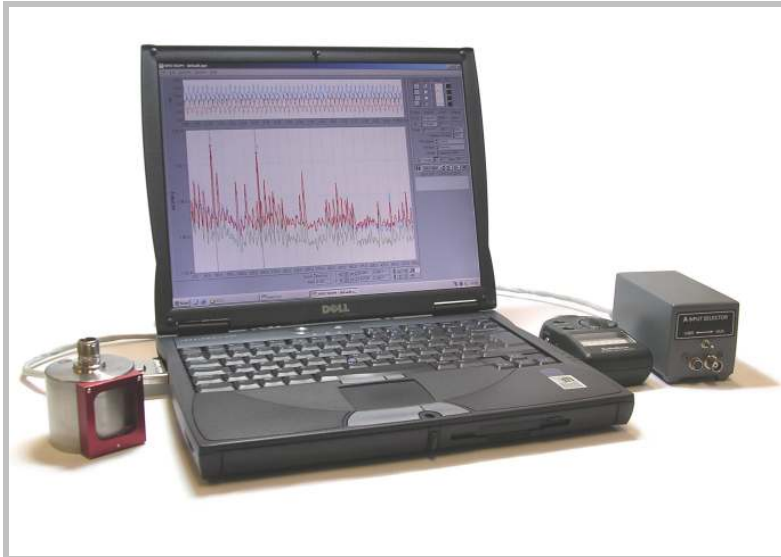




SC11 Analysis System - Basic System



SC11 System in case

- **Completely portable, laptop based, measurement and analysis system**
- **Survey environmental magnetic fields, vibrations and sound levels**
- **In-depth analysis using Oscilloscope, Chart Recorder and Spectrum Analyser software.**
- **Easy to operate**
- **Wizard program loads pre-defined measurement setups.**
- **Laptop-powered sensors**
- **Traceable Calibration**
- **Windows 98/Me/NT/2000/XP**
- **Narrow-band and third octave spectrum analysis with immediate comparison to pre-set specifications**
- **Chart recorder with data logging for long term measurements**

Overview

There was a time when conducting accurate site surveys involved a mass of complex, bulky and difficult-to-use equipment. Based on a laptop computer and operating under Windows 98/Me/NT/2000/XP, the SC11 has revolutionised site surveys. It is a fully portable tool for measurement and analysis of ambient magnetic fields, vibrations and acoustic levels in one compact system. The system is based on a laptop personal computer, a three axis magnetic field sensor, an accelerometer and a sound level meter. An optional flux gate magnetometer measures DC magnetic fields. There is also the ability to attach extra sensors if so desired.

The software suite consists of three virtual instruments, an oscilloscope, a spectrum analyser and a chart recorder. All results are displayed graphically on the laptop screen. The data can be printed directly or exported for further processing in SCplot or spreadsheet programs.

The SC11 fits neatly into a carrying case which is supplied. The system is powered from the laptop so that operation without a main power connection is possible. The sound level meter and magnetometer have their own batteries. The complete system is accurate, easy to operate with a minimum of training and produces user friendly results.

SC11 Applications

Surveys

Designed with electron microscope and E-beam vendors and consultants in mind, the SC11 provides all the features needed for site surveys in one simple, easy to use package.

The SC11 is ideal for making accurate surveys of magnetic fields, vibrations and acoustic levels prior to installing equipment such as a scanning electron microscope (SEM). In an environment where there are many pieces of equipment, power cables and air handling units it is difficult to judge in advance whether there could be problems. You can use the SC11 system to survey the magnetic field, vibration and sound levels to make sure that they are within specification at the proposed site for the SEM. With the latest software, you can load the SEM specifications into the spectrum analyser for quick comparison with your measurements. The industry standard 1/3 octave analysis feature is useful in this application.

