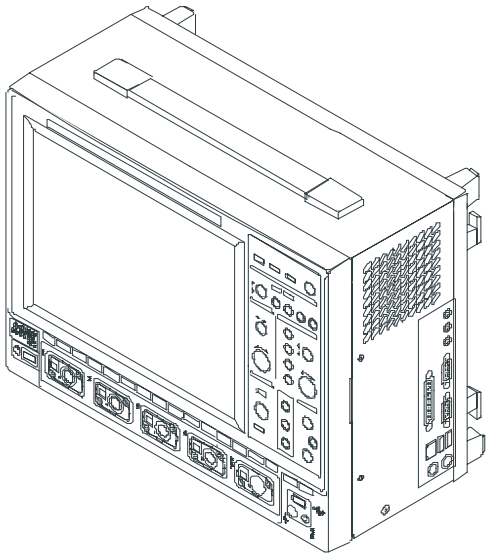
LeCroy Color Digital Oscilloscopes

WaveSurfer 400 Series

Service Manual



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LeCroy

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1. Warranty and Product Support

It is recommended that you thoroughly inspect the contents of the oscilloscope packaging immediately upon receipt. Check all contents against the packing list/invoice copy shipped with the instrument. Unless LeCroy is notified promptly of any missing or damaged item, responsibility for its replacement cannot be accepted. Contact your nearest LeCroy Customer Service Center or national distributor immediately (see chapter 2 for *contact numbers*).

1.1 Warranty

LeCroy warrants its oscilloscope products for normal use and operation within specifications for a period of three years from the date of shipment. Calibration each year is recommended to ensure in-spec. performance. Spares, replacement parts and repairs are warranted for 90 days. The instrument's firmware has been thoroughly tested and is thought to be functional, but is supplied without warranty of any kind covering detailed performance. Products not made by LeCroy are covered solely by the warranty of the original equipment manufacturer.

Under the LeCroy warranty, LeCroy will repair or, at its option, replace any product returned within the warranty period to a LeCroy authorized service center. However, this will be done only if the product is determined after examination by LeCroy to be defective due to workmanship or materials, and not to have been caused by misuse, neglect or accident, or by abnormal conditions or operation.

1.2 Product Assistance

> Note: ***This warranty replaces all other warranties, expressed or implied, including but not limited to any implied warranty of merchantability, fitness, or adequacy for any particular purpose or use. LeCroy shall not be liable for any special, incidental, or consequential damages, whether in contract or otherwise. The client will be responsible for the transportation and insurance charges for the return of products to the service facility. LeCroy will return all products under warranty with transport prepaid.***

Help on installation, calibration, and the use of LeCroy equipment is available from the LeCroy Customer Service Center in your country.

1.3 Maintenance Agreements

LeCroy provides a variety of customer support services under Maintenance Agreements. Such agreements give extended warranty and allow clients to budget maintenance costs after the initial three-year warranty has expired. Other services such as installation, training, enhancements, on-site repairs and calibrations are available through special supplemental support agreements.

1.4 Staying Up to Date

LeCroy is dedicated to offering state-of-the-art instruments, by continually refining and improving the performance of LeCroy products. Because of the speed with which physical modifications may be implemented, this manual and related documentation may not agree in every detail with the products they describe. For example, there might be small discrepancies in the values of components affecting pulse shape, timing or offset, and — infrequently — minor logic changes. However, be assured the scope itself is in full order and incorporates the most up-to-date circuitry. LeCroy frequently updates firmware and software during servicing to improve scope performance, free of charge during warranty. You will be kept informed of such changes, through new or revised manuals and other publications.

Nevertheless, you should retain this, the original manual, for future reference to your scope's hardware specifications.

1.5 Service and Repair

Please return products requiring maintenance to the Customer Service Department in your country or to an authorized service facility. The customer is responsible for transportation charges to the factory, whereas all in-warranty products will be returned to you with transportation prepaid. Outside the warranty period, you will need to provide us with a purchase order number before we can repair your LeCroy product. You will be billed for parts and labor related to the repair work, and for shipping.

1.6 How to return a Product

Contact the nearest LeCroy Service Center or office to find out where to return the product. All returned products should be identified by model and serial number. You should describe the defect or failure, and provide your name and contact number. In the case of a product returned to the factory, a Return Authorization Number (RAN) should be used.

Return shipments should be made prepaid. We cannot accept COD (Cash On Delivery) or Collect Return shipments. We recommend air-freighting.

It is important that the RAN be clearly shown on the outside of the shipping package for prompt redirection to the appropriate LeCroy department.

1.7 What Comes with Your Scope

Refer to chapter 10 for a list of the items that ships standard with the different configurations of this oscilloscope.

Note: Wherever possible, please use the original shipping carton. If a substitute carton is used, it should be rigid and packed so that that the product is surrounded by a minimum of four inches or 10 cm of shock-absorbent material.

2. General Information

2.1 Product Assistance

Help on installation, calibration, and the use of LeCroy equipment is available from your local LeCroy office, or from LeCroy's

- Customer Care Center, 700 Chestnut Ridge Road, Chestnut Ridge, New York 10977–6499, U.S.A., tel. (845) 578–6020
- European Service Center, 4, Rue Moïse Marcinhes, Case postale 341, 1217 Meyrin 1, Geneva Switzerland, tel. (41) 22/719 21 11.
- LeCroy Japan Corporation, Sasazuka Center Bldg – 6th floor, 1-6, 2-Chome, Sasazuka, Shibuya-ku, Tokyo Japan 151-0073, tel. (81) 3 3376 9400

2.2 Installation for Safe and Efficient Operation

Operating Environment

The oscilloscope will operate to its specifications if the environment is maintained within the following parameters:

Temperature .....5 to 40 °C (41 to 104 °F) rated.

Humidity .....Maximum relative humidity 80 % RH (non-condensing) for temperatures up to 31 °C decreasing linearly to 50 % relative humidity at 40 °C

Altitude .....2000 m (6560 ft)

The oscilloscope has been qualified to the following EN61010-1 category:

Installation (Overvoltage) CategoryII

Pollution Degree 2

Safety Symbols

Where these symbols or indications appear on the front or rear panels, and in this manual, they have the following meanings:

 ..... **CAUTION**: Refer to accompanying documents (for Safety-related information). *See elsewhere in this manual wherever the symbol is present,as indicated in the Table of Contents*.

 ..... **CAUTION**: Risk of electric shock

 ..... **On (Supply)**

 Off (Supply)

 ..... Earth (Ground) Terminal

 ..... **Protective Conductor Terminal**

 ..... **Earth (Ground) Terminal on BNC Connectors**

WARNING ..... **Denotes a hazard. If a WARNING is indicated on the instrument, do not proceed until its conditions are understood and met.**

Any use of this instrument in a manner not specified by the manufacturer may impair the instrument's safety protection.

The oscilloscope has *not* been designed to make direct measurements on the human body. Users who connect a LeCroy oscilloscope directly to a person do so at their own risk.

Power Requirements

The oscilloscope operates from a 115 V (90 to 132 V) or 220 V (180 to 250 V) AC power source at 45 Hz to 66 Hz. No voltage selection is required, since the instrument automatically adapts to the line voltage present.

The power supply of the oscilloscope is protected against short-circuit and overload by means of a 10.0 A/250 V AC, “T” rated fuses (size: 5 X 20 mm), located above the mains plug. Disconnect the power cord before inspecting or replacing a fuse. Open the fuse box by inserting a small screwdriver into the slot and turning counter clockwise.

For continued fire protection at all line voltages, replace only with fuse of the specified type and rating (T 10.0 A/250 V).

Maintain the ground line to avoid an electric shock.

None of the current-carrying conductors may exceed 250 V rms with respect to ground potential. The oscilloscope is provided with a three-wire electrical cord containing a three-terminal polarized plug for mains voltage and safety ground connection.

The plug's ground terminal is connected directly to the frame of the unit. For adequate protection against electrical hazard, this plug must be inserted into a mating outlet containing a safety ground contact.

Cleaning And Maintenance

Maintenance and repairs should be carried out exclusively by a LeCroy technician Cleaning should be limited to the exterior of the instrument only, using a damp, soft cloth. Do not use chemicals or abrasive elements. Under no circumstances should moisture be allowed to penetrate the oscilloscope. To avoid electric shocks, disconnect the instrument from the power supply before cleaning.

Risk of electrical shock: No user serviceable parts inside. Leave repair to qualified personnel.

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3. Specifications

3.1 Vertical

	WS424	WS422	WS434	WS432	WS454	WS452
Bandwidth (at probe tip)	200 MHz		350 MHz		500 MHz	
Rise Time (typical)	1.75 ns		1 ns		750 ps	
Input Channels	4	2	4	2	4	2
Display	10.4" Color flat-panel TFT-LCD, 800x600 SVGA, touch screen					
Sample Rate (single-shot)	2 GS/s max (interleaved mode), 1 GS/s (all channels)					
Sample Rate (RIS mode)	50 GS/s					
Standard Record Length	500 kpts/Ch (interleaved mode), 250 kpts/Ch (all channels)					
Maximum Record Length (Optional)	2 Mpts/Ch (interleaved mode), 1 Mpts/Ch (all channels)					
Standard Capture Time	up to 250 µs at full sample rate					
Maximum Capture Time (Optional)	up to 1 ms at full sample rate					
Vertical Resolution	8 bits					
Vertical Sensitivity	1 mV/div - 10 V/div (1 MΩ); 1 mV/div - 2 V/div (50 Ω)					
Vertical (DC Gain) Accuracy	±(1.5% + 0.5% of full scale)					
BW Limit	20 MHz 20 MHz, 200 MHz					
Maximum Input Voltage	±400 Vpk (CAT I), ±300 Vpk (CAT II)					
Input Coupling	AC, DC, GND (AC for 1 MΩonly)					
Input Impedance	1 MΩ//16 pF, or 50 Ω+/-1%,					
Probing System	BNC or ProBus®					
Probes	One PP007 per channel (standard)					
Time/div Range	1 ns - 1000 s/div 500 ps - 1000 s/div 200 ps - 1000 s/div					
Roll mode	from 200 ms/div - 1000 s/div					
Timebase Accuracy	10 ppm					

3.2 Triggering System

Trigger Modes	Normal,Auto, Single, and Stop
Sources	Any input channel, External, Ext/10, or line; slope and level unique to each source (except for line trigger)
Trigger Coupling	AC, DC, HF, HFRej, LFRej
Pre-trigger Delay	0 – 100% of full scale
Post-trigger Delay	0 – 10,000 divisions
Hold-off	2 ns to 20 s or 1 to 99,999,999 events
Internal Trigger Level Range	±5 div from center
External Trigger Range	EXT/10 ±5 V; EXT ±500 mV
External Trigger	Input Impedance 50 Ω, 1MΩ

3.3 Standard Triggers

Edge	Triggers when signal meets slope (positive, negative, or Window) and level condition
Glitch	Triggers on positive or negative glitches with widths selectable from 2 ns to 20 s or on intermittent faults. Includes exclusion mode (trigger on intermittent faults by specifying the normal width period).
Width	Triggers on positive or negative glitches with widths selectable from 2 ns to 20 s or on intermittent faults. Includes exclusion mode (trigger on intermittent faults by specifying the normal width period).
Logic (Pattern)	Logic combination (AND,NAND, OR, NOR) of 5 inputs (4 channels and external trigger input). Each source can be high, low, or don't care.The High and Low level can be selected independently.
TV-Composite Video	Triggers selectable fields (1, 2, 4, or 8), Positive or Negative slope, for NTSC, PAL, SECAM, or non-standard video (up to 1500 lines)

3.4 Optional SMART Triggers®

Runt	Trigger on positive or negative runts defined by two voltage limits and two time limits. Select between 2 ns and 20 ns. Includes exclusion mode (trigger on intermittent faults by specifying the normal width period).
Slew Rate	Trigger on edge rates. Select limits for dV, dt, and slope. Select edge limits between 2 ns and 20 ns. Includes exclusion mode (trigger on intermittent faults by specifying the normal width period).
Interval (Signal or Pattern)	Triggers on a source if a given state (or transition edge) has occurred on another source. Delay between sources is 2 ns to 20 s, or 1 to 99,999,999 events. Includes exclusion mode (trigger on intermittent faults by specifying the normal width period).
Dropout	Triggers if signal drops out for longer than selected time between 2 ns and 20 s. Includes exclusion mode (trigger on intermittent faults by specifying the normal width period).
Qualified (State or Edge)	Triggers on any input source only if a defined state or edge occurred on another input source. Delay between sources is 2 ns to 20 s, or 1 to 99,999,999 events. Includes exclusion mode (trigger on intermittent faults by specifying the normal width period).

3.5 Documentation and Connectivity

Printing	Connect to any WindowsXP-compatible printer. Load any standard WindowsXP printer driver onto the unit as future needs require.
Email	Configure the unit to send an email of a screen image in a variety of formats using MAPI (i.e. through a default email program) or SMTP (no additional program needed).
Waveform Memories	Save waveform data as a reference trace to be compared to channels, zooms, or math functions.
Waveform File Data	Save waveform data in the following formats: Binary, ASCII, Excel,Mathcad,MATLAB.
Screen Image	Save a screen image to the internal hard drive, a user-supplied USB memory stick, or any other peripheral connected to one of the three USB 2.0 ports. Image can be saved in a variety of formats, and with white or black background.
Waveform Labeling (Annotation)	Attach up to 10 labels to any combination of waveforms. Labels appear on screen images.
Hardcopy Front Panel Button	Configure the front panel Hardcopy button to send an email, save a screen image, save waveform file data, and save to the clipboard.
Networking	Standard 10/100Base-T Ethernet interface (RJ-45 connector). Connect to any network using DHCP with automatically assigned IP address.
Remote Control	Via LeCroy Remote Command Set (via Ethernet)
USB Ports	3 USB ports (one on front of instrument) support Windows compatible devices
External Monitor Port	Standard 15-pin D-Type female SVGA-compatible connector for external color
Parallel Port	25-pin D-type female (Centronics)
Serial Port	9-pin D-type male (not for remote oscilloscope control)
Audio Port	Mic Input, Line Input, Line Output

3.6 Measure, Zoom, and Math Tools

Standard Parameter Measurement	Up to 6 of the following parameters can be calculated at one time on any waveform: Amplitude,Area, Base (Low), Delay, Duty, Fall Time (90%-10%), Fall Time (80%-20%), Frequency,Maximum,Mean,Minimum,Overshoot+, Overshoot-, Period, Peak-Peak, Rise Time (10%-90%), Rise Time (20%-80%), RMS, Skew, Standard Deviation, Top (High), Width. Measurements may be gated.
Zooming	Use front panel QuickZoom button, or use touch screen or mouse to draw a box around the zoom area.
Standard Math	Operators include Sum, Difference, Product, Ratio, and FFT (up to 25 kpts with power spectrum output and rectangular,VonHann, and FlatTop windows). 1 math function may be defined at a time.
Extended Math (MathSurfer Options)	Adds the following additional math functions: Absolute Value,Averaging (summed and continuous), Derivative, Envelope, Enhanced Resolution (to 11 bits), Floor, Integral, Invert, Reciprocal, Roof, Square, and Square Root. Also adds chaining of two math functions, and rescaling to different units.

3.7 Automatic Setup

Auto Setup	Automatically sets timebase, trigger, and sensitivity to display a wide range of repetitive signals.
Vertical Find	Scale automatically sets the vertical sensitivity and offset for the selected channel.
Analog Persistence	When ON, persistence applied to all waveforms. Select analog or color-graded. Variable saturation level, with aging time selectable from 500 ms to infinity.

3.8 Setup and Waveform Storage

Front Panel and Instrument Status	Save to the internal hard drive, over the network, or to a USB connected peripheral device.
Waveform Traces	Save to one of four internal memories with 16 bit resolution for recall/comparison.
Waveform Data	Save to the internal hard drive, over the network, or to a USB connected peripheral device.

3.9 Outputs

Calibrator	1 KHz square wave or DC level; Select from -1.0 to +1.0 into 1 MΩ, output on front panel test point and ground lug
Control Signals Rear Panel:	TTL level, BNC output; Choice of trigger ready, trigger out, pass/fail status. (output resistance 300 Ω ±10%)

3.10 Environmental and Safety

Temperature (Operating)	+5 °C to +40 °C
Temperature (Non-Operating)	–20 °C to +60 °C
Humidity (Operating)	5% to 80% relative humidity (non-condensing) at <= 30 °C.Upper limit derates to 55% relative humidity (non-condensing) at +40 °C.
Humidity (Non-Operating)	5% to 95% relative humidity (non-condensing) as tested per MIL–PRF–28800F.
Altitude (Operating)	up to 3048 m (10,000 ft) at up to 25 °C
Altitude (Non-Operating)	up to 12,190 m (40,000 ft)
Vibration (Operating)	Random vibration, 0.31 grms 5 Hz to 500 Hz, 15 minutes in each of three orthogonal axes
Vibration (Non-Operating)	Random vibration, 2.4 grms 5 Hz to 500 Hz, 15 minutes in each of three orthogonal axes
Functional Shock	20 g peak, half sine, 11 ms pulse, 3 shocks (positive and negative) in each of three orthogonal axes, 18 shocks total
Certification	CE Approved, UL (Std. UL 3111-1) and cUL (Std. CSA C22.2 No. 1010-1) listed. EMC Directive 89/336/EEC; EN61326-1:1997+A1:1998+A2:2001. Low Voltage Directive 73/23/EEC; EN 61010-1:2001 Product Safety (Installation Category II, Pollution Degree 2, Protection Class 1)

3.11 Physical Dimensions

Dimensions (HxWxD)	260 mm x 340 mm x 152mm (10.25" x 13.4" x 6"). Excluding accessories and projections.
Net Weight	6.8 kg (15 lbs). Excluding accessories.

3.12 General

Power	(AC) 100–120 Vrms at 50/60/400 Hz; 200–240 Vrms at 50/60 Hz;Max. Power Consumption: 170 VA

3.13 Warranty & Calibration

Warranty	Three year warranty.
Calibration	Calibration recommended yearly.

4. Theory of Operation

4.1 System Block Diagram

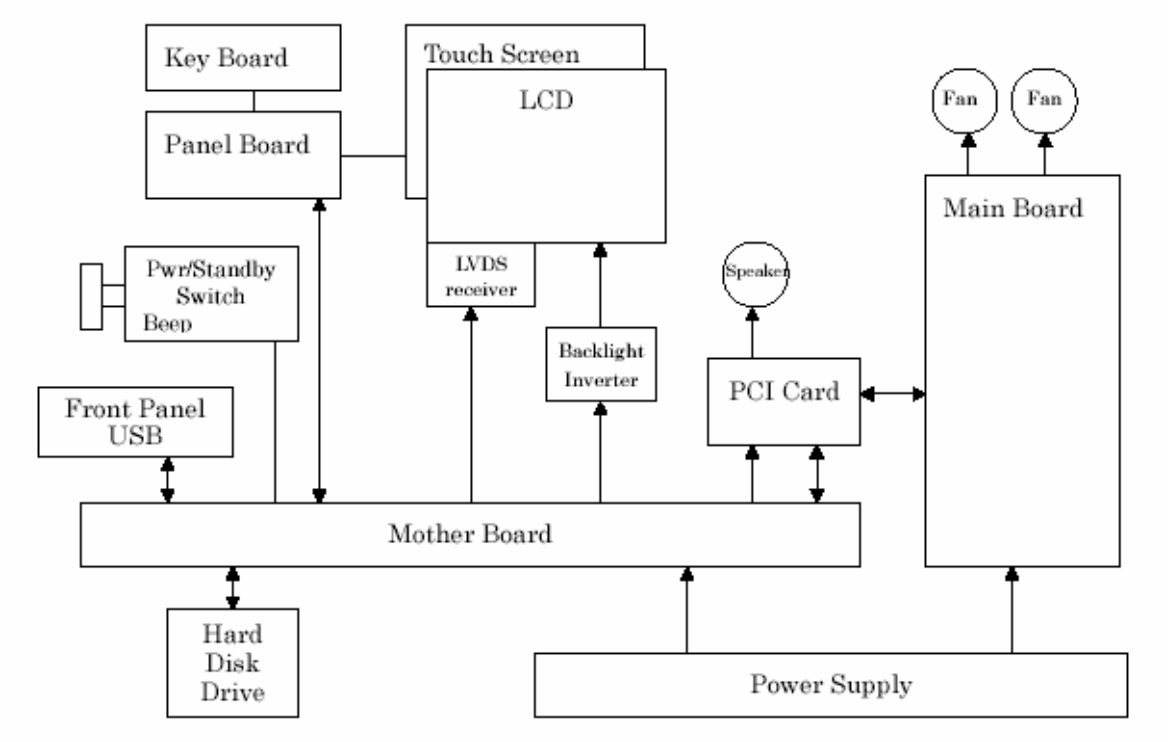


Figure 4-1 WaveSurfer Block Diagram

4.2 Main Board

The main board is divided into the following sections:

- **Front End**
  Based on high impedance buffer, variable gain amplifier and differential amplifiers.
- **Analog to Digital Converter**
  Based on the HAM631 and the relay switchyard to combine the input channels.
- **Trigger**
  Based on the Hybrids HTR420 discriminator & MST429A smart trigger.
- **Time Base**
  Based on the MCG426 clock generator & MTB411A controller.
- **Calibrator**
- **SCAN DAC**
- **Main Board Control**

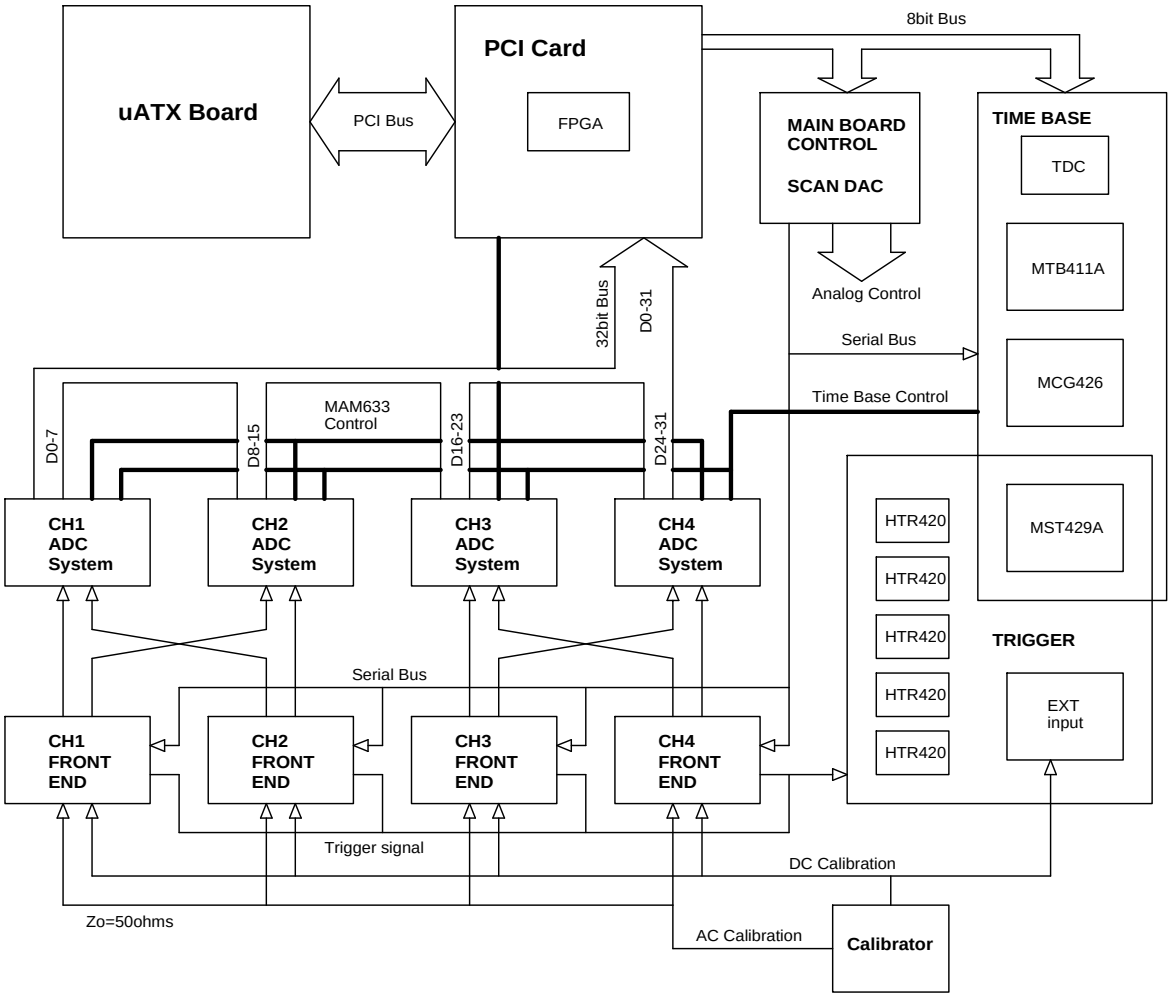


Figure 4-2 Acquisition Block Diagram

4.2.1 Front End

The front end processes an analog signal for ADC and trigger, consists of 1M ohms attenuators, high impedance buffer, 200 ohms attenuator, variable gain amplifier SA5209D and differential amplifiers.

The main functions of the Front end without the amplifiers are:

- Four channels operation, calibration with Software control.
- Input protection (clamp + thermal detection) and coupling (AC, DC, 1MΩ, 50Ω).
- Attenuator by 5, by 10, by 50, by 100 & by 500.
- Offset control of ±1V.
- Detection of 50Ω over loading.
- Input of signal for DC calibration and skew calibration.

The main functions of SA5209D and differential amplifiers are:

- Amplitude normalization for the ADC system : at the BNC the dynamic range is 16 mV to 80V FS (full scale) and the ADC/TRIG system input is 500 mV differential.
- Fine adjustment of gain and variable control.
- Band width limiter of 20MHz, 200MHz.
- Switch for channel combine mode.

Control

Relay control

The relay of the attenuator is set by selecting the input coupling and the gain as shown in the table below.

All relays are driven with +5V/0V.

Input coupling

Control port	Relay	GND	1M,DC	1M,AC	50,DC
CAL	RL2	H	L	L	L
1M/*50	RL1	H	H	H	L
AC/*DC	RL5	H	L	H	L
1/*10	RL3	H	X	X	X
1/*100	RL4	L	X	X	X

Switch of attenuator

Control port	Relay	2mV-49mV	50mV-0.49V	0.5V-10V
1/*10	RL3	H	L	L
1/*100	RL4	H	H	L

Divide gain

The gain ratio in each block and input range is a table below.
At the BNC the dynamic range is 16 mV to 80V FS (full scale) and the output is 500 mV differential (HAD631 input).

	Range V/div											
Block	2mV	5mV	10mV	20mV	50mV	100mV	200mV	500mV	1V	2V	5V	10V
ATT 1/*10	1	1	1	1	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
ATT 1/*100	1	1	1	1	1	1	1	1	0.1	0.1	0.1	0.1
ATT 1/5	1	1	1	0.2	1	1	0.2	1	1	0.2	0.2	0.2
SA5209D	31.25	12.5	6.25	15.62	1.25	6.25	15.62	1.25	6.25	15.62	6.25	3.125
Total(ratio)	31.25	12.5	6.25	3.125	1.25	0.625	0.3125	0.125	0.0625	0.03125	0.0125	0.00625

Analog control voltage

Circuit name	signal level	Signal name
CHx OFFSET	+/-4V	Offset control signal for Front End
CHx GAIN	+/-4V	SA5209D gain control signal
CHx OS ADJ	0 to +4V	Offset control signal for differential amplifiers
INT CAL	-6V to +6V	Signal each CH commonness for calibration

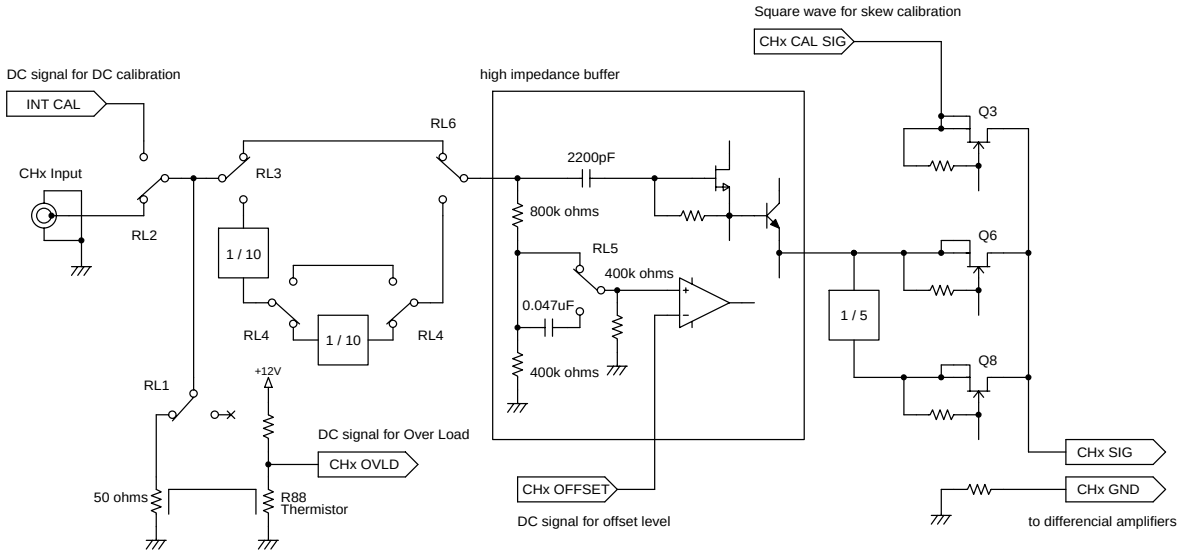


Figure 4-3 Front End Block Diagram 1

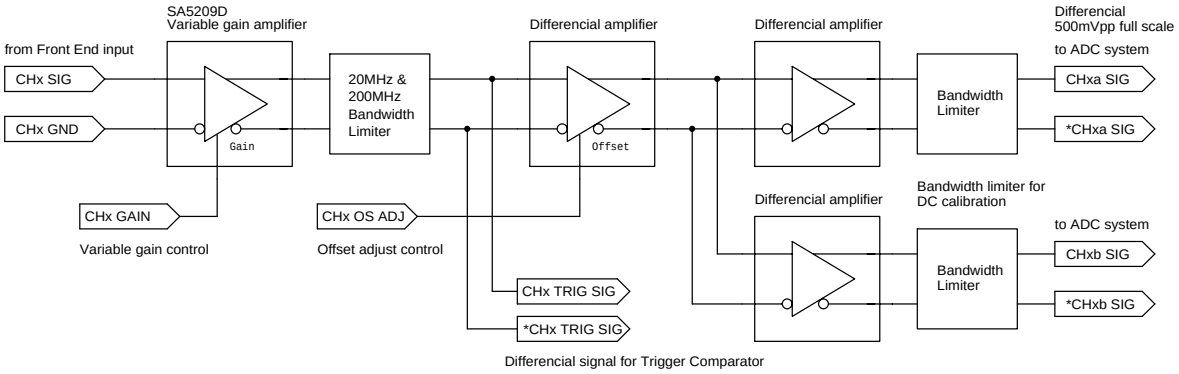


Figure 4-4 Front End Block Diagram 2

4.2.2 Analog to Digital Converter

The analog to digital converter system does the signal conversion to 8 bits, using the HAM631:
The system has the relay switchyard to combine the input channels.

- **HAM631**
  Hybrid ADC 1GS/s with 4Mb memory. It consists of MAD442 and MAM633.
  Provide 83 MHz clock for memory and refresh for DRAM.

Analog Control voltage

Circuit name	signal level	Signal name
CHx ADGAN	0 to +4V	Adjust ADC gain (+/-15%)
CHx ADOFS	0 to +4V	Adjust ADC offset (+/-100mV)
CHx ADDLY	0 to +4V	Adjust ADC sampling delay (+/-250ps)

These are mainly used on channel combine mode.

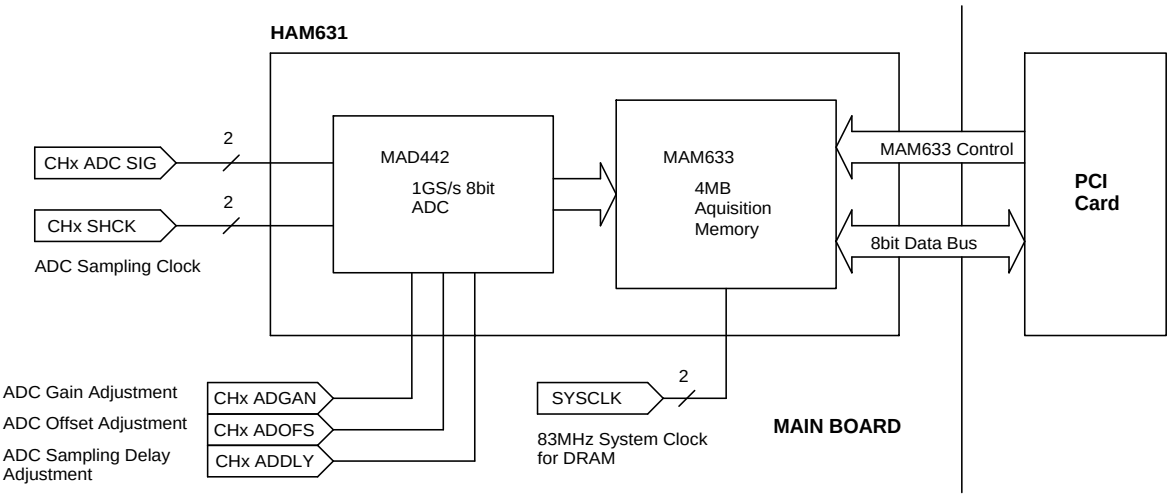


Figure 4-5 HAM631 System Architecture

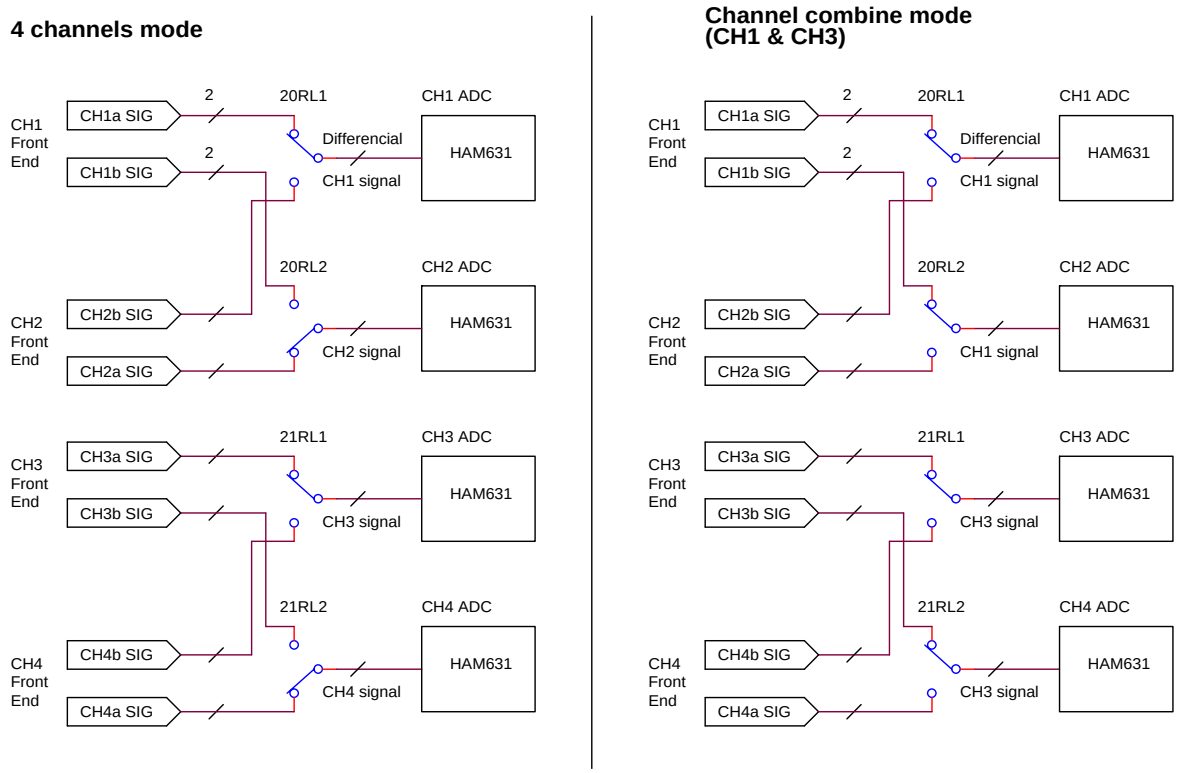


Figure 4-6 4 & 2 Channel Mode

4.2.3 Trigger

HTR420

The main function of HFE420 are:

- Generation of trigger signal (analog input and digital output) with comparator
- Setting of trigger level (TRIG,VALIDATE)
- Setting of trigger coupling (DC,AC,LFREJ,HFREJ,HF)
- Setting of slope (+,-,WINDOW)

The different trigger couplings using HTR420 are :

- DC
- AC : cut off frequency is almost 7.5 Hz.
- LF REJ : single pole high pass filter with a cut off frequency at 50 kHz.
- HF REJ : single pole low pass filter with a cut off frequency at 50 kHz.
- HF : frequency divider by four for high frequency signal.

TV Trigger

Each channel has a pick-off after the HTR420. Selected trigger source goes to commercial chip (LM1881) via AGC amplifier and provides three outputs (Composite Sync. Output, Vertical Sync. Output, and ODD/EVEN output) to the MST429A.

MST429A

The main function of MST429A are:

- generates main trigger signal for Time Base system

The trigger function of MST429A are:

- Single source trigger,
  - Standard trigger,
  - Hold off by Time
  - Hold off by Events,
  - Pulse width
  - Interval
- Multiple source trigger,
  - State qualified,
  - Edge qualified

Analog Control voltage

Circuit name	signal level	Signal name
CHx TRIG LVL1	+/-4V	Trigger level control signal
CHx TRIG LVL2	+/-4V	Trigger level control signal for smart trigger/window
CHx HYST	0 to +4V	Trigger hysteresis control signal

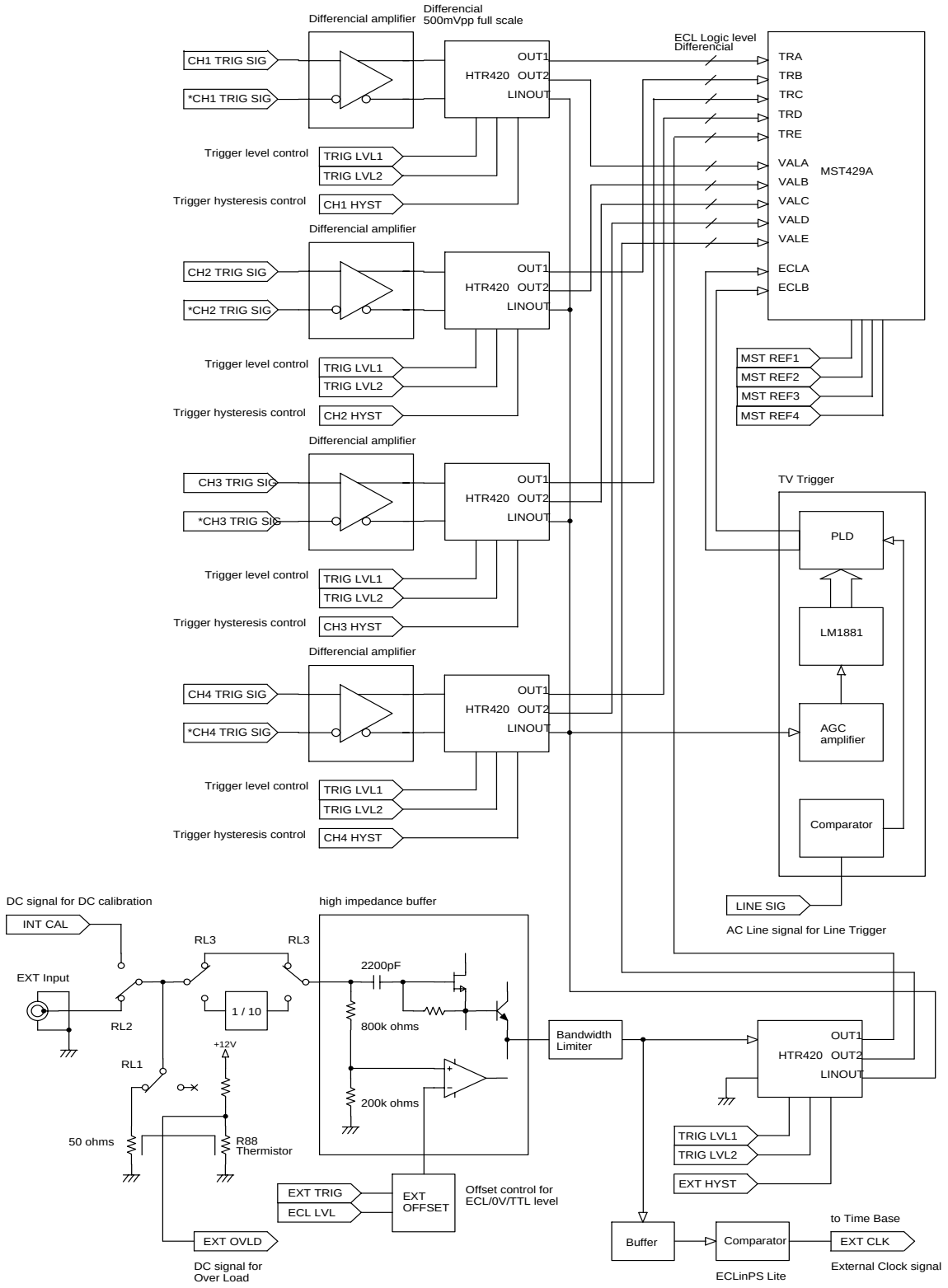


Figure 4-7 Trigger Block Diagram

4.2.4 Time Base

The time base includes four circuits:

- **MCG426**: generates sampling clocks: 12.5 MHz up to 2GHz
  generates clocks for the MTB411
  interleaves sampling clocks to increase sampling rate and memory depth.
- **MTB411A**: Time Base System
  Trigger circuitry
  Main oscillator circuitry
  Frequency divider for a Probe Calibrator
- **TDC**: Time to Digital Converter interpolator and Real Time computation
- **MST429A**: generates main trigger signal for Time Base system.

Analog Control voltage

Circuit name	signal level	Signal name
MST REF1	+/-4V	Reference signal for analog time of Smart trigger
MST REF2	+/-4V	Reference signal for analog time of Smart trigger
MST REF3	+/-4V	Reference signal for analog time of Smart trigger
MST REF4	+/-4V	Reference signal for analog time of Smart trigger
TDC ADJ	0 to +4V	TDC gain control signal

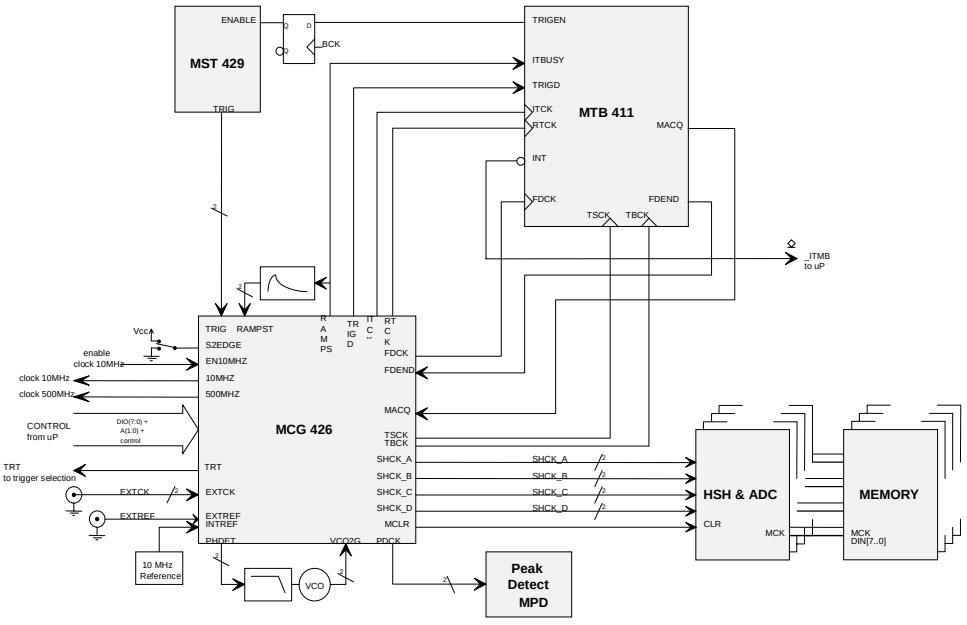


Figure 4-8 Time Base Block Diagram

4.2.5 Calibrator

The main functions of the Calibrator are:

- Probe calibration signal output.
- DC calibration signal output.
- Skew calibration signal output.

