes of operation is rapid, since it involves only the addition or removal of the resolving DC voltages.

The 4000 QTRAP system offers the following benefits over a standard triple quadrupole and a traditional 3-D ion trap mass spectrometer:

- The proven quadrupole quantitation capabilities of the API 4000™ instrument with additional scan types: Enhanced MS, Enhanced Multiply Charged, Enhanced Product Ion, Enhanced Resolution, MS/MS/MS, and Time Delayed Fragmentation.
- Higher sensitivity in all RF/DC scan modes.
- Scanning to a mass range of m/z 3–2800 quadrupole mode, 50–2800 LIT mode.
- Enhanced resolution at reduced scan speeds.

Parts of the Instrument

This section contains diagrams of the instrument and general descriptions of its components.

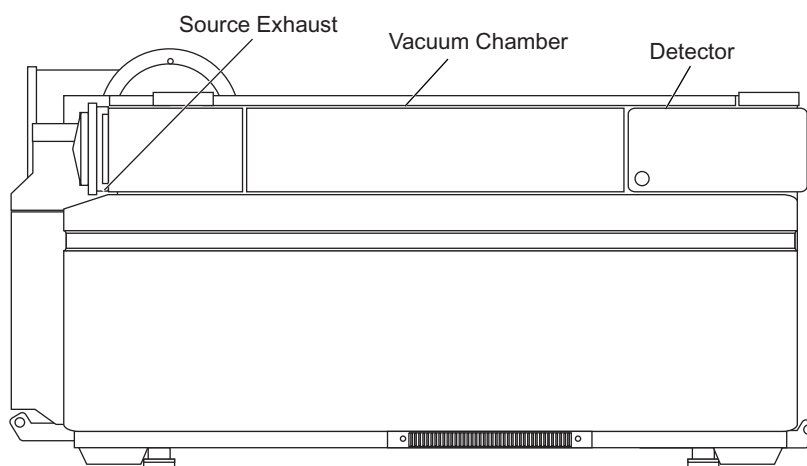


Figure 1-1 Front view of the instrument

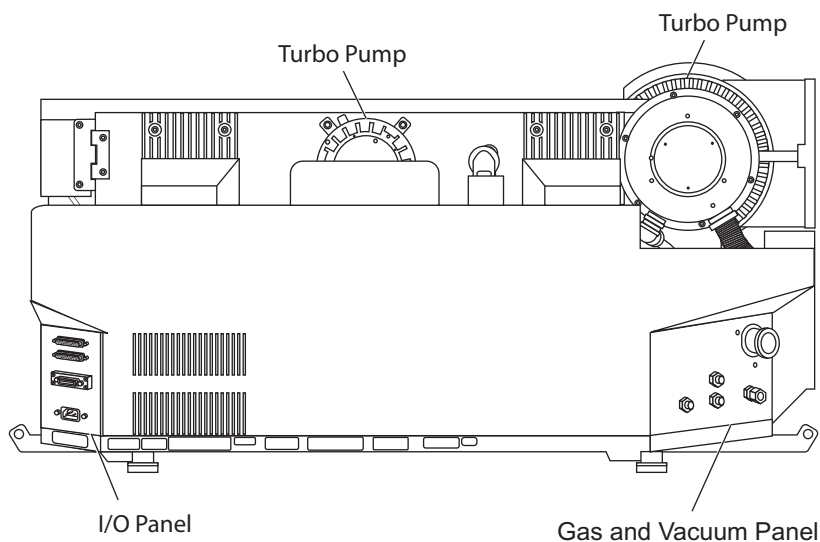


Figure 1-2 Back view of the instrument

Component Descriptions

This section contains general descriptions of the components of the instrument.

Table 1-1 Component Descriptions

Component	Description
I/O Panel	The external power supply, the IEEE-488 (GPIB) connections to the computer, the AUX I/O to your peripherals and the Sources connection are made through the I/O panel on the right side of the chassis.
Gas and Vacuum Panel	The vacuum lines to the external roughing pump are connected through the gas and vacuum panel. The panel also houses the gas supply connections and the external connection for the source exhaust pump.
Control Panel	The control panel contains the main power switch, four fuses, and two Indicator/Reset buttons.
Source Exhaust System	Most ion sources produce both sample and solvent vapors. These vapors are a potential hazard to the laboratory environment. The source exhaust system is designed to safely remove and allow for the appropriate handling of the ion source exhaust products.
Vacuum Chamber	The vacuum chamber houses the quadrupole rod sets, most of the ion optics, the collision cell, and the ion detector.