Trouble shooting

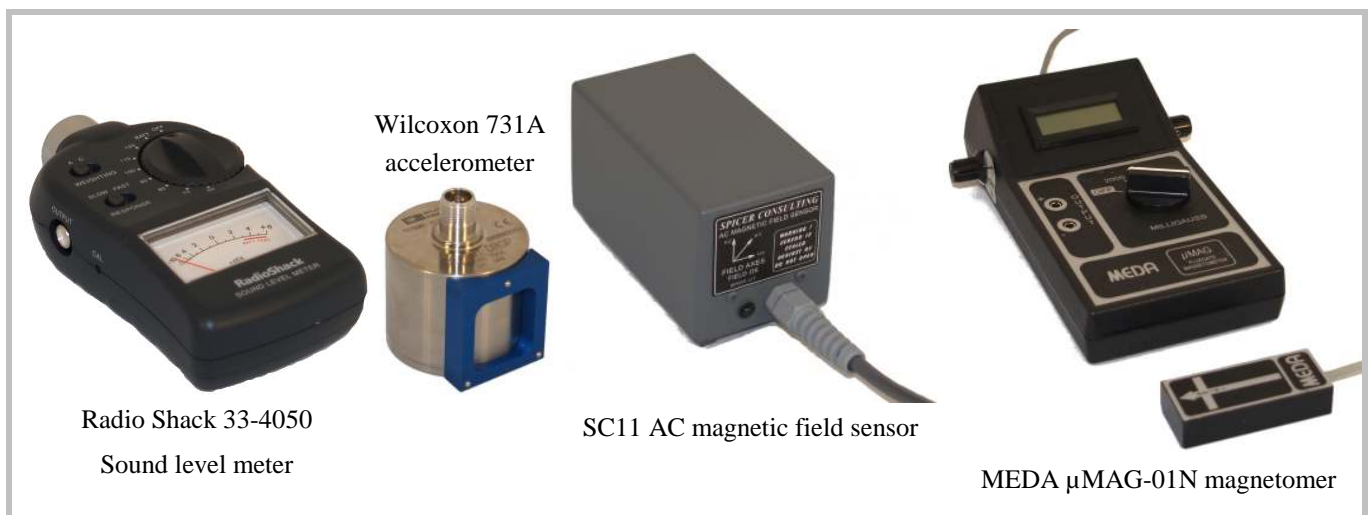
The magnetic field sensor is very sensitive, so it allows you to pin-point sources of magnetic fields, such as transformers, motors and poorly installed power cables.

The oscilloscope and the spectrum analyser enable you to see the waveforms and frequencies of the field, which can be very helpful in identifying its source. You can use the same techniques for vibrations and sound levels.

Analysis

You can directly compare the magnetic fields with accelerometer or sound waveforms using the oscilloscope or the chart recorder. Also for example, you can connect the auxiliary input to the video output of an SEM in spot mode to compare magnetic fields with the movement of the electron beam.

You can use the SC11 chart recorder to trace intermittent sources of magnetic fields, vibrations or acoustic levels. For example, you can chart the floor displacement or use the narrow band filter to log the magnitude of a known-frequency vibration over a long period. You can use the extended low frequency mode to monitor long term magnetic field fluctuations. This can help you to identify fields due to the movement of such things as steel doors, lifts, trains and trams.



SC11 Hardware

Laptop computer

The laptop computer is optionally supplied by Spicer Consulting with all the software pre-installed. Alternatively you may install the software on your own laptop PC. If desired, Spicer Consulting can install the system on your own computer. The minimum requirement for the computer is a 700 MHz Pentium with 128 MB RAM, 100 MB free hard disc, CD-ROM, and PCMCIA slot.

Magnetic Field Sensor

The three axis magnetic field sensor is derived from the Spicer Consulting SC12 range of field cancelling systems. The sensor has a magnetic field measurement range of 80 mG pk-pk with a bandwidth of 1 Hz to 5 kHz and a noise limit of 7 μ G RMS.

Sound Level Meter

The sound level meter supplied is a Radio Shack model 33-4050 for general purpose sound measurements. It can measure from 50 to 126 dBA or dBC on its internal meter.

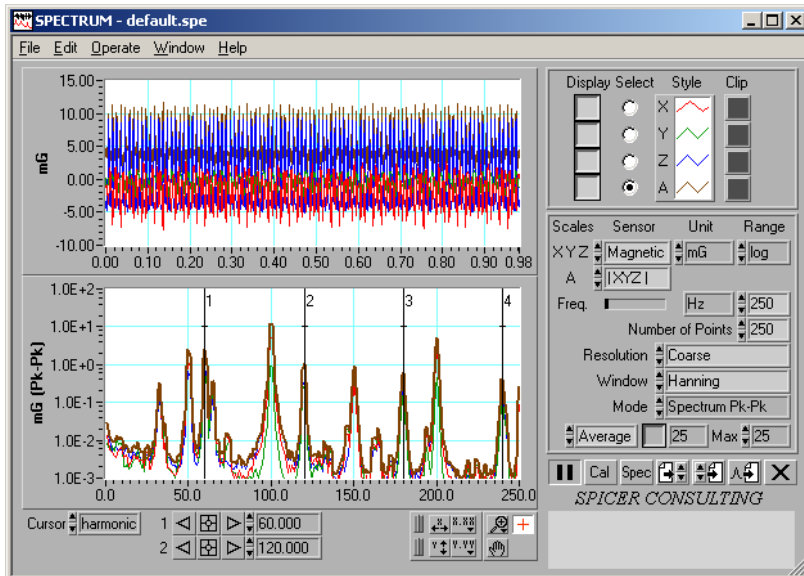
Accelerometer

The accelerometer supplied is a Wilcoxon Research model 731A, with a measurement range of 200 mg's pk-pk and a bandwidth of 0.1 Hz to 500 Hz. It is suitable for the measurement of extremely low level vibrations. The accelerometer measures along one independent axis.