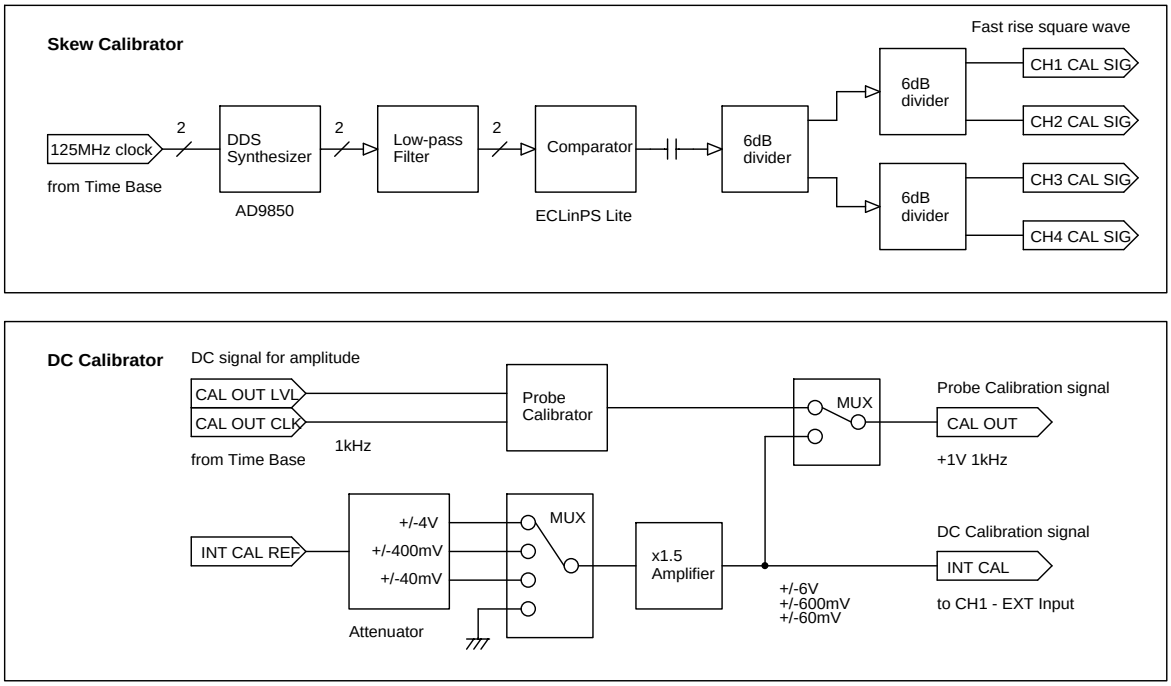


Figure 4-9 Calibrator Block Diagram

4.2.6 SCAN DAC

The main functions of the SCAN DAC are:

- 16 bit precision DAC with uP system.
- 24 analog control signal outputs.
- +/-4V dynamic range outputs.
- 16 ADC inputs for Probe sense, overload detection and so on.

4.2.7 MAIN BOARD CONTROL

The main functions of MAIN BOARD CONTROL are:

- 3 wire Serial Bus for serial device control.
- IIC Bus for EEPROM, Thermometer and ProBus system.
- 16 Analog control outputs using 10 bit DAC.
- 12 Analog control outputs using 8 bit DAC.
- Interface between Main Board and PIC Card.

4.3 Computer

The WaveSurfer processor is an 850 MHz Intel Celeron processor. This motherboard was designed for embedded system.

4.3.1 Operating System

The system uses Microsoft Windows XP embedded as the operating system. The operating system license can be found on the rear panel of the instrument.

4.3.2 Memory

The standard memory configuration for a WaveSurfer is 256MB, consisting of 1 piece of 32M x64 Bit PC-2100 DDR DIMM.

4.3.3 Interfaces

The standard interfaces provided by the Motherboard to external are SVGA, Audio, Ethernet, RS-232, Centronics, three USBs(side 2, front 1), PS/2 Keyboard and PS/2 Mouse. Also one USB and IDE port provided by the Motherboard are used inside the unit for Front panel and HDD.

4.3.4 Storage Devices

The system has an internal hard drive of at least 30 GB in size. 10 GB is allocated for LeCroy use, 16 GB is in a user partition for the saving of panel setups, waveform memory, hard copies, application programs, user data, etc. The balance is allocated as invisible partition for system recovery data

4.3.5 Video port

The Mother board has an on-board video display processor with a LVDS output as well as the ability to drive a rear panel external display. This external port is enabled on power up if it an external monitor is sensed. If the monitor is connected after the initial power on, the power to the instrument must be cycled in order for this monitor to operate.

4.4 PCI Card

The PCI card is the interface between the PCI bus on the processor card and the rest of the system (acquisition system and amplifier for speaker). It has the following interfaces:

- PCI interface (32 bit 33MHz bus with bus mastering capability)
- Acquisition data interface using 32bit local bus.
- Acquisition control interface using 8bit local bus.
- Dallas OneWire interface and chip for scope id.
- Audio amplifier for internal speaker.

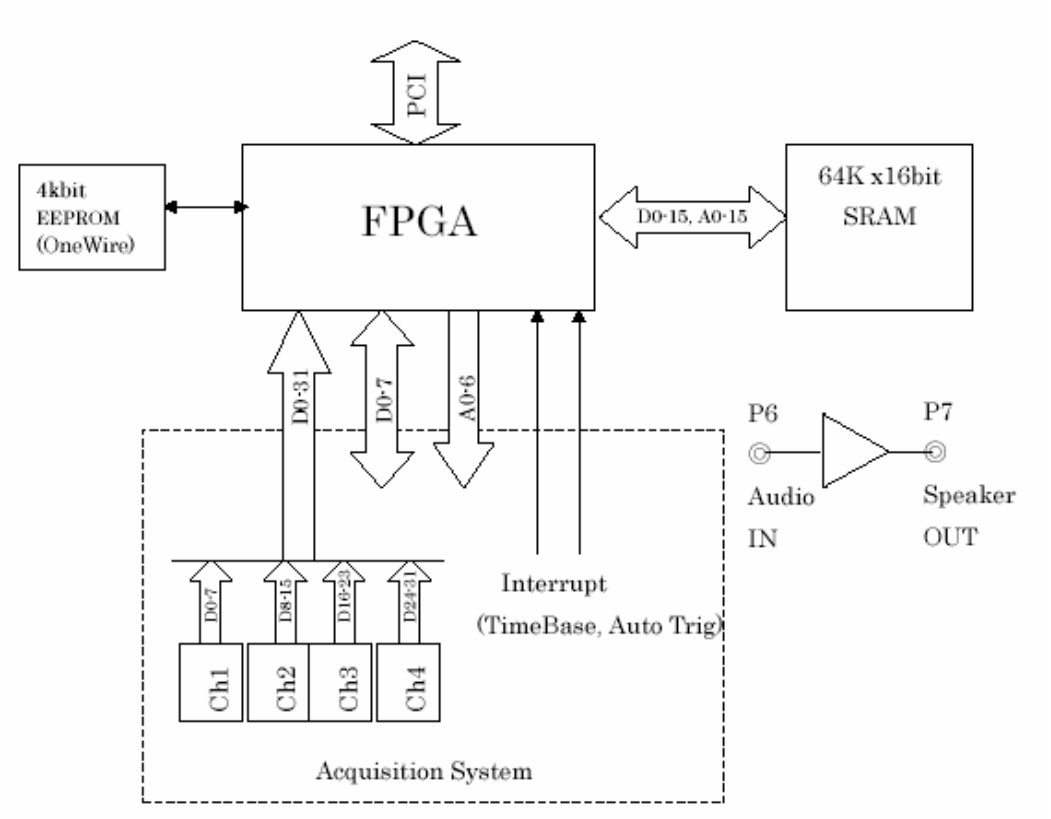


Figure 4-10 PCI Card Block Diagram

4.4.1 PCI Interface

The PCI interface is implemented with a Xilinx FPGA. It is a 32 bit, 33 MHz bus master that allows the PCI card to take control of the PCI bus and push data directly into the processor memory without requiring the direct involvement of the processor. In readout mode, the FPGA reads the data and puts it in the correct time order for the processor memory. The FPGA also has a special readout mode to access the acquisition data in roll mode, store the data, and then transfer this data in blocks to the processor memory. This implementation is the most complicated but is needed in order to maximize the PCI throughput.

4.4.2 Local bus for acquisition

The acquisition interface consists of 2 local buses to read out acquisition data and to control the main board.

4.4.2.1 Control

All resource on main board is controlled through 8bit local bus.

4.4.2.2 Acquisition Data

32bit local bus is used to access the acquisition memories. Each 8bit is connected to each channel's memories directly. (bit0-7 is connected to ch1, bit8-15 is connected to ch2, bit16-23 is connected to ch3 and bit24-31 is connected to ch4)

4.4.3 Dallas OneWire Interface

The Dallas onewire interface is controlled by FPGA. The 4kbits EEPROM is connected to this interface. This device has unique id to generate scope id.

4.4.4 Audio amplifire

The audio amplifier to drive internal speaker is on PCI board. This is independent from other PCI function.

4.5 Front Panel

The front panel consists of two assemblies, the panel board and the key board assembly.

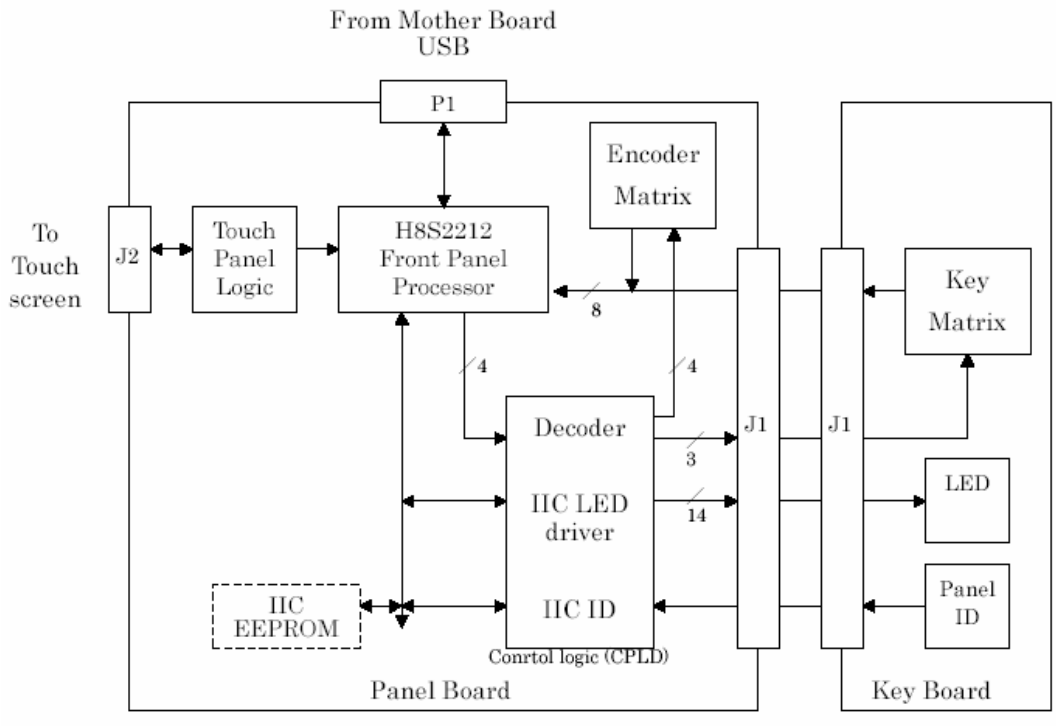


Figure 4-11 Front Panel Block Diagram

4.5.1 Key board

The front panel assembly consists of the panel board PCB, the panel board metal,the elastomeric keypad and the key board PCB. The key board PCB connects to the panel board assembly which is connected to the mother board by USB. The key board has the LED's which illuminate some of the front panel buttons and has trace patterns which act as switches when the elastomeric keypad shorts the traces together in response to a key press.

The key board has configuration jumper which must be selected based on the identification of the front panel (2 channel model or 4 channel model).

4.5.2 Panel Board

Panel board consists of rotary encoder function and touchscreen function.

The encoder status, the front panel key status and the touch panel status is read by the front panel processor, the H8S2212. Power for the panel board comes from the cable of the USB.

4.5.2.1 Encoders

The panel board contains all of the rotary encoders. There are two different types of encoders on this assembly, some have a push switch, others do not. The V/Div and timebase use encoders that do not have push switch, the rest of the encoders have a push switch. The encoders contain two switches, they are not potentiometers. The software can determine the direction and speed the encoder is turning based on the order and frequency of make and break connections of these internal switches.

4.5.2.2 Touchscreen Interface

Provides a control interface to a 4-wire resistive touchscreen. The pointing location is measured by 4 A/D convertors in the front panel processor.

4.6 Display and Touchscreen

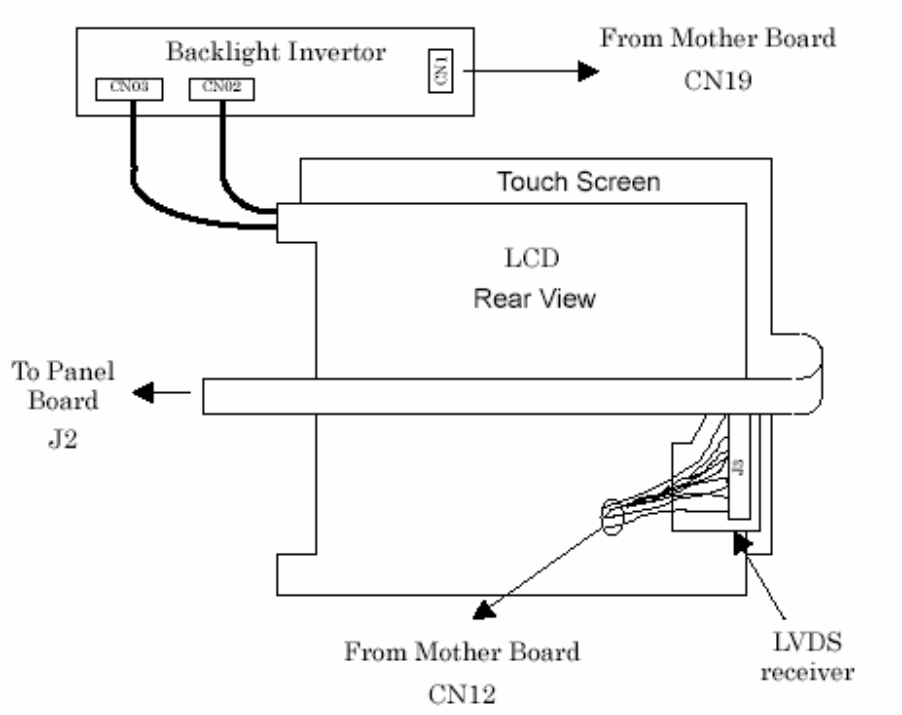


Figure 4-12 Display & Touchscreen Block Diagram

4.6.1 Color LCD Module

The display module is an SHARP TFT (thin film transistor) active matrix color liquid crystal display (LCD) module comprising amorphous silicon TFT attached to each signal electrode, a driving circuit and a backlight. The 26cm diagonal display area contains 800x600 pixels (SVGA) and can display 262144 colors simultaneously.

4.6.2 Backlight Inverter

The inverter which supplies power to the LCD's backlight is supplied with +12V from the Mother board, it then converts this to 1000-2000V AC to drive the CCFT (Cold Cathode Fluorescent Tube). There is also a signal from the Mother board which controls the On/Off of the backlight.

4.6.3 Touch Screen

The touch screen is a 4 wire resistive touch screen. It must be calibrated so that software can determine where a touch corresponds to a position on the screen. This calibration is done at four points and can be invoked through the Utilities menu.

4.6.4 LVDS receiver

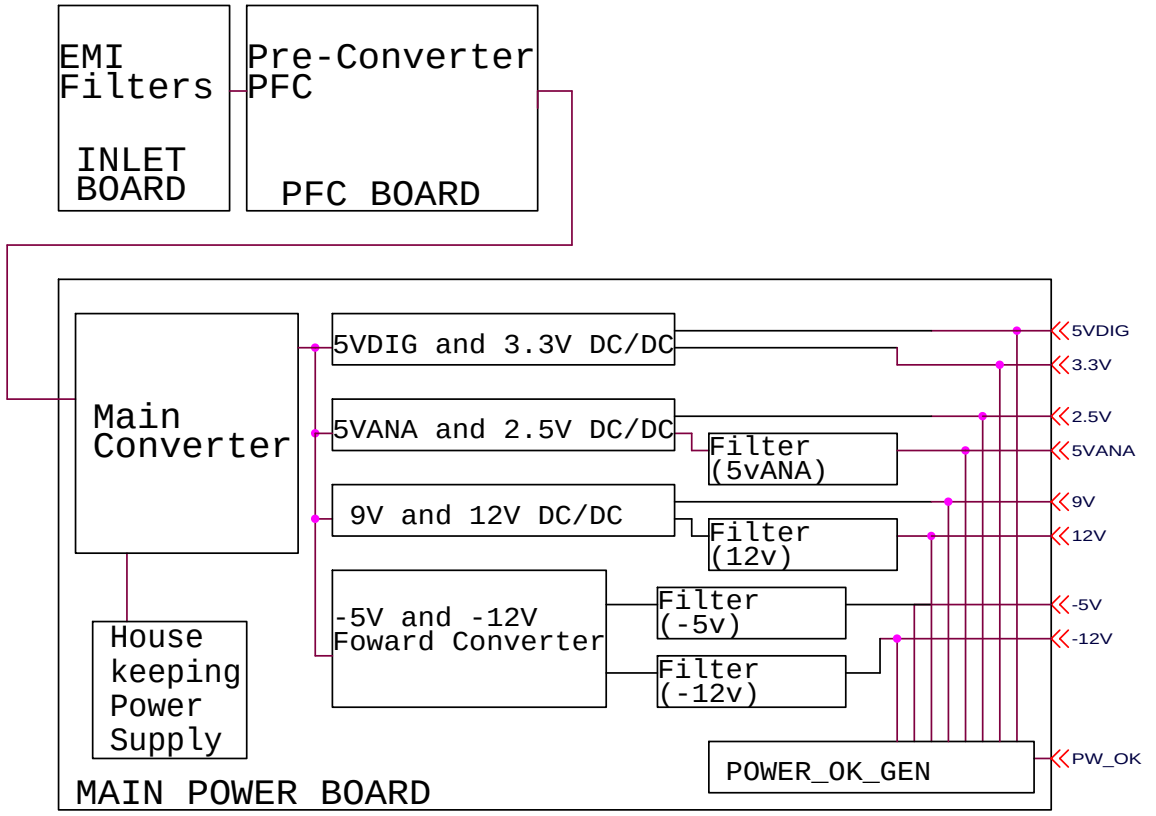
Mother board has LVDS output for LCD. LVDS receiver receive the LVDS signal from Mother board, it then converts this to 18bits RGB (each color has 6bits depthfor input type of LCD module.

4.7 Power Supply

Do not touch any electric parts inside the power supplies during operation as the primary side of the power unit has many high voltage portions to ground.

Power Supply Unit comprises of INLET BOARD, PFC BOARD and MAIN BOARD.

The INLET BOARD includes EMI Filters.
The PFC BOARD includes Pre-converter, which is operated Power Factor Correction.
The MAIN BOARD includes Main Converter (off line), House Keeping Power Supply, Post Converters, Filters, Power OK Generater circuit and internal Bias Supply Circuits.



Solid Line Blocks represent Daughter Boards.

Figure 4-13 Power Supply Block Diagram

4.7.1 Input Voltages

The power supply supports a wide ranges of inputs, 90-132 V AC (45-65HZ, 360-440Hz) and 90-264V AC (45-65Hz) are allowed.

4.7.2 Output Voltages

The power supply makes several output voltages:

OUTPUT VOLTAGE	"TOTAL" REGULATION BAND	Min. Load	Typ. Load	Max. Load	CAPACITIVE LOADING	
					Minimum Capacitance	Maximum Capacitance
+5.0Vana (RS)	+/-1%	0.1A	4.0A	4.2A	1200μF	1800μF
-5.0V (RS)	+/-1%	1.0A	5.0A	5.25A	1200μF	1600μF
+9.0V	+/-2%	0.1A	0.4A	0.5A	330μF	390μF
+2.5V	+/-5%	0.1A	1.0A	1.4A	1400μF	2000μF
+12.0Vana	+/-1%	0.1A	0.16A	1.16A	330μF	560μF
-12.0V	+/-2%	0.1A	0.62A	1.7A	330μF	560μF
+5.0Vdig	+/-5%	0.1A	3.1A	5.5A	2400μF	10000μF
+12Vdig	+/-5%	0.1A	1.0A	1.24A	500μF	1000μF
3.3V	+/-5%	0.1A	2.0A	3.0A	4000uF	6000uF
5.0V(stand)	+/-5%	0.1A	0.1A	1.0A		

Note: RS represent Remote Sense.

4.7.3 Basic Operation

The power supply utilizes 5 converter, 5 synchronous step- down switching regulator and step-down switching regulator.

4.7.3.1 Pre-converter

Power Factor Correction (PFC) circuit. It uses a Critical Mode Boost Converter topology switching and using MosFETs as the primary switches. The output of the PFC Converter is regulated to 385VDC.

4.7.3.2 Main Converter

The converters are like dual-switch half-bridge converters switching at approximately 88KHz and utilizing the module integrated controller and two MosFETs as the primary switches. Output is regulated using a post switching regulation scheme. The output has its own raw voltage provided on its own separate winding on the transformers. The output is regulated to 24V secondary bus voltage,.

4.7.3.3 House Keeping Power Supply

It is a fly back converter switching at approximately 80 kHz. The bias supply also provides other voltages for internal housekeeping. The bias supply is "ON" whenever AC is present. +5VSB is provided from an step-down switching regulator.

4.7.3.4 +5VDIG and 3.3V DC/DC(Daughter Board)

Dual 2-phase synchronous step-down switching regulator is used for the +5Vdig and +3.3V supply.

4.7.3.5 +5VANA and 2.5V DC/DC (Daughter Board)

Dual 2-phase synchronous step-down switching regulator is used for the +5.0Vana and 2.5V supply.

4.7.3.6 +9 and 12V DC/DC (Daughter Board)

Step-down switching regulator is used for the +9.0V supply. Synchronous step-down switching regulator is used for the +12V supply.

4.7.3.7 -5V and –12V Forward converter

This converter is used for the –5.0V supply. There is also a linear regulator which supplies the –12V supply.

4.7.3.8 Filter Circuits (Daughter Boards)

The Filter circuits are implemented for analog outputs ;+5.0V,+12.0V,-5.0V and –12.0V.

4.7.4 Connector Assignments

The power supply connectors are arranged as follows:

INLET BOARD

Reference	Supplied BOARD	Connector	Pin#	Voltage /Function	Comment
1CN2	PFC BOARD	5566-2A	Total 2	Input AC Line	

PFC BOARD

2CN2	INLET BOARD	5566-2A	Total 2	Input AC Line	
2CN3	MAIN BOARD	5566-2A	1	385VDC	
			2	Primary Return	
2CN1	MAIN BOARD	5267-3A	1	18.5VDC	
			2	Primary Return	
			3	Traiac Bias	
2CN4	MAIN BOARD	5267-2A	1	Line	
			2	GND	

MAIN BOARD

Primary

3CN1	PFC BOARD	5267-3A	1	18.5VDC	
			2	Primary Return	
			3	Triac Bias	

5CN2	PFC BOARD	5566-2A	1	385VDC	
			2	Primary Return	

Secondary

Reference	Supplied BOARD	Connector	Pin#	Voltage /Function	Comment
CN9	EXT BOARD	5566-2A	1	24V	Bus Voltage
			2	GND	

5CN1	EXT BOARD	5267-3A	1	24V	To printer
			2	N.C	
			3	GND	

CN2	Main Board	51067	1,2	+5.0V	
			3,6	GND	
			4,5	-5.0V	
			7,8	+2.5V	

CN3	Main Board	51067	1	+12.0V	
			2,4	GND	
			3	+9.0V	
			5	-12.0V	

CN4	Main Board	5268-07A	1	-12.0V	F.B –12.0V
			2	+12.0V	F.B +12.0V
			3	-5.0V	F.B –5.0V
			4	+5.0V	F.B +5..0V
			5	LINE	Line tiger Signal
			6	BAT EN	Battery EN.
			7	BAT VS	Battery V.S.

CN5	Main Board FAN MOTOR	5568-02A	1	+12Vdig	
			2	GND	

Reference	Supplied BOARD	Connector	Pin#	Voltage /Function	Comment
CN6	UATX-Board	5566-20A	1,2,11	3.3Vdig	
			3	GND	
			4	5.0Vdig	
			5,7,13	GND	
			6,19,20	5.0Vdig	
			8	PWR_OK	TTL level
			9	+5.0Vstb	Standby Power
			10	+12.0Vdig	
			12	-12Vdig	
			15,16,17	GND	
			14	PS_ON#	<0.8V:ON/>2V:OFF
			18	-5.0Vdig	

CN11	PFC BOARD	5267-02A	1	LINE	
			2	GND	

CN7	EXT Board	5267-06A	1	GND	
			2	REMOTE_ON	
			3	BAT VS	
			4	BAT EN	
			5	Vaux	
			6	5Vstd	

CN10	EXT Board	5267-02A	1	24V	External OUT
			2	GND	

4.7.5 Output Voltage Adjustment Range

Each output voltage has an adjustment range of the nominal Vset voltage as specified in the table. The adjustments are clearly labeled and accessible from the top of the Power Supply. Turning adjustment potentiometers clockwise increases the absolute value of output voltages.

4.7.6 +5VSB Standby Supply Rail

+5VSB is a standby supply output that is active whenever the AC power is present. It provides a power source for the processor standby circuits that must remain operational when the other main DC output rails are in a disabled state. The 5VSB output is capable of delivering up to 0.5A continuously with the fan not operating.

4.7.7 Control

The following control signals are required.

4.7.7.1 Output Enable OUTPUT-EN/ (active low)

This is an active low signal which comes from the processor board that turns on (enables) all of the power supply DC outputs.

4.7.7.2 Line Frequency Synchronization Output Signal (LFS)

The LFS signal is safety-isolated from the primary circuits of the power supply. The LFS signal is a digital signal (TTL levels) that toggles at each zero-crossing of the AC line input.

4.7.7.3 PWR_OK signal

PWR_OK is a “power good” signal. It is asserted high by the power supply a minimum of 100ms after all Secondary Outputs are above the minimum voltage as specified by the lower limit of the regulation band and the AC line is present. The PWR_OK rise time is <= 10ms. In the case of AC line disconnection or drop-out, the PWR_OK signal goes low when at least one of Secondary Outputs drop out of regulation.

4.7.8 Over-Current Protection

All outputs are protected against damage due to overloads or short circuits. Short circuit current levels for any output, unless specified below, will not exceed 125% of maximum current for that output.
Each output has independent current limiting, that is the over-current of any of these outputs will not cause any other output except –5.0V Output. If –5.0V output will short, -12.0V output reduces output voltage. The over current circuitry is latch type. Whenever Over-Current protection occur, all Outputs shut down to protect Circuitry damage. –5V output only have over-current adjustment value(6A) and adjustment potentiometer.

4.7.9 Over-Temperature Protection

The power supply will shut down before any damage occurs from over-temperature. This is true independent of the cause of the over-temperature condition (i.e. blocked power supply cooling fan, excessive ambient temperature, etc.) When the power supply restart , the power supply must remove AC Line for a few minutes and remove the cause of the over-temperature condition.

4.7.10 Over-Voltage Protection

Over-voltage protection is required to reduce the likelihood of damage to system components in the event of a single point fault within the power supply. All outputs incorporate an over-voltage protection limited to less than 135% of the nominal Vset values. When the power supply restart , the power supply must remove AC Line for a few minutes and remove the cause of the over-Voltage condition.

5. Performance Verification

5.1 Introduction

This chapter contains procedures suitable for determining if the WaveSurfer 400 Series of Digital Storage Oscilloscope performs correctly and as warranted. They check all the characteristics listed in subsection 5.1.1.

In the absence of the computer automated calibration system based on LeCroy Calibration Software (Calsoft), this manual performance verification procedure can be followed to establish a traceable calibration. It is the calibrating entities' responsibility to ensure that all laboratory standards used to perform this procedure are operating within their specifications and traceable to required standards if a traceable calibration certificate is to be issued for the WaveSurfer 400 series Digital Storage Oscilloscope.

5.1.1 List of Tested Characteristics

This subsection lists the characteristics that are tested in terms of quantifiable performance limits.

- Input Impedance
- Leakage Current
- Peak to Peak noise level
- Positive and Negative DC accuracy
- Positive and Negative Offset
- Bandwidth
- Trigger Accuracy
- Time Base Accuracy

5.1.2 Calibration Cycle

The WaveSurfer 400 series Digital Storage Oscilloscope requires periodic verification of performance. Under normal use (2,000 hours of use per year) and environmental conditions, this instruments calibration cycle is 12 months.

5.2 Test Equipment Required

These procedures use external, traceable signal generators, DC precision power supply and digital multi-meter, to directly check specifications.

Instrument	Specifications	Recommended
Signal Generator Radio Frequency	Frequency : .5 MHz to 1 GHz Frequency Accuracy : 1 PPM	HP 8648B or C or Fluke 9500
Signal Generator Audio Frequency	Frequency : 0 to 5 kHz Amplitude : 8 V peak to peak	HP 33120A
Voltage Generator DC Power Supply	Range of 0 to 20 V, in steps of no more than 15 mV	HP 6633A
Power Meter + Sensor	Accuracy ±1 %	HP437B + 8482A or equivalent
Digital Multimeter Volt & Ohm	Voltmeter Accuracy : 0.1 % Ohmmeter Accuracy : 0.1 %	Keithley 2000, Fluke 9500 or 5820 Oscilloscope Calibrator
Coaxial Cable, 5 ns	50Ω, BNC, length 100 cm,	
Coaxial Cable, 5 ns	50Ω, SMA, length 100 cm,	
2 Attenuators, 20 dB	50Ω, BNC, 1 % accuracy	
T adapter	50Ω, BNC T adapter	

Table 5-1 : Test Equipment

5.2.1 Test Records

The last pages of this chapter contain the WaveSurfer 400 series test records in the format of tables. Keep them as masters and use a photocopy for each calibration.

5.3 Turn On

If you are not familiar with operating the WaveSurfer 400, refer to the operator's manual.

- Switch on the power using the power switch.
- Wait for about 20 minutes for the scope to reach a stable operating temperature:
- To provide for quicker setup of the scope for each test, a CD containing panel setups has been included with this manual. An external USB CD ROM drive will need to be connected if you wish to use these. Detailed set up information is contained in the text and the panel setups are not needed if a CD ROM drive is not available.

5.4 Input Impedance

Specifications

DC 50Ω ±1.0 %
EXT DC 50Ω ±1.0 %
DC 1MΩ ±1.0%
EXT 1MΩ ±1.0 %
AC 1.2MΩ ±1.0%

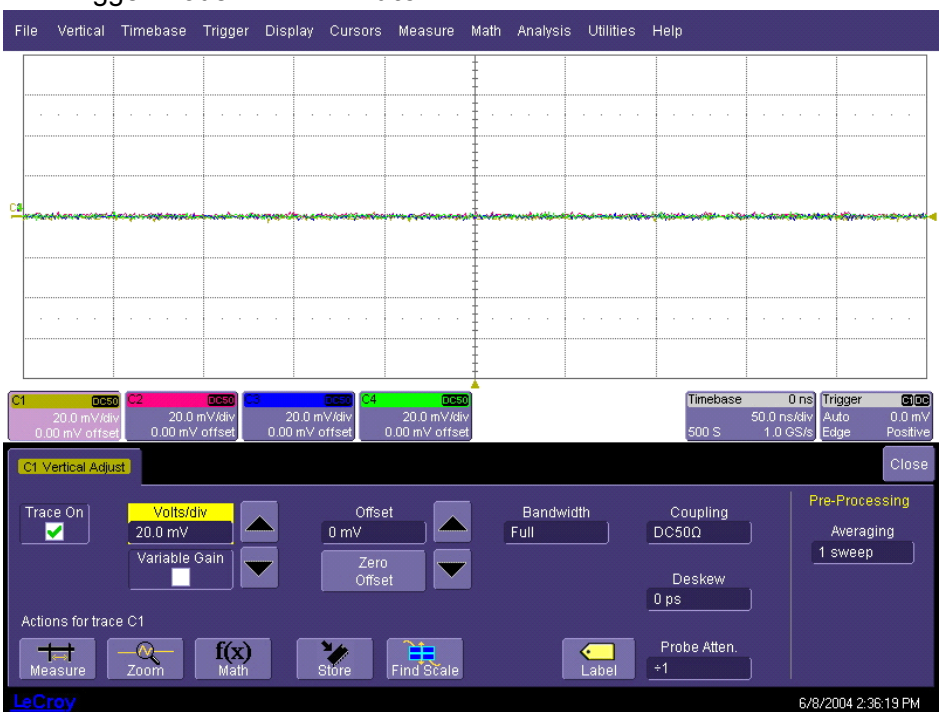
The impedance values for 50Ω coupling are measured with a high precision digital multimeter. The DMM is connected to the DSO in 4 wire configuration (input and sense), allowing for accurate measurements.

5.4.1 Channel Input Impedance

a. DC 50Ω

- Recall **Input Impedance - 50 ohm x1.lss** or configure the DSO :

Panel Setups	:	**Recall FROM DEFAULT SETUP**
Channels Trace ON		**Channel 1, Channel 2, Channel 3 & Channel 4**
Input Coupling	:	**DC 50Ω** on all 4 Channels
Input gain	:	**20 mV/div.** on all 4 Channels
Time base	:	**50 ηsec/div.**
Trigger mode	:	**Auto**



- Set the DMM with **Ohms and Ohms sense** to provide a 4 wire measurement.
- Connect it to Channel 1.
- Measure the **input impedance**, reverse the meter leads and measure the input impedance.
- **Average** these two numbers and record it in Table 2, and compare it to the limits.
- Repeat the above test for all input channels.
- Recall **Input Impedance - 50 ohm x10.lss** or Set Input gain to **200 mV/div.** on all 4 Channels
- Repeat the test for all input channels.
- Record the measurements in Table 2, and compare the test results to the limits in the test record.
- Recall **Input Impedance - 50 ohm x1.lss** or Set Input gain to **2 V/div.** on all 4 Channels
- Repeat the test for all input channels.
- Record the measurements in Table 2, and compare the test results to the limits in the test record.

b. DC 1MΩ

- Recall **Input Impedance - 1 Mohm DC x1.lss** or configure the DSO :

Panel Setups	:	**Recall FROM DEFAULT SETUP**
Channels Trace ON		**Channel 1, Channel 2, Channel 3 & Channel 4**
Input Coupling	:	**DC 1MΩ** on all 4 Channels
Input gain	:	**20 mV/div.** on all 4 Channels
Time base	:	**50 ηsec/div.**

Trigger mode : **Auto**

- Set the DMM with **Ohms and Ohms sense** to provide a 4 wire measurement.
- Connect it to Channel 1.
- Measure the **input impedance**, reverse the meter leads and measure the input impedance.
- **Average** these two numbers and record it in Table 2, and compare it to the limits.
- Repeat the above test for all input channels.
- Recall **Input Impedance - 1 Mohm DC x10.lss** or Set Input gain to **200 mV/div.** on all 4 Channels
- Repeat the test for all input channels.
- Record the measurements in Table 2, and compare the test results to the limits in the test record.
- Recall **Input Impedance - 1 Mohm DC x1.lss** or Set Input gain to **2 V/div.** on all 4 Channels
- Repeat the test for all input channels.
- Record the measurements in Table 2, and compare the test results to the limits in the test record.

c. AC 1MΩ

- Recall **Input Impedance - 1 Mohm AC x1.lss** or configure the DSO :

Panel Setups	:	**Recall FROM DEFAULT SETUP**
Channels Trace ON		**Channel 1, Channel 2, Channel 3 & Channel 4**
Input Coupling	:	**AC 1MΩ** on all 4 Channels
Input gain	:	**20 mV/div.** on all 4 Channels
Time base	:	**50 ηsec/div.**
Trigger mode	:	**Auto**

- Set the DMM with **Ohms and Ohms sense** to provide a 4 wire measurement.
- Connect it to Channel 1.
- Measure the **input impedance**.
- Record the measurements in Table 2, and compare the test results to the limits in the test record.
- Repeat the above test for all input channels.

5.4.2 External Trigger Input Impedance

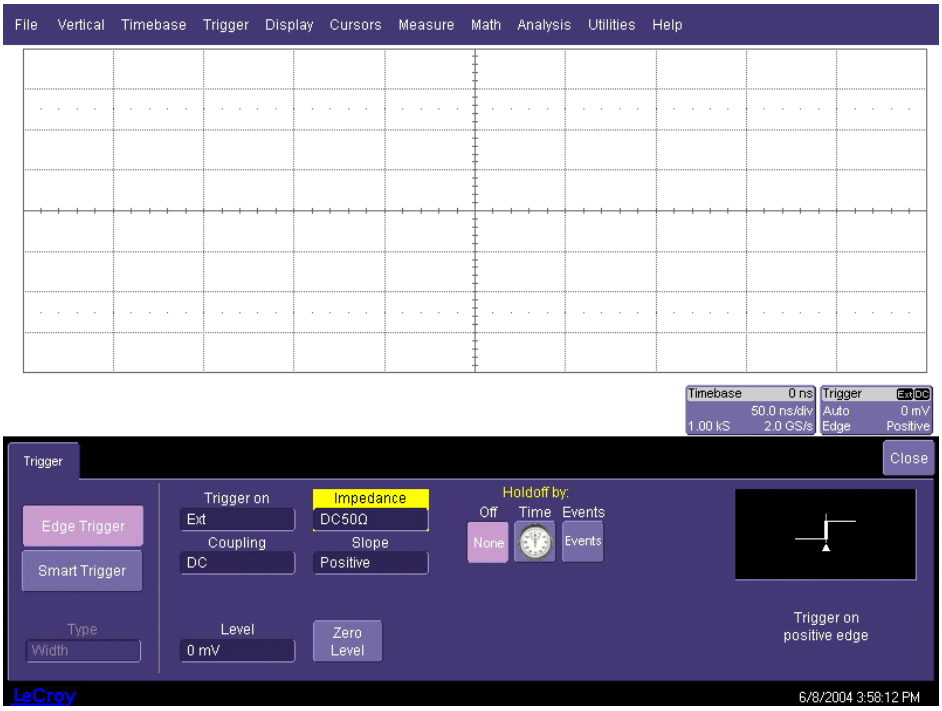
a. DC 50Ω

- Recall **Input Impedance - 50 ohm ext x1.lss** or configure the DSO :

  Select Setup trigger

  Trigger on : **EXT**

  Impedance : **DC 50Ω**



- Connect the DMM to External, and measure the **input impedance**, reverse the meter leads and measure the input impedance.
- **Average** these two numbers and record the input impedance in Table 2, and compare the result to the limit in the test record.
- Recall **Input Impedance - 50 ohm ext x10.lss** or Set Trigger Source to **Ext/10.**
- Repeat the test.
- Record the measurements in Table 2, and compare the test results to the limits in the test record.

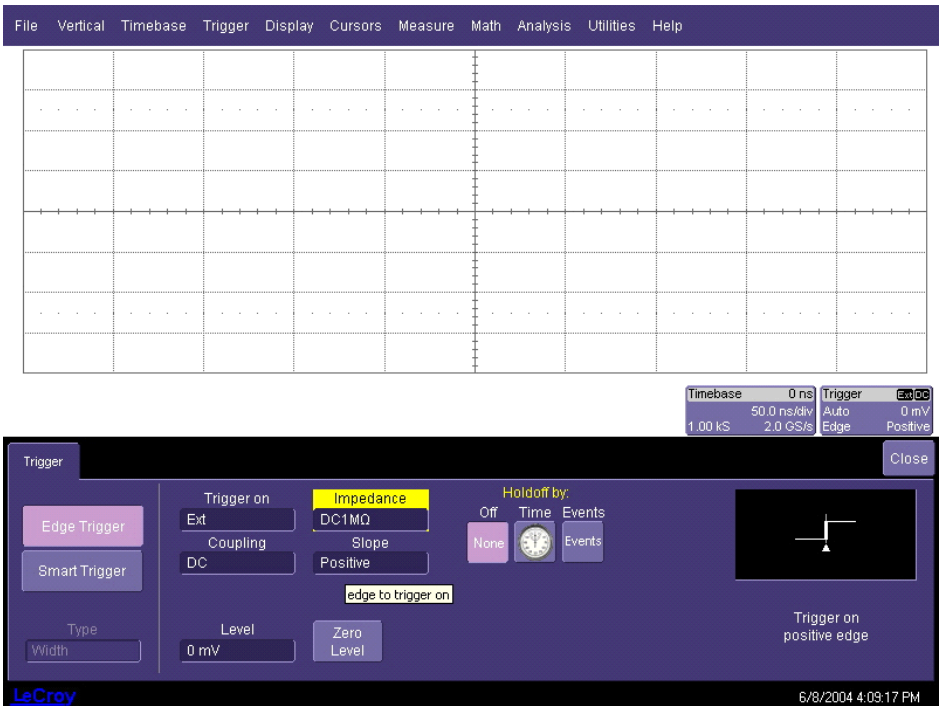
b. Ext DC 1MΩ Input Impedance

- Recall **Input Impedance - 1 Mohm DC Ext x1.lss** or configure the DSO :

  Select Setup trigger

  Trigger on : **EXT**

  Impedance : **DC 1MΩ**



- Connect the DMM to External, and measure the **input impedance**.
- **Record** the input impedance in Table 2, and compare the result to the limit in the test record.
- Recall **Input Impedance - 1 Mohm DC Ext x10.lss** or Set Trigger Source to **Ext/10.**
- Repeat the test for all input channels.
- Record the measurements in Table 2, and compare the test results to the limits in the test record.

5.5 Leakage Current

Specifications

DC 50Ω, EXT DC 50Ω : ±0.5 mV
DC 1MΩ, EXT DC 1MΩ : ±1.0 mV

The leakage current is tested by measuring the voltage across the input channel.

