TECHNICAL SPECIFICATION
SDI-5150

Automated Ultrasonic Precision Immersion Inspection System

Note: This specification is for the standard SDI-5150 Immersion Inspection System and is for information only. The details may differ significantly from those proposed for specific customer requirements. The specification provided in the Statement of Compliance and formal quotation supersedes this document.

Specification for an Advanced Ultrasonic Immersion System

1 INTRODUCTION

This specification is for an advanced immersion system for the ultrasonic inspection of aero engine and airframe components. The equipment components include a heavy duty precision bridge mounted on a rigid gantry frame that sits around a stainless steel immersion tank typically fitted with an SDI-1320 series turntable. The system is available with single or dual precision search tubes configured to accept a range of gimbal options. The equipment will operate with any system level ultrasonic instrumentation. It is designed to achieve the accuracy and resolution required at high throughput speeds in a harsh operating environment. SDI have supplied systems of this type for testing product from all major aircraft, aero engine and rocket motor producers.

In addition to being approved by all major aerospace manufacturers, the following advanced features of SDI systems give major advantage over competitor's equipment in terms of ease of use and inspection setup and test time;

- Automatic multi-transducer inspection with different transducers on dual search tubes performing simultaneous or sequential independent scans on the same part. (Dual search tube systems only).
- Multiple scan inspection with a series of scans being performed without operator intervention. Each scan can have a different instrument setting and produces a different data file. The scan sequence, or script, can include automatic DAC setup, and transducer characterization. If SDI instruments are used the instrument parameters, such as gate position and gain, can be changed during the scan at rep rate speeds and coordinated with the motion.
- System functional axes where the operator is able to move the transducer along its axis, or change the angle of incidence without moving the sound entry point, with a single control.
- Automatic identification of defects with the cluster analysis feature.
- Import/Export of scan plans to CAD.
- Automatic normalization and water path adjustment.
- Advanced complex contour following capabilities
- Nested scan plans where multiple parts in different locations can be tested in the same sequence
- Automatic teaching of component scan plans.

The following instrument dependent features are also fully integrated with the scan plan with SDI's standard instrument.

- Change instrument parameters at rep rate speeds
- Back wall following gates
- Coordination of instrument parameters with complex scan plan i.e. integrate variable gain with on-the-fly scanning of complex shapes

All these features are available on the Socomate series of instruments and most system type instruments available from other manufactures.

2 SYSTEM DESCRIPTION

The system consists of floor mounted heavy gauge gantry which spans the stainless steel immersion tank. The precision bridge, search tube and gimbal assembly are mounted on the gantry, isolating them from the tank structure. The stainless steel tank is provided with polycarbonate windows to meet the customer's requirements. The base of the tank is reinforced to support turntables, rotators and lift platforms. The turntables have interchangeable drives making it possible to employ an auxiliary small high speed turntable in a system fitted with a large heavy duty unit for normal operation. All SDI turntables and rotators are removable and interchangeable.

The heavy duty 1324 and 1325 turntables have high power servo drives installed in air purged underwater housings. The 1325 is the heavy duty unit for parts weighing up to 5000#. The 1324 is for parts up to 2000#. They are fitted with three jaw self-centering chucks with an option motorized drive. For larger parts, the SDI-5350 immersion systems are supplied with lift platforms and turntables with capacities up to 7000#.

For deeper tanks with a large Z range, a number of lift platform options are available. For lower cost systems the 1645 series lift platforms provide an upper loading position and a lower test position on fixed locator stops. The drive is independent of the system controller and is positioned by limit switches. For precision elevation the 1640 series lift platforms are available. These are lead screw driven with closed loop servo control and can be positioned accurately at any height for component testing. Their motion is fully integrated with the system control and the position can be stored as part of a scan plan.

2.1 Gantry-X Axis.

The gantry is fabricated from heavy steel box section with a high redundancy frame design calculated to provide the required rigidity and stability for the large accelerating mass of the bridge and search tubes. The gantry is fitted with ground tracks with leveling jack screws and guide bars. Mounted to the tracks are the linear ways and heavy duty rack and pinion drive components to provide precise positioning and encoder feedback. The gantry also carries the cable distribution components. All drives are closed loop d.c. servos with encoders/resolvers.

2.2 Bridge Y Axis

The bridge is fabricated from heavy aluminum box section. Mounted to it are the precision V ways for the Y-axis carriages which support the Z-axis vertical drive housings. The design incorporates methods of adjusting the orthogonality and alignment of the X, Y and Z axes.