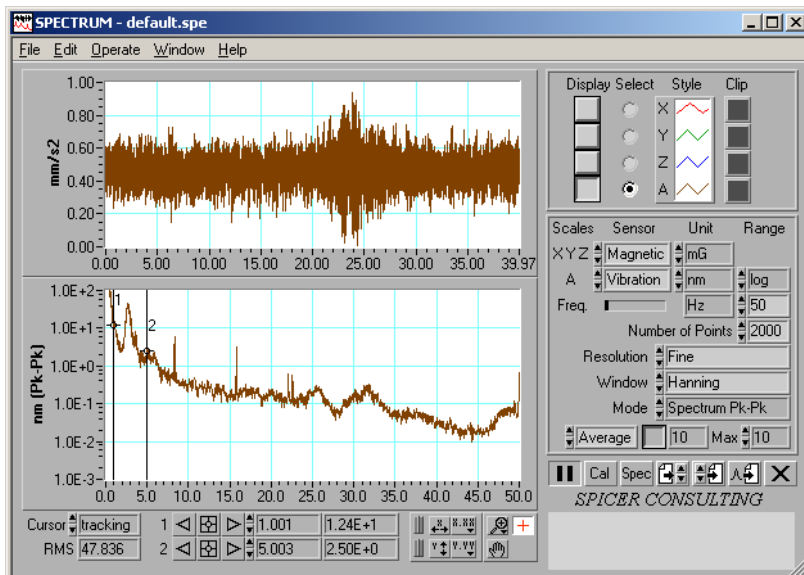
The accelerometer can be rotated to measure three orthogonal axes while standing on a horizontal plane.

Flux Gate Magnetometer

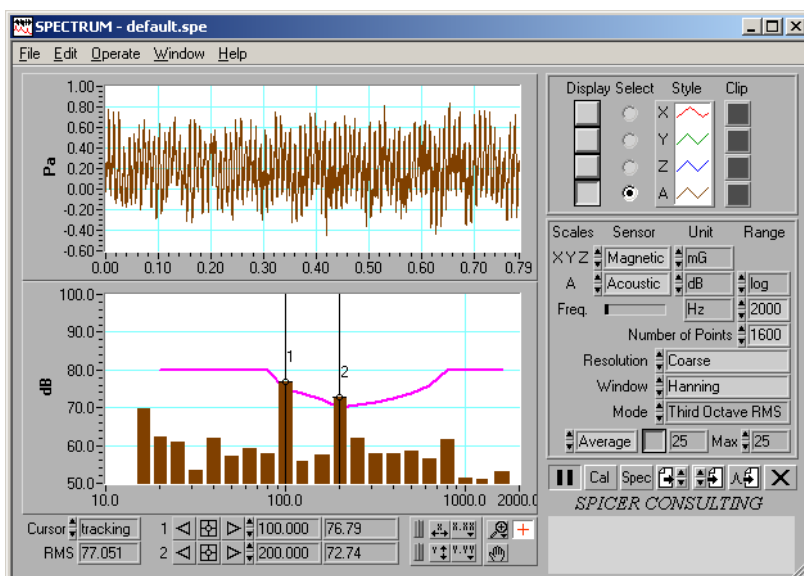
The optional flux gate magnetometer is a μ MAG-01N from MEDA. It measures one axis magnetic fields from DC to 100 Hz, with a maximum range of ± 2000 mG and a meter resolution of 0.01 mG on the most sensitive 20 mG range.



Magnetic field spectrum with harmonic cursors



Displacement vibration spectrum with tracking cursors



Sound level spectrum with specification and tracking cursors

Sensor Calibration

The calibration of the magnetic field sensor is NAMAS traceable. The accelerometer is supplied with a calibration certificate traceable to the National Institute of Standards and Technology, Gaithersburg, MD, USA. Spicer Consulting provides a re-calibration service for the entire system.

SC11 Spectrum Analyser

The spectrum analyser displays the waveforms and spectra of up to 4 channels (3 Magnetic Field and one other). It highlights the selected channel.