5.5.1 Channel Leakage Current

a. DC 50Ω

- Recall **Leakage - 50 ohm x1.lss** or configure the DSO :

Panel Setups	:	**Recall FROM DEFAULT SETUP**
Channels Trace ON		**Channel 1, Channel 2, Channel 3 & Channel 4**
Input Coupling	:	**DC 50Ω** on all 4 Channels
Input gain	:	**20 mV/div.** on all 4 Channels
Trigger mode	:	**Auto**
Time base	:	**50 nsec/div.**

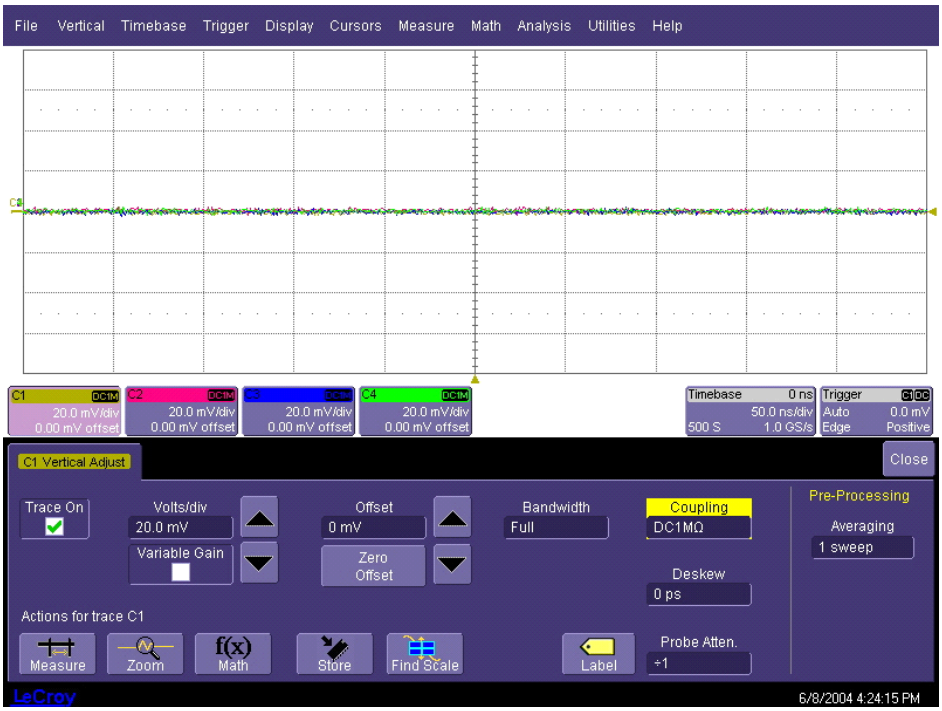
- Set the DMM to measure Volts, and connect it to Channel 1.
- Measure the **voltage** and enter it in Table 3. Compare it to the limits.
- Repeat the test for all input channels.
- Recall **Leakage - 50 ohm x10.lss** or set Input gain to **200 mV/div.** on all 4 Channels
- Repeat the test for all input channels. Record the measurements in Table 3, and compare the results to the limits in the test record.
- Recall **Leakage - 50 ohm x100.lss** or set Input gain to **2 V/div.** on all 4 Channels
- Repeat the test for all input channels. Record the measurements in Table 3, and compare the results to the limits in the test record.

b. DC 1MΩ

- Recall **Leakage - 1 Mohm x1.lss** or configure the DSO :

Panel Setups	:	**Recall FROM DEFAULT SETUP**
Channels Trace ON		**Channel 1, Channel 2, Channel 3 & Channel 4**
Input Coupling	:	**DC 1MΩ** on all 4 Channels
Input gain	:	**20 mV/div.** on all 4 Channels
Trigger mode	:	**Auto**
Time base	:	**50 nsec/div.**

- Set the DMM to measure Volts, and connect it to Channel 1.
- Measure the **voltage** and enter it in Table 3. Compare it to the limits.



- Repeat the test for all input channels.
- Recall **Leakage - 1 Mohm x10.lss** or set Input gain to **200 mV/div.** on all 4 Channels
- Repeat the test for all input channels. Record the measurements in Table 3, and compare the results to the limits in the test record.
- Recall **Leakage - 1 Mohm x1.lss** or set Input gain to **2 V/div.** on all 4 Channels
- Repeat the test for all input channels. Record the measurements in Table 3, and compare the results to the limits in the test record.

5.5.2 External Trigger Leakage Current

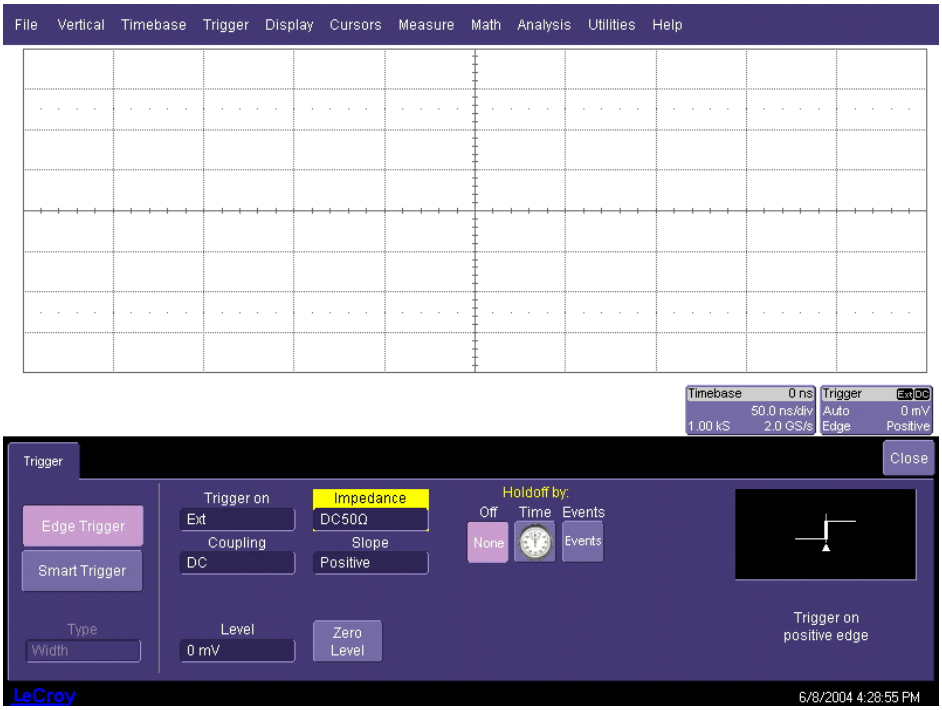
a. DC 50Ω

- Recall **Leakage - 50 ohm ext x1.lss** or configure the DSO:

  Panel Setups : **Recall FROM DEFAULT SETUP**
  Channels Trace OFF **Channel 1, Channel 2, Channel 3 & Channel 4**

  Select Setup trigger
  Set Trigger on : **EXT**

  Impedance : **DC 50Ω**



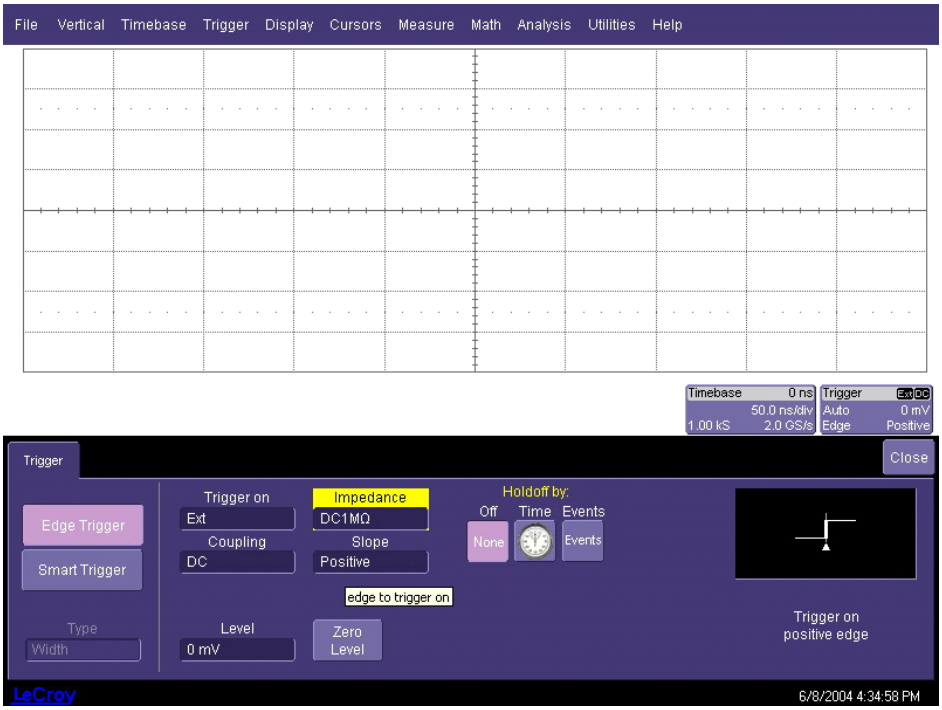
- Connect the DMM to External.
- Measure the **voltage** and enter it in Table 3. Compare it to the limits.
- Recall **Leakage - 50 ohm ext x10.lss** or Set Trigger Source to **Ext/10.**
- Repeat the test.
- Record the measurements in Table 3, and compare the test results to the limits in the test record.

b. DC 1MΩ

- Recall **Leakage – 1 Mohm ext x1.lss** or configure the DSO as shown in 5.5.2.a and make the following changes:

  Select Setup trigger
  Set Trigger on : **EXT**

  External : **DC 1MΩ**



- Connect the DMM to External.
- Measure the **voltage** and enter it in Table 3. Compare it to the limits.
- Recall **Leakage - 1 Mohm ext x10.lss** or Set Trigger Source to **Ext/10.**
- Repeat the test.
- Record the measurements in Table 3, and compare the test results to the limits in the test record.

5.6 Peak-Peak Noise Level

Description

Noise tests with open inputs are executed on all channels with 1 MΩ input coupling, 0 mV offset, at a gain setting of 2 mV/div and 10 mV/div. The scope parameters functions are used to measure the Peak to Peak amplitude of the noise.

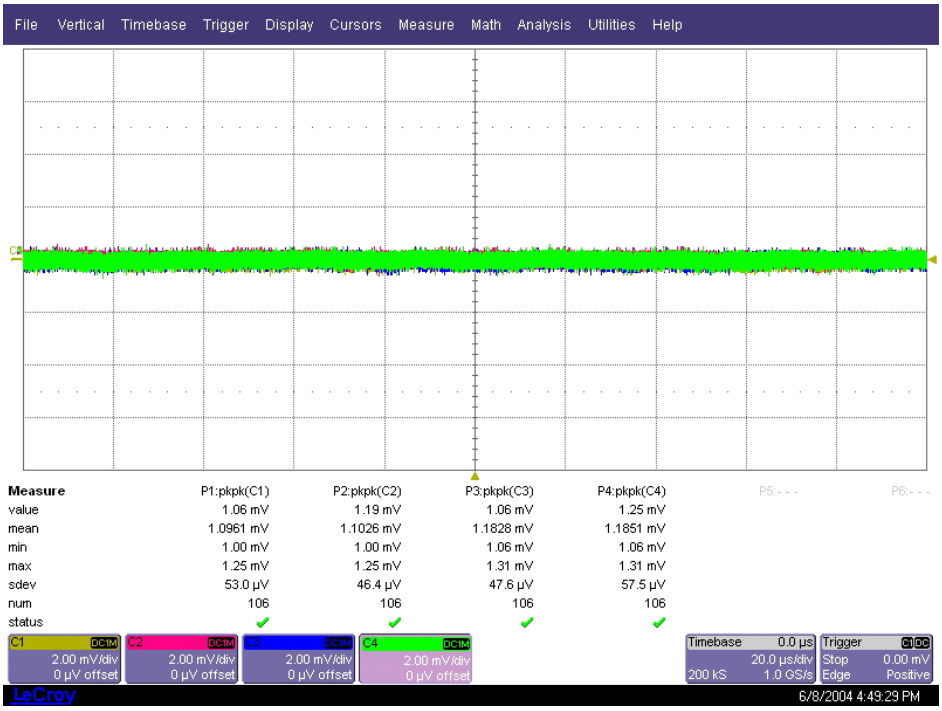
Specifications

1.6 mV Peak-Peak at 2 mV/div.
3.8 mV Peak-Peak at 10 mV/div.

With no signal connected to the inputs

- Recall **Noise - 2mv.lss** or configure the DSO :

Panel Setups	:	**Recall FROM DEFAULT SETUP**
Channels Trace ON		**Channel 1, Channel 2, Channel 3 & Channel 4**
Input Coupling	:	**DC 1M0Ω** on all 4 Channels
Input gain	:	**2 mV/div.** on all 4 Channels
Input offset	:	**0.0 mV** on all 4 Channels
Trigger setup	:	**Edge**
Trigger on	:	**Line**
Trigger Mode	:	**Auto**
Time base	:	**20 µsec/div.**
Press	:	**Measure, Measure Setup**
Statistics	:	**On**
P1	:	**Mean C1**
P2	:	**Mean C2**
P3	:	**Mean C3**
P4	:	**Mean C4**



- Press **Clear Sweeps.**

- Measure for at least **50 sweeps**, and then press **Stop** to halt the acquisition.

- Record the four **mean** parameter values in Table 4, and compare the test results to the limits in the test record.

- Recall **Noise - 10mv.lss** or set Input gain to **10 mV/div.** on all 4 Channels

- Record the measurements (**mean** of 1,2,3,4) in Table 4, and compare the results to the limits in the test record.

5.7 DC Accuracy

Specification

≤ ±1.5 % of reading + 1.0% of FS + 1mV full scale with 0 mV offset.

Description

This test measures the DC Accuracy within the gain range specified.
It requires a DC source with a voltage range of 0 V to 6 V adjustable in steps of no more than 15 mV, and a calibrated DMM that can measure voltage to 0.1 %. Measurements are made using voltage values applied by the external voltage reference source, measured by the DMM, and in the oscilloscope using the parameters Mean. For each known input voltage, the deviation is checked against the tolerance.

5.7.1 Positive DC Accuracy

Procedure

- Recall **DC accuracy - 50 ohm 2mv.lss** or configure the DSO :

Panel Setups	:	**Recall FROM DEFAULT SETUP**
Channels Trace ON		**Channel 1, Channel 2, Channel 3 & Channel 4**
Input Coupling	:	**DC 50Ω** or **DC 1MΩ** (see Table 5) on all 4 Ch
Input offset	:	**0.0 mV** on all 4 Channels
Input gain	:	from **1mV/div to 2 V/div (10V/div 1MΩ).** (see Table 5)
C1 Averaging	:	**10 sweeps**
C2 Averaging	:	**10 sweeps**
C3 Averaging	:	**10 sweeps**
C4 Averaging	:	**10 sweeps**
Trigger	:	**Edge Trigger**
Trigger on	:	**Line**
Mode	:	**Auto**
Time base	:	**1 µsec/div**.
Change parameters		
P1	:	**Measure mean of C1**
P2	:	**Measure mean of C2**
P3	:	**Measure mean of C3**
P4	:	**Measure mean of C4**

- Connect the test equipment as shown in Figure 5-2.

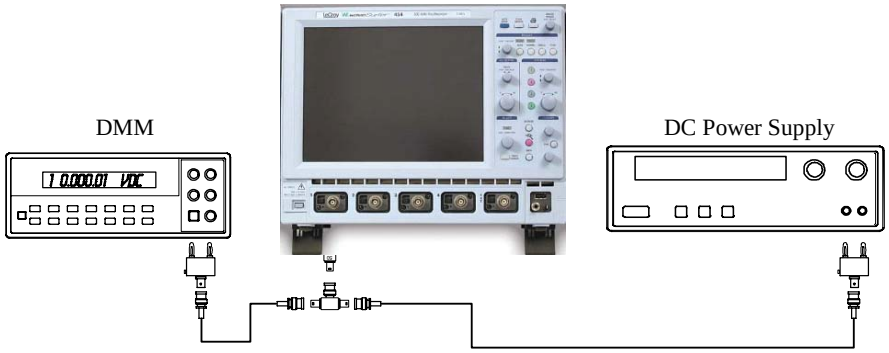


Figure 5-2 : DC Accuracy Equipment Setup

- For each **DSO Volts/div**, set the output of the external **DC voltage reference source** as shown in Table 5, column **PS output**.

  1) Connect the DMM and record the **voltage reading** in Table 5, column **DMM.**

  2) Disconnect the DMM from the BNC T connector.

  3) Press **Clear Sweeps**

  4) After 100 sweeps, read off the **DSO mean parameter**, and record the measurement in Table 5, column **Mean**.

- For each DC voltage applied to the DSO input, repeat parts 1), 2), 3) and 4).

- Calculate the **Difference (Δ)** by subtracting the **DMM voltage** reading from the **DSO mean** voltage reading. Record the test result in Table 5, and compare the **Difference (Δ)** to the corresponding limit in the test record.

- Repeat step 5.7.1.a. for the other channels, substituting channel controls and Input connector.


File Vertical Timebase Trigger Display Cursors Measure Math Analysis Utilities Help
C3
Measure P1:mean(C1) P2:mean(C2) P3:mean(C3) P4:mean(C4) P5:- - - P6:- - -
value 3.107 mV 43 µV 2 µV 41 µV
mean 3.09663 mV 34.58 µV 3.26 µV 37.78 µV
min 3.080 mV 21 µV -11 µV 20 µV
max 3.109 mV 46 µV 13 µV 49 µV
sdev 5.58 µV 6.26 µV 6.65 µV 6.07 µV
num 36 36 36 36
status
C1 1.00 mV/div 0 µV offset 37 #
C2 1.00 mV/div 0 µV offset 37 #
C3 1.00 mV/div 0 µV offset 37 #
C4 1.00 mV/div 0 µV offset 37 #
Timebase 0.00 µs 1.00 µs/div 10.0 kS 1.0 GS/s
Trigger Auto Edge Positive
C1 Vertical Adjust
Close
Trace On
Volts/div 1.00 mV
Variable Gain
Offset 0.0 mV
Zero Offset
Bandwidth Full
Coupling DC50Ω
Deskew 0 ps
Pre-Processing
Averaging 10 sweeps
Actions for trace C1
Measure Zoom f(x) Math Store Find Scale Label
Probe Atten. ÷1
LeCroy
7/8/2004 3:35:39 PM

5.7.2 Negative DC Accuracy

- Recall **DC accuracy - 50 ohm 2mv.lss** or configure the DSO as shown in 5.7.1.
- Connect the test equipment as shown in Figure 5-2.
- For each **DSO Volts/div**, set the output of the external **DC voltage reference source** as shown in Table 6, column PS output. (if a banana-BNC adapter is being used it can simply be turned to get the opposite polarity)

1) Connect the DMM and record the **voltage reading** in Table 6, column **DMM.**
2) Disconnect the DMM from the BNC T connector.
3) Press **Clear Sweeps**
4) After 100 sweeps, read off the **DSO mean parameter**, and record the measurement in Table 6, column **Mean**.

- For each DC voltage applied to the DSO input, repeat parts 1), 2), 3) and 4).
- Calculate the **Difference (Δ)** by subtracting the **DMM voltage** reading from the **DSO mean** voltage reading. Record the test result in Table 6, and compare the **Difference (Δ)** to the corresponding limit in the test record.
- Repeat step 5.7.2. for the other channels, substituting channel controls and input connector.

5.8 Offset Accuracy

Specifications

±(1.0% of offset + .5% of FS + 1mv)

Description

The offset test is done at 50 mV/div, with a signal of ±0.750 Volt cancelled by an offset of the opposite polarity.

5.8.1 Positive Offset Accuracy

Procedure

- Recall **Offset - Positive.lss** or configure the DSO:

Panel Setups	:	**Recall FROM DEFAULT SETUP**
Channels Trace ON		**Channel 1, Channel 2, Channel 3 & Channel 4**
Input Coupling	:	**DC 50Ω** on all 4 Channels
Input gain	:	**50mV/div** on all 4 Channels
Input offset	:	**+0.750 Volt** on all 4 Channels
C1 Averaging	:	**10 sweeps**
C2 Averaging	:	**10 sweeps**
C3 Averaging	:	**10 sweeps**
C4 Averaging	:	**10 sweeps**
Trigger setup	:	**Edge**
Trigger on	:	**Line**
Mode	:	**Auto**
Time base	:	**1 µsec/div**.
Statistics	:	**on**
Change parameters		
P1	:	**Measure mean of C1**
P2	:	**Measure mean of C2**
P3	:	**Measure mean of C3**
P4	:	**Measure mean of C4**

- Connect the test equipment as shown in Figure 5-2.

- Set the output of the external **DC voltage reference source until the DVM measures –0.750 Volt.**

  1) Verify that the displayed trace A : Average (1) is on the screen, near the center horizontal graticule line. If the trace is not visible, modify the **DC voltage reference source output** until the trace is within ± 2 divisions of center.

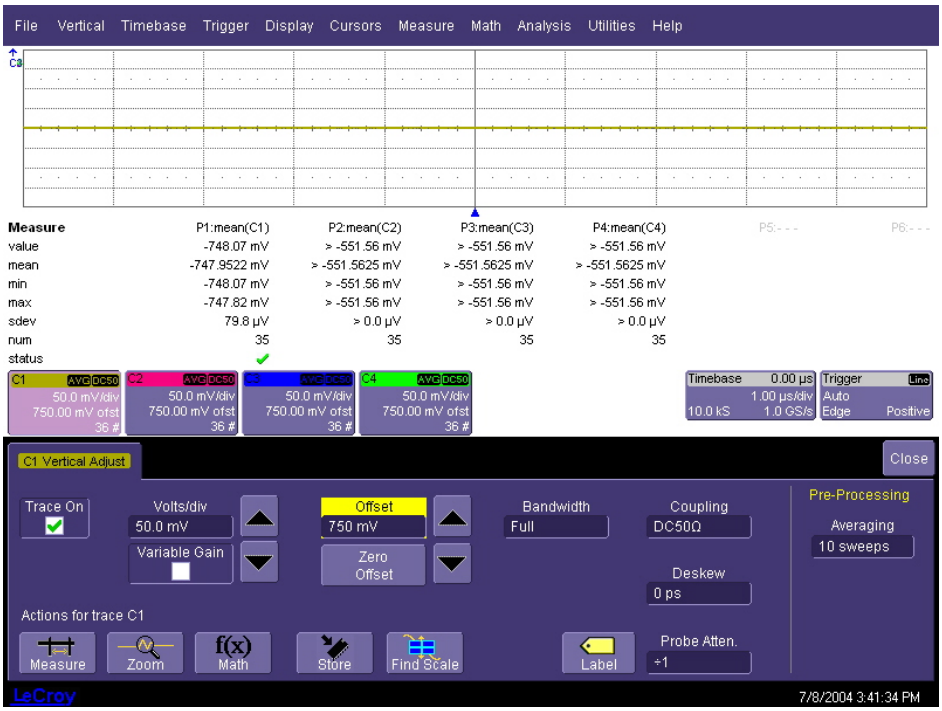
  2) Connect the DMM and record the **voltage reading** in Table 7, column **DMM**.

  3) Disconnect the DMM from the BNC T connector.

4) Press **Clear Sweeps**

5) After 100 sweeps, Read off the DSO Mean parameter voltage, and record the measurement in Table 7, column Mean.

- Repeat the test for the other channels, substituting channel controls and input connector. Record the measurements in Table 7.



- Calculate the **Difference (Δ)** by subtracting the **DMM voltage** reading from the **DSO mean** voltage reading.

- Record the test result in Table 7, and compare the **Difference (Δ)** to the corresponding limit in the test record.

5.8.2 Negative Offset Accuracy

Procedure

- Recall **Offset - Negative.lss** or configure the DSO as shown in 5.8.1 and for each channel make the following change :

  Input offset : **–0.750 Volt** on all 4 Channels

- Connect the test equipment as shown in Figure 5-2.

- Set the output of the external **DC voltage** reference source until the DMM measures +0.750 Volt.

  1) Verify that the displayed trace A : Average (1) is on the screen, near the center horizontal graticule line. If the trace is not visible, modify the **DC voltage reference source output** until the trace is within ± 2 divisions of center.

  2) Connect the DMM and record the **voltage reading** in Table 8, column **DMM**.

  3) Disconnect the DMM from the BNC T connector.

  4) Press **Clear Sweeps**

  5) After 100 sweeps, Read off the **DSO Mean parameter** voltage, and record the measurement in Table 8, column **Mean**.

- Repeat the test for the other channels, substituting channel controls and input connector. Record the measurements in Table 8.

- Calculate the **Difference (Δ)** by subtracting the **DMM voltage** reading from the **DSO mean** voltage reading. Record the test result in Table 8, and compare the **Difference (Δ)** to the corresponding limit in the test record.

5.9 Bandwidth

5.9.1 Description

The purpose of this test is to ensure that the entire system has a bandwidth of at least 500 MHz for a WaveSurfer 45x, 350 MHz for a WaveSurfer 43x and 200 MHz for a WaveSurfer 42x. An external source is used as the reference to provide a signal where amplitude and frequency are well controlled.
The amplitude of the generator and cable as a function of frequency and power is calibrated using a HP8482A power sensor, and HP437B power meter or equivalent. Note: If a leveled generator is used then the corrections needed by using the power meter may not be necessary.

Specifications

WaveSurfer 45x
50Ω : DC to at least 500 MHz (-3 dB)

WaveSurfer 43x
50Ω : DC to at least 350 MHz (-3 dB)

WaveSurfer 42x
50Ω : DC to at least 200 MHz (-3 dB)

- Recall **Bandwidth - CH1 10mv.lss** or configure the DSO:

Panel Setups	:	**Recall FROM DEFAULT SETUP**
Channels Trace ON		**Channel 1**
Input Coupling	:	**DC 50Ω** on all 4 Channels
Input gain	:	**10 mV/div** on all 4 Channels
Input offset	:	**0 mV** on all 4 Channels
Trigger setup	:	**Edge**
Trigger on	:	**Line**
Mode	:	**Auto**
Time base	:	**50 ηsec/div**.
Change parameters		
P1	:	**PK-PK of C1**
P2	:	**Freq of C1**

- Connect the HP8482A power sensor to the power meter.

- Zero and **calibrate** the HP8482A power sensor using the power meter **Power Ref output**.

- Connect a **BNC adapter** to the HP8482A power sensor.

- Connect a 50Ω SMA cable to the **RF output** of the HP8648B generator and then through the necessary adapters to the power sensor. It is very important that the same cable/generator be used throughout this BW procedure and that the SMA connectors are torqued at all their mating locations.

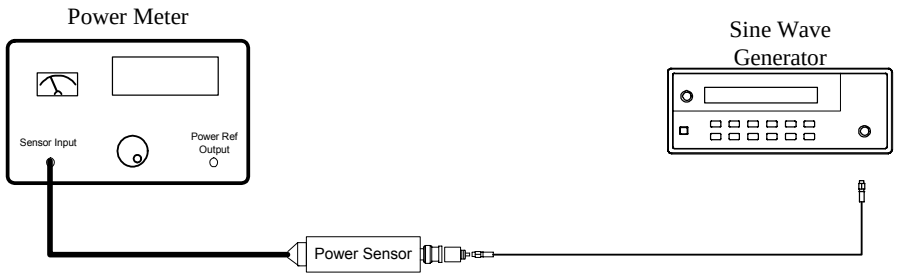


Figure 5-3 : Power Meter Equipment Setup

- Set the generator frequency to **10 MHz**

- Set the generator amplitude to measure **8 µW** on the power meter**.**

- Read the displayed **generator output amplitude,** and record it in the third column of Table 9.

- Repeat the above measurement for the model under test either**, 200.1 350.1 MHz & 500.1 MHz.** Record the generator output amplitude readout in the third column of Table 9.

- Disconnect the **RF output** of the HP8648B generator from the power sensor.

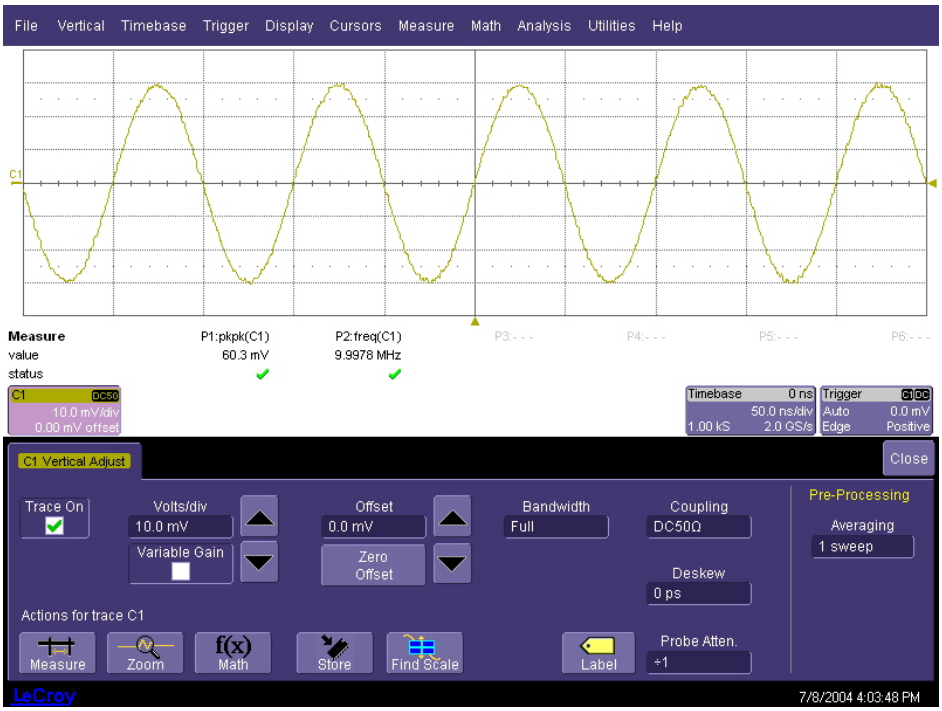
- Connect the **RF output** of the HP8648B generator through the same cable that was calibrated in the previous step into Channel 1 and connect any attenuators as listed in the table.

Figure 5-4 : 50Ω Bandwidth Equipment Setup

- Set the generator frequency to **10 MHz**.

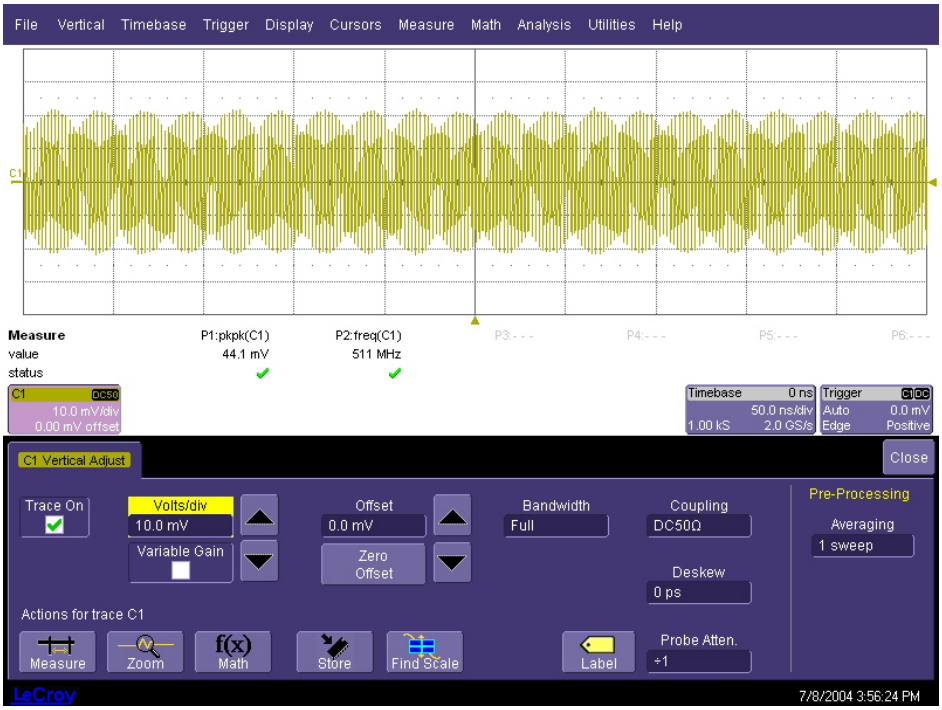
- From the generator, apply the **recorded generator signal amplitude** to Channel 1.

- Measure the value of **pkpk(1)** in Table 9.



- Increase the frequency of the generator to the maximum input frequency for that model, adjusting the amplitude so that the power remains constant and measure the value of pk-pk. Record in Table 9.

- Repeat the above 3 steps for Channel 2, (**Bandwidth – CH2 10mv.lss s**) Channel 3 (**Bandwidth – CH3 10mv.lss**) & Channel 4 (**Bandwidth – CH4 10mv.lss**) substituting channel controls and input connector. Record the measurements in Table 9.



- Calculate the ratio to 10 MHz for each channel, pk-pk$_{500.1}$/pk-pk$_{10}$ (for WaveSurfer 45X), pk-pk$_{350.1}$/pk-pk$_{10}$ (for WaveSurfer 43X), or pk-pk$_{200.1}$/pk-pk$_{10}$ (for WaveSurfer 42X) and compare the results to the limits in the test record.

- Repeat the above steps for V/div setting of 50 mV, 100 mV, and 500 mV, using the appropriate **Bandwidth - CHx vvmv.lss** (where x is channel and yy is V/div setting) panel setup and recording your results in Tables 10 through 12. Use the power setting and attenuators as shown in the tables.

5.10 Trigger Level

Specifications

+/- (3% of Trigger Level + 20% of sensitivity)

5.10.1 Description

The trigger capabilities are tested for several cases of the standard edge trigger:

- Channel (internal), and External Trigger sources
- Three DC levels: –2.5, 0, +2.5 major screen divisions
- Positive and negative slopes

5.10.2 Channel Trigger at 0 Division Threshold

Recall **Trigger - CH1 0 div pos slope.lss** or configure the DSO:

Panel Setups	:	**Recall FROM DEFAULT SETUP**
Channels Trace ON		**Channel 1, Channel 2, Channel 3 & Channel 4**
Input Coupling	:	**DC 50Ω** on all 4 Channels
Input gain	:	**100 mV/div.** on all 4 Channels
Input offset	:	**0 mV** on all 4 Channels (use show status to verify)
Trigger setup	:	**Edge**
Trigger on	:	**C1**
Slope	:	**Pos**
Mode	:	**Auto**
Set Trigger level	:	**DC 0.0 mV**
Pre-Trigger Delay	:	**50 %**
Time base	:	**200 ηsec/div.**
C1 Pre-Processing:		**Averaging 10 sweeps**
C2 Pre-Processing:		**Averaging 10 sweeps**
C3 Pre-Processing:		**Averaging 10 sweeps**
C4 Pre-Processing:		**Averaging 10 sweeps**
Measure P1	:	mean C1
Measure P2	:	mean C2
Measure P3	:	mean C3
Measure P4	:	mean C4
Gate Start	:	4.99 div
Gate Stop	:	5.01 div

- Set the output of the sine wave generator to **1 MHz.**

- Connect the output of the generator to Channel 1 through a 50 Ohm coaxial cable as shown in Figure 5-5 and adjust the sine wave output amplitude to get **90% of full scale.**

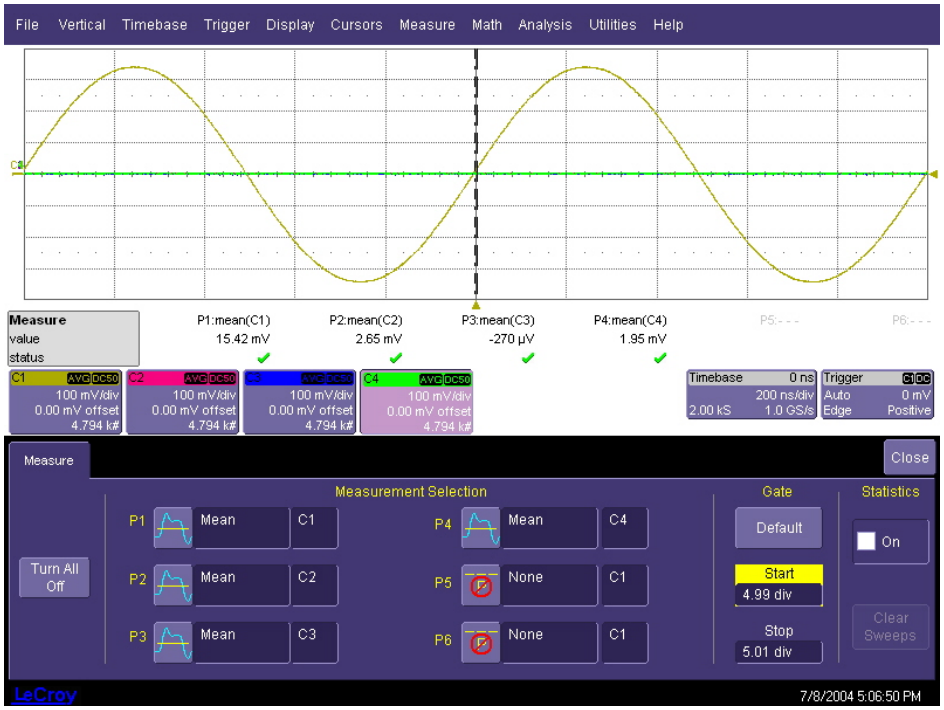
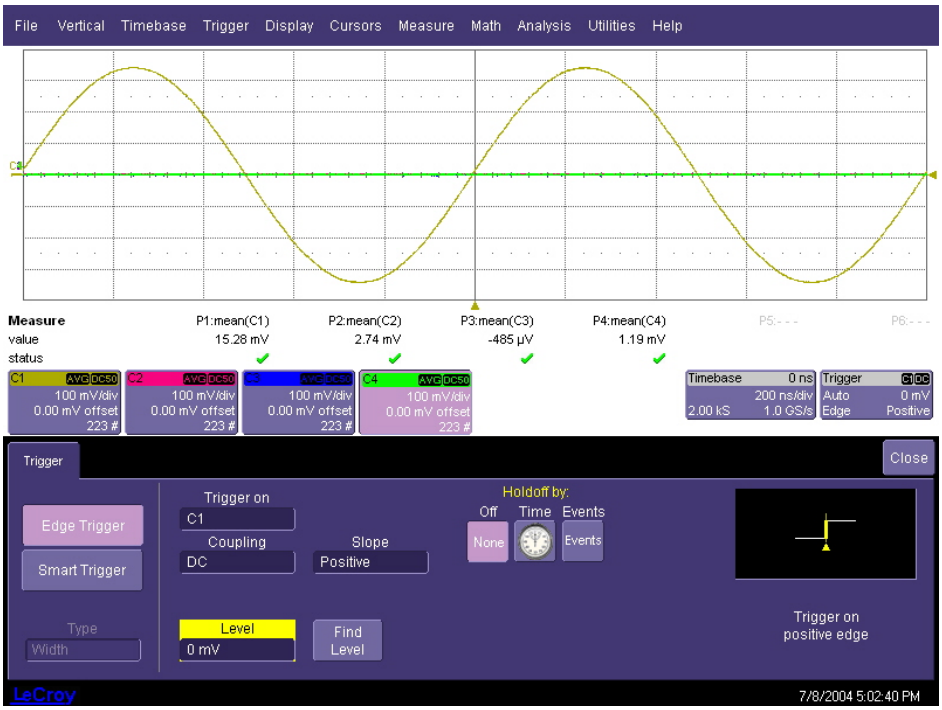
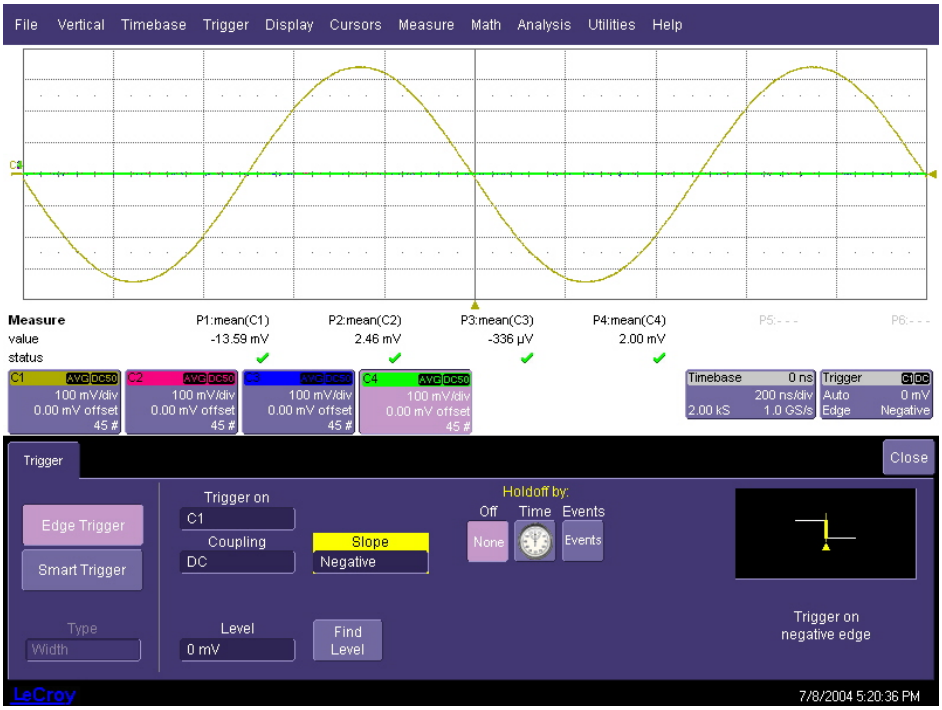


Figure 5-5 Channel Trigger Equipment Setup



- Press **Clear Sweeps**,
- Acquire 10 sweeps and record in Table 13 the **level** readout displayed below 100 mV in the icon **1,** at top left**.**
- Compare the test results to the corresponding limit in the test record.
- Set Trigger Slope 1 : **Neg**
- Acquire 10 sweeps and record in Table 13 the **level** readout displayed below 100 mV in the icon **1,** at top left**.**

- Set trigger to channels 2, 3 and 4 and for both POS and NEG slope, move input signal to appropriate channel and compare the test results to the corresponding limit in the test record.



5.10.3 Channel Trigger at +2.5 Divisions Threshold

- Recall **Trigger - CH1 +2.5 div pos slope.lss** or configure the DSO as shown in 5.10.2 and for each Channel make the following change :

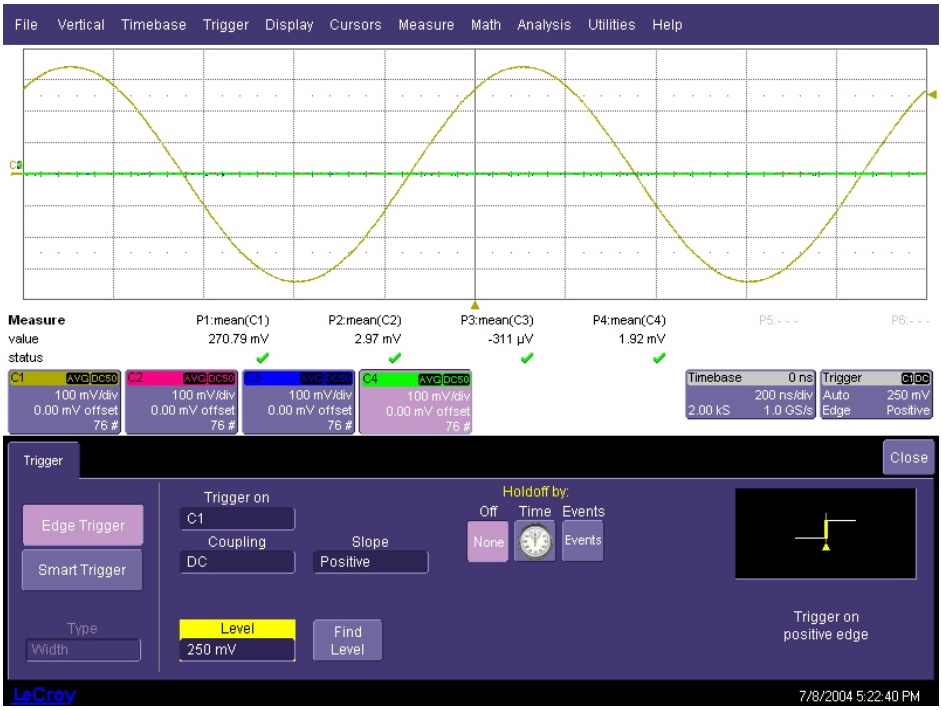
  Set Trigger level : **DC +250 mV**
  Trigger slope : **POS**

- Connect the output of the generator to Channel 1 through a 50 Ohm coaxial cable.