2.3 Search Tubes Z-Axis

The search tubes incorporate several novel design features to provide the required adjustments and accuracy to maintain the alignment of two independent search tubes during high speed 3D contour following. The stainless steel cruciform construction, precision rack and pinion drive and V ways provide exceptional dimensional rigidity and repeatability.

2.4 Gimbals

The gimbals are closed loop servos with integral high precision resolvers. The units are housed

in a waterproof stainless steel enclosure. The transducer is attached to the gimbals by a UHF mount.

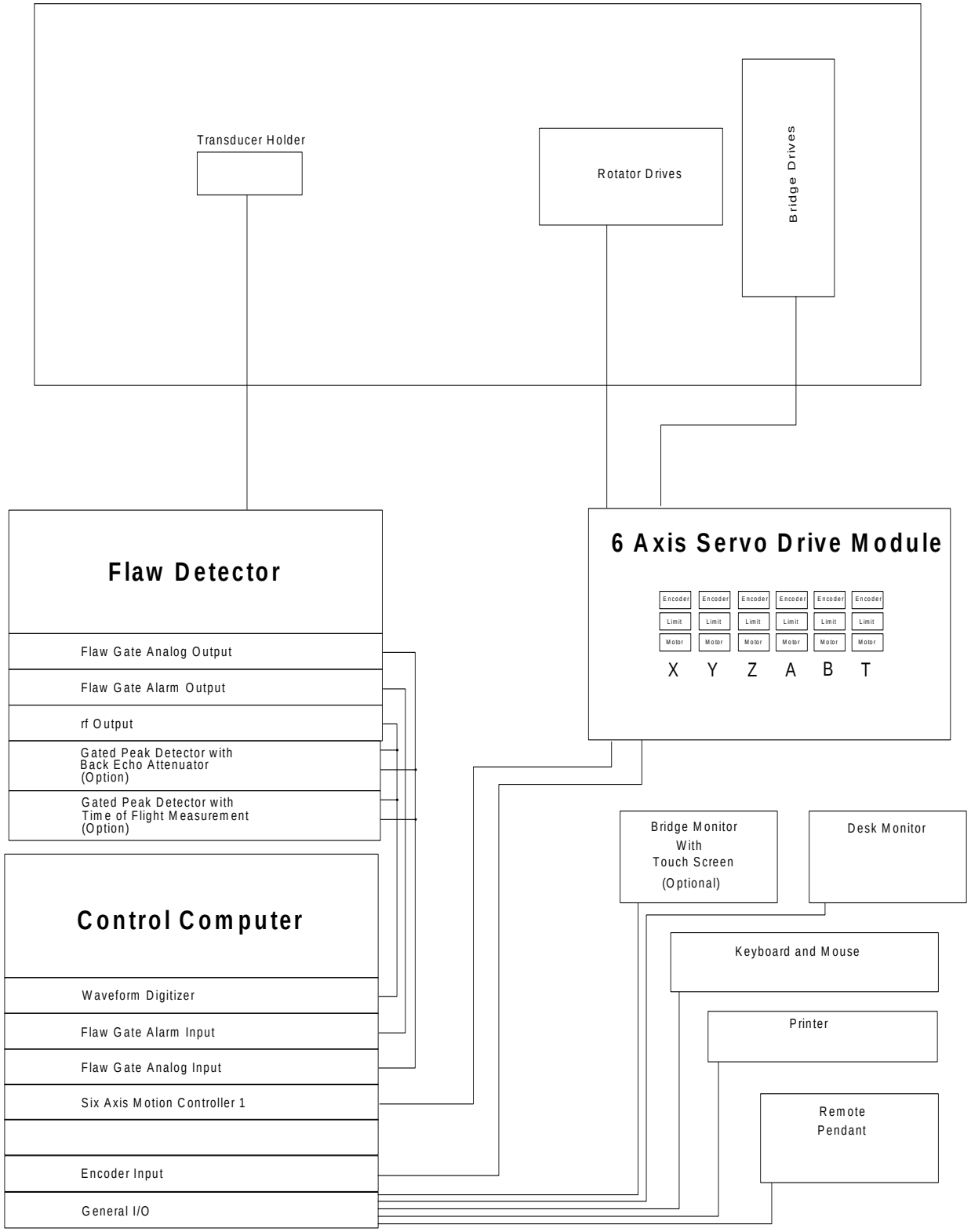
3 ELECTRICAL CONFIGURATION

The electrical configuration describes the components and interconnections for the motion control, drive, instrumentation and data acquisition sub systems. The majority of the components are housed in the system console. All system components meet applicable US and International safety codes. Apart from the very low current ultrasonic signals, no voltages greater than 70 volts are present anywhere on the system outside the control console.