This tool has a wide range of units for use with all the sensors. The software integrates the output of the accelerometer to provide measurements of velocity and displacement as well as acceleration.

Tracking cursors are provided to measure features of the spectrum as well as define bands for RMS measurement. Harmonic cursors can be used to recognise harmonics in the spectrum and enable more accurate measurement of the fundamental frequency.

The spectra can be averaged over a period of time to reduce noise, enabling state of the art measurements of floor vibration with the Wilcoxon 731A accelerometer. The displacement vibration spectrum shown here was measured on the concrete floor of our laboratory during the night. This spectrum demonstrates the noise limit specification of the vibration sensor.

In a similar way to averaging, the peak values over a period of time can be displayed, for example to provide an estimate of the worst case vibrations at a site.

The spectra can also be data-logged to a file at a maximum rate of once every minute, to monitor or trace sources of interference that vary from time to time.

The sound level spectrum shown here is a typical 1/3 octave analysis display. The frequency range from 16 Hz to 2000 Hz is divided into 22 frequency bands, each one third of an octave wide. The total amplitude of the frequency components in each band is computed to provide the histogram display. The figure also shows an electron microscope specification that has been loaded in for comparison with the measurements. In this case, the specification is highlighted in magenta, showing that the specification has been exceeded.

SC11 Oscilloscope

A typical oscilloscope display is shown here. There are common controls for the timebase and vertical gain of the magnetic field axis and independent controls for the vertical gain of the auxiliary channel and vertical position of each channel. The Auto position controls provide AC coupling that varies with the timebase. The oscilloscope screen also displays numerically both RMS and Pk-Pk continuously. The scope has a bandwidth of 5 kHz.

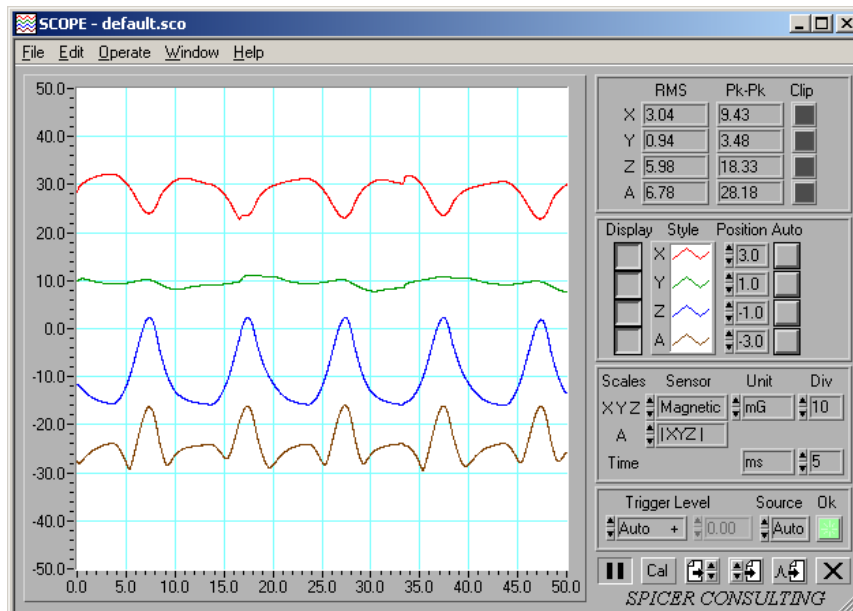
SC11 Chart Recorder

The chart recorder simulates plotting on a paper chart which is up to 200 divisions long, of which typically 10 divisions are displayed as it scrolls. Controls for vertical gain, chart speed and bandwidth are provided. Pan and zoom controls enable any section of the plot to be examined.

The chart recorder can be used to monitor slow events. The bandwidth of the AC magnetic field sensor may be extended down to 0.01 Hz to monitor the magnetic field of lifts and passing trains. A typical chart recorder display is shown here.

An integrating filter tailored to the 731A accelerometer allows direct displacement and velocity charts to be made.

A narrow band filter allows the RMS or Pk-Pk value of the signal to be recorded at an adjustable centre frequency.