- Press **Clear Sweeps**,

- Acquire 10 sweeps and record in Table 13 the **level** readout displayed below 100 mV in the icon **1,** at top left**.**

- Compare the test results to the corresponding limit in the test record.



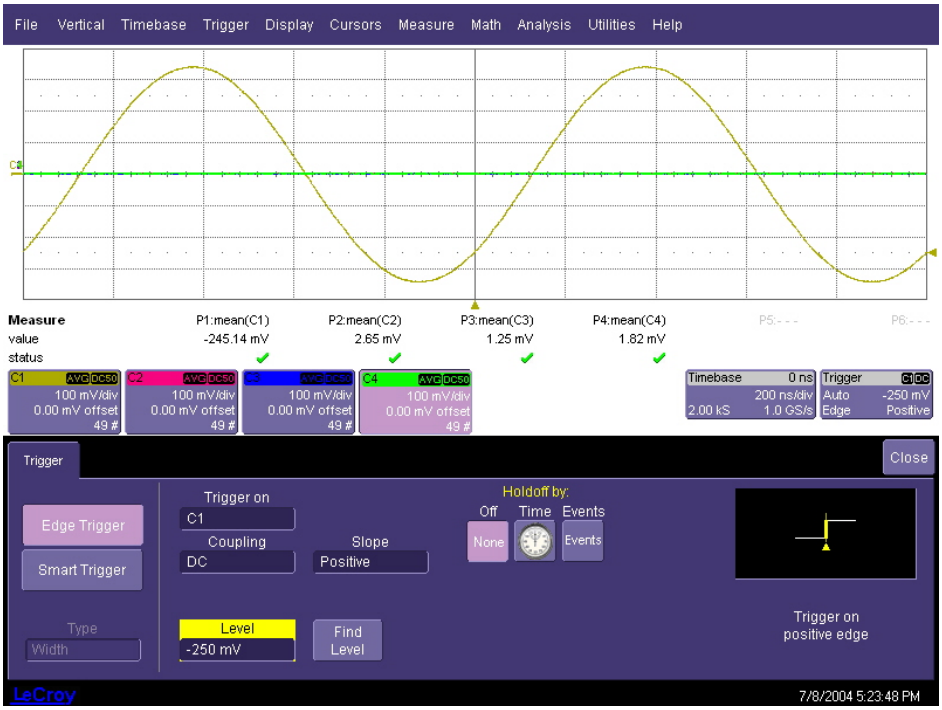
- Set Trigger Slope 1 : **Neg**
- Acquire 10 sweeps and record in Table 13 the **level** readout displayed below 100 mV in the icon **1,** at top left**.**
- Set trigger to channels 2, 3 and 4 and for both POS and NEG slope move input signal to appropriate channel and compare the test results to the corresponding limit in the test record.

5.10.4 Channel Trigger at –2.5 Divisions Threshold

- Recall **Trigger - CH1 -2.5 div pos slope.lss** or configure the DSO as shown in 5.10.2 and for each channel make the following change :

  Set Trigger level : **DC –250 mV**

- Connect the output of the generator to Channel 1 through a 50 Ohm coaxial cable.
- Press **Clear Sweeps**,
- Acquire 10 sweeps and record in Table 13 the **level** readout displayed below 100 mV in the icon **1,** at top left**.**



- Compare the test results to the corresponding limit in the test record.
- Set Trigger Slope 1 : **Neg**
- Acquire 10 sweeps and record in Table 13 the **level** readout displayed below 100 mV in the icon **1,** at top left**.**
- Set trigger to channels 2, 3 and 4 and for both POS and NEG slope move input signal to appropriate channel and compare the test results to the corresponding limit in the test record.

5.11 Time Base Accuracy

5.11.1 Description

An external sine wave generator of **10.0 MHz** with frequency accuracy better than 1 PPM is used.

Specifications

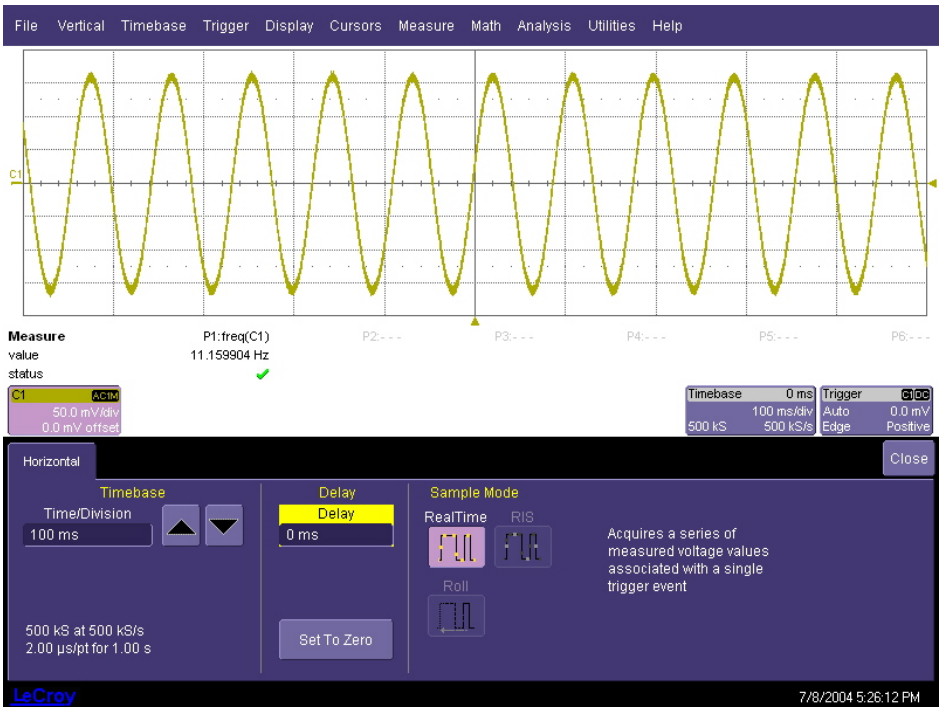
Clock : accuracy : ≤ ±**0.001 % or** ≤ ±**10 PPM**

5.11.2 Clock Verification Procedure

- Recall **Timebase Accuracy.lss** or configure the DSO

Panel Setups	:	**Recall FROM DEFAULT SETUP**
Channels trace ON		**Channel 1**
Input gain	:	**.1 V/div.**
Input offset	:	**0 mV**
Trigger setup	:	**Edge**
Trigger on	:	**C1**
Slope 1	:	**Pos**
Level 1	:	**0 mV**
Trigger mode	:	**Auto**
Delay	:	**50 %**
Time base	:	**100 msec/div.**
Measure	:	**Parameters**
P1	:	**Frequency of C1**

- Connect the **RF output** of the HP8648B generator through a 50 Ohm coaxial cable into Channel 1.
- Set the generator frequency to **10.0 MHz**.
- Adjust the generator output amplitude to get **6 divisions peak to peak.**
- Read of the frequency parameter (to 2 decimal places) and record the value in Table 14.
- Verify that the error is less than 100 Hz.


File Vertical Timebase Trigger Display Cursors Measure Math Analysis Utilities Help
C1
Measure
value
status
P1:freq(C1)
11.159904 Hz
P2:- - -
P3:- - -
P4:- - -
P5:- - -
P6:- - -
C1 ACIM
50.0 mV/div
0.0 mV offset
Timebase 0 ms
100 ms/div
500 kS 500 kS/s
Trigger C1 DC
Auto 0.0 mV
Edge Positive
Horizontal
Close
Timebase
Time/Division
100 ms
Delay
Delay
0 ms
Sample Mode
RealTime
RIS
Roll
Acquires a series of measured voltage values associated with a single trigger event
500 kS at 500 kS/s
2.00 µs/pt for 1.00 s
Set To Zero
LeCroy
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LeCroy Digital Storage Oscilloscope

Performance Certificate

WaveSurfer 400 Manual Performance Test Procedure Version D – Sept 2007

Model_____ Serial Number_____ Customer_____

Software Version_____

Inspection Date_____ Next Due_____

Temperature_____ Humidity_____%

Tested By_____ Report Number_____

Place of Inspection_____

Condition found_____ Condition Left_____

Approved By_____

Test Equipment Used

Instrument	Model	S/N	Cal Due Date
Signal Generator Radio Frequency			
Signal Generator Audio Frequency			
Voltage Generator DC Power Supply			
Digital Multimeter			
Power Meter			
Power Senser			

Traceable to_____

Table 1: WaveSurfer Test Report

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Coupling	Volts/div.	Measured Channel 1 Impedance Ω, MΩ	Measured Channel 2 Impedance Ω, MΩ	Measured Channel 3 Impedance Ω, MΩ	Measured Channel 4 Impedance Ω, MΩ	Measured External Impedance Ω, MΩ	Lower Limit Ω, MΩ	Upper Limit Ω, MΩ
DC 1MΩ	20 mV/div						0.990 MΩ	1.010 MΩ
DC 1MΩ	200 mV/div						0.990 MΩ	1.010 MΩ
DC 1MΩ	2 V/div						0.990 MΩ	1.010 MΩ
AC 1MΩ	20 mV/div						1.188 MΩ	1.212 MΩ
DC 50Ω	20 mV/div						49.5 Ω	50.5 Ω
DC 50Ω	200 mV/div						49.5 Ω	50.5 Ω
DC 50Ω	2 V/div						49.5 Ω	50.5 Ω
Ext DC 50Ω							49.5 Ω	50.5 Ω
Ext/10 DC 50Ω							49.5 Ω	50.5 Ω
Ext DC 1MΩ							0.990 MΩ	1.010 MΩ
Ext/10 DC 1MΩ							0.990 MΩ	1.010 MΩ

Table 2: Impedance Test Record

Coupling	Volts/div.	Measured Channel 1 Leakage mV	Measured Channel 2 Leakage mV	Measured Channel 3 Leakage mV	Measured Channel 4 Leakage mV	Measured External Leakage mV	Lower Limit mV	Upper Limit mV
DC 1MΩ	20 mV/div						–1	+1
DC 1MΩ	200 mV/div						–1	+1
DC 1MΩ	2 V/div						–1	+1
DC 50Ω	20 mV/div						–0.5	+0.5
DC 50Ω	200 mV/div						–0.5	+0.5
DC 50Ω	2 V/div						–0.5	+0.5
Ext DC 50Ω							–0.5	+0.5
Ext/10 DC 50Ω							–0.5	+0.5
Ext DC 1MΩ							–1	+1
Ext/10 DC 1MΩ							–1	+1

Table 3: Leakage Voltage Test Record

Coupling	V/Div.	Measured pkpk - mean Channel 1 mV	Measured pkpk - mean Channel 2 mV	Measured pkpk - mean Channel 3 mV	Measured pkpk - mean Channel 4 mV	Limits pk-pk mV
DC 1MΩ	2 mV					1.6
DC 1MΩ	10 mV					3.8

Table 4: Peak to Peak Noise Test Record
(Record the mean value)

Volts /div.	P S	Cpl	Measured Channel 1 V & mV			Measured Channel 2 V & mV			Measured Channel 3 V & mV			Measured Channel 4 V & mV			Limits
	V		DMM 1	Mean (A)	Δ 1 Mean– DMM	DMM 2	Mean (B)	Δ 2 Mean– DMM	DMM 3	Mean (C)	Δ 3 Mean– DMM	DMM 4	Mean (D)	Δ 4 Mean– DMM	mV
2 mV	+6m	50Ω													±1.25
5 mV	+15m	50Ω													±1.625
10 mV	+30m	50Ω													±2.25
.1 V	+0.3	50Ω													±13.5
1 V	+3.0	50Ω													±126
2 V	+6.0	1MΩ													±251

Table 5: Positive DC Accuracy Test Record

Volts /div.	P S	Cpl	Measured Channel 1 V & mV			Measured Channel 2 V & mV			Measured Channel 3 V & mV			Measured Channel 4 V & mV			Limits
	V		DMM 1	Mean (A)	Δ 1 Mean– DMM	DMM 2	Mean (B)	Δ 2 Mean– DMM	DMM 3	Mean (C)	Δ 3 Mean– DMM	DMM 4	Mean (D)	Δ 4 Mean– DMM	mV
2 mV	-6m	50Ω													±1.25
5 mV	-15m	50Ω													±1.625
10 mV	-30m	50Ω													±2.25
.1 V	-0.3	50Ω													±13.5
1 V	-3.0	50Ω													±126
2 V	-6.0	1MΩ													±251

Table 6: Negative DC Accuracy Test Record

Volt /div.	Coupling DC	DSO Offset V	P S Output V	Measured Channel 1 V & mV			Measured Channel 2 V & mV			Measured Channel 3 V & mV			Measured Channel 4 V & mV			Limits
				DMM 1	Mean (A)	Δ 1 Mean– DMM	DMM 2	Mean (B)	Δ 2 Mean– DMM	DMM 3	Mean (C)	Δ 3 Mean– DMM	DMM 4	Mean (D)	Δ 4 Mean– DMM	mV
50mV	50 Ω	+.750	–.750													±10.5

Table 7: Positive 50Ω Offset Test Record

Volt /div.	Coupling DC	DSO Offset V	P S Output V	Measured Channel 1 V & mV			Measured Channel 2 V & mV			Measured Channel 3 V & mV			Measured Channel 4 V & mV			Limits
				DMM 1	Mean (A)	Δ 1 Mean– DMM	DMM 2	Mean (B)	Δ 2 Mean– DMM	DMM 3	Mean (C)	Δ 3 Mean– DMM	DMM 4	Mean (D)	Δ 4 Mean– DMM	mV
50mV	50 Ω	+.750	–.750													±10.5

Table 8: Negative 50Ω Offset Test Record

Frequency	Measured Power	Generator Amplitude	Measured Channel 1		Measured Channel 2		Measured Channel 3		Measured Channel 4		Lower Limit
MHz	µW	mV	pk-pk(1) mV	Ratio(1) to 10	pk-pk (2) mV	Ratio(2) to 10	pk-pk(3) mV	Ratio(3) to 10	pk-pk(4) mV	Ratio(4) to 10	
10	8.0			N/A		N/A		N/A		N/A	N/A
200.1 (WS 42X)	8.0										0.707
350.1 (WS 43X)	8.0										0.707
500.1 (WS 45X)	8.0										0.707

Table 9: DC 50Ω, 10 mV/div. Bandwidth Test Record

Frequency	Measured Power	Generator Amplitude	Measured Channel 1		Measured Channel 2		Measured Channel 3		Measured Channel 4		Lower Limit
MHz	mW	mV	pk-pk(1) mV	Ratio(1) to 10	pk-pk(2) mV	Ratio(2) to 10	pk-pk(3) mV	Ratio(3) to 10	pk-pk(4) mV	Ratio(4) to 10	
10	0.4			N/A		N/A		N/A		N/A	N/A
200.1 (WS 42X)	0.4										0.707
350.1 (WS 43X)	0.4										0.707
500.1 (WS 45X)	0.4										0.707

Table 10: DC 50Ω, 50 mV/div. Bandwidth Test Record

Frequency	Measured Power	Generator Amplitude	Measured Channel 1		Measured Channel 2		Measured Channel 3		Measured Channel 4		Lower Limit
MHz	mW	mV	pk-pk(1) mV	Ratio(1) to 10	pk-pk(2) mV	Ratio(2) to 10	pk-pk(3) mV	Ratio(3) to 10	pk-pk(4) mV	Ratio(4) to 10	
10	0.8			N/A		N/A		N/A		N/A	N/A
200.1 (WS 42X)	0.8										0.707
350.1 (WS 43X)	0.8										0.707
500.1 (WS 45X)	0.8										0.707

Table 11: DC 50Ω, 100 mV/div. Bandwidth Test Record

Frequency	Measured Power	Generator Amplitude	Measured Channel 1		Measured Channel 2		Measured Channel 3		Measured Channel 4		Lower Limit
MHz	mW	mV	pk-pk(1) mV	Ratio(1) to 10	pk-pk(2) mV	Ratio(2) to 10	pk-pk(3) mV	Ratio(3) to 10	pk-pk(4) mV	Ratio(4) to 10	
10	20.0			N/A		N/A		N/A		N/A	N/A
200.1 (WS 42X)	20.0										0.707
350.1 (WS 43X)	20.0										0.707
500.1 (WS 45X)	20.0										0.707

Table 12: DC 50Ω, 500 mV/div. Bandwidth Test Record

Trigger Level	Trigger Slope	Channel 1	Channel 2	Channel 3	Channel 4	Lower Limit	Upper Limit
mV		Measured DC Trigger Level (1) mV	Measured DC Trigger Level (2) mV	Measured DC Trigger Level (3) mV	Measured DC Trigger Level (4) mV	mV	mV
0	Pos					−27.5	+27.5
0	Neg					−27.5	+27.5
+250	Pos					+222.5	+277.5
+250	Neg					+222.5	+277.5
−250	Pos					-277.5	-222.5
−250	Neg					-277.5	-222.5

Table 13: Channel DC Trigger Test Record

Generator Frequency MHz	Freq. (Hz)	Lower Limit	Upper Limit
10.0		-100	+100

Table 14: Time Base Test Record

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6. Maintenance

6.1 Introduction

This section contains information necessary to disassemble, assemble, maintain, calibrate and troubleshoot the LeCroy WaveSurfer 400.

6.1.1 Safety Precautions

The  symbol used in this manual indicates dangers that could result in personal injury.

The  symbol used in this manual identifies conditions or practices that could damage the instrument.

 The following servicing instructions are for use by qualified personnel only. Do not perform any servicing other than contained in service instructions. Refer to procedures prior to performing any service.

 Exercise extreme safety when testing high energy power circuits. Always turn the power OFF, disconnect the power cord and discharge all capacitors before disassembling the instrument.

6.1.2 Anti-static Precautions

 Any static charge that builds on your person or clothing may be sufficient to destroy CMOS components, integrated circuits, Gate array's.....etc.

In order to avoid possible damage, the usual precautions against static electricity are required.

- Handle the boards in anti-static boxes or containers with foam specially designed to prevent static build-up.
- Ground yourself with a suitable wrist strap.
- Disassemble the instrument at a properly grounded work station equipped with anti-static mat.
- When handling the boards, do not touch the pins.
- Stock the boards in anti-static bags.

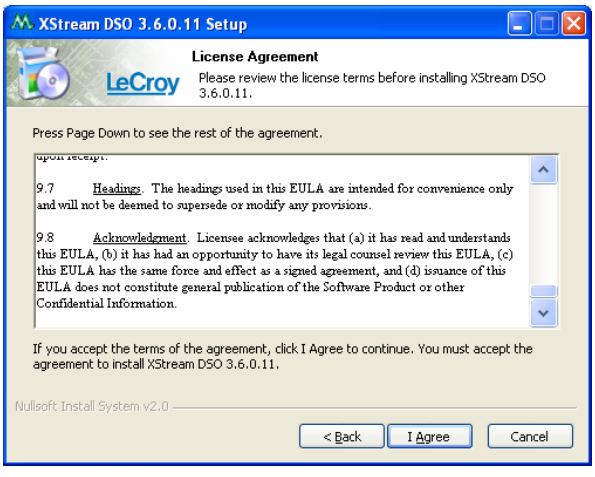
6.3 Software Update Procedure

6.3.1 Installing New X-Stream DSO Application Software

In order to load new X-Stream DSO software the system must be capable of booting up to the Windows desktop.

- If the XStream application is running, exit it through the File, Exit menu option.
- Connect an external USB-CD ROM or USB Memory Stick containing the version to be installed into the CD ROM drive.
- From the windows desktop, select My Computer, then select the storage device.
- Launch XStreamDSOInstallerx.x.x.x.exe (where x.x.x.x is the version number) application.

- Press Next, You will be prompted to read and accept the software license agreement.



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9.1 Compliance with Laws. You will comply with all laws, legislation, rules, regulations, and governmental requirements with respect to the Software Product, and the performance by you of your obligations hereunder, of any jurisdiction in or from which you directly or indirectly cause the Software Product to be used or accessed.

9.2 No Agency. Nothing contained in this EULA will be deemed to constitute either party as the agent or representative of the other party, or both parties as joint venturers or partners for any purpose.

9.3 Entire Agreement; Waiver; Severability. This EULA constitutes the entire agreement between the parties with regard to the subject matter hereof. No provision of, right, power or privilege under this EULA will be deemed to have been waived by any act, delay, omission or acquiescence by LeCroy, its agents, or employees, but only by an instrument in writing signed by an authorized officer of LeCroy. No waiver by LeCroy of any breach or default of any provision of this EULA by you will be effective as to any other breach or default, whether of the same or any other provision and whether occurring prior to, concurrent with, or subsequent to the date of such waiver. If any provision of this EULA is declared by a court of competent jurisdiction to be invalid, illegal or unenforceable, such

provision will be severed from this EULA and all the other provisions will remain in full force and effect.

9.4 Governing Law; Jurisdiction; Venue. This EULA will be governed by and construed in accordance with the laws of the State of New York, USA, without regard to its choice of law provisions. The United Nations Convention on Contracts for the International Sale of Goods will not apply to this EULA. Exclusive jurisdiction and venue for any litigation arising under this EULA is in the federal and state courts located in New York, New York, USA and both parties hereby consent to such jurisdiction and venue for this purpose.

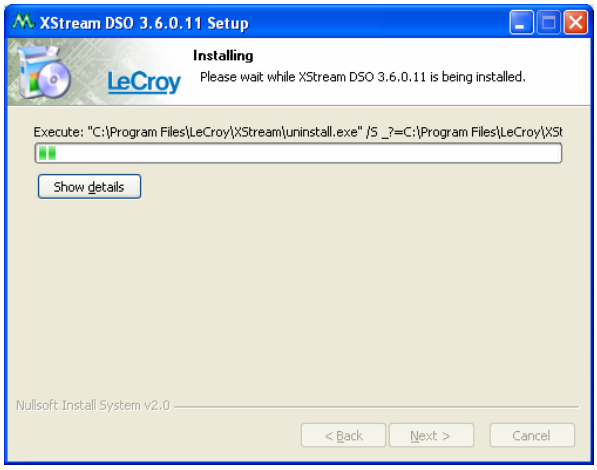
9.5 Assignment. This EULA and the rights and obligations hereunder, may not be assigned, in whole or in part by you, except to a successor to the whole of your business, without the prior written consent of LeCroy. In the case of any permitted assignment or transfer of or under this EULA, this EULA or the relevant provisions will be binding upon, and inure to the benefit of, the successors, executors, heirs, representatives, administrators and assigns of the parties hereto.

9.6 Notices. All notices or other communications between LeCroy and you under this EULA will be in writing and delivered personally, sent by confirmed fax, by confirmed e-mail, by certified mail, postage prepaid and return receipt requested, or by a nationally recognized express delivery service. All notices will be in English and will be effective upon receipt.

9.7 Headings. The headings used in this EULA are intended for convenience only and will not be deemed to supersede or modify any provisions.

9.8 Acknowledgment. Licensee acknowledges that (a) it has read and understands this EULA, (b) it has had an opportunity to have its legal counsel review this EULA, (c) this EULA has the same force and effect as a signed agreement, and (d) issuance of this EULA does not constitute general publication of the Software Product or other Confidential Information.

- Accept the agreement and press Next. The software installation process will begin and a progress bar will be displayed. Wait until completion.



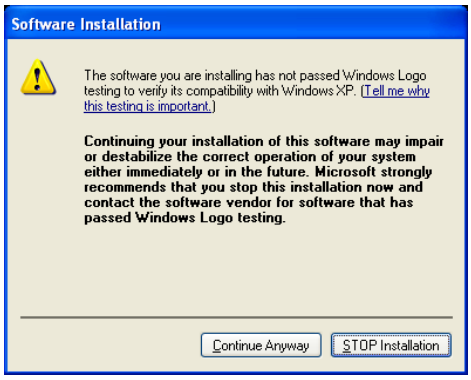
- At the completion on the software installation you will receive a dialog box as shown below:

- The check box should be checked to install the Windows device drivers and to upgrade the Microcode in the instrument.

6.3.3 Installing Device Drivers

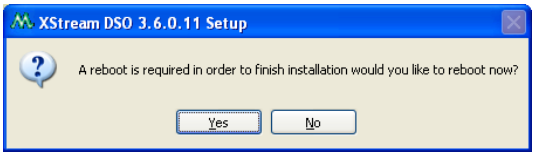
- Pressing finish will first install the device drivers. Displayed will be a dialog box as shown below:

- Press Install, an error message box may appear as shown below:



- Press Continue Anyway, you may receive several more of the same dialog boxes, accept each one.

- After this is complete you may be prompted to reboot:



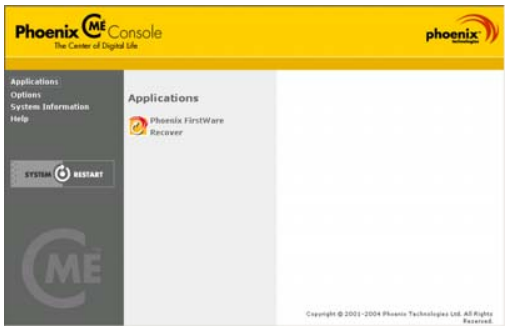
- The XStream DSO application should automatically begin after power has been restored and after Windows has finished booting up. As the XstreamDSO application is launching the screen will appear as:

6.3.4 Restoring the Operating System

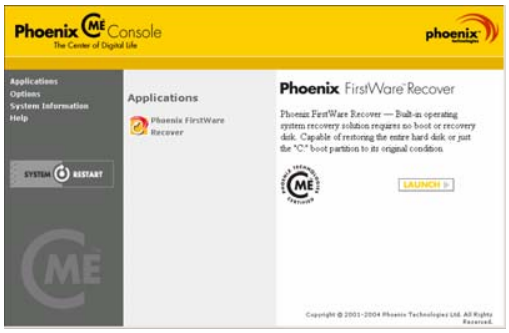
Your WaveSurfer oscilloscope was designed to operate very reliably for many years. However, the application software does run on an internal hard drive. In the event of a hard disk problem, you may need to recover the application software on drive “C:” and/or the user data on drive “D:”. Since WaveSurfer does not have an installed CD-ROM drive, LeCroy has provided a recovery application program that will allow you to recover the application software and user data by accessing a partition on the hard drive. This is very easy to do, if necessary. Instructions are as follows:

1. Connect a keyboard and a mouse to the WaveSurfer.
2. Power the WaveSurfer ON.
3. As soon as anything (logo, graphic, text) appears on the screen after boot-up, press and hold down the **F4** key.
4. The FirstWare cME console splash screen displays. Wait about 10 seconds.
5. The cME console End User License Agreement displays. There are [Accept] and [Decline] buttons at the end of this License Agreement. Click the [Accept] button.

6. Phoenix cME Console main page displays. Click “Applications”.
7. Click Phoenix FirstWare Recover. (If you click “SYSTEM RESTART” button, WaveSurfer will reboot.)



8. Click the LAUNCH button.



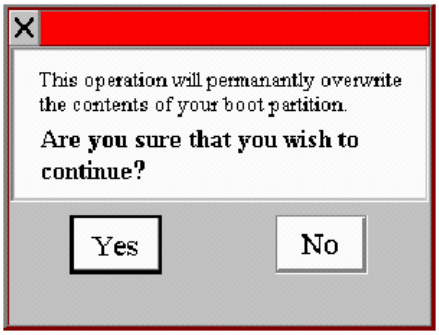
9. The First Ware Recover splash screen displays.

10. Read the license agreement and click [Accept] to proceed.

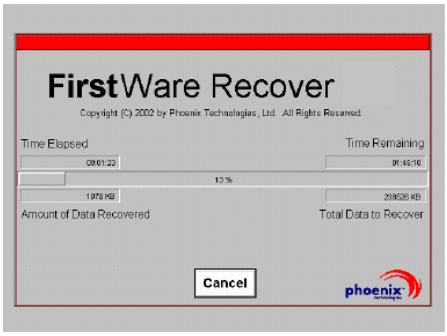
11. The Select Recover Type screen displays. Select recover option, as defined below:

[Recover Boot Partition] Recovers drive "C:" only. Drive “C:” is the drive that the WaveSurfer application software is stored on. Drive "D:" is not recovered. (Drive "D:" is the USERDATA area of the hard disk.)
[Recover Entire Drive] Select this button if you want to recover both the “C:” and “D:” drives of the hard disk (Note: Any USERDATA will be erased if this option is selected)

12. Read the license agreement and click [Accept] to proceed.
13. The following dialog box will be displayed. Click the [Yes] button.
    - When you select [Recover Boot Partition], the dialog message is “This operation will permanently overwrite the contents of your boot partition. Are you sure that wish to continue?”
    - When you select [Recover Entire Drive], the dialog message is “This operation will permanently overwrite the contents of your entire drive. Are you sure that wish to continue?”



14. The recovery starts, and the FirstWare Progress screen displays. No further selections are required. The recovery takes about 10 minutes.



15. When the recovery is completed, Windows will start automatically. No message or dialog box will display.
16. If you selected [Recover Entire Drive] in step 11, CheckDisk will run after the Windows splash screen.
17. After the “Welcome” screen, the FBReseal dialog box will display. Click the [OK] button. Windows will restart automatically.

6.3.5 Software Options

There are many software options available, new ones are being developed all of the time, refer to the LeCroy website for the latest selection of options available.

6.3.5.1 Changing Software Option Key

a. Scope ID, Scope Serial Number

The scope ID and scope s/n: are used to request a Software Option Key

- Enter the scope's Software Options menu (located under Utilities, Options)

.Note the **SCOPE ID**, i.e.: 12c5c6-a4 and **Scope s/n**: LCRY0601P10241 that are found on that menu.

b. Entering Option Key in the DSO

- Enter the scope's Software Options menu (**Utilities, Options** menu).
- Press the **ADD KEY** button on the DSO touch screen
- Enter the new option key, i.e.: **5F4F-3184-2C81-8EF8**
- Press **O.K.** to add the key
- The XStream application will need to be exited and restarted for any new option key to take effect.

6.4 Board Exchange Procedure

6.4.1 PCI Board Exchange Procedure

The WaveSurfer uses option keys to identify the correct model number, memory size and software options. These option keys must be re-installed if the PCI board is exchanged..

6.4.2 Hard Drive Replacement Procedure

6.4.2.1 Required items

(a) PC (DVD-ROM drive and network interface card required; OS: Windows 2000 or XP)

(b) Network cable

(c) USB floppy disk drive

(d) Master DVD labeled as "WS400 Series Control Program (for loading on the hard disk)"

(e) Floppy disk labeled as "Startup Disk for WS400 Series Control Program" (will be created during this procedure, using Master DVD (item d))

(f) PS/2 keyboard

6.4.2.2 Preparation of host machine

(1) Select Start → Settings → Control Panel.

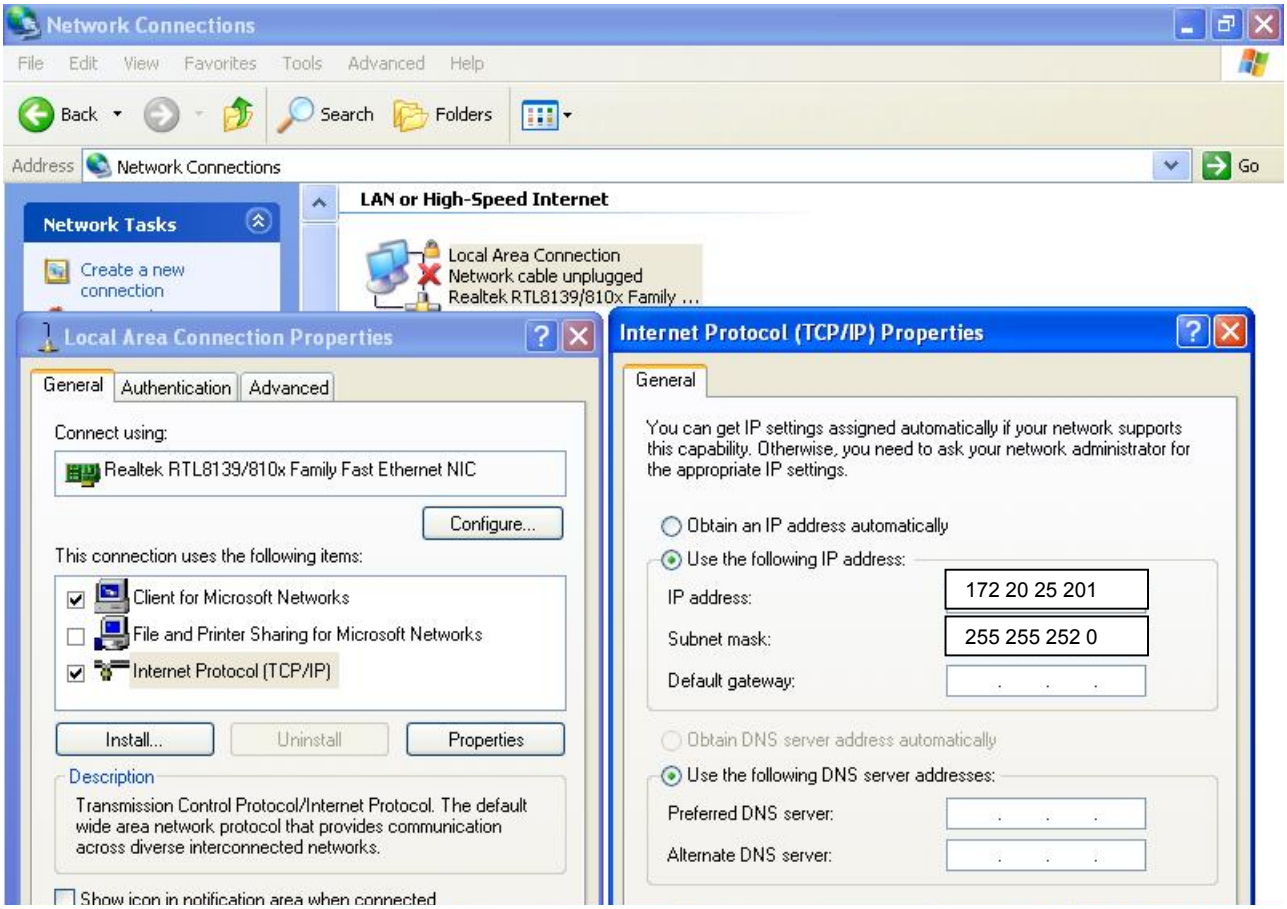
(2) Double-click the Network icon in the Control Panel. A network dialog box similar to this one appears

(3) If the TCP/IP protocol is not listed, you will have to add it. Follow your operating system user guide to add the TCP/IP protocol and bind it to the Ethernet adapter

(4) Double-click the 

line. A dialog box similar to the one below appears. Select


and enter the default IP address as shown below:



Note:

- There must be a user account on the host computer which has local rights to the machine. If the host is used as part of a domain and that user does not have local rights then a local user account must be created.

- Confirm the host PC's name (visible in control panel/system/computer name), log in name, log in password, IPAddress and SubNetMask.

6.4.2.3 Copying necessary files to the PC to share them through a network

(1) Create a folder named "FW" in the C drive of the host PC.

(2) Copy TOOLS and IMAGE folders in the DVD-ROM drive of the PC to C:\FW. (See Figure 6.1 & 6.2) Take note that the size of the folders is about 1.2 GB.

(3) Configure so that others can access the folder C:\FW over the network with the share name "FW". (If you use Windows XP, right-click the FW folder icon to call up the FW Properties dialog box and configure the settings as shown on Figure 6.2)

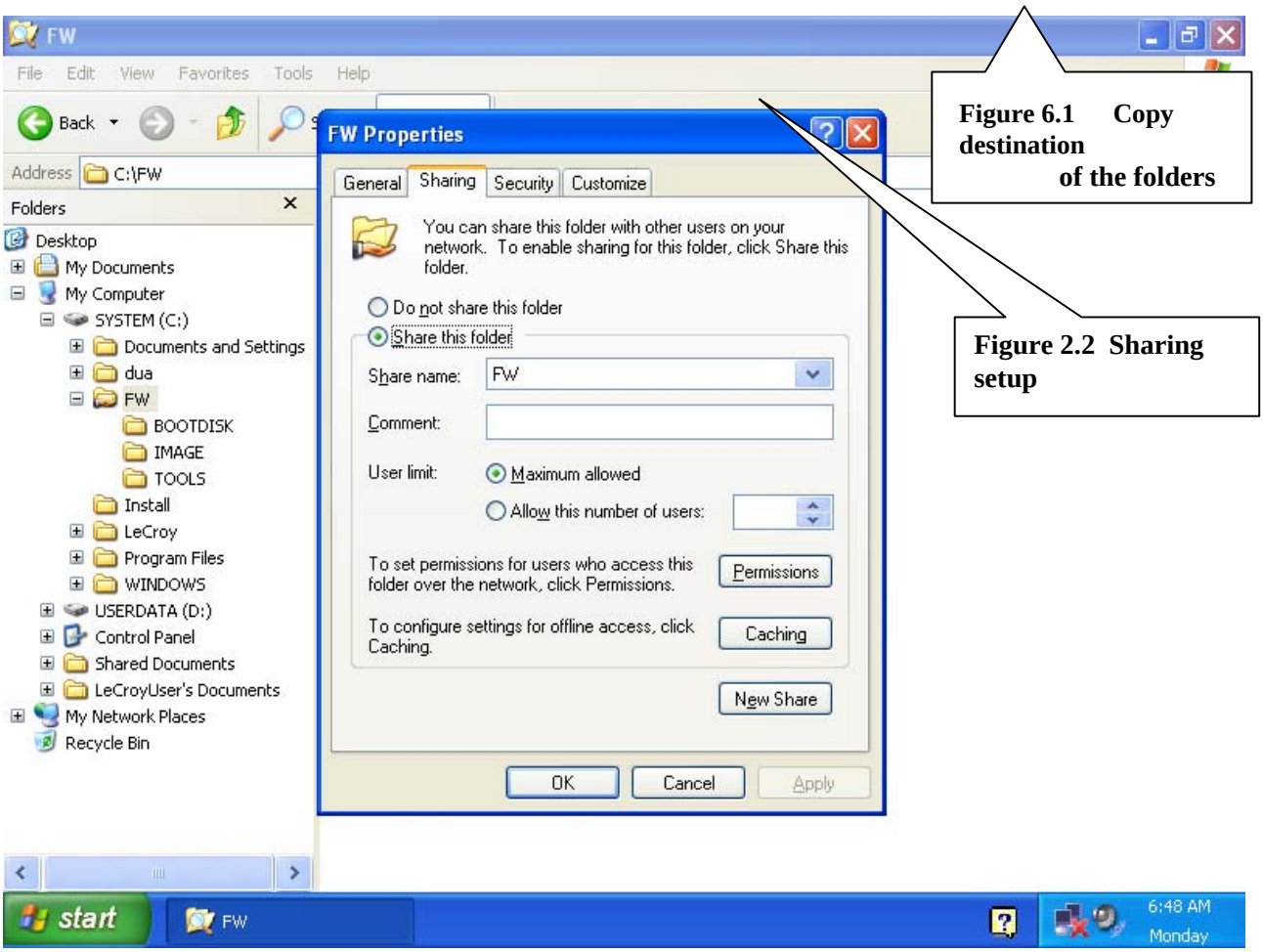


Figure 6.1 Copy destination of the folders

Figure 2.2 Sharing setup

6.4.2.4 Creating a network-ready startup disk

<Required items>

1. WS400 Series Control Program (DVD-R for loading on the hard disk)
2. PC with Windows running on it
3. DVD-ROM drive (irrespective of built-in type or external type)
4. Floppy disk drive (irrespective of built-in type or external type)
5. An empty floppy disk. A floppy disk label (Inscribe "Startup Disk for WS400 Series Control Program" on it.)
6. Master DVD labeled as "WS400 Series Control Program (DVD-R for loading on the hard disk)"

(1) Insert the DVD-R labeled as "WS400 Series Control Program (DVD-R for loading on the hard disk)" in the DVD-ROM drive of the PC.

(2) Insert an empty floppy disk in the floppy disk drive. (Prior to insertion, affix a label inscribed with "Startup Disk for WS400 Series Control Program" to the disk.)

(3) Using Windows Explorer or My Computer, double-click on BOOTDISK\NETBOOT\MAKEFD.BAT in the DVD-R.

(4) A command prompt screen appears to indicate the progress of floppy creation by %. At the completion, the command prompt screen automatically closes.

(5) Open A:\Autoexec.bat in the floppy disk by a text editor. Search for the description "FSERVER=PCNAME" and replace PCNAME with the "name of the PC" connected to the WaveSurfer. (See Figure 6.2.)

```
@ECHO OFF
::-----------------------------------------------------------
:: Server name
set FSERVER=PCNAME
::↑ Replace the underlined part with the PC name of the server.
::-----------------------------------------------------------

REM [Autoexec.bat : Created by ClientBuilder
PATH = a:\;a:\Net\
prompt $p$g
cd net
net initialize /dynamic
netbind.com
tcptsr.exe
tinyrfc.exe
net start basic
net use Z: \\%FSERVER%\FW
        echo off
        PATH                                                    =
        %PATH%;Z:\TOOLS\BUILDER\;Z:\TOOLS\DISK\;Z:\TOOLS\REC
        OVER\
        cd ..\
        @ECHO
        ================================================
        @ECHO waveSurfer hard disk update program version 1.0.0
        @ECHO (Using network connection)
        @ECHO
        ================================================
        @ECHO  Menu
        @ECHO    1. Updates both drives (C: and D:) and recovery area.
        @ECHO    0. Exit
PROMPT Select number:
```

Figure 6.2 Autoexec.bat

(6) Open A:\NET\Protocol.ini in the floppy disk by a text editor. Delete "DisableDHCP=0" and add the following three lines as shown in Figure below. "IPAddress0" is the IP address to be assigned to the WaveSurfer. This must be different from that for the PC.

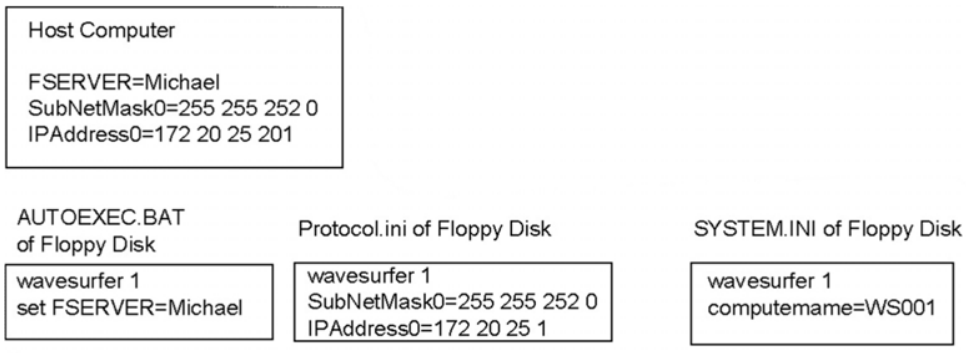
DisableDHCP=1
SubNetMask0=255 255 252 0
IPAddress0=172 20 25 1

```
[network.setup]
version=0x3110
netcard=ms$REALTEK,1,MS$REALTEK,1
transport=tcpip,TCPIP
lana0=ms$REALTEK,1,tcpip

[ms$REALTEK]
drivername = RTSND$

[protman]
drivername = PROTMAN$
priority = MS$NDISHLP

[tcpip]
NBSessions=6
DefaulGateway0=
DisableDHCP=1
SubNetMask0=255 255 252 0  :: The same address as server
IPAddress0=172 20 25 1  :: (172 20 25) is the same address as the
                           server.
:: ↑ IP address subnet mask to be assigned to the waveSurfer
DriverName=TCPIP$
Bindings=ms$REALTEK
LanaBase=0
```

Figure 6.3 Protocol.ini

(7) Save the Protocol.ini file.