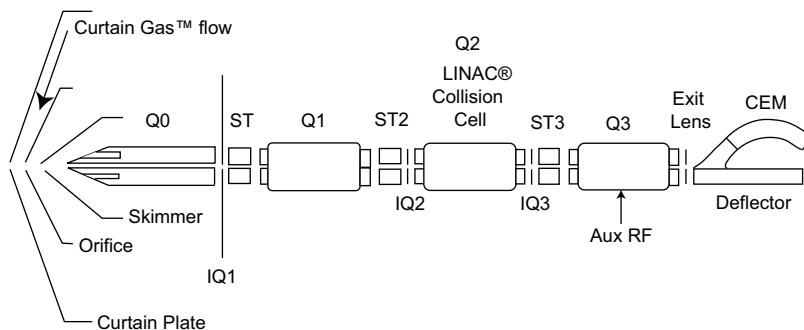


Figure 1-3 Ion Optics

Shutting Down and Turning on the System

Use the following procedures if you need to shut down or turn on the system.

To shut down the system

1. In the Analyst® software, complete or stop any ongoing scans.
2. Turn off the sample flow to the instrument.

CAUTION! Potential Instrument Damage: Shut off the sample flow before you shut down the instrument.

3. In the Analyst software, deactivate the hardware profile and then close the application software.
4. Stop the Analyst® Service. (See the *Software Reference Guide* for the Analyst software.)

CAUTION! Leave the roughing pump running for a minimum of 15 minutes after turning off the instrument's main power switch. When the main power switch is turned off, the turbo pumps continue to rotate without power for a few minutes and continue to provide vacuum to the vacuum chamber. If, during this time, the roughing pump is turned off, the pressure in the vacuum line between the roughing pump and the turbo pumps increases. The increase in back pressure can create an incorrect load on the turbo pumps' bearings and can cause a catastrophic failure of the turbo pumps.

CAUTION! If the instrument is to be shut down for any length of time, we recommend that the vacuum chamber be vented to prevent exhaust from the roughing pump being sucked back into the vacuum chamber. To vent the vacuum chamber, follow steps 5 to 7.

CAUTION! If the vacuum chamber is not going to be vented while the instrument is shut down, we recommend the roughing pump remain turned on to prevent the pump exhaust from being sucked back into the vacuum chamber. If you do not want to vent the vacuum chamber, skip steps 6 and 7.

5. Turn off the main power to the instrument. As you face the instrument where the instrument name is visible and with the source to your left, the switch is located on the bulkhead at the back right corner of the chassis.
6. After fifteen minutes, turn off the roughing pump. The power switch is located beside the power supply input attachment on the roughing pump.



Note: The roughing pump has its own power toggle switch and must be turned off manually. The roughing pump is not controlled remotely by the system controller.

7. Let the vacuum chamber vent naturally through the orifice for ten minutes to allow the instrument to reach atmospheric pressure.
8. Unplug the mains power cord to the instrument from the rear bulkhead near the main power switch for the instrument.

To turn on the system

Certain conditions outside the direct control of the instrument firmware must be satisfied before the turbo pumps will be initiated. The Curtain Gas™ supply must be turned on at the source, and the roughing pump must be turned on manually. Interlocks (pressure switches) monitored by the firmware detect if the Curtain Gas supply and the roughing pump are switched on. If the interlocks are not satisfied, the turbo pumps are not initiated.

CAUTION! If the ion source is removed, the system electronics will be disabled, interrupting any data acquisition tasks. The turbo pump and the vacuum system will not be affected.

1. Turn on the roughing pump, if it was turned off. The power switch is located beside the power supply input attachment on the roughing pump.



Note: The roughing pump has its own power toggle switch and must be turned on manually. The roughing pump is not controlled remotely by the system controller.

2. Make sure that all gas supplies are flowing correctly to the instrument.
3. Plug the mains power cord into the bulkhead.
4. Turn on the main power switch.
5. Make sure that the GPIB (general purpose interface bus) cable is connected to both the instrument and the computer.

6. Turn on the computer, if it was turned off, and then start the Analyst® software.

Instrument Safe Fluids

The following fluids can safely be used with the instrument:

- Methanol (0 to 100%)
- Acetonitrile (0 to 100%)
- Water
- Formic acid (0 to 1%)
- Ammonium acetate (0 to 1%)



Note: This list is not complete. If you are uncertain about a specific fluid, do not use the fluid until confirmation is received from AB SCIEX that it will not present a hazard.

Source/Gas Parameters

The parameters in [Table 1-2](#) are optimized for different LC conditions involving flow rate. For more information about the parameters, see the Analyst® software Help system.