3.1 Control Console.

The mobile control console can be positioned anywhere within reasonable distance from the system. Current SDI systems have similar remote consoles up to 80 ft. from the scanner. It is fitted with two 24 inch monitors linked in the Windows operating environment to allow windows to be dragged from one screen to the next, or expanded over two screens. The console requires a single 110V 60 Amp single phase supply. SDI will install the necessary transformers to achieve this from the customer's supply. The console houses all the computing, drive and instrumentation components required to operate the system. The enclosure includes cooling fans, as well as a filtration and refrigeration unit where required.

The electrical layout is shown below


Transducer Holder
Rotator Drives
Bridge Drives
Flaw Detector
Flaw Gate Analog Output
Flaw Gate Alarm Output
rf Output
Gated Peak Detector with Back Echo Attenuator (Option)
Gated Peak Detector with Time of Flight Measurement (Option)
6 Axis Servo Drive Module
Encoder
Limit
Motor
X Y Z A B T
Control Computer
Waveform Digitizer
Flaw Gate Alarm Input
Flaw Gate Analog Input
Six Axis Motion Controller 1
Encoder Input
General I/O
Bridge Monitor With Touch Screen (Optional)
Desk Monitor
Keyboard and Mouse
Printer
Remote Pendant

4 SYSTEM CONTROL - GENERAL

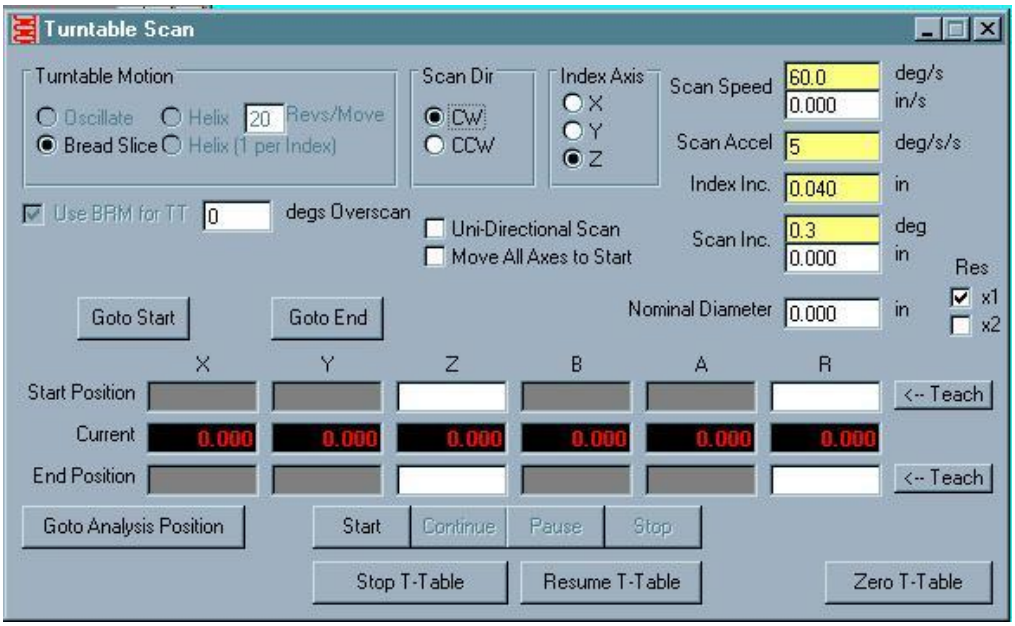
The SDI MasterScan/WinScan suite is one of the most powerful motion control and acquisition packages available. The well-structured modular software has evolved by incorporating customer's motion control and acquisition requests into the standard product. With a user base of over 200 systems, incorporating the suggestions of technicians who spend all their time operating our equipment has resulted in the most versatile, user friendly, package in the industry. Targeted primarily at high volume test lab users, the principal operational criteria are ease of use and fastest possible inspection times.