Oscilloscope display showing magnetic field waveforms

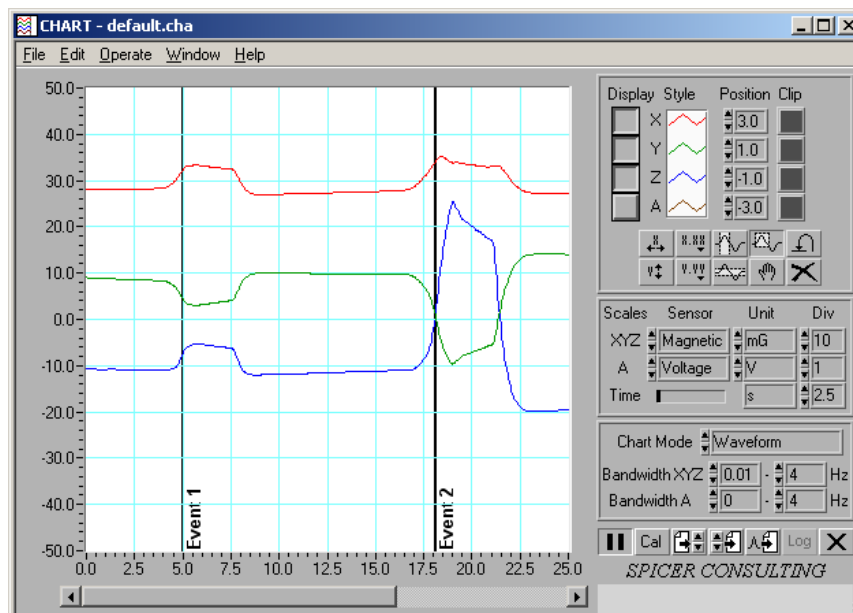
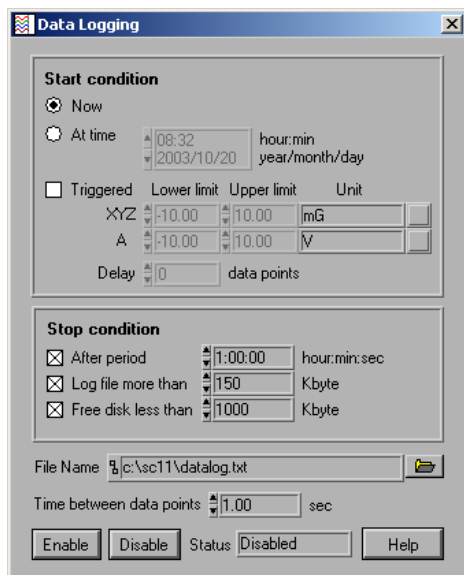


Chart recorder display showing magnetic field waveforms with extended low frequency and event markers



Data logging control panel

You can mark events that occur during measurement of the chart, such the movement of trains. The markers are exported with the results.

The data logging feature of the chart recorder writes each point to a file as the data is acquired, for open-ended long term recording of disturbances that occur occasionally or overnight. The figure here shows the comprehensive start and stop controls for data logging.

Hardware Options

The SC11 Sensor Interface supports all the features of the SC11 Basic System with the addition of sound level spectra at frequencies below 20 Hz and charts of 3-axis DC magnetic field and vibration. See the separate product guide for more details.

Customisation

All the virtual instruments can load and save their control settings to named files so that they can be quickly configured for standard measurements.

User-defined units may be entered for use with other sensors connected to the auxiliary input.