Example of Startup disk



6.4.2.5 Updating the hard disk (through a network)

<Required items>

1. PC (DVD-ROM drive and network interface card required; OS: Windows 2000 or XP)
2. Network cable
3. USB floppy disk drive
4. Floppy disk labeled as "Startup Disk for WS400 Series Control Program"
5. Master DVD labeled as "WS400 Series Control Program (for loading on the hard disk)"
6. WaveSurfer
7. PS/2 keyboard & mouse

(1) Connect the USB floppy disk drive, PS/2 keyboard & mouse, and the network cable to the waveSurfer. (See Figure 6.4)

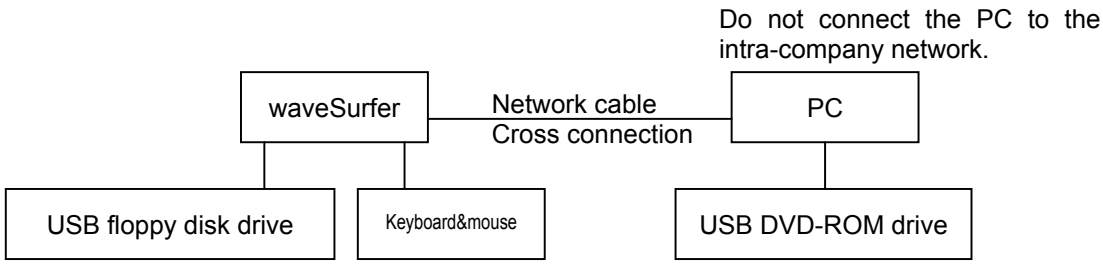


Figure 6.4 Connecting waveSurfer with PC

(2) Insert the "Startup Disk for WS400 Series Control Program" to the USB floppy disk drive.

(3) Turn on the power to the waveSurfer.

(4) If the following message appears on the screen, enter the user name to log in to the PC.
Type your user name, or press ENTER if it is WS002:

(5) If the following message appears, enter the password to log in to the PC.
Type your password:

(6) If the following message appears, enter "N". ****** stands for the user name entered in Step (4) above.

There is no password-list for ******

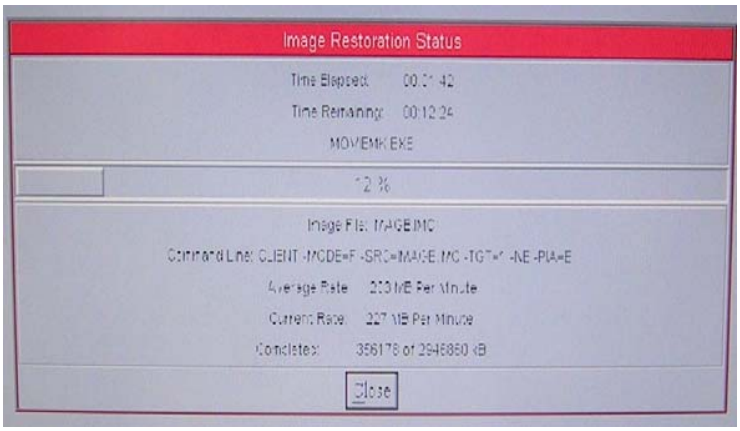
Do you want to create one? (Y/N) [N]:

(7) If the following menu appears, choose 1.

Menu

1. Updates both drives (C: and D:) and recovery area.
2. Exit

(8) The process to update the hard disk will start. It takes about 30 minutes to complete it.



Display “Image Restoration Status” message.

(9) At the completion, the following message will appear

: Success: The operation completed without error.

==========

cME Install is complete

==========

Z:_\TOOLS\DISK>

(10) Remove the floppy disk from the floppy disk drive

(11) Press the Delete key while pushing Ctrl and Alt key.

6.4.2.6 Setup at the first startup

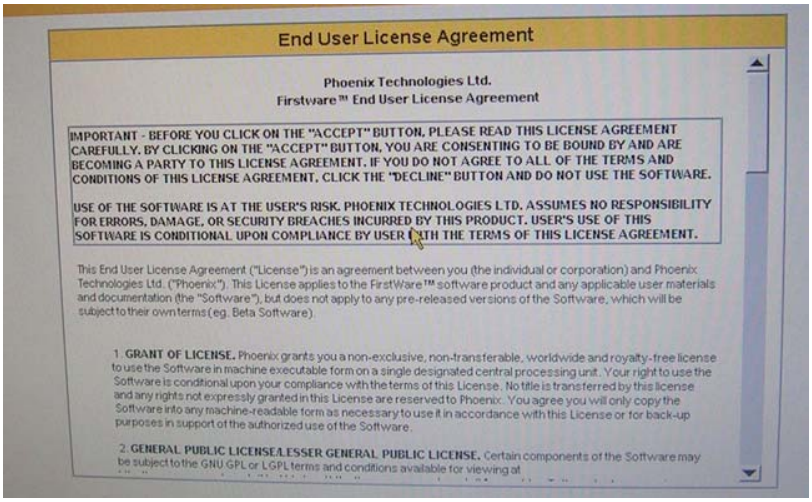
(Make sure to perform the following procedure after updating the hard disk.)

(1) Turn on the power to the waveSurfer.

(2) Wait until the LeCroy's logo LeCroy fills the screen, then press [F4] until the Phoenix will appear. (Hold it down for a while.)

(3) A message "Please Standby ..." will appear. Wait until the next screen appears. (If this message does not appear, reboot Windows, then restart the waveSurfer and perform Step (2) again. If the message does not appear even then, perform the hard disk copying operation again.)

(4) If "End User License Agreement" appears on the screen, scroll down to the end with the mouse and press the [Decline] button. (NEVER press the [Accept] button! If you press the [Accept] button, you are forced to return to Section 4 to update the hard disk again.)



(5) The screen is blackened for a while. Then the Windows startup screen appears.

(6) The following message appears informing you that the check of D drive now starts. No operation is necessary. If there is no problem, the operation automatically completes.

Checking file system on D:

(7) First [Welcome], then the [FBReseal] dialog box appears. If you are sure that the dialog box contains the message "Machine Resealed! Click OK to reboot.", press the [OK] button. Windows will automatically reboots itself.

(8) The following message appears informing you that the check of D drive now starts. No operation is necessary. If there is no problem, the operation automatically completes. After completion, Windows will automatically reboots itself.

Please wait while windows preparing to start …

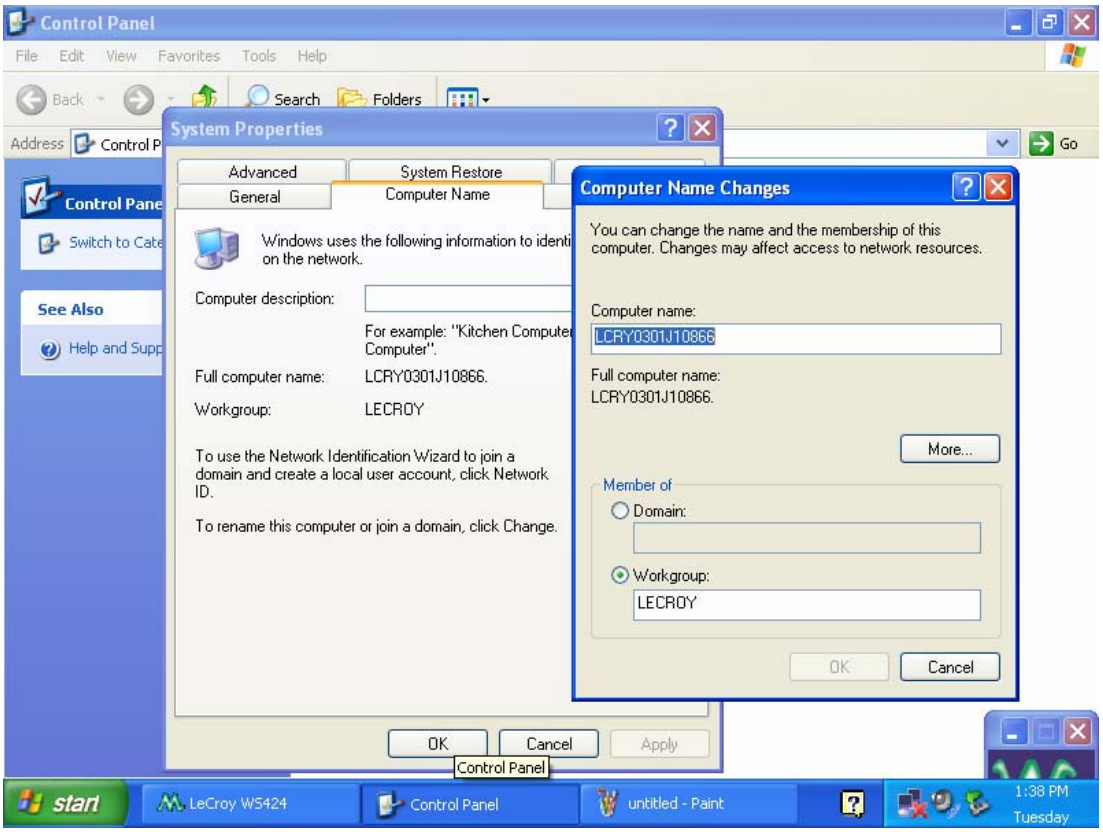
Exit the XStreamDSO application

(9) If XStreamDSO has started up, choose "Minimize or Exit " from the "File" menu.

From "Start" menu of Windows, start "Control Panel".

(10) Double-click the "System" icon.

(11) Open the "Computer Name" tab and press the "Change" button.



(12) The "Computer Name Changes" dialog box will appear. Enter the main unit serial number "LCRY0301Jxxxxxx" for LeCroy, then press the "OK" button. (xxxxxx stands for the serial number.)

(13) Reboot Windows following the instruction given on the dialog box.

Windows will automatically reboot itself.

(14) If XStreamDSO has started up, choose "Utilities Setup ..." from the "Utilities" menu.

(15) Open the "Status" tab and check to make sure that the "Firmware Version" is identical to the “3.6.0.11”(build 61005).

(16) Open the "Remote" tab and check to make sure that the main unit serial number has been set as the "Host Name".

6.4.2.7 Validating the software

1. Turn on the power to the WaveSurfer.

   (A) After the power is turned on, music shall be played when the OS (Windows XP) starts up.

   (B) "WaveSurfer" shall be displayed on the screen. If "WaveMaster" appears, the system may fail to recognize the hardware.

   (C) Make each channel active by pressing the corresponding channel button (1, 2, ...). Then press the AUTO button and check to make sure that each waveform is displayed correctly.

2. Adjusting the touch screen

   (A) Click "Utilities Setup..." in "Utilities" on the top menu bar.

   (B) From the "Utilities" menu, click "Touch-Screen Calibration".

   (C) Correctly click the four X marks on the screen with a thin stick or the like.

   (D) Check to make sure that the cursor moves to the actually clicked point.

   Important! Use caution not to damage the touch screen.

6.4.2.8 Initialization of panel setup

(1) Click "Recall Setup." of a top menu bar "File".

(2) Click "Recall Default Setup" of "Recall Setup" menu.

6.4.2.9 BIOS setting

If the system does not boot up on the start-up floppy disk, please confirm “First Boot Device” in the “Advanced BIOS Features” of the BIOS setting. Turn on the power while pushing the Delete Key.

STANDARD CMOS Features
- Date (mm: dd: yy):
- Time (hh: mm: ss):

IDE Primary Master	None
IDE Primary	Auto
Access Mode	Auto
IDE Primary Slave	None
IDE Primary Slave	Auto
Access Mode	Auto
IDE Secondary Master	None
IDE Secondary Master	Auto
Access Mode	Auto
IDE Secondary Slave	None
IDE Secondary Slave	Auto
Access Mode	Auto

- Drive A : None
- Drive B : None

- Video : EGA/VGA
- Halt On : All, But keyboard

Advanced BIOS Features

CPU Internal Cache	: Enabled
External Cache	: Enabled
CPU L2 Cache ECC Checking	: Enabled
Processor Number Feature	: Enabled
Quick Power on Self Test	: Enabled
Boot Sequence	
First Boot Device	: USB-FDD
Second Boot Device	: USB-CDROM
Third Boot Device	: HDD-O
Boot Other Device	: Enabled
Swap Floppy Drive	: Disabled
Boot Up Floppy Seek	: Disabled
Boot Up Numlock Status	: On
Gate A20 Option	: Fast
Typematic Rate Setting	: Disabled
Typematic Rate(Chars/Sec)	: 6
Typematic Delay (Msec)	: 250
Security Option	: Setup
OS Select For DRAM>64Mb	: Non-OS2
Video BIOS Shadow	: Enabled
Small Logo (EPA) Show	: Disabled

Advanced Chipset Features
- DRAM Clock/Drive Control

DRAM Clock : By SPD
DRAM Timing : By SPD
DRAM Command Rate : 2T Command
AGP & P2P Bridge Control
AGP Aperture Size : 64M
AGP Driving Control : Auto
AGP Fast Write : Disabled
AGP Master 1WS Write : Disabled
AGP Master 1WS Read : Disabled
CPU & PCI Bus Control
CPU & PCI Write Buffer : Enabled
PCI Master 0WS Write : Enabled
PCI Delay Transaction : Disabled
System BIOS Cacheable : Disabled
Video RAM Cacheable : Disabled
Video Share Memory size : 16M
Select Display Device : CRT+LCD
Panel Type : 01
Panel Outport Port : DIO
Panel Clock Mode : Single
Panel Bus Width : 24 Bits
Memory Parity/ECC Check : Disabled

INTERGRATED PERIPHERALS
VIA OnChip IDE Device
IDE DMA Transfer access : Enabled
IDDE Prefetch Mode : Enabled
IDE HDD Block Mode : Enabled
Onchip IDE Channel0 : Enabled
IDE Primary Master PIO : Auto
IDE Primary Slave PIO : Auto
IDE Primary Master UDMA : Auto
IDE Primary Slave UDMA : Auto
Onchip IDE Channel 1 : Enabled
IDE Secondary Master PIO : Auto
IDE Secondary Master UDMA : Auto
IDE Secondary Slave UDMA : Auto

VIA Onchip PCI Device
Realtek ALC650 : Enabled
Onchip USB Controller : Enabled
USB2.0 Controller : Enabled
USB Keyboard Support : Disabled

Super IO Device
Onboard FDC Controller : Disabled
Onboard Serial Port 1 : 3F8/IRQ4
Onboard Serial Port 2 : Disabled
UART Mode Select : Normal
Onboard Parallel Port : 378/IRQ7
Parallel Port Mode : SPP
Init Display First : PCI Slot

POWER MANAGEMENT SETUP

ACPI function	: Enabled
ACPI Suspend Type`	: S1(POS)
Power Management Option	: User Define
HDD Power Down	: Disabled
Suspend Mode	: Disabled
Video Off Option	: Suspend ->Off
Video Off Method	: V/H SYNC+Blank
MODEM Use IRQ	: 3
Sort-Off by PWRBTN	: Instant-Off
Run VGABIOS if S3 Resume	: Auto
Ac Loss Auto Restart	: OFF
Power-On by Ring	: Disabled
Wake Up on Lan	: Disabled

IRQ/Event Activity Detect

VGA	:Off
LPT&COM	:LPT/COM
HDD&FDD	:On
PCI Master	:Off
PowerOn By PCI Card	:Disabled
Wake Up On LAN/RING	:Disabled
RTC Alarm Resume	:Disabled

IRQ's Activity Monitoring

Primary INTR	ON
IRQ3 (COM2)	Enabled
IRQ4 (COM 1)	Enabled
IRQ5 (LPT 2)	Enabled
IRQ6 (Floppy Disk)	Enabled
IRQ7 (LPT 1)	Enabled
IRQ8 (RTC Alarm)	Disabled
IRQ9 (IRQ 2 Redir)	Disabled
IRQ10 (Resaved)	Disabled
IRQ11 (Resaved)	Disabled
IRQ12 (PS/2Mouse)	Enabled
IRQ13 (Coprocessor)	Enabled
IRQ14 (Hard Disk)	Enabled
IRQ15 (Reserved)	Disabled

PNP/PCI Configurations

PNP OS Installed	: No
Reset Configuration Data	: Disabled
Resources Controlled By	: AUTO(ESCD)
PCI/VGA Palette Snoop	: Disabled
Assign IRQ For NGA	: Enabled
Assign IRQ For USB	: Enabled

PC Health Status

Shutdown Temperature	: 75˚C

Frequency/Voltage Control

AutoDetect DIMM/PCI CLK	: Enabled
Spread Spectrum	: Enabled

CPU Clock : 100

6.5 Battery Exchange Procedure

Exchange Battery

Setting BIOS

(1) Turn on the power while pushing the Delete key

(2) Load Optimized Defaults

(3) Standard CMOS Features → Set Date and Time

(4) Save and Exit Setup

Note:
If the Wavesurfer was set to the old BIOS setting, after "Load optimized Defaults" does, each setting becomes initial as a general PC.
For instance,
Standard CMOS Features → Drive A : 1.44MB,3.5 in.
Correctness is "None".
In this case, update the new BIOS.

6.6 Update BIOS

(1) Expand "BIOSCHK.ZIP" to Pc's hard disk.

(2) Start to make the BIOS update floppy disk.

(3) Boot the WS and connect USB-FDD to WS.

(4) Double-click BIOSCHK.VBS in Windows Explorer and verify the version.
If the release date is not 20040309, please proceed to the next step.

(5) Boot the WS with the BIOS update floppy disk.
If you get a message "You don't have to update BIOS", the BIOS is updated correctly.

Note:
Please never turn off the power while updating BIOS.
Battery: Part Number is IWDES011171, description is CR2032

6.7 Equipment and Spare Parts Recommended for Service

6.7.1 Test Equipment Required

See Table 5-1 in section 5.2.

6.7.2 WaveSurfer Spare Parts

LeCroy P/N	Assembly	Adjustments	Performance Tests
IW211857900	WS4-Processor RB80526RY	None	None
IW211857902	WS4-LCD CIRCUIT	None	None
IW211857903	WS454 PANEL BOARD	None	None
IW211857904	WS4X4 KEY BOARD	None	None
IW211857905	WS4X2 KEY BOARD	None	None
IW211857918	WS454 FE/ACQ BOARD	None	Chapter 5
IW211857921	WS452 FE/ACQ BOARD	None	Chapter 5
IW211857923	WS422 FE/ACQ BOARD	None	Chapter 5
IW211857920	WS424 FE/ACQ BOARD	None	Chapter 5
IW211857922	WS432 FE/ACQ BOARD	None	Chapter 5
IW211857919	WS434 FE/ACQ BOARD	None	Chapter 5
IW211857914	WS454 MAIN POWER UNIT	None	None
IW211857915	WS454 PFC CIRCUIT	None	None
IW211857916	WS454 INLET CIRCUIT	None	None
IWDZB100221	Hard disk MHT2030AT	HDD Update	None
IW211857901	WS PCI BRIDGE	Add Keycodes	Verify Model
IWKAS159811	WS4 TFT TOUCHSCREEN ASSY	Touchscreen	None

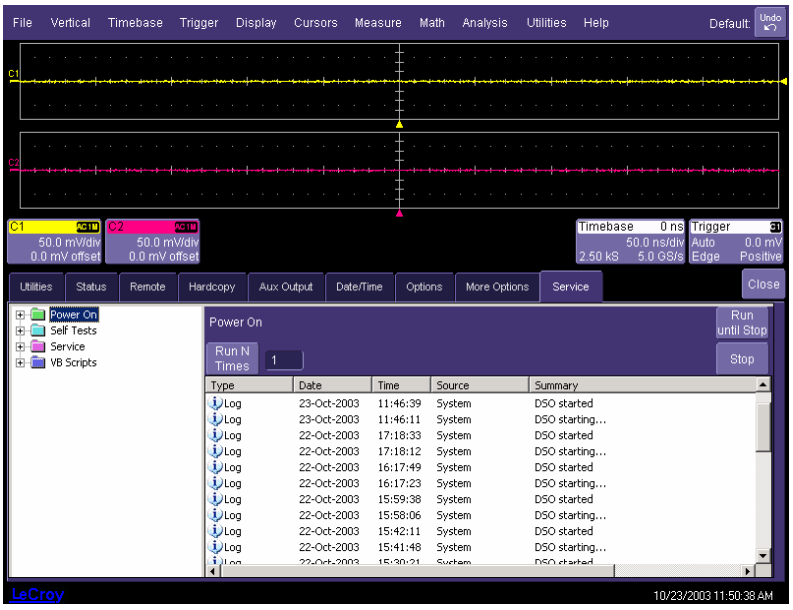
See chapter 7 for mechanical replaceable parts.

6.8 Service Menu

6.8.1 Accessing Service Menu

The service menu is accessed by pressing Utilities, Utilities Setup.

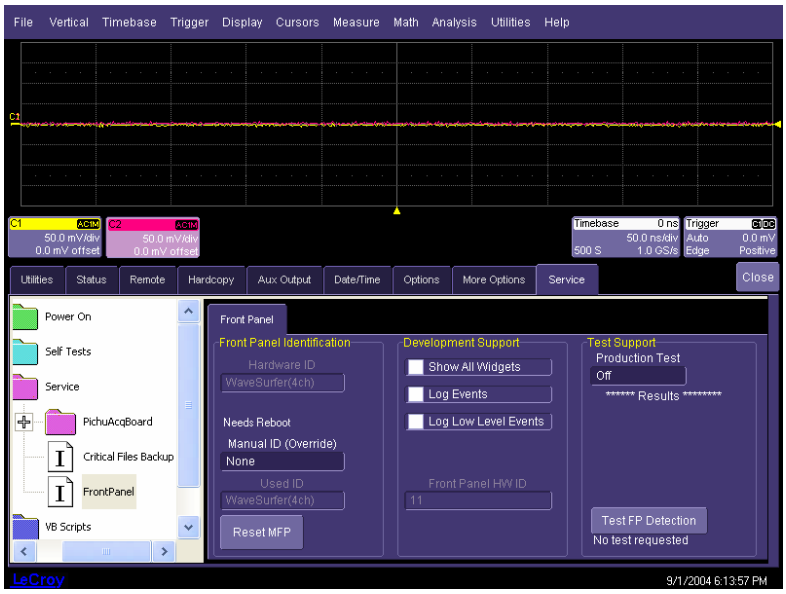
Press the service button in the lower right corner, you will be prompted with a password dialog box. Enter password 9472. You will be granted service center access.



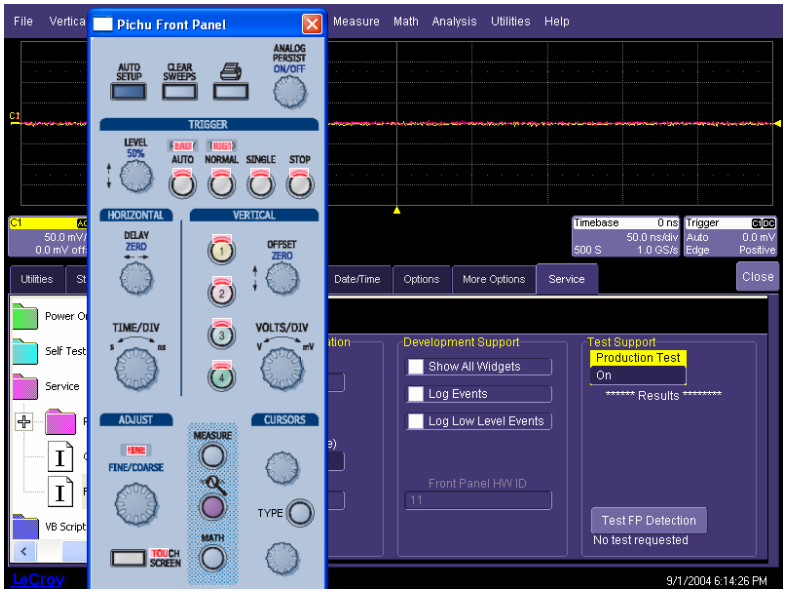
6.8.2 Mainframe Tests

6.8.2.1 Front Panel Test

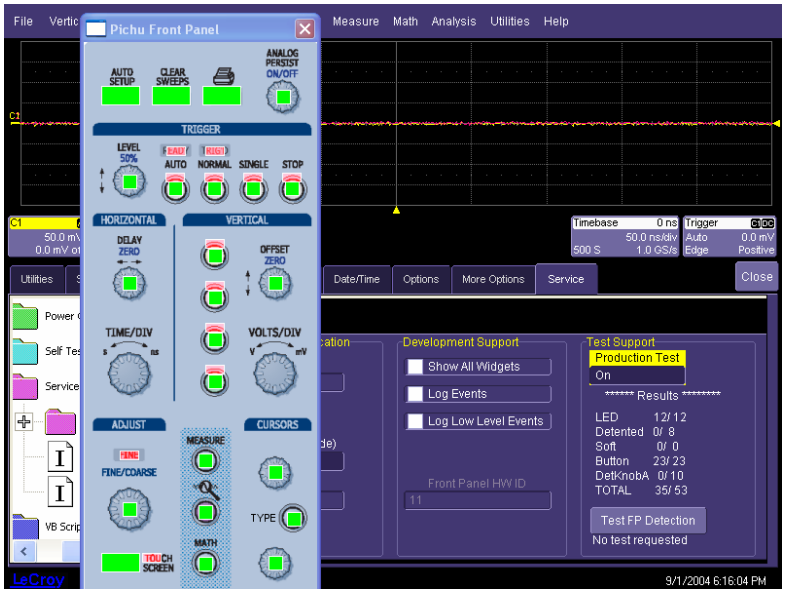
From the service menu select Front Panel



Next select Production Test. Select On. A picture of the front panel will appear on the screen as shown below:



Verify that all LED's are illuminated.
Press each button in turn, each push knob and turn each knob in both directions, they will change color as shown below:



Continue until all buttons and knobs have been tested, the total should indicate that all needed items were pressed or turned. .

Select Production test and then off to turn off the test. The front panel LED's will be left in an abnormal state. This will be corrected when either the functions are used or when the application is restarted.

6.9 Calibration Procedures

The following section includes the manual adjustments that can be made in the WaveSurfer system.

6.9.1 System Power Supply Calibration Procedure

 ..... **CAUTION**: Risk of electric shock

- Measure the power supply voltages as shown in the table below. If any are found to be outside of their specifications proceed with the remainder of this procedure to adjust them.
- To adjust the power supply output voltages, the unit will need slight disassembly. The front panel and hard drive assy will need to be dismounted and the power supply unscrewed and reversed inside out so the printed circuit assy is facing outward.
- The system should not be operated for more than 10 minutes outside of the unit powered up without forced air passing through the power supply and acquisition assembly.
- After reversing the power supply in the unit, plug AC power into the rear panel AC receptacle.
- Turn on using the front panel power switch. Measure each voltage as shown in the table below and adjust the potentiometers accessible through the top cover as shown until each voltage is within its specified range.

The following table lists the nominal, min and max voltages for the outputs from the main power supply. Verify them at the locations listed.

Nominal Output Voltage (Vset)	Tolerance	Min (V)	Max (V)	Measurement Location
+3.3 V	5%	3.14	3.47	CN6 pin 1
+5 V_{DIG}	5%	4.75	5.25	CN6 pin 4
+5 V_A	1.5%	4.93	5.08	CN2 pin 1
-5 V	1.5%	-4.93	-5.08	CN2 pin 4
+2.5 V	5%	2.38	2.63	CN2 pin 8
+12 V	2%	11.76	12.24	CN3 pin 1
+9 V	2%	8.82	9.18	CN3 pin 3
-12 V	2%	-12.24	-11.76	CN3 pin 5

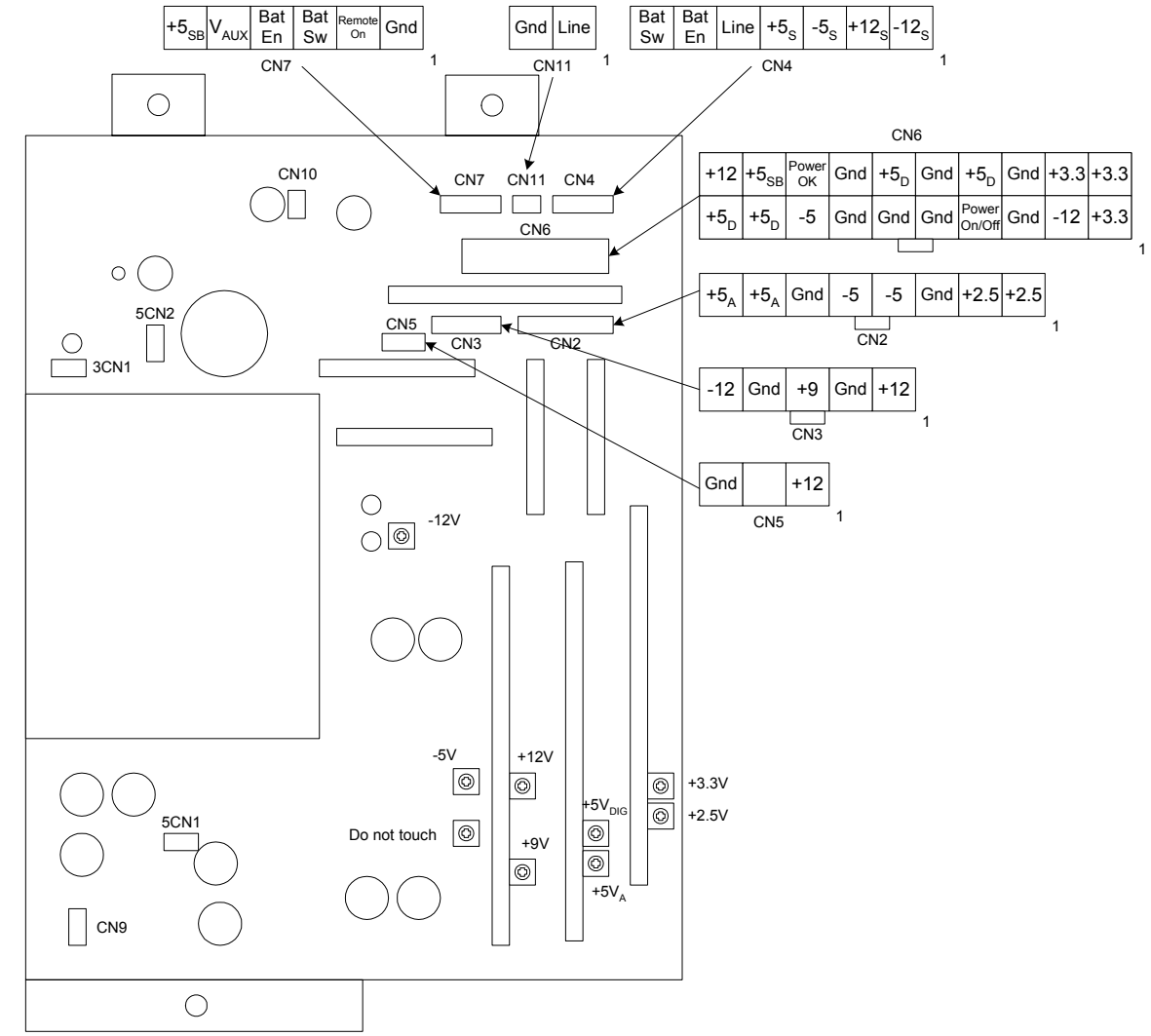


Figure 6-5: View of the power supply adjustment locations

6.9.2 Touch Screen Calibration Procedure

The touch screen must be calibrated based on the users vantage point to the screen, the size of their finger and their visual alignment with the tip of their finger to the screen. The calibration procedure can be invoked through the Utilities menu, Utilities tab. Press the touch screen button called “Touch Screen Calibration”.

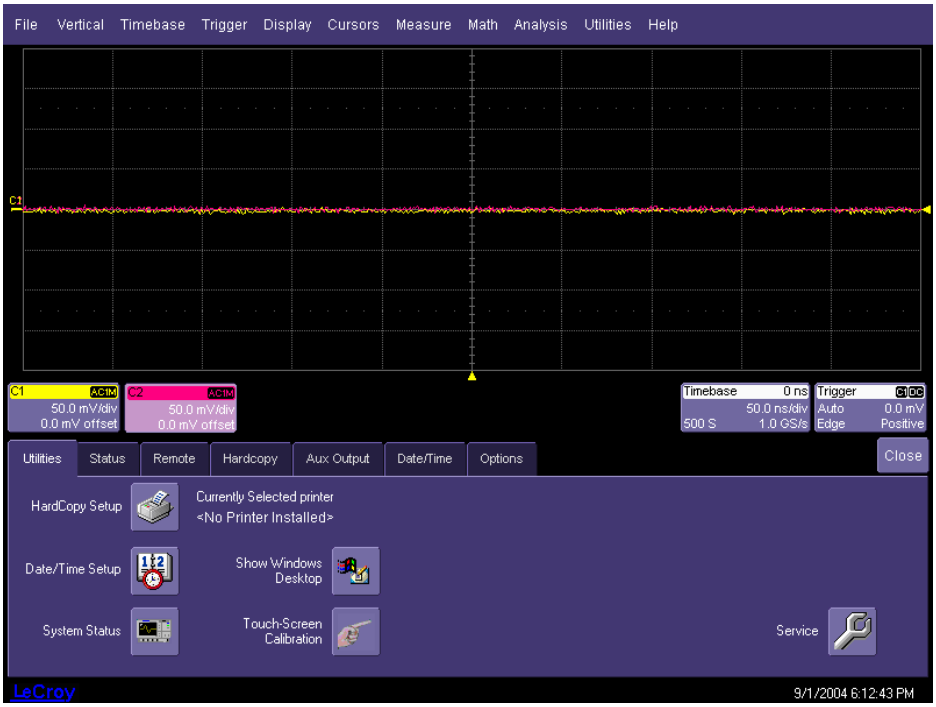
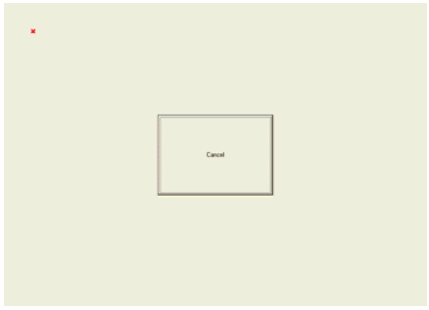
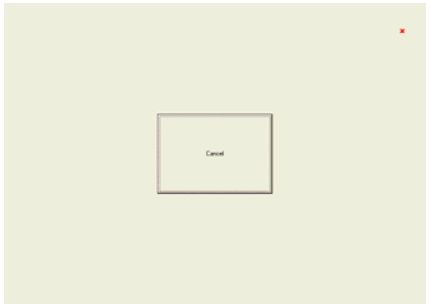


Figure 6-6 Touch Screen Calibration Menu

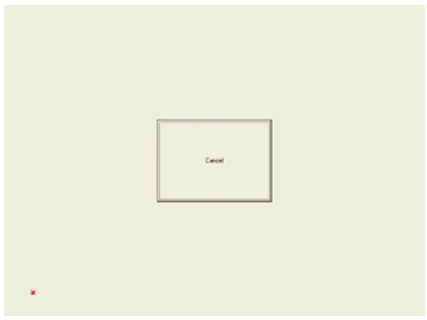
The user will be prompted with 4 locations on the screen for them to touch. They will appear one at a time and after touching each one, a new spot will appear. After all four spots have been touched, the touch screen is calibrated. It is important that you have the same vantage point to the screen that you will when the scope is in operation to have the easiest use of the touch screen.



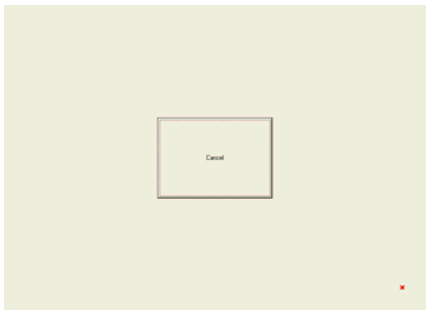
Point 1



Point 2



Point 3



Point 4

After the last point is pressed, then the calibration constants are applied.

6.9.3 Front/ACQ System Adjustments

6.9.3.1 Internal reference voltage adjustment

6.9.3.1.1 Adjustment of reference voltage for automatic calibration

Adjusts the internal reference voltage used for automatic calibration to be within the range from -600mV to +600mV.

Adjustment standard ±0.02%

Adjustment method

(1) Open the "Maintenance2" menu and set "DAC and Calout - CalOut" to "+600mV."
(2) Measure the CAL OUT pin with a multimeter and adjust the reference voltage such that the pin's voltage becomes +600 mV.
(3) Set "CalOut" to "–600 mV."
(4) Measure the CAL OUT pin with a multimeter and adjust the reference voltage such that the pin's voltage becomes –600 mV.
(5) Click "Save To HW" to save to the EEPROM.

Note: If the "+600mV" and "-600mV" adjusting sequence is reversed, repeated adjustments will be necessary.

6.9.3.1.2 Adjustment of reference voltage for CAL signal

Adjusts the CAL signal output voltage to be within the range from +1.0V to -1.0V.

Adjustment standard ±0.1%

Adjustment method

(1) Open the "Maintenance2" menu and set "CalOut" to "+1V."
(2) Measure the CAL OUT pin with a multimeter and adjust the reference voltage such that the pin's voltage becomes +1V ± 0.1%.
(3) Set "CalOut" to "-1V."
(4) Measure the CAL OUT pin with a multimeter and adjust the reference voltage such that the pin's voltage becomes -1 V ± 0.1%.
(5) Click "Save To HW" to save to the EEPROM.

6.9.3.1.3 Measurement of overload detection reference level

Measures automatically the reference level for 50Ω overload detection (when there is no signal).

Adjustment method

(1) With no connections made to the channels, perform a "heat run" for at least 5 minutes.
(2) Open the "Maintenance1" menu and click "Automatic Adjustment – Overload" to measure the reference voltage.
(3) Click "Save To HW" to save to the EEPROM.

Note: The heat run shall not be omitted since reference values cannot be measured accurately immediately after use with 50Ω coupling.

6.9.3.2 Front end adjustment

6.9.3.2.1 Coarse adjustment of channel offset

Setting CHx ⇒ DC 1MΩ, 20mV/div, 0V offset, BWL=20MHz
Timebase ⇒ 1ms/div

Adjustment method

(1) Open the "Production\PichuAcqBoard\Calibration" menu within the "Service" menu.
(2) Select "FE offsetA" from the "Curves" menu, click "Auto cal," remove the check mark and click "Reset current."
(3) Select "FE gain->offsetA" from the "Curves" menu, click "Auto cal," remove the check mark and click "Reset current."
(4) Adjust "Channel Offset Adjustment" in the "Maintenance2" menu so that all channel traces appear in the center of the display screen.
(5) Press "Save To HW" to save to the EEPROM.
(6) Re-enter the "Calibration" menu.
(7) Select "FE offsetA" from the "Curves" menu, click "Auto cal" and add a check mark.
(8) Select "FE gain->offsetA" from the "Curves" menu, click "Auto cal" and add a check mark.

Note: The auto adjust function will not operate unless the "Auto cal" setting is restored.

6.9.3.2.2 DC gain adjustment

Adjustment standard Overshoot: 0.1% or less
Rounding: none

Setting CHx ⇒ DC 50Ω, 5mV/div, BWL=20MHz
Timebase ⇒ 2ms/div

Adjustment method Input a 500mV, 100Hz square-wave signal from the PG-506.
Adjust the smoothing of the square-wave.

Adjustment locations

	CH1	CH2	CH3	CH4
Gain adj.	2R104	3R104	4R104	5R104

6.9.3.2.3 Attenuator phase adjustment

Adjustment standard Overshoot: 0.5% or less
Rounding: 0.5% or less

Setting CHx ⇒ DC 1MΩ, 50mV/div, 500mV/div

Adjustment method Input a 15kHz square-wave signal and adjust the attenuator phase.

Adjustment locations

	CH1	CH2	CH3	CH4
50mV/div	2C44	3C44	4C44	5C44
500mV/div	2C45	3C45	4C45	5C45

After adjusting the input capacitance, again verify the 50 mV/div attenuator phase and readjust if necessary.

6.9.3.2.4 Input capacitance adjustment

Adjustment standard 16pF ± 1.5pF at 50mV/div
Difference between 20mV/div and 50mV/div: ±0.5pF or less
Difference between EXT and EXT10: ±0.5pF or less

Adjustment method CH1 to CH4(2) Verify the input capacitance at 50 mV/div.
Change to 20mV/div and adjust so that the difference with the 50mV/div scale is within the standard range.

EXT Set "Edge Trigger" and verify the input capacitance at "Trigger on – Ext" and "Impedance – DC1MΩ."
Change to "Trigger on – Ext/10" and adjust so that the difference with "Trigger on – Ext" is within the standard range.

Adjustment locations

	CH1	CH2	CH3	CH4	EXT
Input C adj.	2C22	3C22	4C22	5C22	6C22

6.9.3.2.5 EXT10 phase adjustment

Adjustment standard Difference between 1 kHz and 1 MHz trigger points: ±0.1 div or less

Setting CH1 ⇒ 1V/div, DC 1MΩ, offset 0V
Trigger ⇒ Trigger on: Ext/10, Imp: 1MΩ, Coupling: DC, Slope: Positive, Level: 3V

Adjustment method Using a T-branch, input an approximate 10Vp-p, 1KHz sine wave signal to CH1 and EXT.
Verify that the location of the trigger point is +3div ± 0.3div.
Next, change the frequency to 1MHz and adjust 6C6 such that the shift in the trigger point is minimized for 1KHz.

6.9.3.2.6 High-speed waveform adjustment

Adjustment standard

WS45x	
DC 50Ω, 10mV/div	Overshoot / ringing 7% or less
DC 50Ω, 500mV/div	Overshoot / ringing 12% or less (PSPL4050) 9% or less (PSPL2600)
WS43x	
DC 50Ω, 10mV/div	Overshoot / ringing 5% or less
DC 50Ω, 500mV/div	Overshoot / ringing 9% or less (PSPL4050) 7% or less (PSPL2600)
WS42x	
DC 50Ω, 10mV/div	Overshoot / ringing 3% or less
DC 50Ω, 500mV/div	Overshoot / ringing 7% or less (PSPL4050) 6% or less (PSPL2600)

Setting Reference waveform PSPL TD-1107B + 16dB ATT (DC 50Ω, 10mV/div)
Reference waveform PSPL 4050 (4500) + 6dB ATT (DC 50Ω, 500mV/div)

Adjustment method

(1) At 10mV/div and an amplitude of approximately 4.0div, adjust the waveform. Set the frequency response to the range of 4.7 to 4.9 / 6.0div.
(2) At 500mV/div and an amplitude of approximately 6.0div, adjust the waveform so that overshoot is within the standard range.
(3) Adjust the frequency response (500MHz) to be in the range of 3.7 to 3.9 / 5.0div.

Adjustment locations

	CH1	CH2	CH3	CH4
10mV/div	2R28	3R28	4R28	5R28
500mV/div	2C38	3C38	4C38	5C38

6.9.3.3 TDC adjustment

6.9.3.3.1 Auto-adjustment

Adjusts the TDC (verifies time axis during RIS mode operation) automatically.