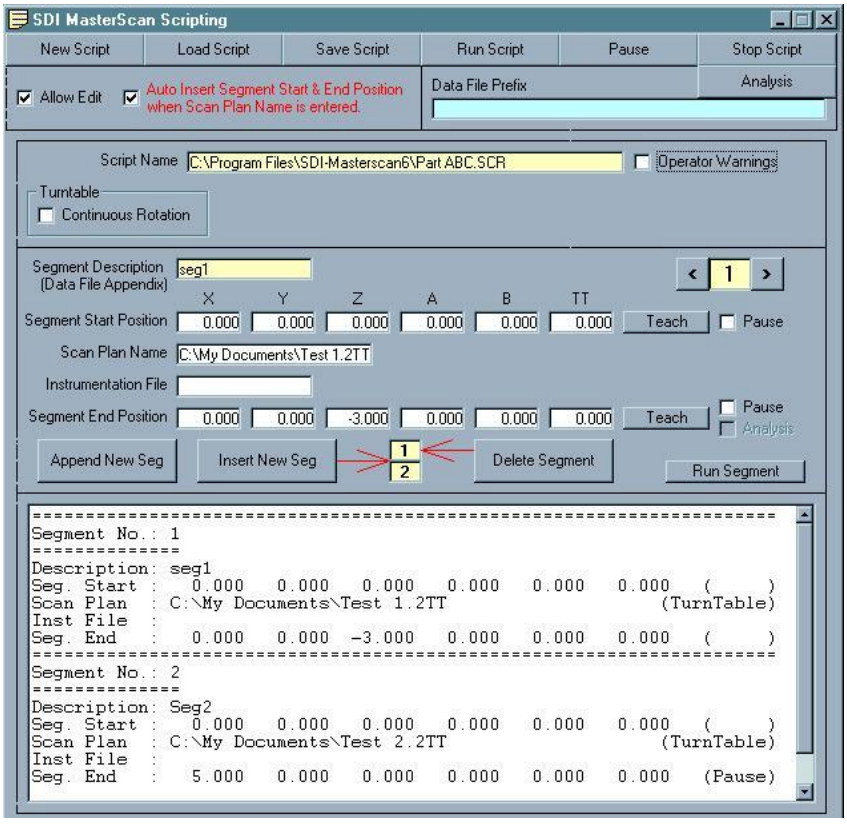
5 MOTION CONTROL

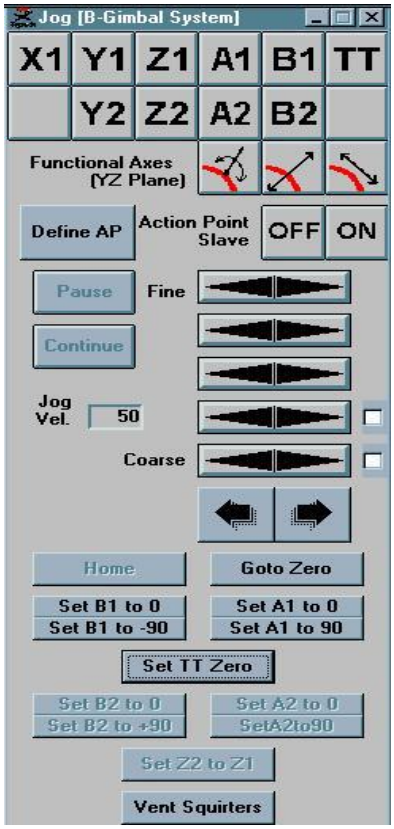
The motion control is provided by the SDI-1830 MasterScan advanced controller. Designed specifically for ultrasonic applications, it features ultrasonic functional axes and scripted scan plans. This means that complex motion control and acquisition activities unique to ultrasonic inspection techniques are available to the operator through simple commands using ultrasonic terminology. The operator can construct complex scans by chaining together individual motion commands, scan plans and instrument set-ups. Full details of MasterScan are given in the data sheet. Some of the key features are:-