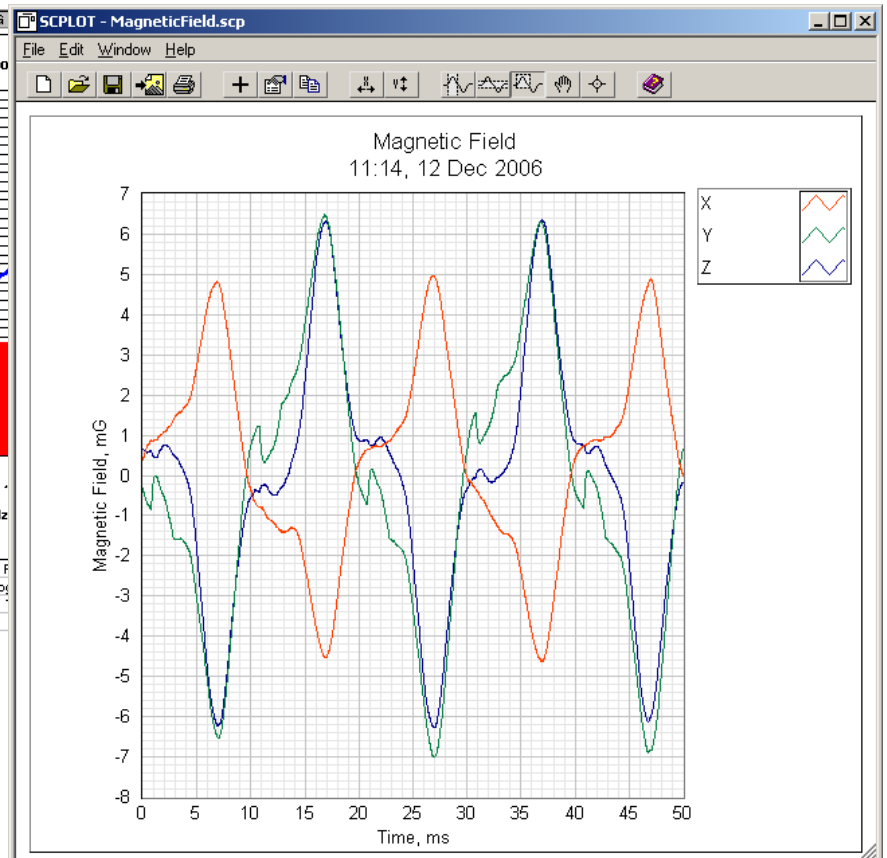
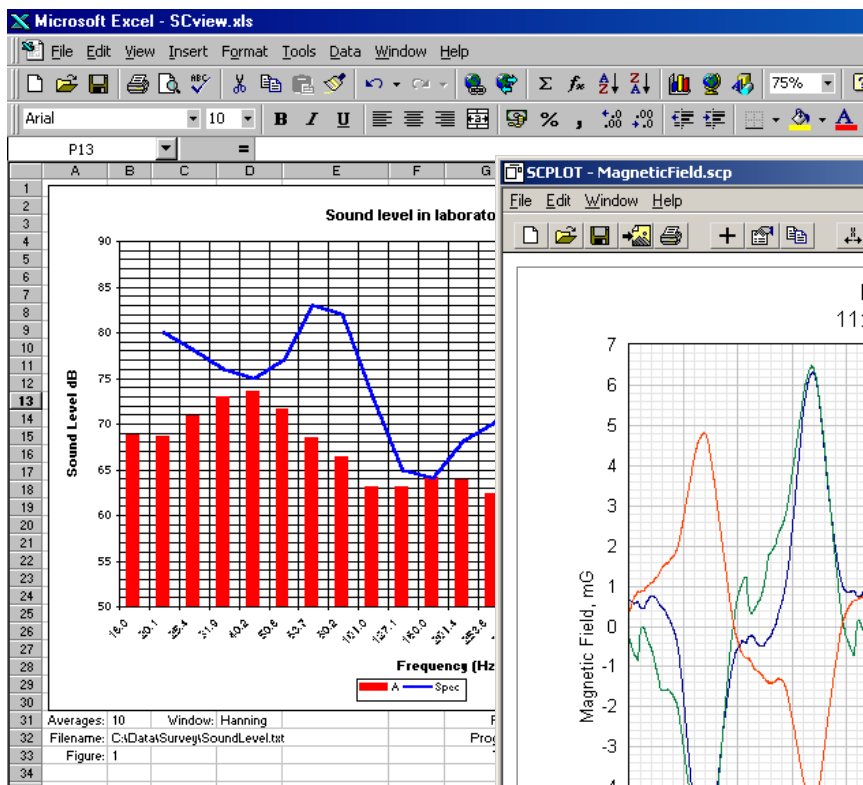
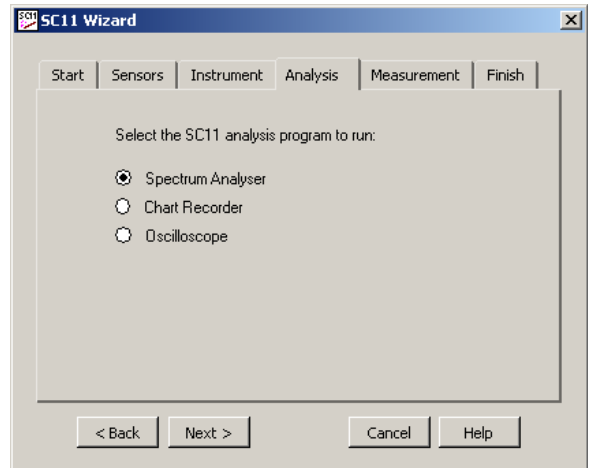
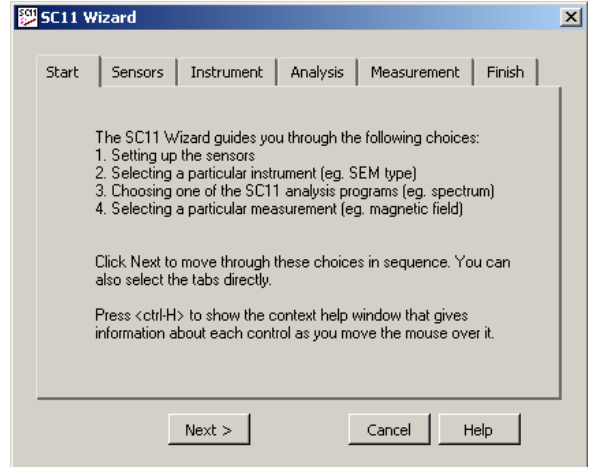
Wizard