Adjustment method

(1) Without inputting any signal, run “Automatic Adjustment – TDC” in the “Mainenance1” menu.
(2) After adjustment is completed, click "Save to HW” to save to the EEPROM.

6.9.3.3.2 Manual adjustment

In the “Maintenance1” menu, verify that “Other Adjustment – TdcGain “ has a default value of 135.

6.9.3.4 Trigger delay adjustment

Adjustment standard ±100ps (pre-trigger)

Setting CHx ⇒ DC 50Ω 10mV/div
Timebase ⇒ RIS, 1ns/div, Delay: 0ns (center of display screen)

Adjustment method

(1) Input a signal from the SG-503 and set the trigger level to roughly the midpoint of the amplitude.
(2) With PERSIST ON, adjust “TrigDelay” of the “Maintenance2” menu such that the actual trigger point (portion of the observed waveform that forms the pivot point) coincides with the trigger delay indicator when the signal frequency is varied within the range of approximately 10MHz to 150MHz.
(3) Click “Save to HW” to save to the EEPROM.

Note: The trigger delay indicator is an arrow displayed at the bottom border of the grid. The trigger delay indicator differs from and should not be confused with the trigger level indicators that are displayed at the right and left borders of the grid.

6.9.3.5 Trigger hysteresis adjustment

6.9.3.5.1 Auto-adjustment

Adjustment standard Trigger hysteresis: 0.3 ± 0.01 div

Adjustment method

(1) Without inputting any signal, run “Automatic Adjustment - Trig Hyst” in the “Mainenance1” menu.
(2) Trigger hysteresis is adjusted automatically to become 0.3div.
(3) After the auto-adjustment is completed, click “Save to HW” to save to the EEPROM.

6.9.3.5.2 Manual adjustment

In the “Maintenance1” menu, verify that “Channel Adjustment Value – Hyst “ has a default value of 128.

6.9.3.6 Event trigger delay adjustment

6.9.3.6.1 Auto-adjustment

Adjustment standard Delay of ±100ps or less for an Edge trigger (holdoff by: Events) or a Qualify trigger (Qualify by: Events) trigger point when the trigger point is Edge trigger (holdoff: OFF)

Adjustment method

(1) Run “Automatic Adjustment - Edge & Qual TrigDelay” in the “Mainenance1” menu.
Trigger point correction between Edge trigger holdoff OFF and Evts, and trigger point correction for Qlfy Events between Qualified trigger wait OFF and Evts are adjusted automatically.
(2) After the auto-adjustment is completed, click “Save to HW” to save to the EEPROM

6.9.3.6.2 Manual adjustment

Method for adjusting edge event trigger delay
Setting Timebase ⇒ 1ns/div, RIS

(1) Input a high-speed pulse signal and set the trigger level to roughly the midpoint of the amplitude.
(2) In the “Measure” menu, set “Delay – C1.” Click ”Statistics” to turn “On” this function.
(3) In the “Trigger” menu, select “Edge Trigger” and switch “Holdoff by” to “None” and Events 1#.” In the “Maintenance1” menu, adjust “Other Adjustment – DelayEdge” such that the “mean” difference for each measured value becomes ±100ps or less.
(4) Click “Save to HW” to save to the EEPROM.

Method for adjusting qualified event trigger delay

Setting Timebase ⇒ 1ns/div, RIS

(1) Input a high-speed pulse signal to CH1 and input an approximate 1kHz signal to CH2.
(2) In the “Measure” menu, set “Delay – C1.” Click ”Statistics” to turn “On” this function.
(1) In the “Trigger” menu, select “Edge Trigger” and set ”Trigger on – C1” and “Holdoff by – None.”
(2) In the “Trigger” menu, select “Smart Trigger - Qualify” and set ”After – C2” and “Holdoff by – Events 1#.”
(3) In the “Trigger” menu, switch “Edge Trigger” and “Smart Trigger.” In the “Maintenance1” menu, adjust “Other Adjustment – DelayQual” such that the “mean” difference for each measured value becomes ±100ps or less.
(4) Click “Save to HW” to save to the EEPROM.

6.9.3.7 Odd path adjustment

6.9.3.7.1 Auto-adjustment

Adjustment method

(1) Run “Automatic Adjustment - OddPathCorrection” in the “Maintenance1” menu.
(2) After the auto-adjustment is completed, click “Save to HW” to save to the EEPROM.

6.9.3.7.2 Manual adjustment

Adjustment standard Delay sdev 7ps

Setting CH1 ⇒ DC 50Ω 10mV/div
Timebase ⇒ RIS, 1ns/div
Trigger ⇒ Delay: 0ns (center of display screen)

Adjustment method

(1) Input a high-speed pulse signal and set the trigger level to roughly the midpoint of the amplitude.
(2) In the “Measure” menu, select “Delay.”
(3) In the “Maintenance1” menu, adjust “OddPath” such that the measured value ”sdev” is minimized.
(4) After the adjustment is completed, click “Save to HW” to save to the EEPROM.

6.9.3.8 Trigger analog time adjustment

For “holdoff by time” or a trigger mode based on a SMART trigger time setting, the time accuracy is adjusted for time settings of 100ns or less.
(In the case of a time setting longer than 100ns, the time will be accurate since it will be calculated using a 500MHz internal reference clock.)

6.9.3.8.1 Automatic / semiautomatic adjustment

Adjustment standard W≤10ns: +/-0.3ns
10ns<W≤100ns: +/-(1.5%+0.6ns)

Setting Trigger ⇒ Glitch at end of : Pos (when the output from the PSPL2600 is a positive pulse)
LEVEL : Midpoint of amplitude

Adjustment method

(1) Without inputting any signal, Open the “Maintenance1” menu and click “64ns/32ns AnalogTime” in the “Automatic Adjustment” menu. When the auto-adjustment is completed, save to EEPROM. “AnalogTime Adjustment value for Interval” and “AnalogTime Adjustment value for Pulse” are adjusted automatically. (64ns Ref4, 64nsRef3, 32nsRef4, 32nsRef4)
(2) Set the output pulse width (half-value width) of the PSPL2600 to 4.0ns±0.1ns, input this signal to CH1 and then click “Pulse 4ns” in the “Half Adjustment” menu. When the auto-adjustment is completed, save to EEPROM. The “4nsRef4, 4nsRef3“ setting in “AnalogTime Adjustment value for Pulse” is adjusted automatically.
(3) Set the output pulse width (half-value width) of the PSPL2600 to 8.0ns±0.1ns, input this signal to CH1 and then click “Pulse 8ns” in the “Half Adjustment” menu. When the auto-adjustment is completed, save to EEPROM. The “8nsRef4, 8nsRef3“ setting in “AnalogTime Adjustment value for Pulse” is adjusted automatically.
(4) Set the output frequency of the SG-503 to 250MHz (4.0ns±0.1ns cycle), input this signal to CH1 and then click “Interval 4ns” in the ”Half Adjustment” menu. When the auto-adjustment is completed, save to EEPROM. The “4nsRef4, 4nsRef3“ setting in “AnalogTime Adjustment value for Interval” is adjusted automatically.
(5) Set the output frequency of the SG-503 to 125MHz (8.0ns±0.1ns cycle), input this signal to CH1 and then click “Interval 8ns” in the ”Half Adjustment” menu. When the auto-adjustment is completed, save to EEPROM. The “8nsRef4, 8nsRef3“ setting in “AnalogTime Adjustment value for Interval” is adjusted automatically.

Notes: (1) Pulse width is defined as the time width at 50% of the pulse amplitude, and therefore unless the trigger level has been set to 50% of the pulse amplitude, adjustments will be unsuccessful.

(2) “Pulse 4ns” and (3)”Pulse 8ns” auto-adjustments will fail if the Glitch trigger has been set with the wrong polarity.

Precautions when using a trigger analog time adjustment jig

When using a trigger analog time adjustment jig instead of the PSPL2600 or SG-503, connect a –10dB attenuator to the output of the adjustment jig, and with CH1 set to 50Ω input and a 20mV/div range, verify that the output amplitude is approximately 7 div before making adjustments.

Set the CH1 OFFSET to 0.0000V and the trigger level to DC0.0mV.

The relationship between ”Adjust item” and output frequency of the adjustment jig is listed below.

“Pulse 4ns” → Set output frequency to 125MHz and adjust automatically.
“Pulse 8ns” → Set output frequency to 62.5MHz and adjust automatically.
“Interval 4ns” → Set output frequency to 250MHz and adjust automatically.
“Interval 8ns” → Set output frequency to 125MHz and adjust automatically.

6.9.3.8.2 Manual adjustment

Glitch trigger time

Adjustment standard ± (0.5% + 0.5ns)

Setting Trigger Ref4 at time of adjustment: Smart Trigger - Width - Greater Than
Ref3 at time of adjustment: Smart Trigger - Width - In Range – Limits
Slope : Positive (when the output from the PSPL2600 is a positive pulse)
LEVEL : Midpoint of amplitude

Adjustment method Set the amplitude of the signal source to approximately 6.0div. Open the “Maintenance1” menu and adjust as indicated below, using PSPL2600 as the signal source.

After the adjustment is complete, click ”Save To HW” to save to the EEPROM.

Adjustment item	Time setting	Adjustment method
4ns Ref4	Lower Limit 4.0ns	Adjust to achieve sync with a pulse width of 4.0 ns or more.
8ns Ref4	Lower Limit 8.0ns	Adjust to achieve sync with a pulse width of 8.0 ns or more.
32ns Ref4	Lower Limit 32ns	Adjust to achieve sync with a pulse width of 32 ns or more.
64ns Ref4	Lower Limit 64ns	Adjust to achieve sync with a pulse width of 64 ns or more.
4ns Rref3	2.0ns≤W≤4.0ns	Adjust to achieve sync with a pulse width of 4.0 ns or less.
8ns Ref3	2.0ns≤W≤8.0ns	Adjust to achieve sync with a pulse width of 8.0 ns or less.
32ns Ref3	2.0ns≤W≤32ns	Adjust to achieve sync with a pulse width of 32 ns or less.
64ns Ref3	2.0ns≤W≤64ns	Adjust to achieve sync with a pulse width of 64 ns or less.

Notes: Pulse width is defined as the time width at 50% of the pulse amplitude, and therefore unless the trigger level has been set to 50% of the pulse amplitude, adjustments will be unsuccessful When adjusting Ref3 and Rref4, adjust Ref4 first. (If Rref4 has not already been adjusted, Rref3 may be difficult to adjust in some cases.)

Interval trigger time

Adjustment standard ± (0.5% + 0.5ns)

Setting Trigger Ref4 at time of adjustment: Smart Trigger - Interval - Greater Than
Ref3 at time of adjustment: Smart Trigger - Interval - In Range –

Limits
Slope: Positive
LEVEL: Midpoint of amplitude

Adjustment method Set the amplitude of the signal source to approximately 6.0div. Open the "Maintenance1" menu and adjust as indicated below, using SG-503 as the signal source.
After the adj is complete, click "Save To HW" to save to the EEPROM.

Note: Prior to adjustment, click "Special Mode" in the "Maintenance1" menu (to enable the interval trigger).

Adjustment item	Time setting	Adjustment method
4ns Ref4	Lower Limit 4.0ns	Adjust to achieve sync with a freq of 250MHZ or lower.
8ns Ref4	Lower Limit 8.0ns	Adjust to achieve sync with a freq of 125MHZ or lower.
32ns Ref4	Lower Limit 32ns	Adjust to achieve sync with a freq of 31.25MHZ or lower.
64ns Ref4	Lower Limit 64ns	Adjust to achieve sync with a freq of 15.625MHz or lower.
4ns Rref3	2.0ns≤W≤4.0ns	Adjust to achieve sync with a freq of 250MHZ or higher.
8ns Ref3	2.0ns≤W≤8.0ns	Adjust to achieve sync with a freq of 125MHZ or higher.
32ns Ref3	2.0ns≤W≤32ns	Adjust to achieve sync with a freq of 31.25MHZ or higher.
64ns Ref3	2.0ns≤W≤64ns	Adjust to achieve sync with a freq of 15.625MHz or higher.

6.9.3.9 Adjustment of time difference between channels

Adjustment standard ±20ps or less (10mV/div) for CH1

Setting All CHs ⇒ DC 50Ω 10mV/div
Timebase ⇒ RIS 1ns/div or more
Trigger ⇒ Delay: 0ns (center of display screen)

Adjustment method

(1) Input a high-speed pulse signal (or an approximate 200MHz sine wave signal) through a divider to CH1 and CHX.
(2) Open the "Maintenance1" menu, and using the "Skew" parameter measurement, adjust the Channel Adjustment Value of "Delay CHX" so that the rising (and falling) portions of CH1 and CHX become aligned.
Note: CH1 is a reference and is therefore fixed at " 511."
(3) Click "Save To HW" to save to the EEPROM.

6.9.3.10 Speaker volume adjustment

Adjustment method	Fully turn R18 on the PCI Board so that the volume becomes a maximum. Adjust the speaker volume using the startup sound emitted when the OS (WindowsXPe) starts up, or by opening the "Control Panel" and using "Sounds and Audio Devices – Sounds" or the like.

6.10 Troubleshooting and Flow Charts

6.10.1 Introduction

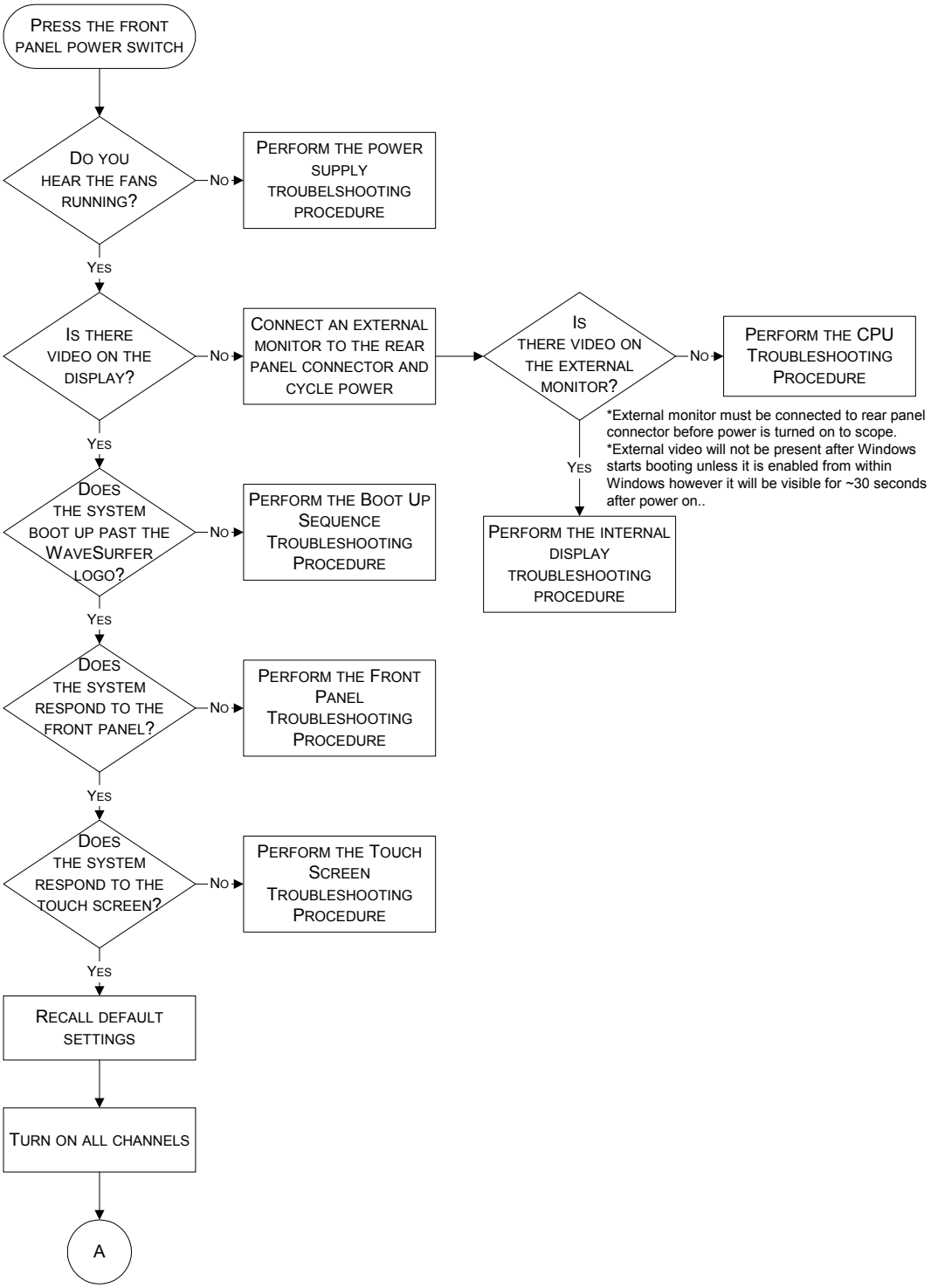
The troubleshooting information contained in this section is intended for use by qualified personnel having a basic understanding of electronics (analog and digital). In order to simplify servicing and minimize downtime, the following list of possible symptoms, likely causes, and troubleshooting steps have been prepared. The first step in troubleshooting is to check for obvious items like blown fuses. The power supply is the next item to check before proceeding to more detailed troubleshooting, since noise or low power supply voltages can cause a variety of digital and analog problems.

6.10.2 Repair Level

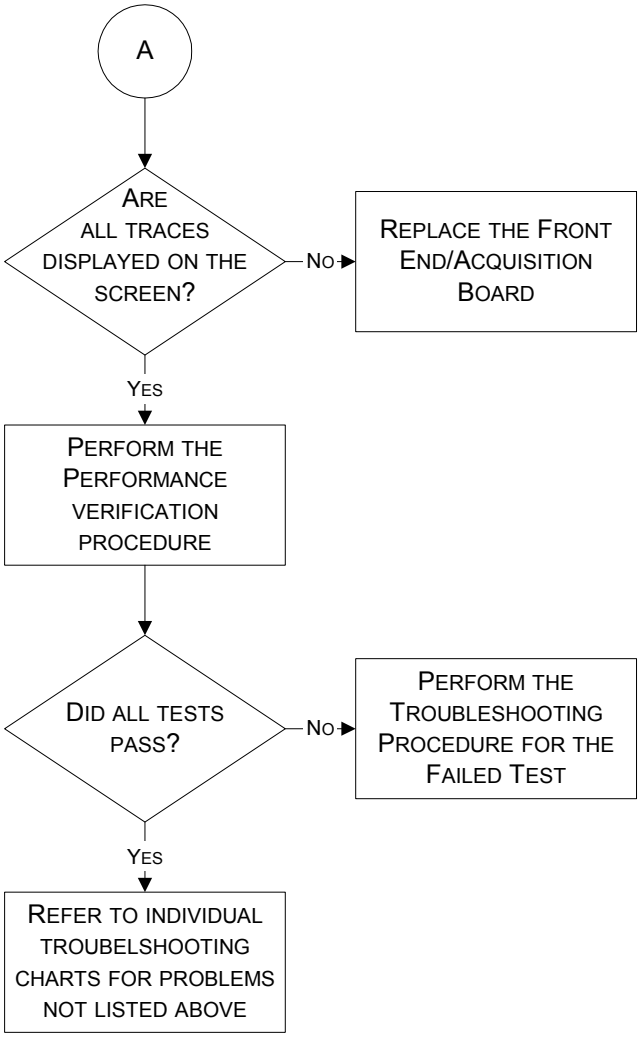
Most procedures in this section will allow troubleshooting down to the **BOARD LEVEL.**

Defective circuit boards will be repaired or exchanged by the regional LeCroy service office or the local representative.

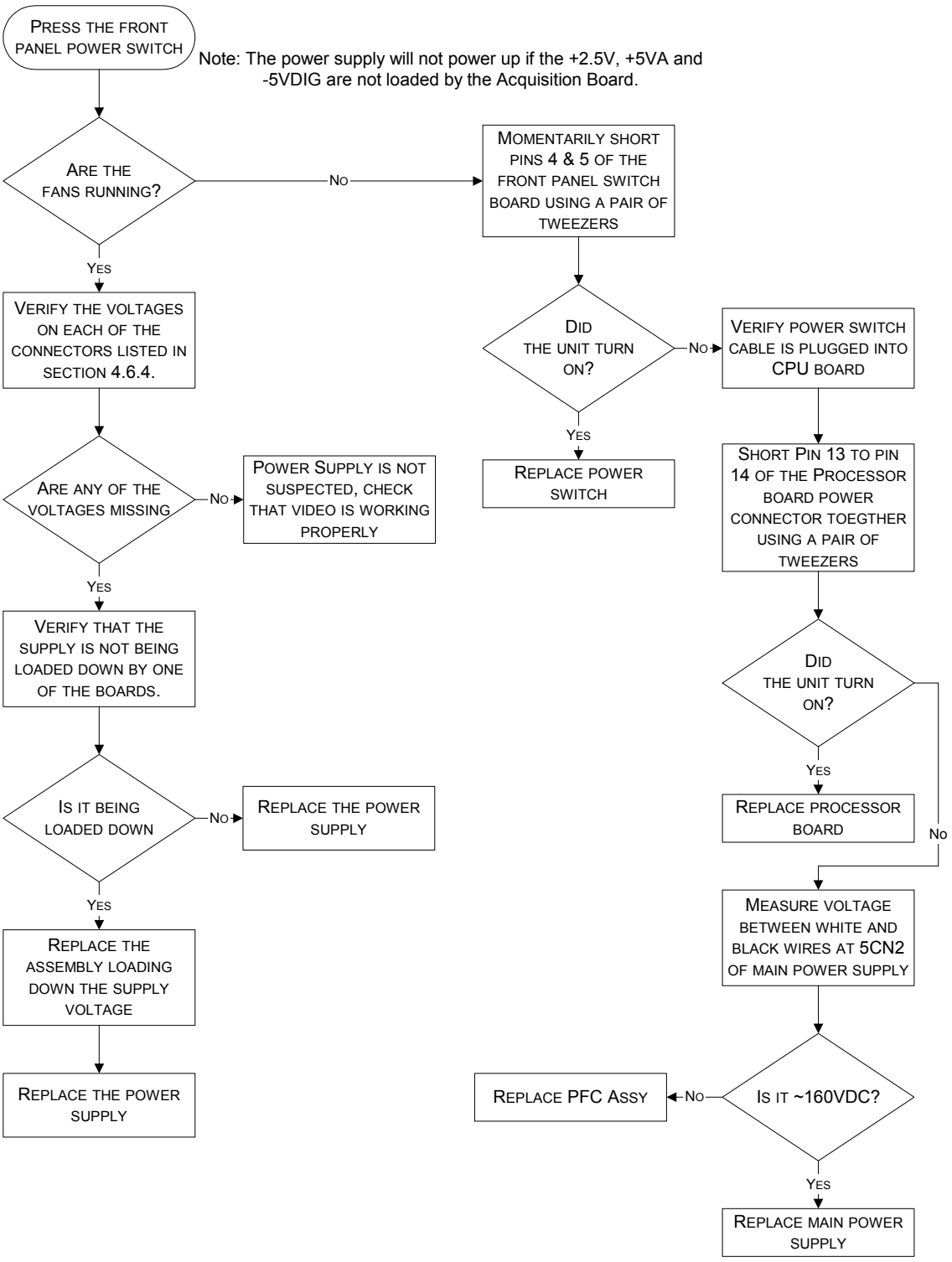
6.10.3 Initial Troubleshooting



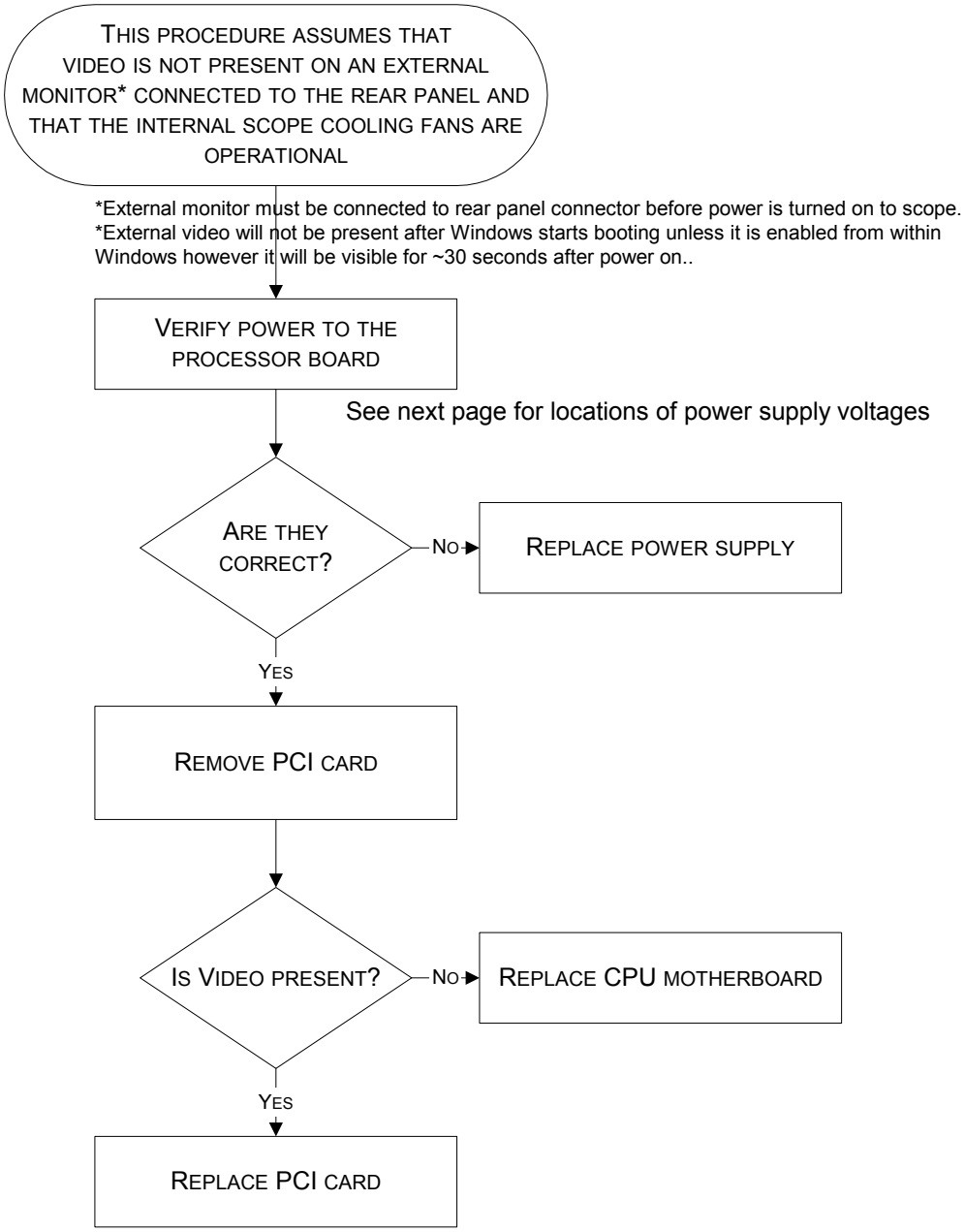
Initial Troubleshooting (continued)



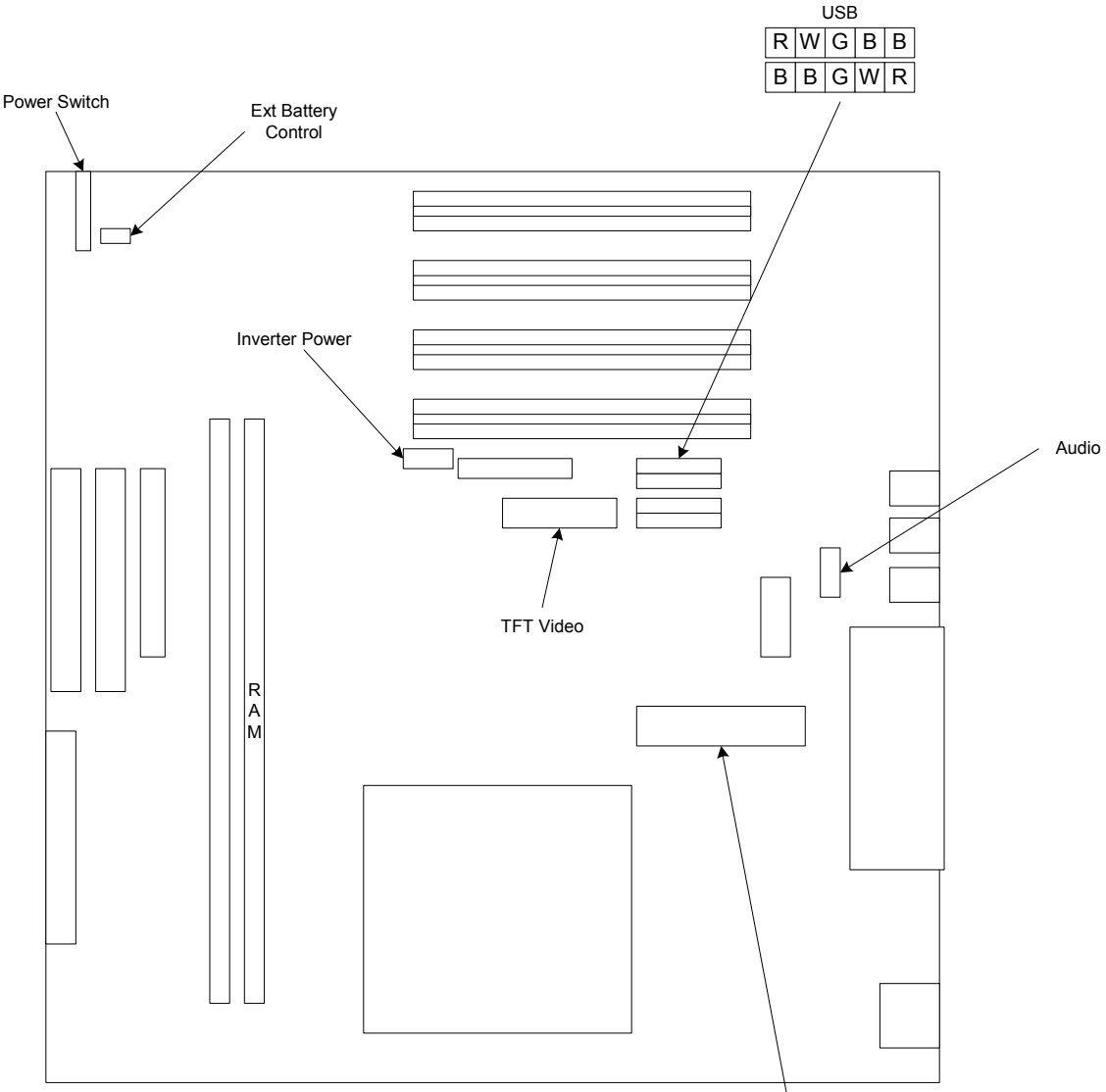
6.10.4 Power Supply Problem



6.10.5 No Display (Internal or External)

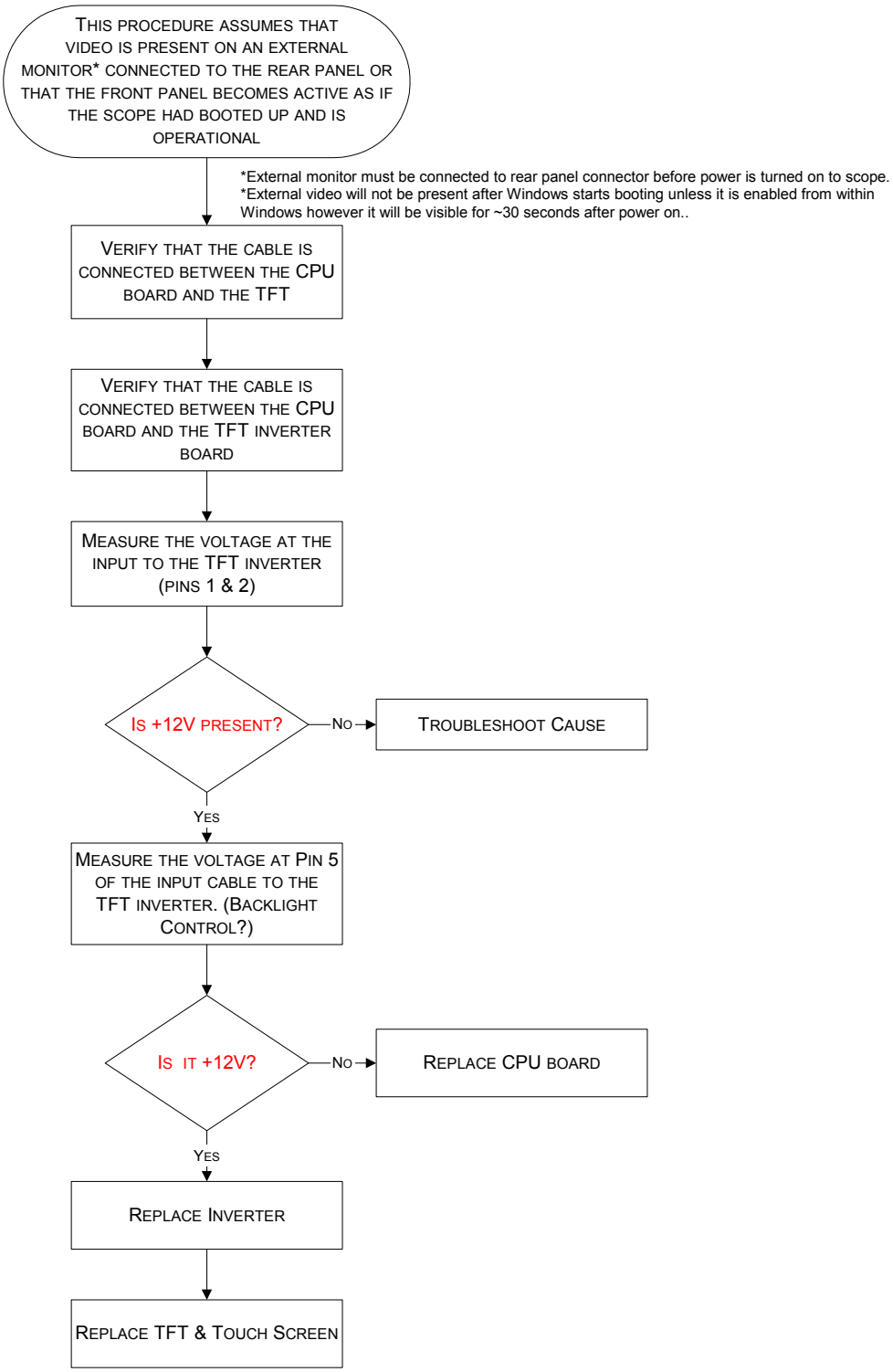


No Display (Internal or External) (continued)

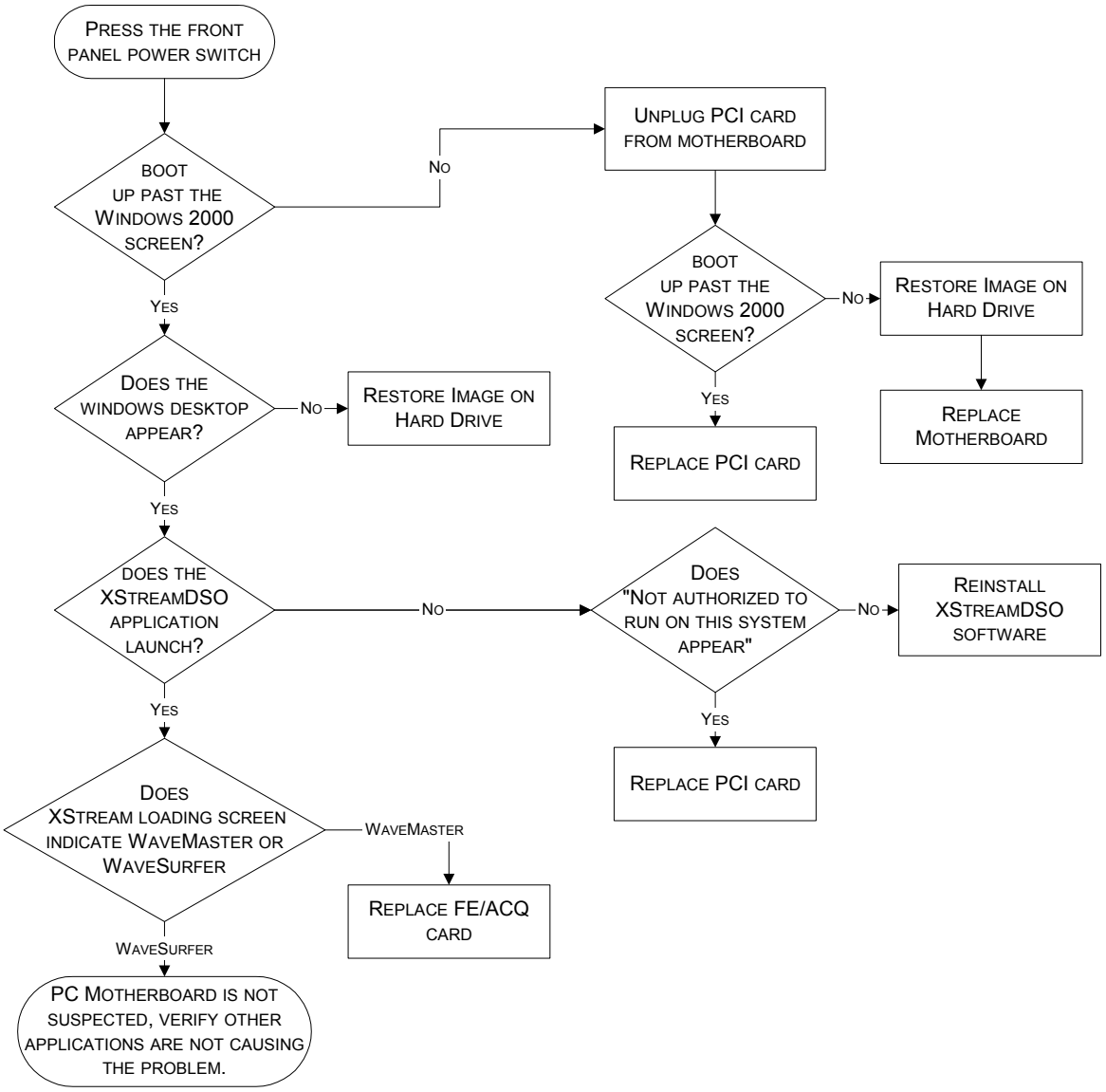


$+5_D$	$+5_D$	-5	Gnd	Gnd	Gnd	Power On/Off	Gnd	-12	+3.3
+12	$+5_{SB}$	Power OK	Gnd	$+5_D$	Gnd	$+5_D$	Gnd	+3.3	+3.3

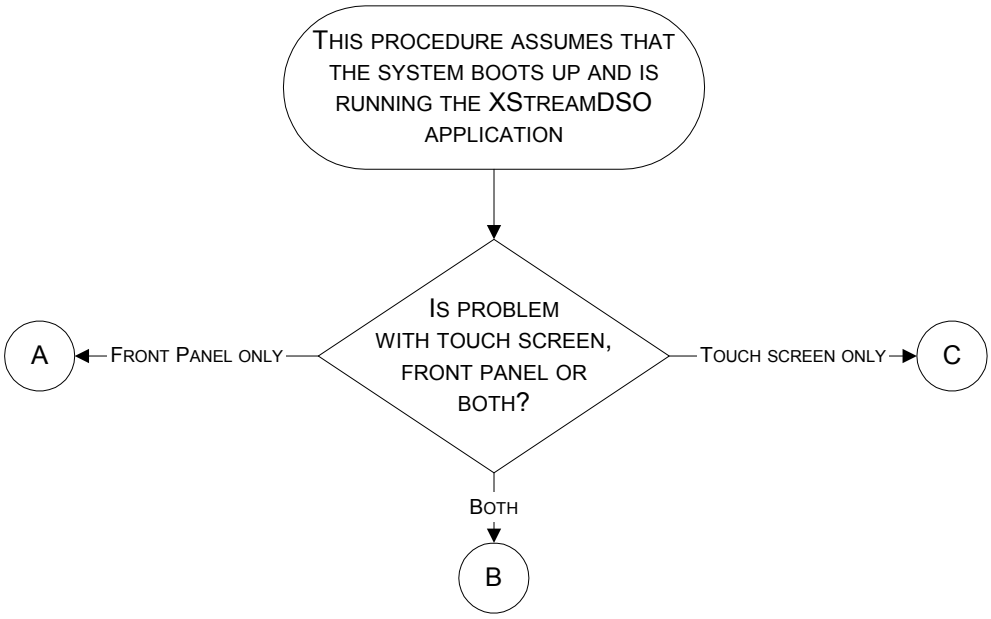
6.10.6 Internal Display Problem



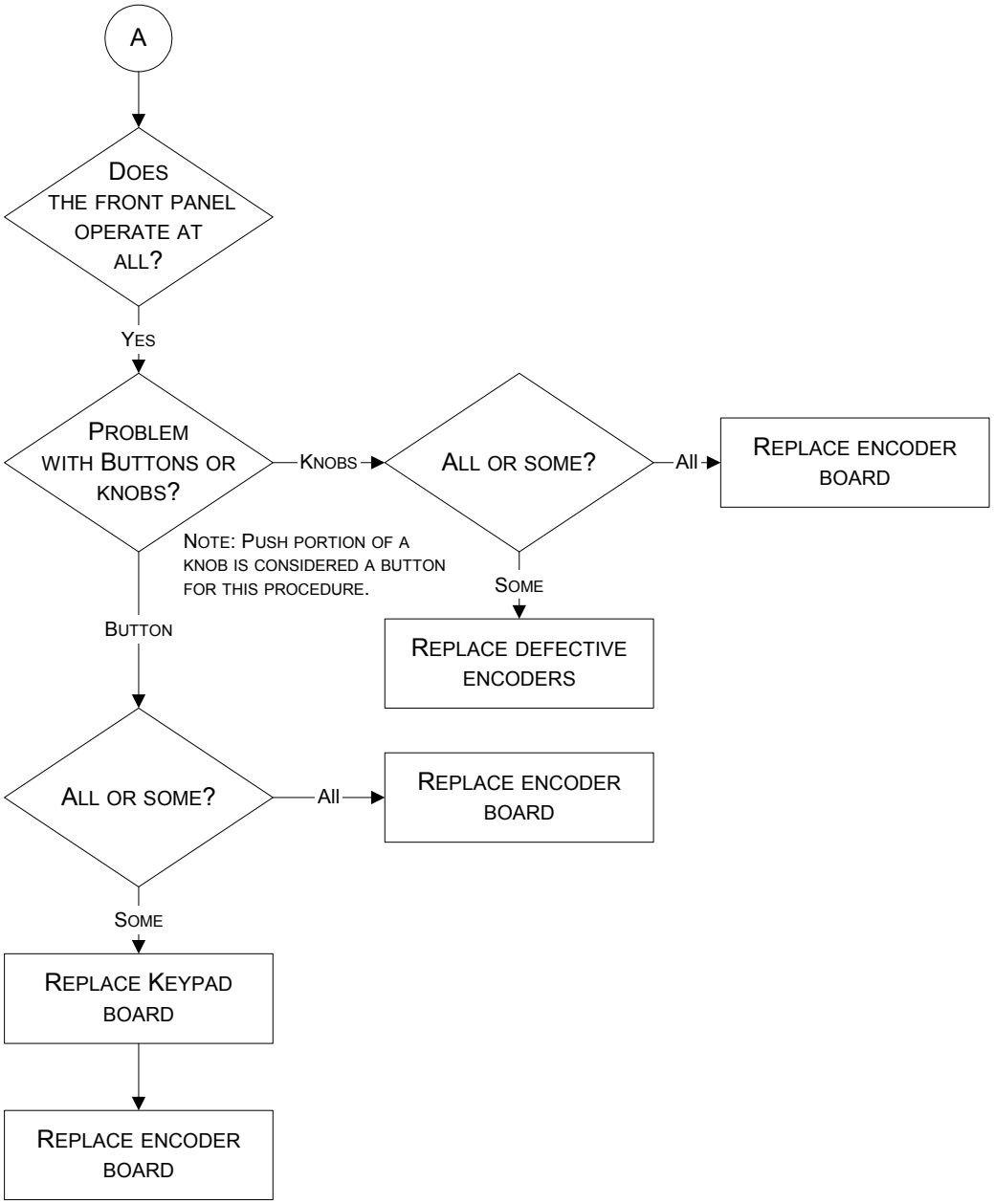
6.10.7 Boot Up Sequence



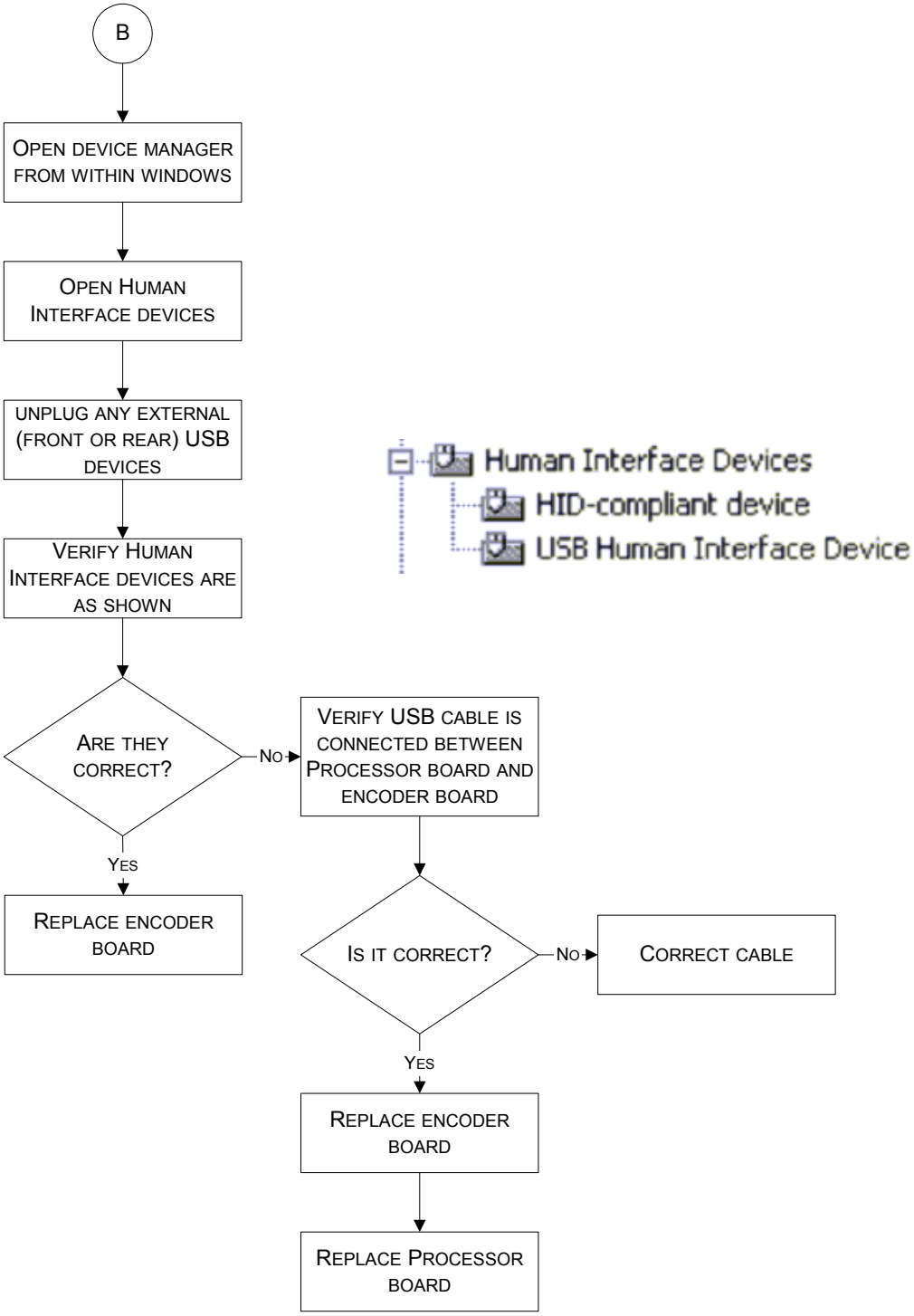
6.10.8 Front Panel Controls or Touch Screen Does not Operate



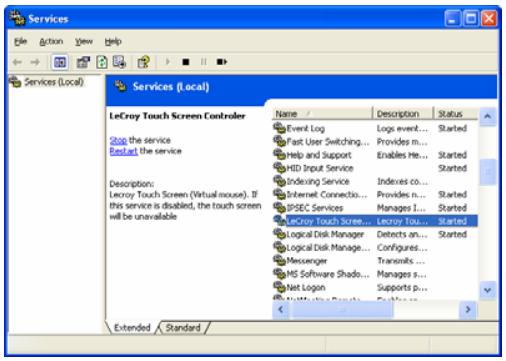
Front Panel Controls or Touch Screen Does not Operate (continued)



Front Panel Controls or Touch Screen Does not Operate (continued)



Front Panel Controls or Touch Screen Does not Operate (continued)



C

DOES THE TOUCH SCREEN OPERATE AT ALL?