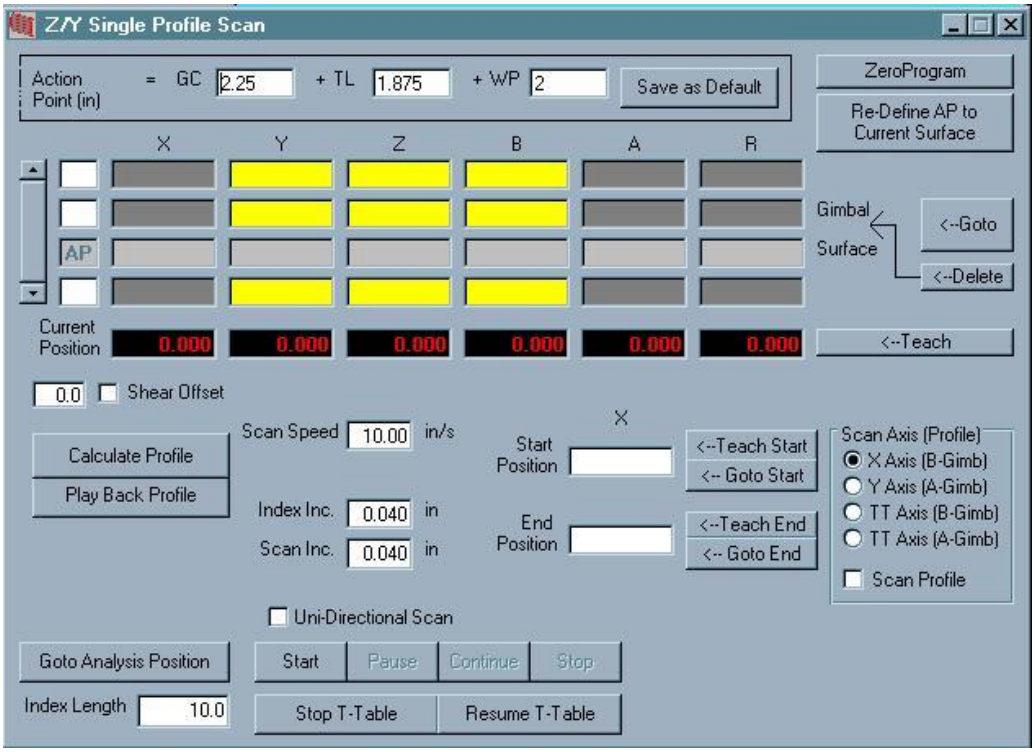
- Functional axes using standard UT terminology
- Import/Export of scan plans to CAD programs
- Automated normalization
- Auto teach of scan plans
- Integrated instrument control coordinated with the motion along a scan trajectory.
- Scripted scan plans
- Chained scans
- Dual independent search tubes performing different scans simultaneously.
- Stop on defect
- Return to defect
- Display of scan progress and time to finish.
- Variable turntable rotation to maintain constant surface speed with changing diameter.

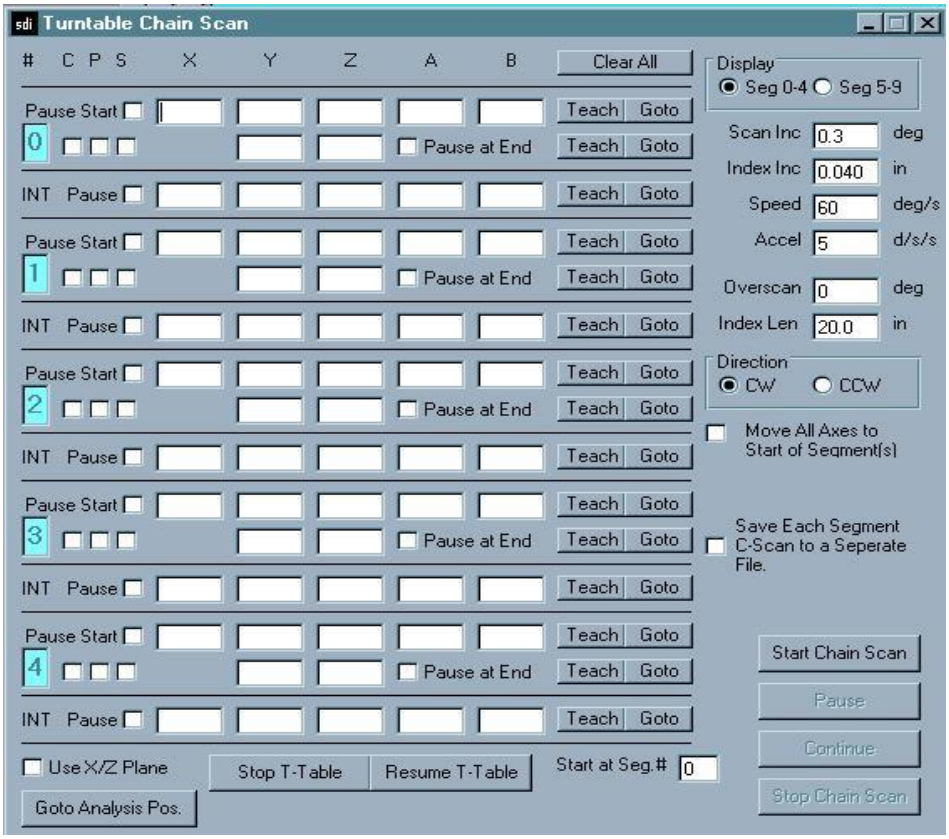
Sample Motion Control Screens








Z/Y Single Profile Scan
Action Point (in)
= GC 2.25
+ TL 1.875
+ WP 2
Save as Default
ZeroProgram
Re-Define AP to Current Surface
X Y Z B A R
AP
Gimbal
Surface
<--Goto
<--Delete
Current Position
0.000
<--Teach
0.0
Shear Offset
Scan Speed 10.00 in/s
Calculate Profile
Play Back Profile
Index Inc. 0.040 in
Scan Inc. 0.040 in
Start Position
End Position
<--Teach Start
<-- Goto Start
<--Teach End
<-- Goto End
Scan Axis (Profile)
X Axis (B-Gimb)
Y Axis (A-Gimb)
TT Axis (B-Gimb)
TT Axis (A-Gimb)
Scan Profile
Uni-Directional Scan
Goto Analysis Position
Start
Pause
Continue
Stop
Index Length 10.0
Stop T-Table
Resume T-Table