Note: We recommend that you run the instrument with the Curtain Gas™ flow set to at least 20 to maintain good instrument performance.

Table 1-2 Source/Gas Parameters

Parameter	Value
Curtain Gas (CUR)	20
IonSpray Voltage (IS)	5000
Temperature (TEM)	700
Ion Source Gas (GS1)	60
Ion Source Gas 2 (GS2)	60

Turbo V™ Ion Source Settings

[Table 1-3](#) shows the recommended starting values for the X- and Y-axis parameters. For more information, see the *Turbo V™ Ion Source Operator's Guide*.

Table 1-3 Vertical and Horizontal Parameters

Parameter	Value
X-axis	5
Y-axis	5

Compound Parameters

In general, you can use the preset values for most of the parameters in [Table 1-4](#). For more information about the parameters, see the Analyst® software Help system.

Table 1-4 Compound Parameters

Parameter	Value
CAD Gas	Use the preset value and optimize for your compound.
DP (Declustering Potential)	Use the preset value and optimize for your compound.
EP (Entrance Potential)	Use the preset value.
CXP (Collision Cell Exit Potential)	Use the preset value and optimize for your compound.
CE (Collision Energy)	Use the preset value and optimize for your compound.
CES (Collision Energy Spread)	Use the preset value and optimize for your compound.
Fixed LIT Fill Time	Use the preset value.
DFT (Dynamic Fill Time)	Either select or deselect the feature based on your experiment. In the Tools > Settings > Method Options dialog box, the Dynamic Fill Time settings are optimized for the 10000 Da/s scan speed. These settings are also suitable for other LIT scan speeds.
Q0 Trapping	Either select or deselect the feature based on your experiment. The recommended fixed fill time to use with Q0 trapping is 20 ms or greater.
MCS (Multi-Charge Separation) Barrier	Use the preset value.
Q3 Entry Barrier	Use the preset value.
Q3 Empty Time	Use the preset value.
MS/MS/MS Fragmentation Time	Use the preset value.
Q3 Cool Time	Use the preset value.
TDF CE (Time Delayed Fragmentation Collision Energy)	Use the preset value.
IE1 (Ion Energy 1) — <i>For experienced instrument operators only</i>	Do not adjust.
IE3 (Ion Energy 3) — <i>For experienced instrument operators only</i>	Do not adjust.

Related Documentation

The guides and tutorials for the instrument and the Analyst® software are installed automatically with the software and are available from the Start menu: All Programs > AB SCIEX. A complete list of the available documentation can be found in the online Help. To view the Analyst software Help, press F1.

Technical Support

AB SCIEX and its representatives maintain a staff of fully-trained service and technical specialists located throughout the world. They can answer questions about the instrument or any technical issues that may arise. For more information, visit the web site at <http://www.absciex.com>.



The following tables contains generic parameters for the 4000 series of instruments. The first number under each scan type is the preset value; the range of numbers is the accessible range for each parameter.

Table 2-1 4000 Series Instrument Parameters

Parameter ID	Access ID	Positive Ion Mode			Negative Ion Mode		
		Q1	Q3	MS/MS	Q1	Q3	MS/MS
CUR	CUR	10 10 to 50	10 10 to 50	10 10 to 50	10 10 to 50	10 10 to 50	10 10 to 50
CAD	CAD	0	1 0 to 12	6 0 to 12	0 0 to 12	1 0 to 12	6 0 to 12
IS ⁽¹⁾⁽²⁾	IS ⁽¹⁾⁽²⁾	5000 0 to 5500	5000 0 to 5500	5000 0 to 5500	-4200 -4500 to 0	-4200 -4500 to 0	-4200 -4500 to 0
NC ⁽³⁾	NC ⁽³⁾	3 0 to 5	3 0 to 5	3 0 to 5	-3 -5 to 0	-3 -5 to 0	-3 -5 to 0
TEM ⁽²⁾⁽³⁾	TEM ⁽²⁾⁽³⁾	0 0 to 750	0 0 to 750	0 0 to 750	0 0 to 750	0 0 to 750	0 0 to 750
OR (DP = OR)	DP	20 0 to 400	20 0 to 400	20 0 to 400	-20 -400 to 0	-20 -400 to 0	-20 -400 to 0
Q0 (EP = -Q0)	EP	10 15 to 2	10 15 to 2	10 15 to 2	-10 -2 to -15	-10 -2 to -15	-10 -2 to -15
IQ1 (IQ1 = Q0 + offset)	IQ1	Q0 + (-1) -0.5 to -2	Q0 + (-1) -0.5 to -2	Q0 + (-1) -0.5 to -2	Q0 + 1 0.5 to 2	Q0 + 1 0.5 to 2	Q0 + 1 0.5 to 2
ST (ST = Q0 + offset)	ST	Q0 + (-5) -7 to -4	Q0 + (-5) -7 to -4	Q0 + (-5) -7 to -4	Q0 + 5 4 to 7	Q0 + 5 4 to 7	Q0 + 5 4 to 7
RO1 (IE1 = Q0 - RO1)	IE1	1 0.5 to 2	n/a	1 0.5 to 2	-1 -2 to -0.5	n/a	-1 -2 to -0.5
RO1 (IE1 = Q0 + offset)	RO1	n/a	Q0 + (-1) -0.5 to -2	n/a	n/a	Q0 + 1 0.5 to 2	n/a