No

IS "LECROY TOUCH SCREEN CONTROLLER" IS IN THE SERVICES (CONTROL PANEL - ADMINISTRATIVE TOOLS - SERVICES)

YES

PERFORM THE TOUCH SCREEN INOPERATIVE PROCEDURE

IS "LECROY TOUCH SCREEN CONTROLLER" IN SERVICES (CONTROL PANEL - ADMINISTRATIVE TOOLS - SERVICES)

No

RE-INSTALL XSTREAM SOFTWARE

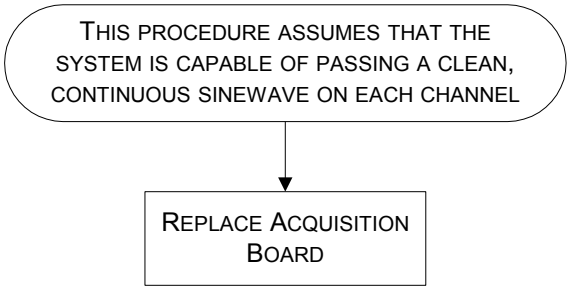
Yes

VERIFY TOUCH SCREEN CABLE IS PLUGGED INTO FRONT PANEL ENCODER BOARD.

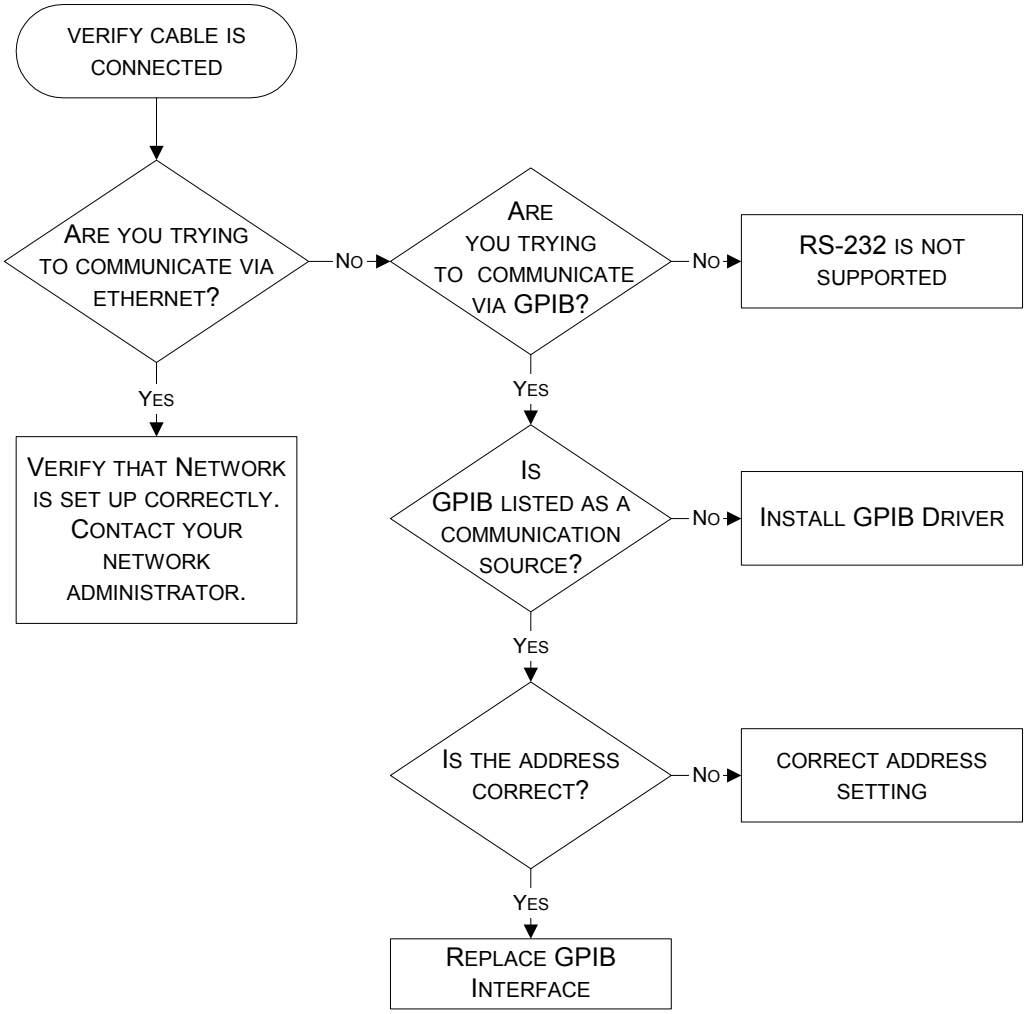
REPLACE TOUCH SCREEN

REPLACE ENCODER BOARD

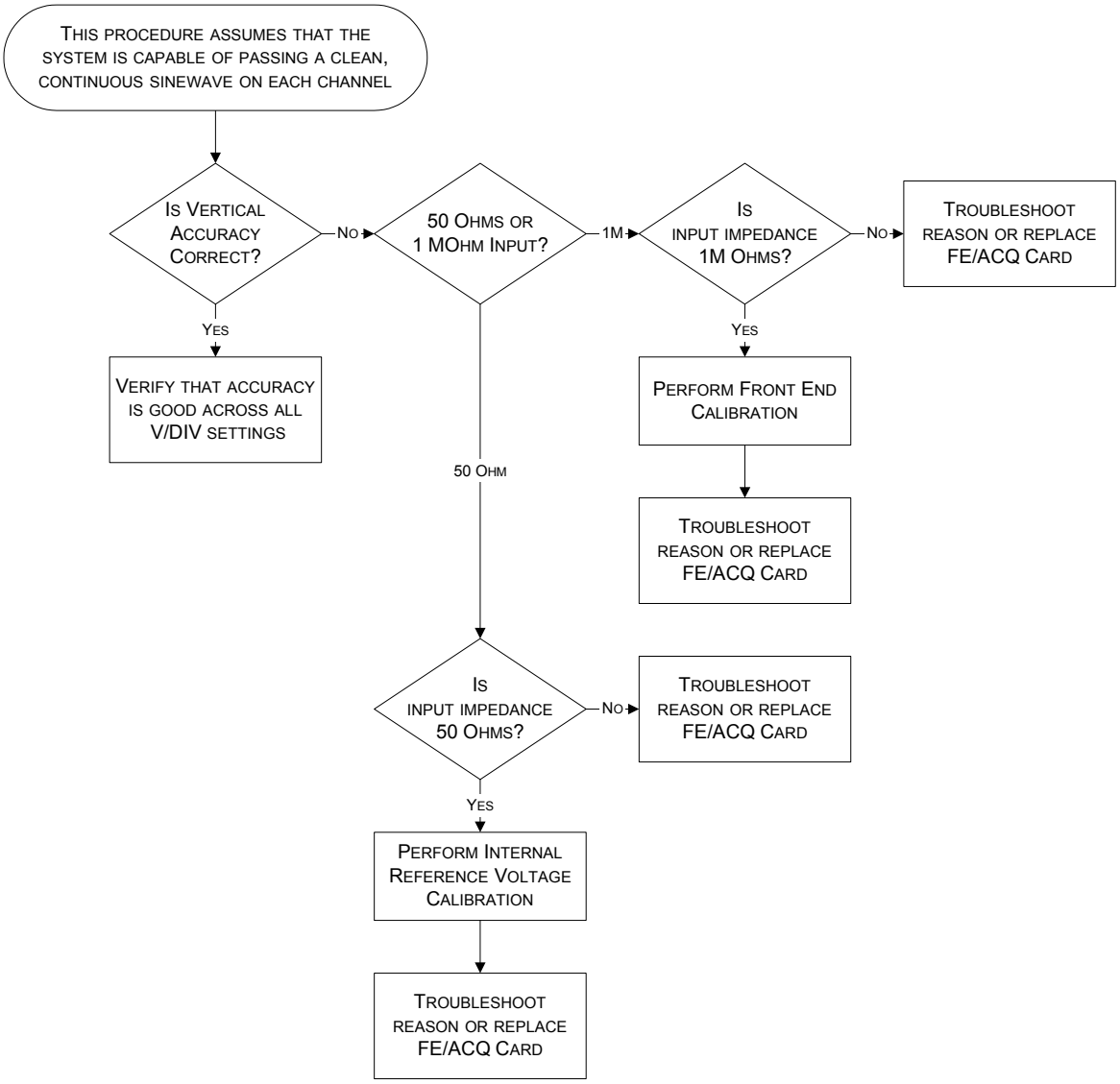
6.10.9 Timebase Problem



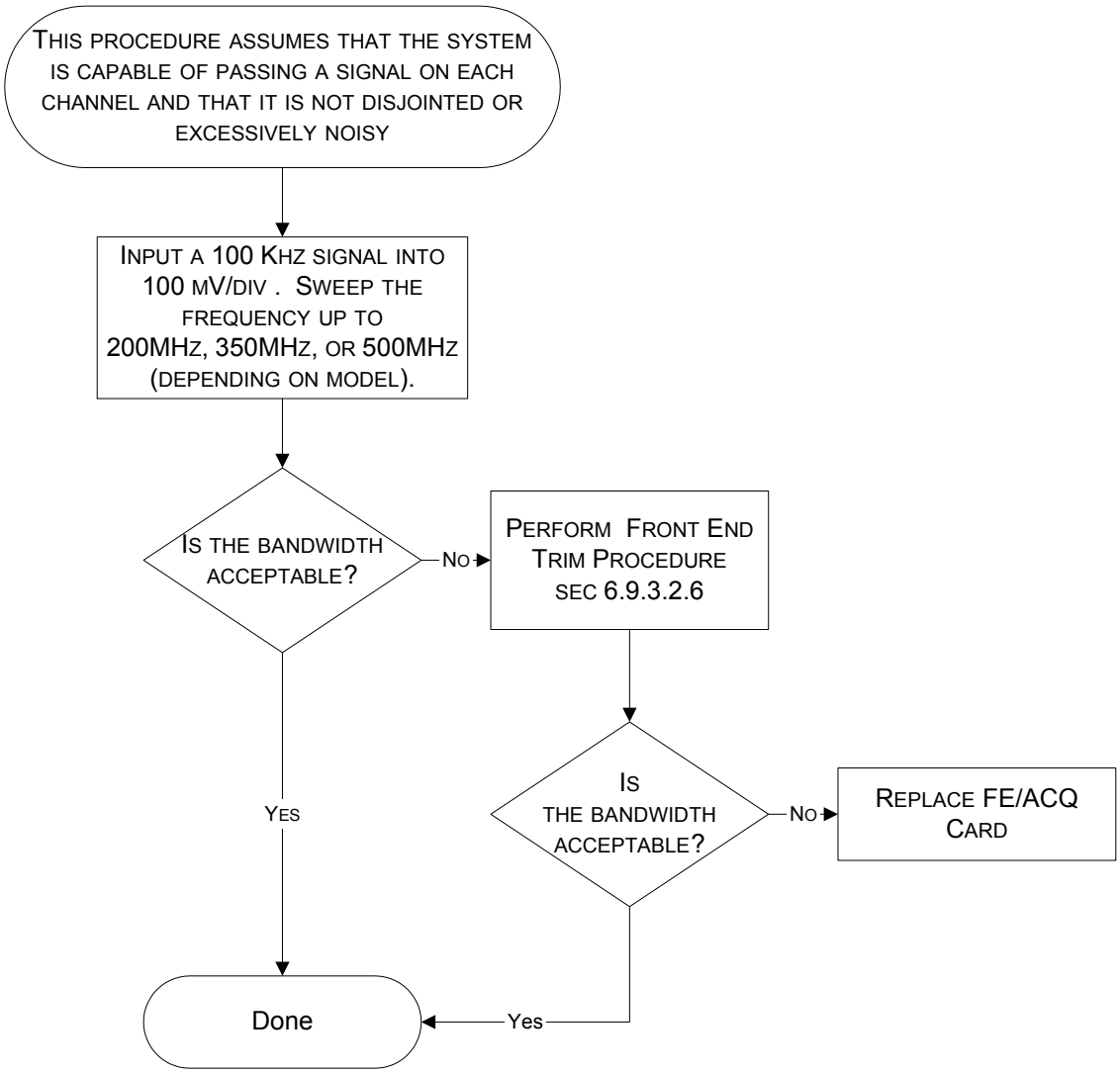
6.10.10 Remote Control Problem



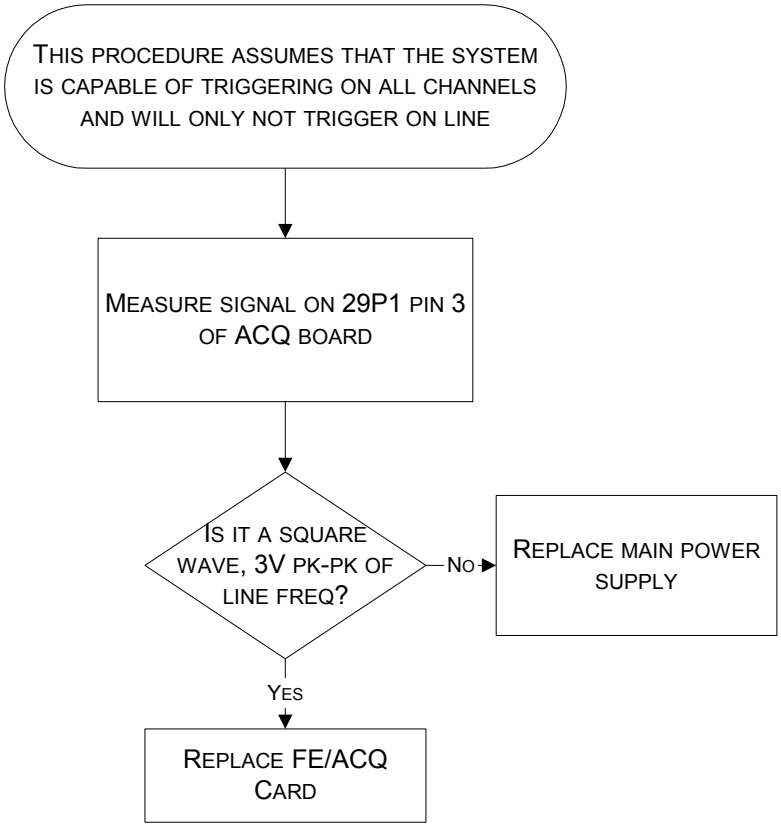
6.10.11 Vertical Accuracy Problem



6.10.12 Bandwidth Problem



6.10.13 Line Trigger Problem



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7 Mechanical Parts & Removal

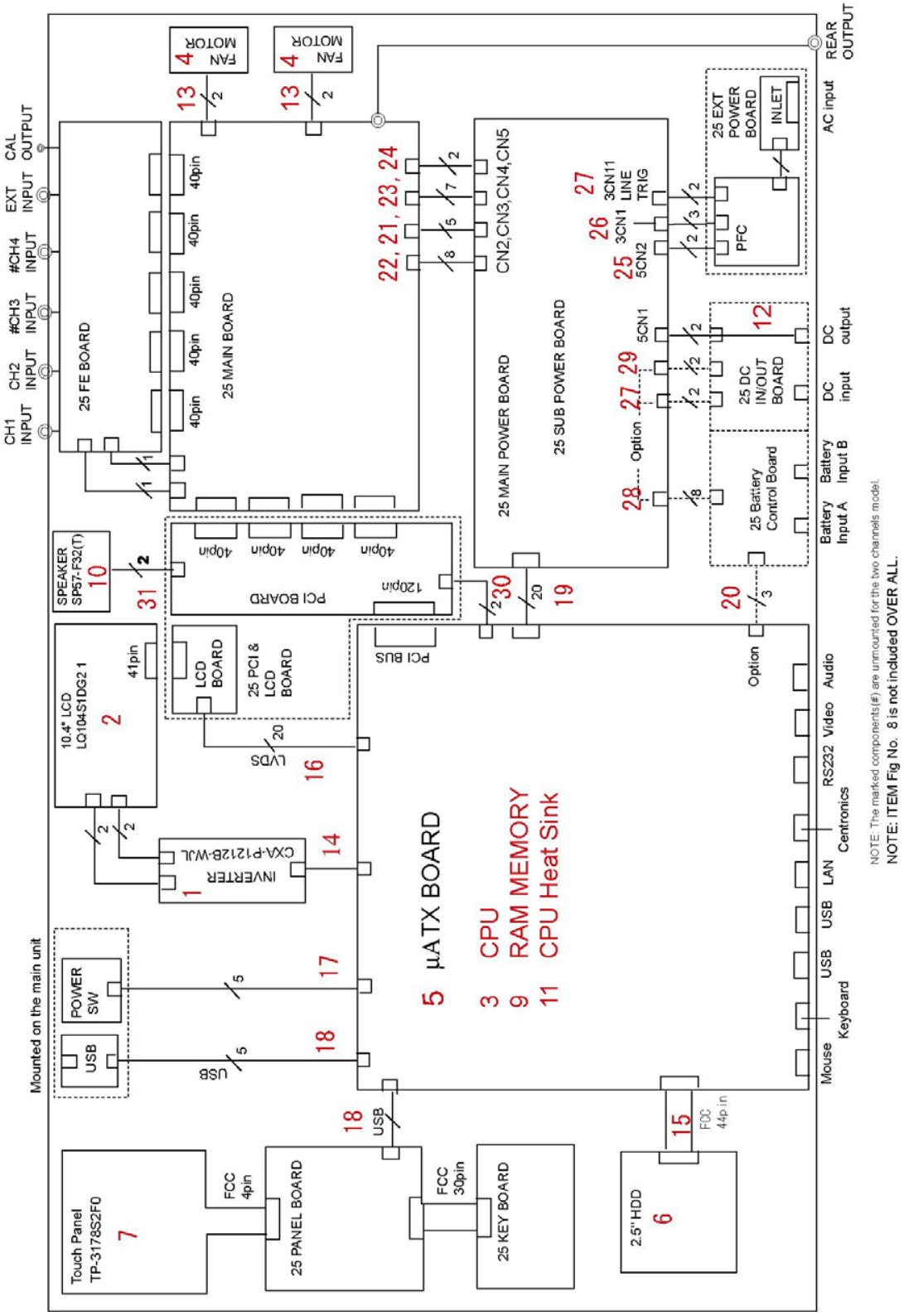
7.1 Over All Replaceable Parts

Item Fig. No	Part Number	Name	Description
1	IWDES040291	Inverter CXA-P1212B-WJL	INVERTER
2	IW211857902	WS4-LCD CIRCUIT	LCD MONITOR included
3	IWDIC561211	RB80526RY850128S L54Q	CPU
4	IWDMT620781	FBA08A12MO	FAN MOTOR
5	IWDZB100231	Mother board MB-266NI	MOTHER BOARD
6	IWDZB100221	Hard disk MHT2030AT	HDD
7	IW211857902	WS4-LCD CIRCUIT	TOUCH PANEL included
8	IWKRA247911	WINDOWS XP-E LICENSE	LICENSE SEAL
9	IWDIC590271	HD-215N256/A	RAM MEMORY
10	IWDSB020991	Speaker SP57-F-32 (T)	SPEAKER
11	IWMHN001441	25EX53X60-SA-U	CPU Heat sink
12	IWKHB200411	DC OUT CABLE	POWER – DC IN/OUT BOARD
13	IWKHB197321	FAN CABLE	FAN - MAIN
14	IWKHB198211	BACK LIGHT CABLE	INVERTER - μATX
15	IWKHB198341	IDE CABLE 4	HDD - μATX
16	IWKHB198411	LVDS CABLE	LCD - μATX
17	IWKHB198511	SW CABLE	SW - μATX
18	IWKHB198621	USB CABLE	PANEL-μATX & USB-μATX
19	IWKHB198721	μ ATX CABLE	POWER - μATX
20	IWKHB198811	SMBUS CABLE	BATT - μATX
21	IWKHB198921	POWER 12V/9V CABLE	POWER - MAIN
22	IWKHB199021	POWER 5V/2.5V CABLE	POWER - MAIN
23	IWKHB199121	SENSE CABLE	POWER - MAIN
24	IWKHB199211	FAN POWER CABLE	POWER – MAIN

Item Fig. No	Part Number	Name	Description
25	IWKHB199421	PFC OUTPUT CABLE 2	POWER - PFC
26	IWKHB199521	AUX OUTPUT CABLE 2	POWER - PFC
27	IWKHB199611	LINE TRG&5V STB CABLE	POWER - PFC
28	IWKHB199721	BATTERY CONTROL CABLE	POWER – Battery
29	IWKHB199821	BATTERY I/O CABLE	Control Board
30	IWKHB200011	SOUND OUT CABLE	μATX - PCI
31	IWKHB200111	SPEAKER CABLE	PCI - SPEAKER

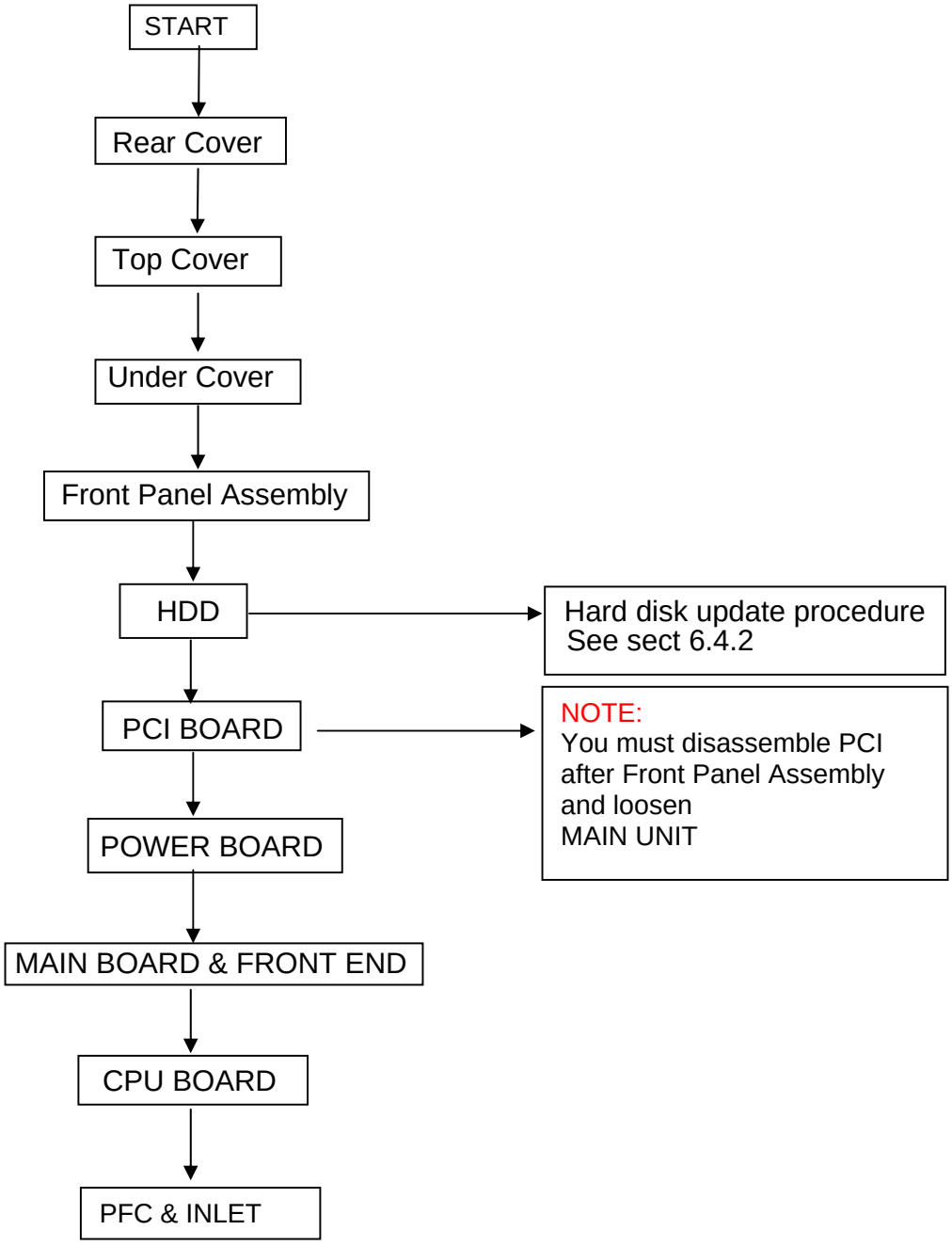
NOTE: ITEM Fig No. 8 is not included OVER ALL.

7.2 Over All Block Diagram



7.3 Disassembly Flow Charts

Note:
Power is always present on the CPU motherboard and inside the Power Supply whenever the power cord is plugged into a power source. Remove the power cord from the instrument before removing or inserting any connectors to the CPU motherboard. Extreme caution should be taken in protecting the LCD face from damage (e.g. scratch marks.) when handling, in particular when inserting or removing from the instrument.



7.4 OUTER Replaceable Parts

Item Fig. No	Part Number	Quantity	Description	*Location
1	IWMKB130069	15	SCREW KB (+) 3X6S	A1-6, B1-7,C1-2
2	IWKCM148511	4	WS FOOT BASE UL-I	C1-4
3	IWKGM030211	2	WS RUBBER FOOT UL-I	A2-2
4	IWMKB130089	4	SCREW KB (+) 3X8S	C1-4
5	IWMSQ920911	4	NYLON WASHER (2.8X7.5X0.5)	B1-2, C1-2
6	IWKCM148421	2	WS ANGLE FOOT UL-I	C1-2
7	IWMKD140101	2	SCREW KD (+) 4X10S	B1-2
8	IWKPL143911	1	FSN CUSHION B	B2
9	IWKPL145511	1	WS I-O CUSHION 153 UL-I	B2
10	IWKPL145611	2	WS I-O CUSHION 40 UL-I	B2-2
11	IWKBA806121	1	WS UNDER COVER	C1
12	IWKBA806221	1	WS TOP COVER	B1
13	IWMTH000791	1	HANDLE THA-238-L260 UL-I	B1
14	IWKRA227411	1	LABEL 12.5X50	B1
15	IWKRA250611	1	ETHERNET POST STICKER	B1
16	IWKRA226821	1	SERIAL NUMBER LABEL	A1

*Location
(ex) A1-6: It is shown to use 6 pieces in figure [A1].

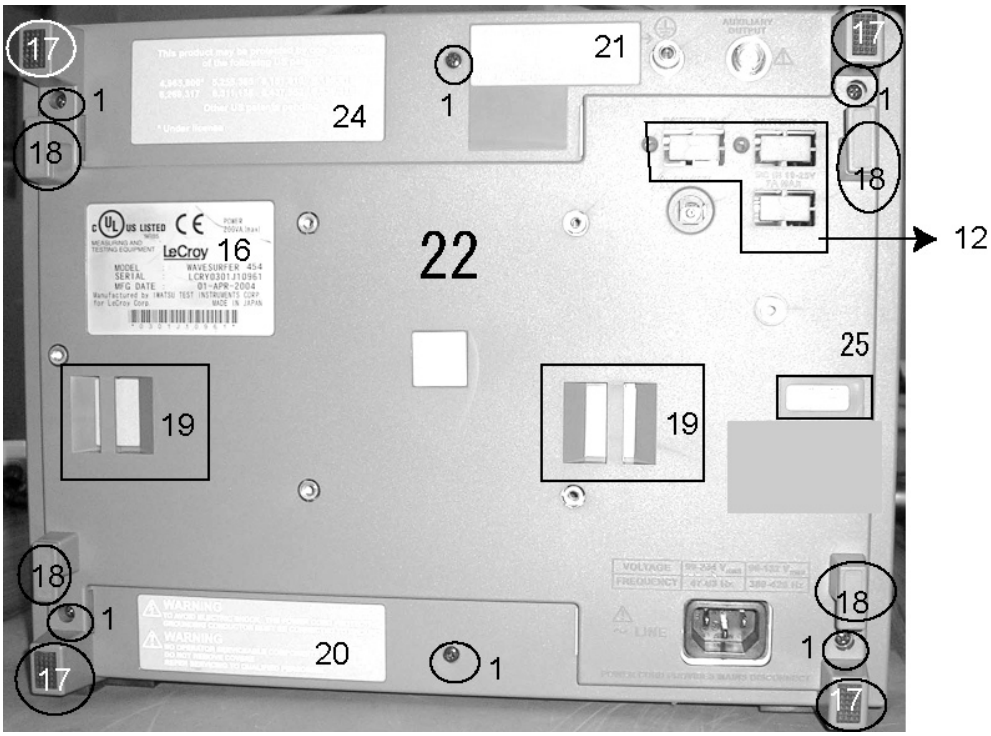
7.5 REAR & SIDE Replaceable Parts

Item Fig. No	Part Number	Quantity	Description	Location
17	IWKGM029111	4	FSN RUBBER FOOT	A1-4
18	IWKCM149111	4	WS CORD HOOK UL-I	A1-4
19	IWKRA249511	2	WS HOLE LABEL UL-I	A1-2
20	IWKRA248111	1	WS WARNING LABEL UL-I	A1
21	IWKRA249211	1	WS BATTERY LABEL UL-I	A1
22	IWKCM148911	1	WS REAR PANEL UL-I	A1
23	IWKPA224411	1	WS I-O OVER LAY	B1
24	IWKRA248211	1	WS PATENT LABEL UL-1	A1
25	IWKRA247911	1	WINDOWS XP-E LICENSE G/ LICENSE SEAL	A1
26	IWMSQ901661	4	SCREW TT2 (+)3X8S	A2-4

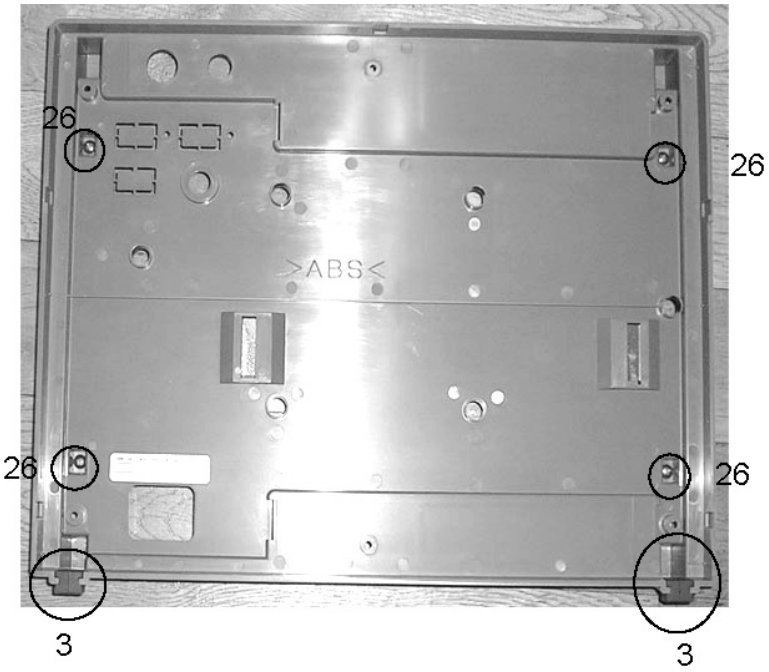
A. Removal of the Rear Cover Assembly

- A1 Remove the six KB (+) 3x6(BLACK) screws (Item Fig No.1) four underneath the plastic rear cover.

[A1]



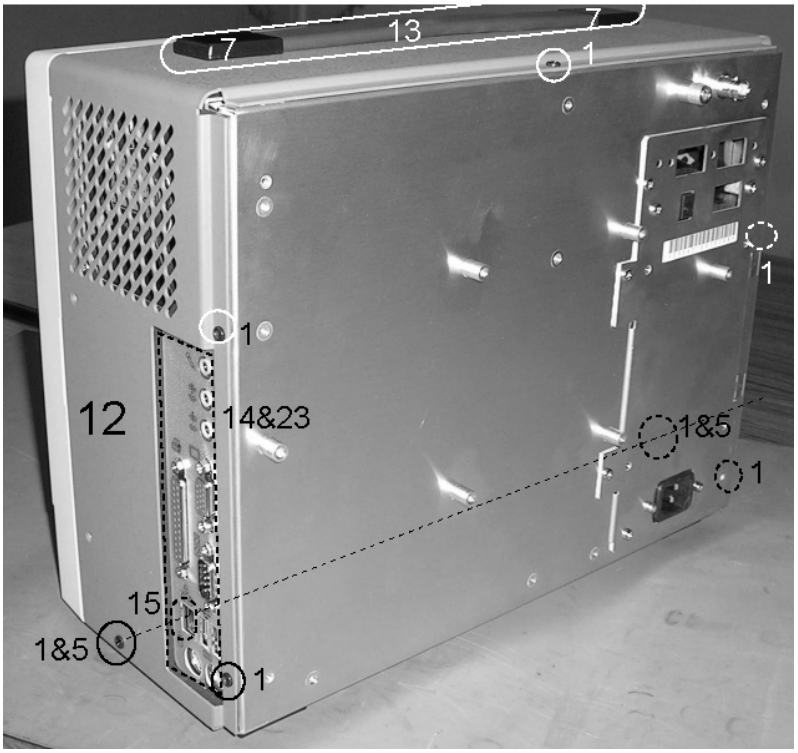
[A2]



B. Removal of the Top Cover Assembly

- B1 Remove the six KB (+) 3x6(BLACK) screws (Item Fig No.1) (two with nylon washer, four on the top cover of left and right).

[B1]



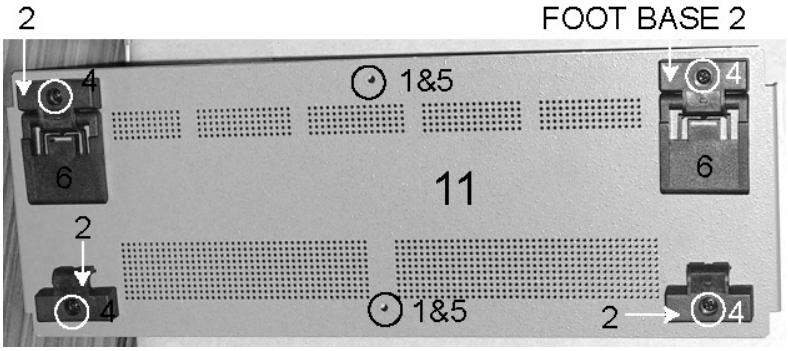
B. Parts of the Top Cover Assembly

[B2]

C. Removal & Parts of the Lower Cover Assembly

- C1 Remove the two KB (+) 3x6(BLACK) screws (Item Fig No.1) with nylon washer on the under cover.