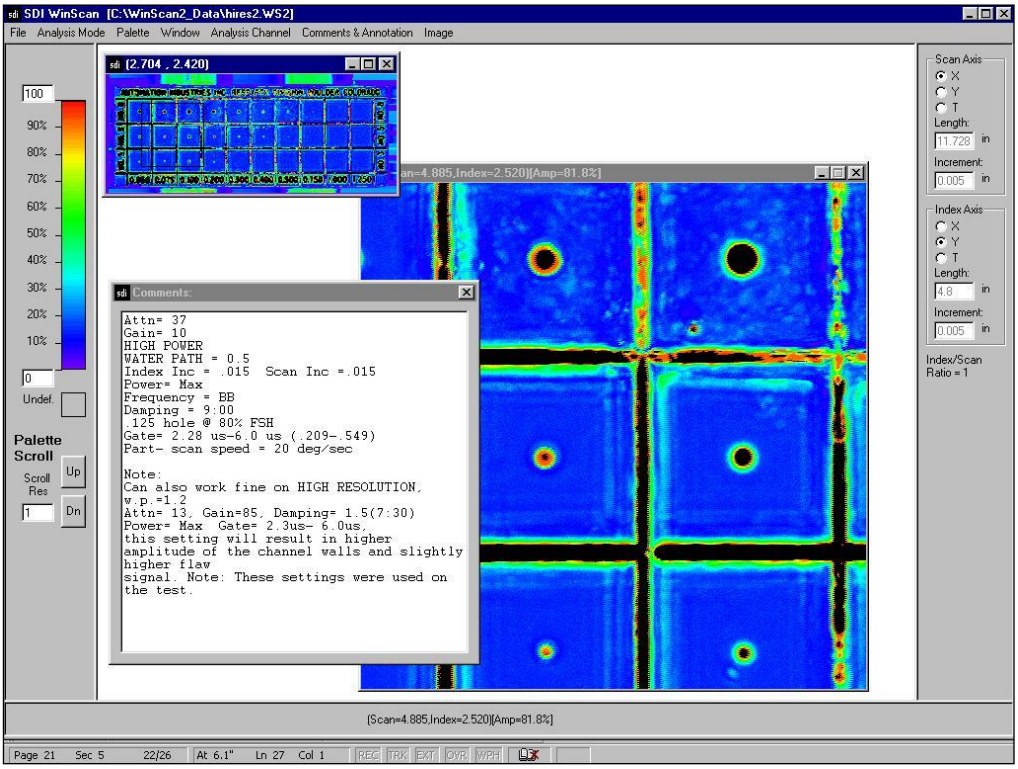

Turntable Chain Scan
C P S X Y Z A B
Clear All
Pause Start
Teach Goto
Pause at End
INT Pause
Display
Seg 0-4 Seg 5-9
Scan Inc 0.3 deg
Index Inc 0.040 in
Speed 60 deg/s
Accel 5 d/s/s
Overscan 0 deg
Index Len 20.0 in
Direction
CW CCW
Move All Axes to Start of Segment(s)
Save Each Segment C-Scan to a Seperate File.
Start Chain Scan
Pause
Continue
Stop Chain Scan
Use X/Z Plane
Stop T-Table
Resume T-Table
Start at Seg.# 0
Goto Analysis Pos.