The SC11 Wizard enables pre-defined measurements to be quickly and easily loaded by infrequent users of the system. It guides you through a step-by-step sequence to select the sensors that are to be used, the type of instrument the survey is for, the type of analysis (such as spectrum analyser) and finally the type of measurement (such as x-axis vibration).

Viewing and Printing Results

All the programs allow you to export your results into a text file for further processing. New in software version 4.2 is the SCplot program for results viewing and presentation. Spicer Consulting also provides a free Excel spreadsheet SCview.xls for quickly viewing and printing your results. You can copy and paste charts from SCplot or SCview directly into reports.

All the programs allow you to print the front panel on a printer or to capture an image of it using the Windows Alt-PrintScreen keystroke.



SC11 Specification

System

Carrying Case Size	58 x 36 x 19 cm approx. (23 x 14 x 7.5 in approx.)
Weight	11 kg (24 lb) approx. including typical laptop.

Laptop Personal Computer

Processor	700 MHz Pentium min, 1 GHz Pentium rec.
Memory	128 MB min, 256 MB rec.
Free Hard Disc	100 MB min.
CDROM	24X rec.
PCMCIA Slot	Type 2
Operating System	Windows 95/98/Me/NT/2000/XP

Data Acquisition Card

Type	National Instruments DAQCard-700 or DAQCard-6024E
Resolution/Range DAQCard-700	Bits: 12 Range: Fine: $\pm 2.5V$, Coarse: $\pm 10V$ Resolution: Fine: 1.2 mV, Coarse: 4.8 mV
DAQCard-6024E	Bits: 12 Range: Fine: $\pm 0.5V$, Coarse: $\pm 10V$ Resolution: Fine: 0.24 mV, Coarse: 4.8 mV

Core System: SC11/Basic AC Magnetic Field Sensor

Co-ordinate System	X, Y, Z rectangular Cartesian
Bandwidth	1 Hz - 5 kHz
Dynamic Range	80 mG (8 μT) Pk-Pk
Noise Limit	7 μG RMS max.
Accuracy	$\pm 1\%$
A channel Inputs	
VIBR	1-axis vibration (Wilcoxon 731A)
AUX	BNC voltage input, DC coupled, $\pm 10 V$ range, 100 k Ω input impedance
Anti-aliasing Filters	5 kHz, 250 Hz (switchable)

Vibration Sensor: Wilcoxon 731A Accelerometer

Type	Wilcoxon Research, model 731A
Bandwidth	0.1 - 500 Hz
Dynamic Range	2 m/s ² (0.2 g's*) Pk-Pk (in this system)
Noise Limit	7 $\mu m/s^2$ RMS max. 0.35 $\mu m/s$ RMS at 1Hz, 0.11 $\mu m/s$ RMS at 5Hz, 0.07 μm RMS at 1Hz, 0.0035 μm RMS at 5Hz
Accuracy	$\pm 5\%$ (with gain calibration file)

Acoustic Sensor: Sound Level Meter

Type	Radio Shack, Model 33-4050
Bandwidth	32 Hz - 20 kHz, dBA and dBC weightings
Dynamic Range	126 dB
Noise Limit	50 dB
Accuracy	± 2 dB at 114 dB sound level
Meter Response	Fast, Slow
Signal Output	1.0 V peak into open circuit with full scale meter deflection at 1 kHz
Load Impedance	10 k Ω min.
Distortion	$< 2\%$ at 1 kHz and 0.5 V

1-Axis Magnetic Field Sensor: Flux gate Magnetometer

Type	MEDA μMAG -01N flux gate magnetometer
Bandwidth	0 - 100 Hz (some models 0 - 400 Hz)
Ranges	± 20.00 , ± 200.0 , ± 2000 mG full scale
Accuracy	$\pm 0.5\%$ of full scale
Linearity	$\pm 0.05\%$ of full scale
Signal Output	$\pm 2 V$ full scale

Programs (General)