⁽¹⁾IonSpray™ ion source ⁽²⁾TurboIonSpray® ion source ⁽³⁾Heated Nebulizer ⁽⁴⁾1 = ON and 0 = OFF ⁽⁵⁾DuoSpray™ ion source, 1 = TIS and 2 = HN

Table 2-1 4000 Series Instrument Parameters (cont'd)

Parameter ID	Access ID	Positive Ion Mode			Negative Ion Mode		
		Q1	Q3	MS/MS	Q1	Q3	MS/MS
IQ2 (IQ2 = Q0 + offset)	IQ2	Q0+ (-8) n/a	Q0+ (-8) n/a	Q0+ (-8) n/a	Q0 + 8 n/a	Q0 + 8 n/a	Q0 + 8 n/a
RO2	RO2	-60 -145 to -20	-20 -145 to -20	n/a	60 60 to 100	20 20 to 145	n/a
RO2 (CE = Q0 - RO2)	CE	n/a	n/a	30 5 to 130	n/a	n/a	-30 -130 to -5
ST3	ST3	-80 -80 to -200	n/a	n/a	80 80 to 200	n/a	n/a
ST3 (CXP = RO2 - ST3)	CXP	n/a	15 0 to 55	15 0 to 55	n/a	-15 -55 to 0	-15 -55 to 0
RO3	RO3	-62 -60 to -200	n/a	n/a	62 60 to 200	n/a	n/a
RO3 (IE3 = RO2 - RO3)	IE3	n/a	2 -0.5 to 5	2 -0.5 to 5	n/a	-2 -5 to 0	-2 -5 to 0
C2	C2	RO3 + 0 n/a	RO3 + 0 n/a	RO3 + 0 n/a	RO3 + 0 n/a	RO3 + 0 n/a	RO3 + 0 n/a
DF	DF	0 -400 to 0	0 -400 to 0	0 -400 to 0	0 0 to 400	0 0 to 400	0 0 to 400
CEM	CEM	1800 500 to 3297	1800 500 to 3297	1800 500 to 3297	1800 500 to 3297	1800 500 to 3297	1800 500 to 3297
GS1	GS1	20 0 to 90	20 0 to 90	20 0 to 90	20 0 to 90	20 0 to 90	20 0 to 90
GS2	GS2	0 0 to 90	0 0 to 90	0 0 to 90	0 0 to 90	0 0 to 90	0 0 to 90
ihe ⁽⁴⁾	ihe	1 0 or 1	1 0 or 1	1 0 or 1	1 0 or 1	1 0 or 1	1 0 or 1
IHT	IHT	40 10 to 250	40 10 to 250	40 10 to 250	40 10 to 250	40 10 to 250	40 10 to 250
svp ⁽⁵⁾	svp	1 1 or 2	1 1 or 2	1 1 or 2	1 1 or 2	1 1 or 2	1 1 or 2

⁽¹⁾IonSpray™ ion source ⁽²⁾TurboIonSpray® ion source ⁽³⁾Heated Nebulizer ⁽⁴⁾1 = ON and 0 = OFF ⁽⁵⁾DuoSpray™ ion source, 1 = TIS and 2 = HN

Table 2-2 4000 QTRAP® System Parameters for LIT Scan Types Only

Parameter ID	Access ID	Positive Ion Mode	Negative Ion Mode
CAD	CAD	High Low–High	High Low–High
AF2**	AF2	100 0 to 200	100 0 to 200
AF3	AF3	Mass-Speed Dependent 0 to 5	Mass-Speed Dependent 0 to 5
EXB	EXB	Mass-Speed Dependent –200 to 0	Mass-Speed Dependent 0 to 200
CES	CES	0 –50 to 50	0 –50 to 50
ROS (Q0 – ROS)	CE	30 5 to 130	–30 –5 to –130
** MS/MS/MS only			