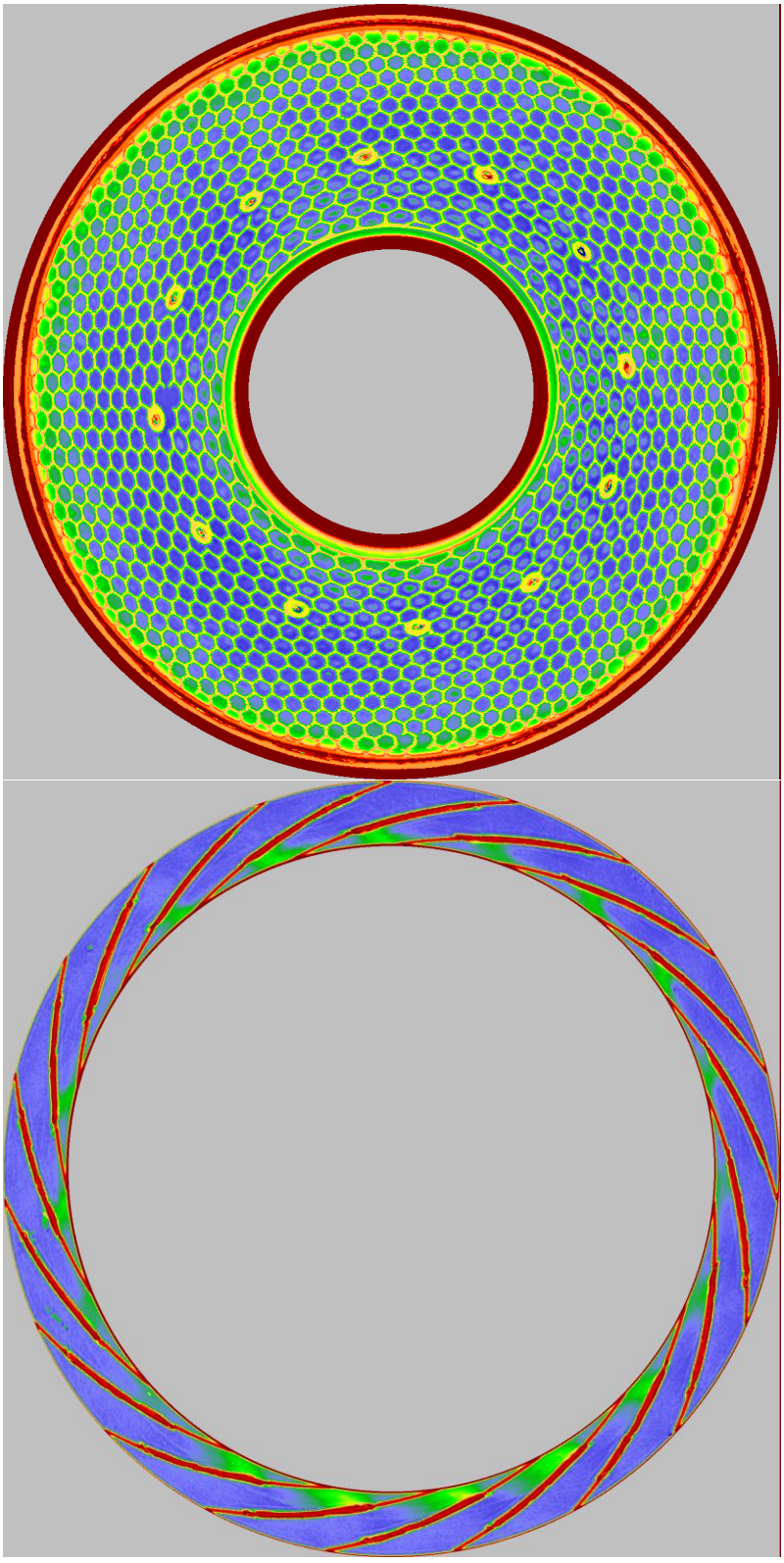
6 DATA ACQUISITION

The system is supplied with the latest SDI-WinScan multi-tasking acquisition and analysis package designed for high throughput production applications. A technical description of the features and benefits of this high performance industrial package is attached. Some of the key features are :-