Clipping	Audio/visual indication
Pause control	Freeze/resume instrument operation
Calibration panel	Add/select sensors, set ranges, calibrate offsets, microphone self check, add/edit user defined units, set export file options.
Setup file	Open/save instrument controls
Export	Export results for SCplot or spreadsheet
Print window	Print current screen display
Help	Context help on controls, online help file
Year 2000	All SC11 programs are year 2000 compliant

Oscilloscope

Channels	4 (X, Y, Z, A) each with style and position controls
Divisions	10 X 10
Amplitude units	
Magnetic Field	mG, nT, μT , mA/m, A/m
Vibration	mg's *, mm/s ²
Acoustic	mPa, Pa
Voltage	mV, V, user defined units
Resultant [XYZ]	Magnetic Field, Vibration, Voltage units
Timebase	0.5, 1, 2, 5, 10, 20, 50, 100, 200 ms/div
Bandwidth	5 kHz (0.5 ms/div - 5 ms/div) 250 Hz (10 ms/div - 0.2 s/div)
Digital Meter	RMS, Peak to Peak (all channels)
Trigger	Auto/Manual level, +/- edge, Auto/Manual source, Single Shot

Spectrum Analyser

Channels	DAQCard-700: 1 (X, Y, Z or A) DAQCard-6024E: 4 (X, Y, Z and A)
Displays	Waveform (autoscaling), Spectrum
Amplitude units	
Magnetic field	mG, nT, μT , mA/m, A/m
Vibration	$\mu g's^*$, mg's*, $\mu m/s^2$, mm/s ² , $\mu m/s$, mm/s, nm, μm
Acoustic	mPa, Pa, dB, dBA, dBC
Voltage	mV, V, user defined units
Resultant [XYZ]	Magnetic Field
Amplitude ranges	0.5, 0.7, 1, 1.5, 2.5, 3.5, 5, 7, 10, 15, 25, 35, 50, 70, 100, 150, 250, log full scale.
Frequency ranges	20, 25, 30, 40, 50, 60, 80, 100, 125, 150, 200, 250, 300, 400, 500, 600, 800, 1000, 1250, 1500, 2000 Hz full scale.
Number of points	200, 250, 400, 500, 800, 1000, 1600, 2000, 3200, 4000
Accuracy	Frequency: $\pm 0.01\%$ ± 0.02 div
Waveform windows	None, Hanning, Flat top
Spectrum modes	RMS, 0-Pk, Pk-Pk, PSD, Third Octave
Combine spectra	Average/Peak, Max no. spectra
Cursor modes	Total RMS between 2 tracking cursors, 10 harmonic cursors
Pan & Zoom Palette	Pan, zoom and format spectrum display
Capture indicator	Indicates progress of data acquisition
Specification files	Create, edit, add & remove. Compare with measurements.
Data logging	Start: Now, At time, Triggered by flat level, Triggered by spec Stop: Period, File size, Disk space Min. time step: 1 minute

Chart Recorder

Channels	4 (X, Y, Z, A) each with style and position controls
Divisions	10 X 10
Amplitude units	
Magnetic Field	mG, nT, μT , mA/m, A/m
Vibration	mg's *, mm/s ² , $\mu m/s$, mm/s, μm
Acoustic	mPa, Pa, dB
Voltage	mV, V, user defined units
Resultant [XYZ]	Magnetic Field, Vibration, Voltage units
Timebase	0.5, 1, 2.5, 5, 10, 25, 50 s/div (50 points/div)
Chart length	200 div. max. (1.6 min - 2:45 hr:min)
Max Bandwidth	(Bandwidth may be reduced by controls)
Magnetic field	0.01 Hz - 5 kHz
Vibration	0.1 Hz - 500 Hz
Acoustic (SLM)	32 Hz - 5 kHz
Voltage	DC - 5 kHz
Bandwidth controls	XYZ/A upper/lower - all modes except narrow band
Narrow band filter	Centre frequency, f_0 range: 1 Hz - 1250 Hz Accuracy: $\pm 1\%$ within pass band, ($f_0 \pm 3\%$) Attenuation: 60 dB min. in stop band, ($f_0 \pm 20\%$) Waveform, RMS, Peak to Peak, Narrow band RMS, Narrow band Pk-Pk.
Chart modes	Time, text string
Markers	Strip chart, scope chart, sweep chart
Update modes	Pan, zoom, format, reset and clear chart
Chart palette	Start: Now, At time, Triggered
Data logging	Stop: Period, File size, Disk space Time step: Whole no. of points (0.01 s at 0.5 s/div)

* g's are units of the acceleration due to gravity