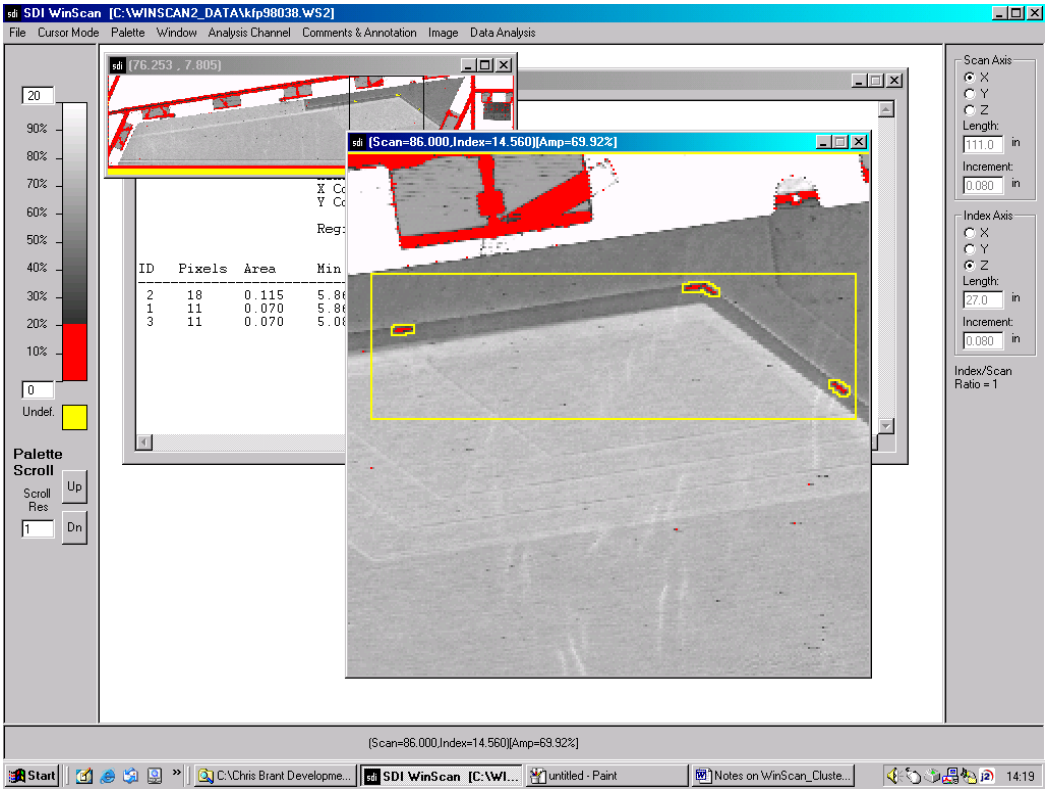
- High-speed pan and zoom through entire data file
- High speed, high quality 1:1 plotting of all or selected areas of the data file.
- Scan comments stored with the data file.
- Multi-channel operation.
- True multi-tasking to allow scanning, plotting and viewing of stored files to be performed simultaneously without a reduction in speed.
- Numerous analysis features such as histograms, in dB and linear scales, cluster analysis providing automatic defect identification, image smoothing and filtering with operator defined kernels.
- Full Waveform Capture with B-Scan

Another time saving feature of the fully integrated motion control and data acquisition package is the ability to perform mini-scans. Areas of interest can be tagged on the data file and the system will automatically drive back to them and re-scan the area using selected defect evaluation scan parameters such as full waveform capture.





Polar Scan and Real Time Display of Aero Engine Components



7 INSTRUMENTATION

All SDI systems are able to operate with a variety of flaw detectors. Systems have been installed using instruments supplied by all major instrument manufacturers. Our preferred instrumentation is the Socomate USPC 3100. When this instruments is used there are a number of system features available which require instrument parameter changes at rep rate speeds. A wide range of SDI manufactured auxiliary instrumentation is also available and compatible with other manufacturers flaw detectors. This includes pre-amplifiers, log amplifiers, tone burst pulsers, high frequency pulser/receivers and others.

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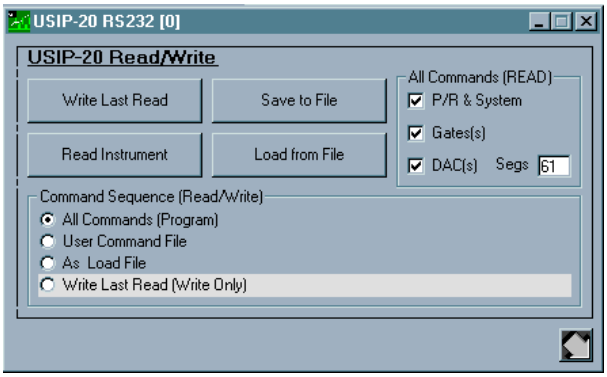

8 SYSTEM ACCEPTANCE/INSTALLATION

The system will be available for customer acceptance trials prior to shipment. The details of the Acceptance Test Procedure (ATP), are in accordance with the customer's requirements. The system will then be installed at the customer's site, where the ATP will be run again. It is understood that the customer will provide suitable single-phase power, water supply and drainage. Full installation drawings will be provided shortly after receipt of order.

9 TRAINING

Training is generally performed at the customer site after installation and completion of the ATP. Operators presented for training should have an understanding of ultrasonics, and the Windows operating system, i.e. how to save files and the directory structure. For most applications, three to five days should cover both operator and maintenance training. Training should be limited to no more than four people at a time.

10 CUSTOMER SUPPORT

The service, maintenance and technical support services offered by SDI can be tailored to meet a wide range of customer requirements. Customers who purchase our equipment receive the complete range of services free of charge for the first year following equipment installation. We continue to service our equipment in the field for the life of the equipment. This includes emergency repair visits, preventative maintenance, and annual calibrations.

Field service personnel are complimented by the technical support and engineering staff at the SDI facility. The technical support staff is available to customer engineering and service personnel for free consultation via phone or email.