[C1]



7.6 FRONT PANEL ASSEMBLY

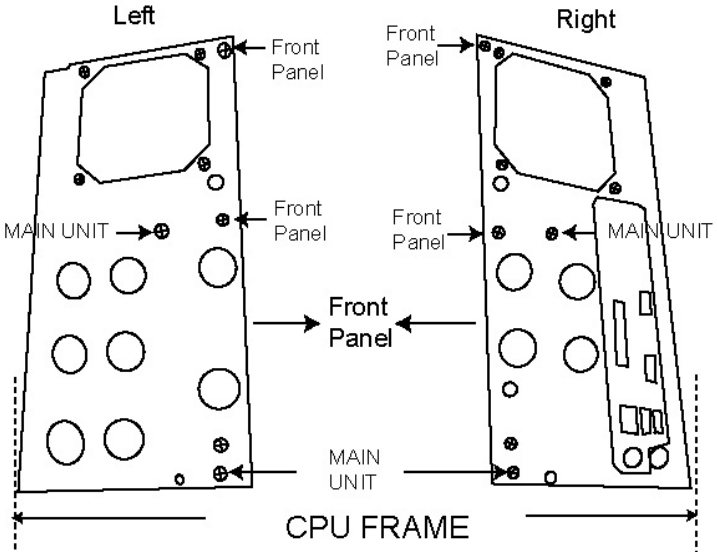
Item Fig. No	Part Number	Quantity	Description	Location
1	IWMSQ901661	13	SCREW TT2 (+) 3X8S	E1-9, E2-4
2	IWMSQ901781	11	SCREW TAP bundle 2X6S(P)	E3-11
3	IWKGM030711	6	WS KNOB SPACER S	E4-6
4	IWKCM149211	6	RUBBER OVERMOLDED KNOB S	E4-6
5	IWKGM030611	3	WS NOBE SPACER ML	E4-3
6	IWTPS183211	3	SP WASHER	E1-3
7	IWKCM149411	2	RUBBER OVERMOLDED KNOB L	E4-2
8	IWKPS009711	2	RAG 70	E3-2
9	IWKCM149311	1	RUBBER OVERMOLDED KNOB M	E4
10	IWMHK002251	1	LOCK WIRE SADDLE LWS-2.5S	D4, E1
11	IWKBA805921	1	WS FRONT CHASSIS	E1
12	IWKBA806711	1	WS BEZEL PLATE	D2, D4
13	IWKGM029311	1	WS KEY RUBBER UL-I	E3
14	IWMZT007871	2	GASKET UC-3E0564 UL-I	E2-2
15	IWMZT006131	2	GASKET UC-300280 with tape	E1, E2
16	IWKGM030211	2	WS RUBBER FOOT UL-I	D2-2
17	IWKPA226011 IWKPA225911 IWKPA225811 IWKPA225711 IWKPA225611 IWKPA224211	1 1 1 1 1 1	WS422 NAME OVER LAY UL-1 WS424 NAME OVER LAY UL-1 WS432 NAME OVER LAY UL-1 WS434 NAME OVER LAY UL-1 WS452 NAME OVER LAY UL-1 WS454 NAME OVER LAY UL-1	E4
18	IWKPA226111 IWKPA224111	1 1	WS PROBUS OVERLAY 2CH WS PROBUS OVERLAY 4CH	E4
19	IWKPA225711 IWKPA224011	1 1	WS CONTROL OVERLAY 2CH WS CONTROL OVERLAY 4CH	E4
20	IWMKB130032	5	SCREW KB (+) 3X6S(NIP)	E1-5
21	IW528623002	1	NOISE SHIELD 43SM24	E1
22	IWKPA221221	1	LOGO PANEL	E4
23	IWKCM149511	1	WS PANEL COVER UL-1	E4
24	IWMZT007951	5	GRIP FINGER- 97-655-02	E1
25	IWKPA224311	1	WS INPUT OVERLAY UL-1	E4

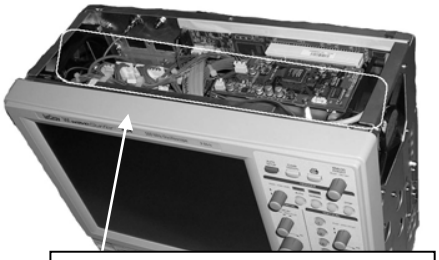
D. Removal of the Front Panel Assembly

Procedure:

- Remove the four KB (+) 3x6 screws (Item Fig No.20) that secure the front panel assembly from the main chassis. D1
- Loose the two KB3X6 (Item Fig No.20) screws on the FRONT END ASSY. D2
- Carefully pivot up the Front Panel Assembly. D3
- Disconnect the four cables from the Front Panel Assembly like step1 to 4. D4

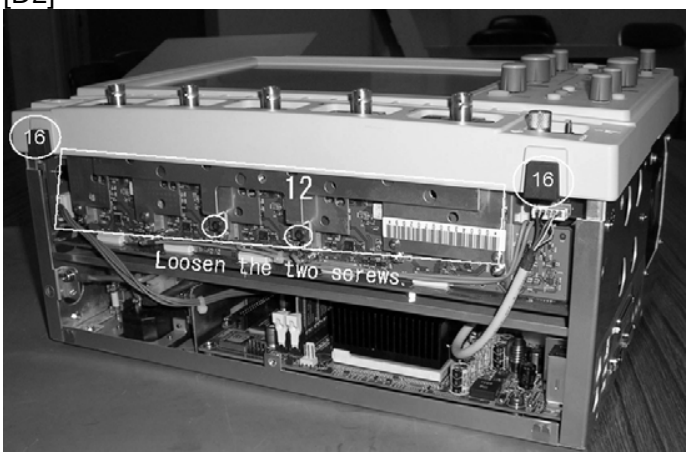
[D1] Remove the three KB (+) 3x6 screws on the each side frames R and L





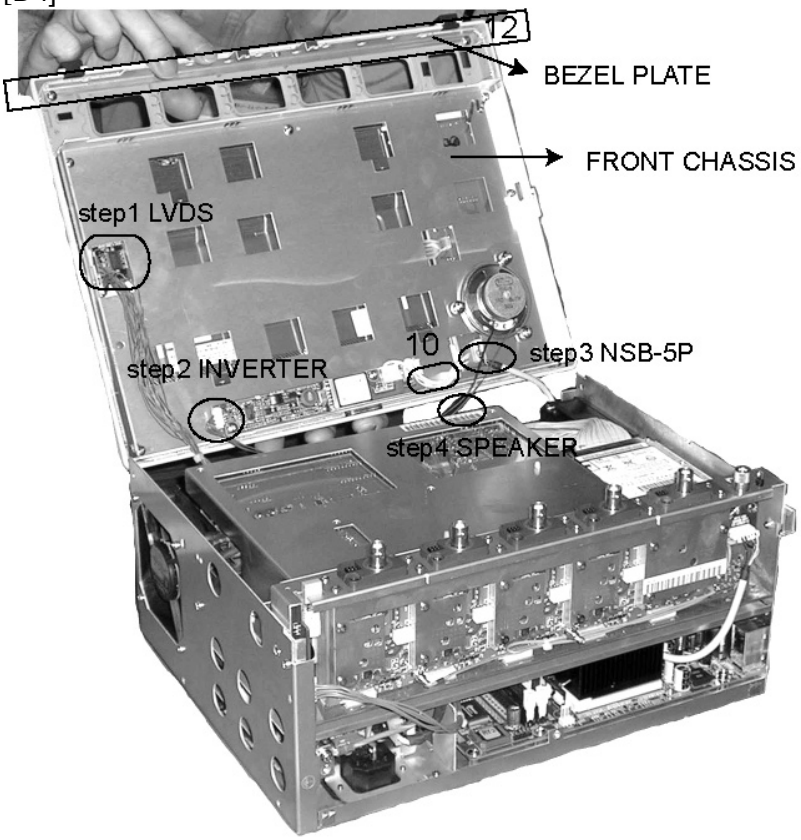
Extra care must be taken to make sure that no cables get pinched while pivoting up the Front Panel Assembly.

[D2]



[D3]
Carefully pivot up the Front Panel Assembly not to pinch the codes.

[D4]

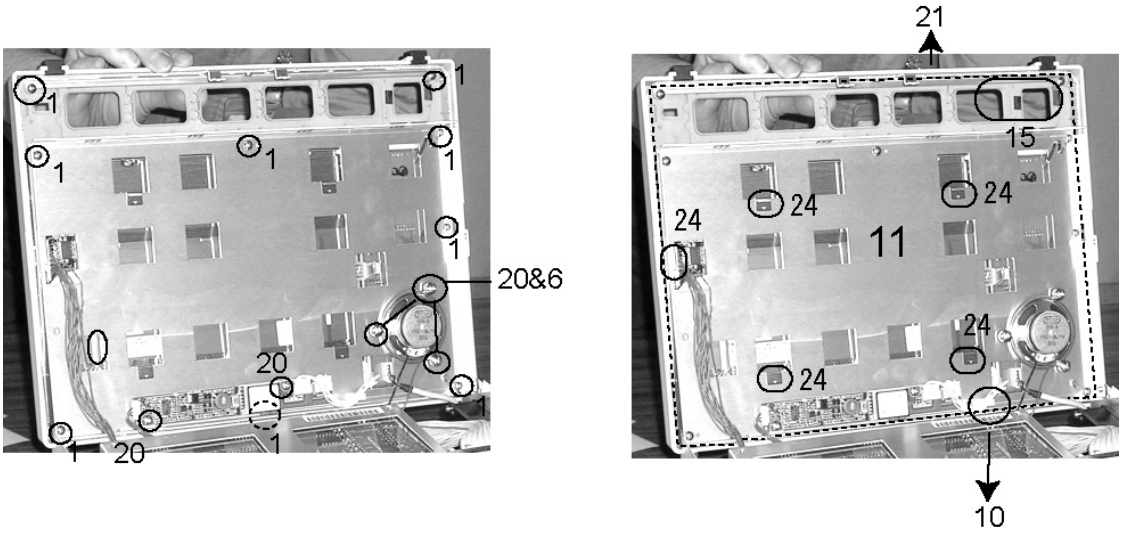


NOTE: When you remove the LVDS connector, pull it out straight not to bend the pins. .

E. Removal of the Front Panel Assembly Parts

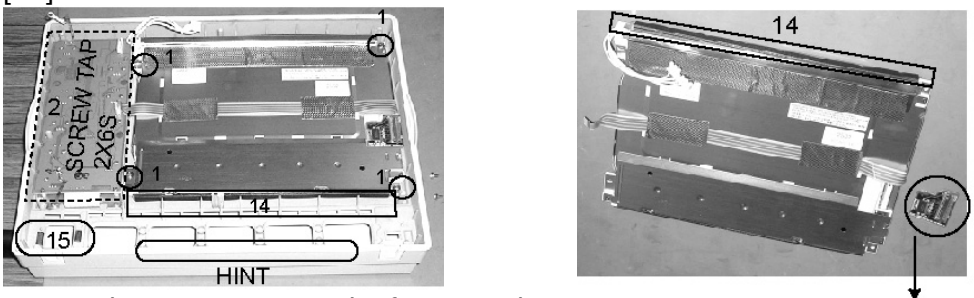
Fig. No	Removal Parts	Screws
E1	SPEAKER	Remove the three KB(+)3X6S(NIP) screws on the front chassis.
E1	INVERTER	Remove the two KB(+)3X6S(NIP) screws on the front chassis.
E1	BEZEL PLATE	Remove the two TT2(+)3X8S screws on the front bezel.
E1	FRONT CHASSIS	Remove the seven TT2(+)3X8S screws on the front bezel.
E2	LCD Assembly	Remove the four TT2(+)3X8S screws on the front bezel.
E3	KEY BOARD Assembly	Remove the eleven 2X6S(P) screws on the front bezel.

[E1]



NOTE: When you assemble the Front Panel Assembly, the noise shield (21) is inserted in the groove at the edges of the front panel assy.

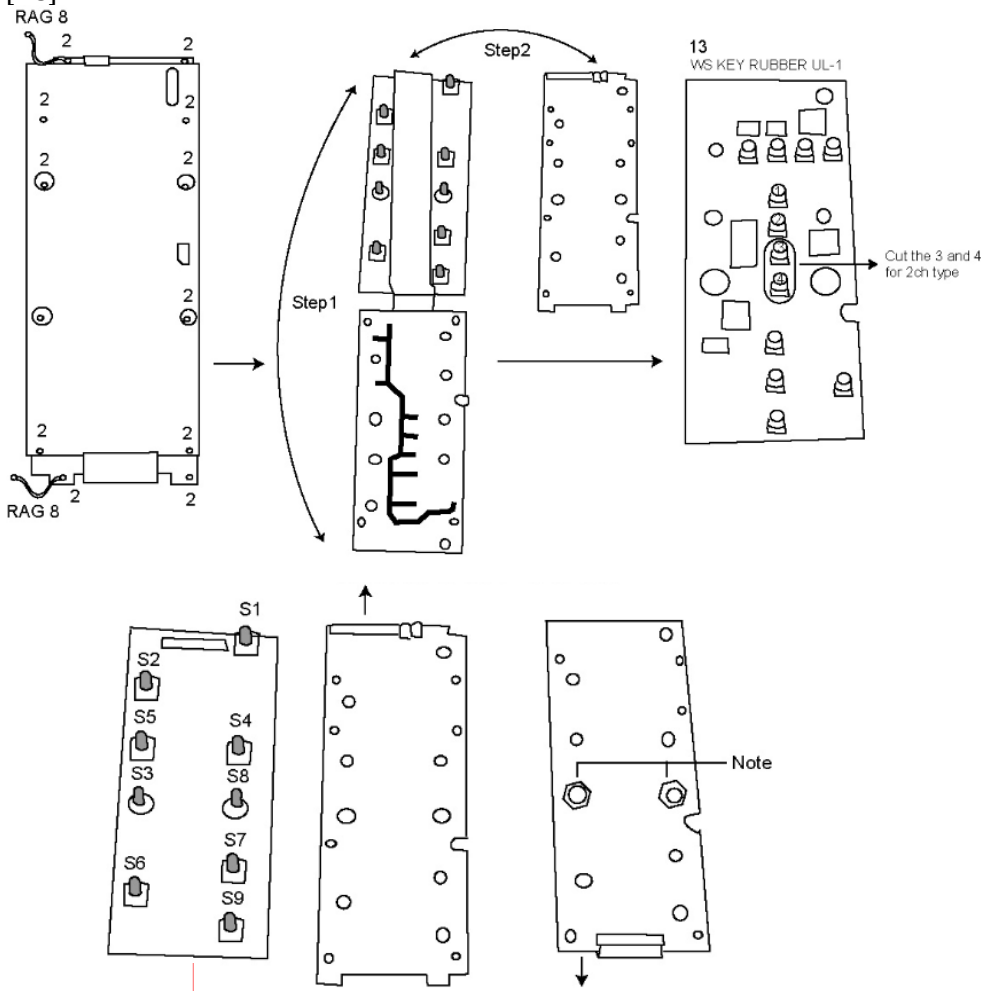
[E2]



HINT: It is easy to remove the front panel parts

using the protective front cover.

[E3]

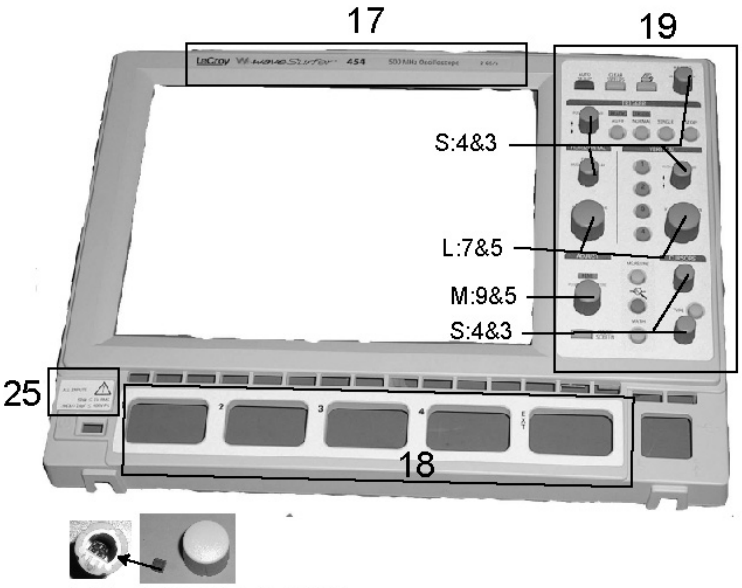


Note:
S3 and S8 are tightened together with these nuts through KEY PLATE, KEY SHEET, and KEY BOARD.

Item Fig. No	Part Number	Quantity	Description
S1-S2	IWDSW035701	2	Smooth, Push Button Encoder
S3	IWDME990431	1	Detented Encoder
S4-S7	IWDSW035701	4	Smooth, Push Button Encoder
S8	IWDME990431	1	Detented Encoder
S9	IWDSW035701	1	Smooth, Push Button Encoder
	IW211857904	1	4 channel keyboard
	IW211857905	1	4 channel keyboard
	IWKBA806011	1	Keyboard Plate
	IWKPL145421	1	Elastomeric Keypad

7.7 FRONT PANEL ASSY

[E4]



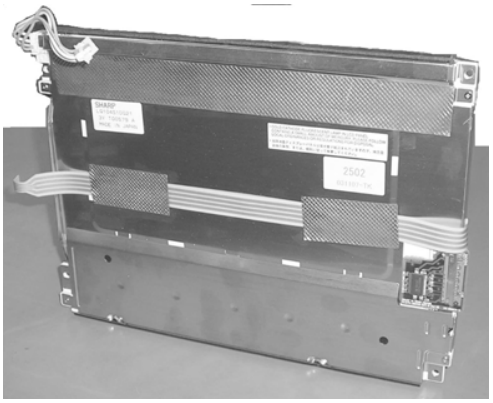
Put the SPECER into the KNOB.

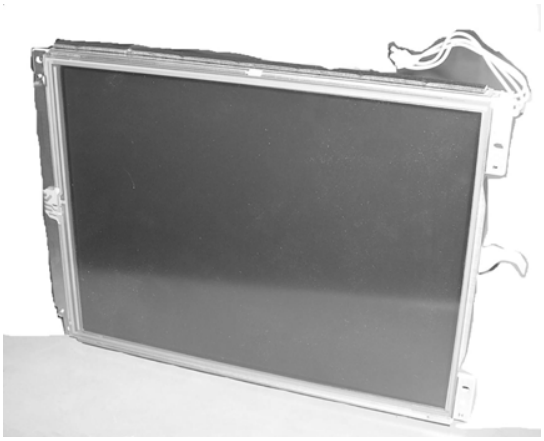
7.8 FRAME Replaceable Parts (MAIN BOARD, POWER BOARD, CPU BOARD)

Item Fig. No	Part Number	Quantity	Description	Location
1	IWMKB130062	13	SCREW KB (+) 3X6S(NIP)	G1, G2-2
2	IWMKP130301	8	SCREW KP (+) 3X30S	J1
3	IWMSM430061	4	SM4-3X6	F1
4	IWAGM000111	4	Rubber Feet 16Ø	F1
5	IWMSM440081	3	SM4-4X8	J1
6	IWKBA805421	1	WS HDD PLATE	F1
7	IWKBA805511	1	WS MAIN CHASSIS	I2
8	IWKBA805621	1	WS CPU FRAME	J1, G1
9	IWKPA224411	1	WS I-O OVER LAY UL-I	G1
10	IWKBA807411	1	WS I-O SHEILD PLATE	J1
11	IWKAS094511	1	GRAND TERMINAL B	I2
12	IWDCN040801	1	BNC RECEPTACLE	I2
13	IWMZT006121	-	FINGER TWIST 97-555	G3

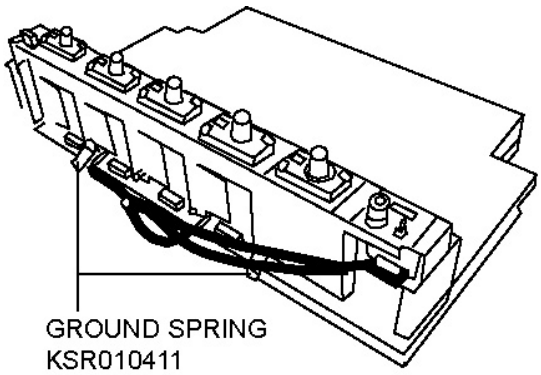
7.9 Spare Parts

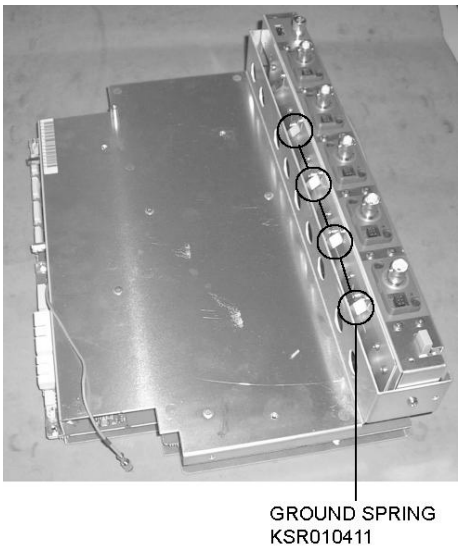
Part Number	Description
IW211857900	WS4-Processor RB80526RY
IW211857902	WS4-LCD CIRCUIT
IW211857903	WS454 PANEL BOARD
IW211857904	WS4X4 KEY BOARD
IW211857905	WS4X2 KEY BOARD
IW211857918	WS454 MAIN UNIT
IW211857921	WS452 MAIN UNIT
IW211857923	WS422 MAIN UNIT
IW211857920	WS424 MAIN UNIT
IW211857922	WS432 MAIN UNIT
IW211857919	WS434 MAIN UNIT
IW211857914	WS454 MAIN POWER UNIT
IW211857915	WS454 PFC CIRCUIT
IW211857916	WS454 INLET CIRCUIT
IWDZB100221	Hard disk MHT2030AT
IW211857902	WS4-LCD CIRCUIT





IW211857918	WS454 FE/ACQ BOARD



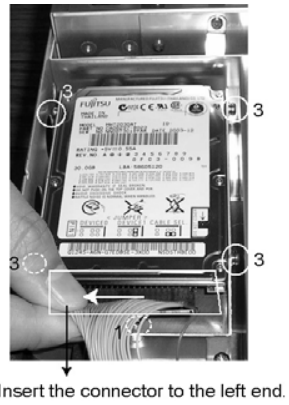


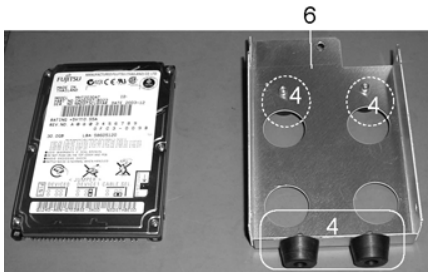
GROUND SPRING is included in MAIN UNIT.

F. Removal & Parts of the HDD

- Disconnect the 44pin FCC cable from the HDD. F1
- Remove the one KB (+) 3x6S screw (Item Fig No.3) on the main chassis.

[F1]





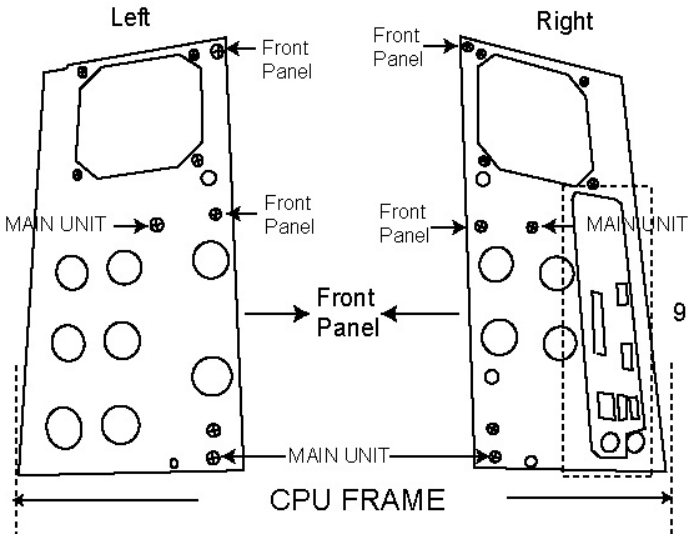
G. Removal & Parts of the PCI BOARD

- Loose the four KB3X6 screws (Item Fig No.1) on the main chassis. G1
- Disconnect the cable from the PCI BOARD. G2

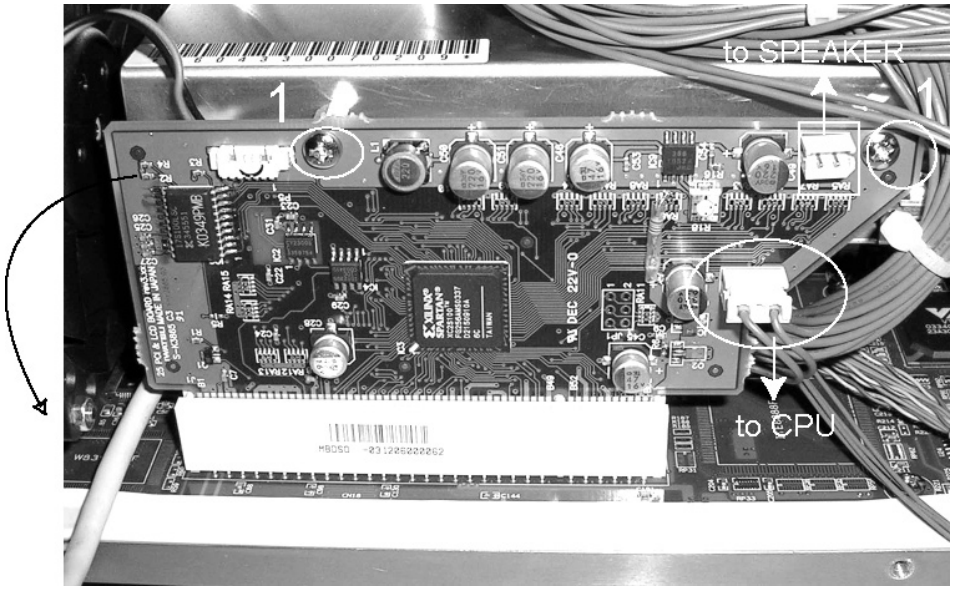
When remove the MAIN board (See page 7-17)

- Disconnect the four connectors from the main board. G3
- Carefully pull out the PCI BOARD from the CPU BOARD. G3

[G1]

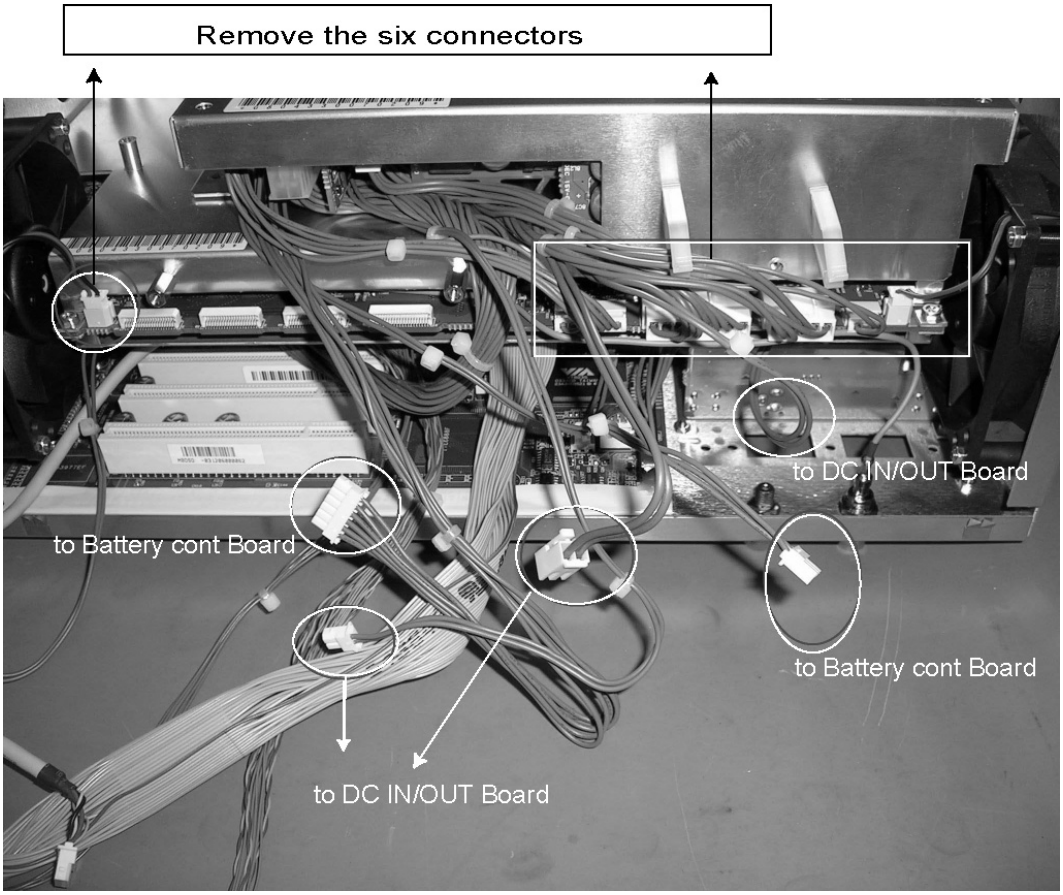


[G2]



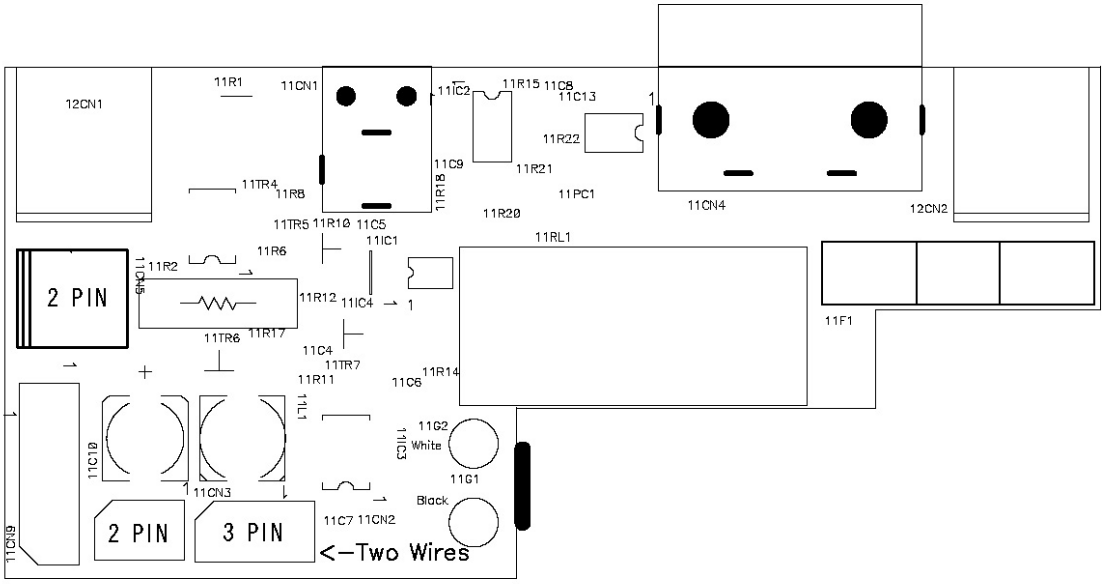
A strong stress shall not hang in the connector of the PCI board.

[G3]

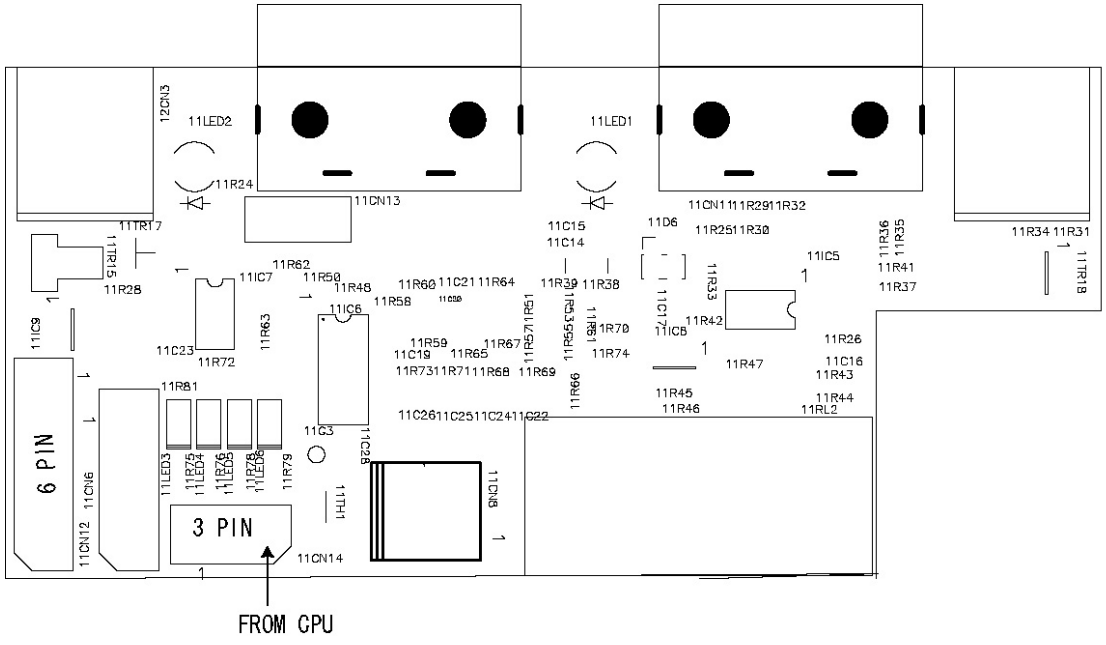


DC / IN OUT Board, Battery Control Board

DC IN / OUT Board



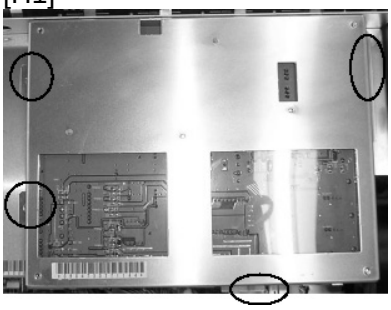
Battery control Board



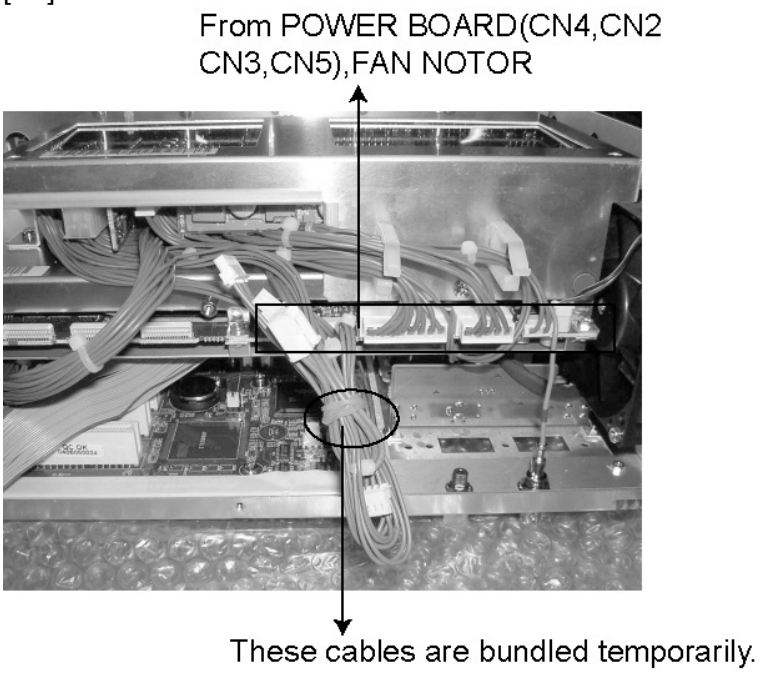
H. Removal of the Power Supply Assembly

- Remove the four KB(+)3x6 screws on the Power case. H1
- Remove the five connectors in the box from the Power board (CN2, CN3, CN4, CN5). H2
- Remove the cables from the cable holder. H2
- Remove the connector (CN11 LINE TRIG) on the Power board. H3
- Remove the connector (3CN1, 5CN4) on the Power board. H3

[H1]

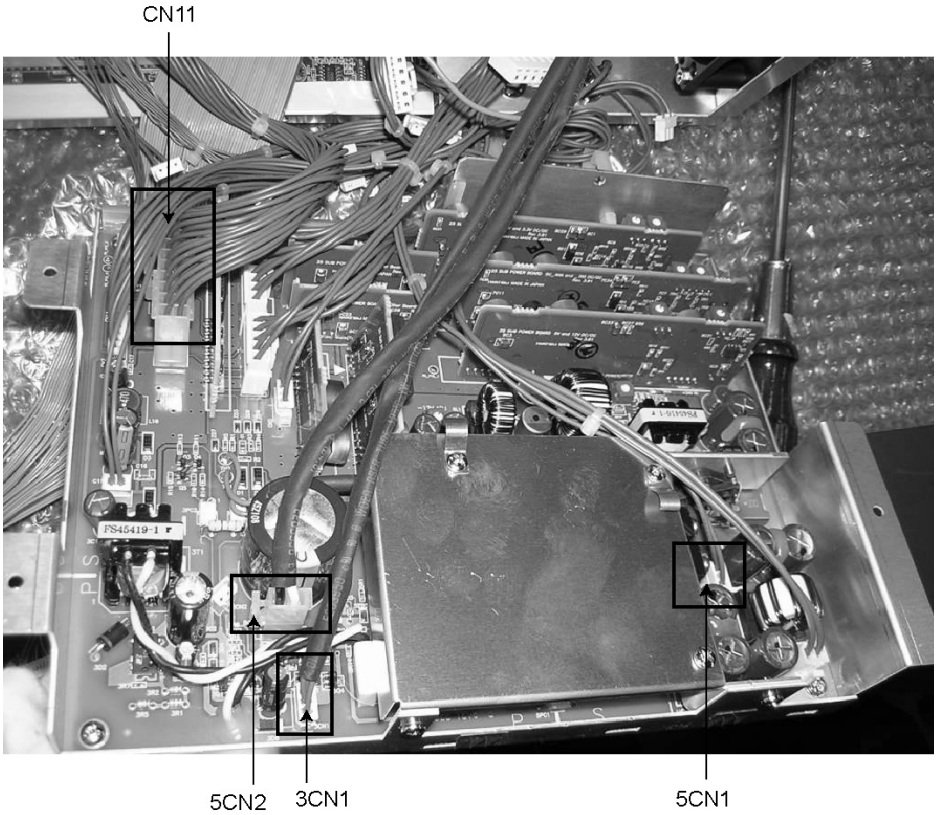


[H2]

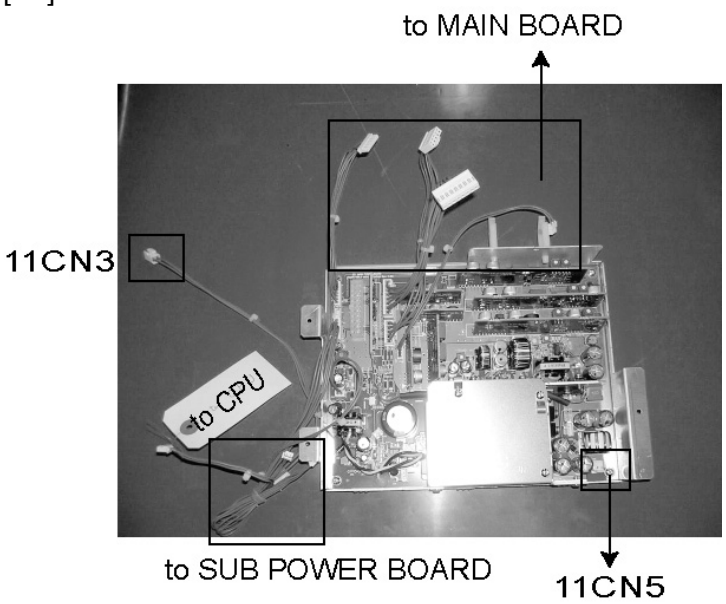


[H3]

- Remove the four connectors



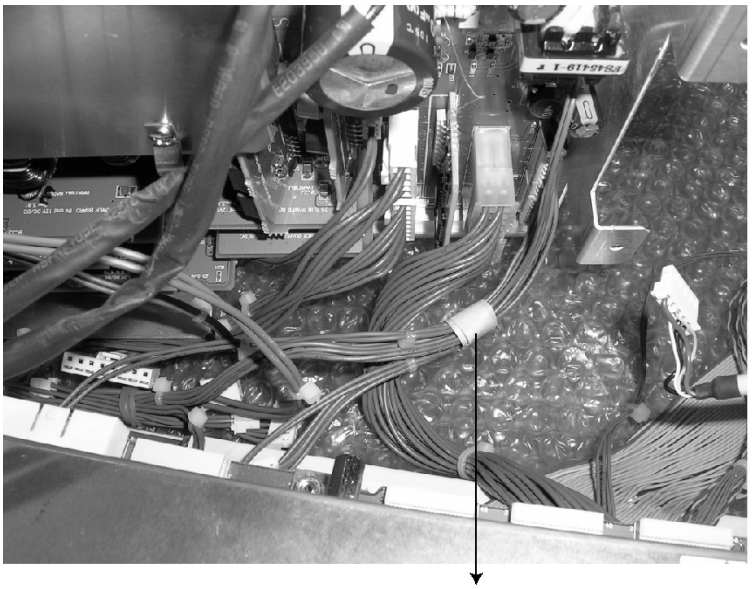
[H4]



Hint:
It is easy to assemble the power board by marking the option cables (tape or etc.).

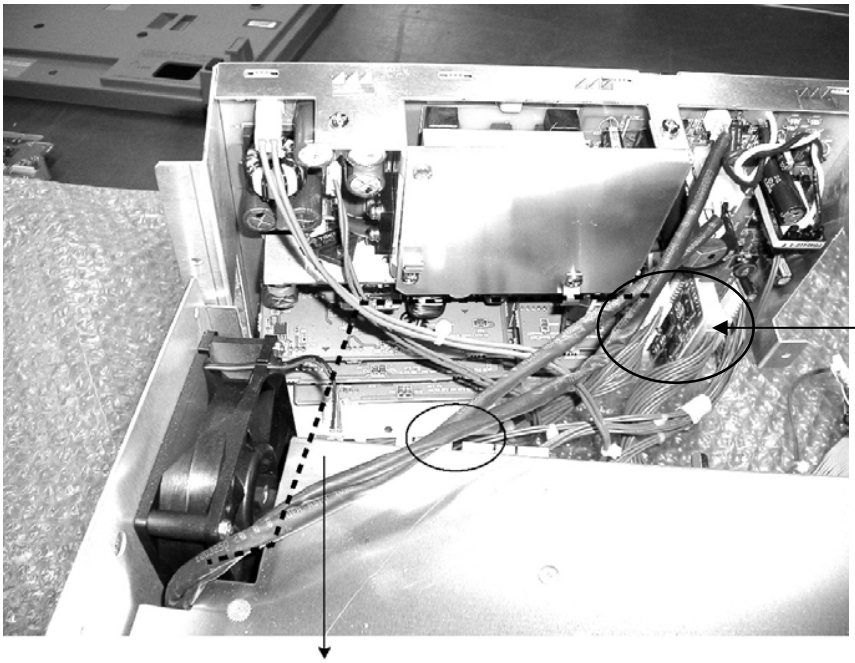
When the connector of the power supply is removed, it is comprehensible when the load side is removed.
Assembly of power board
[H5]

- Connect the five connectors removed [H3] step.
- Wire the five cables removed [H3] step like the following figures.



This code group are bundled temporarily

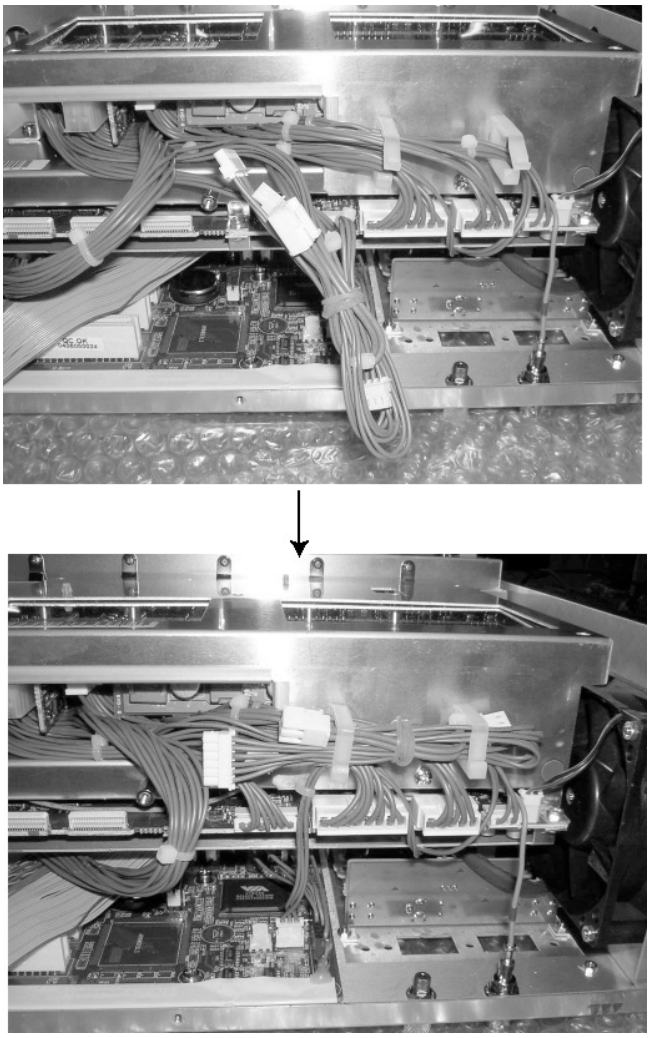
This code group are wired above 20 pin code group (to CPU).



These two cables is wired under this chassis.

Two cables covered with the insulating tape where it goes to the PFC circuit is wired like the dotted line.

[H6]

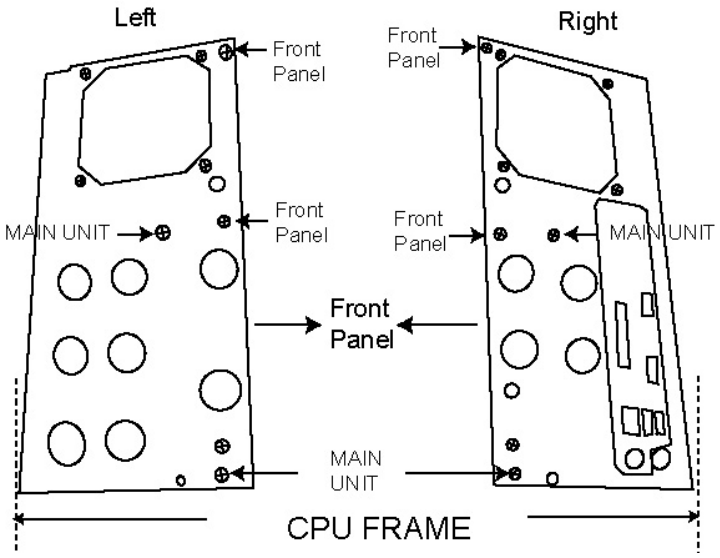


Put the option cables into the cable holder last.

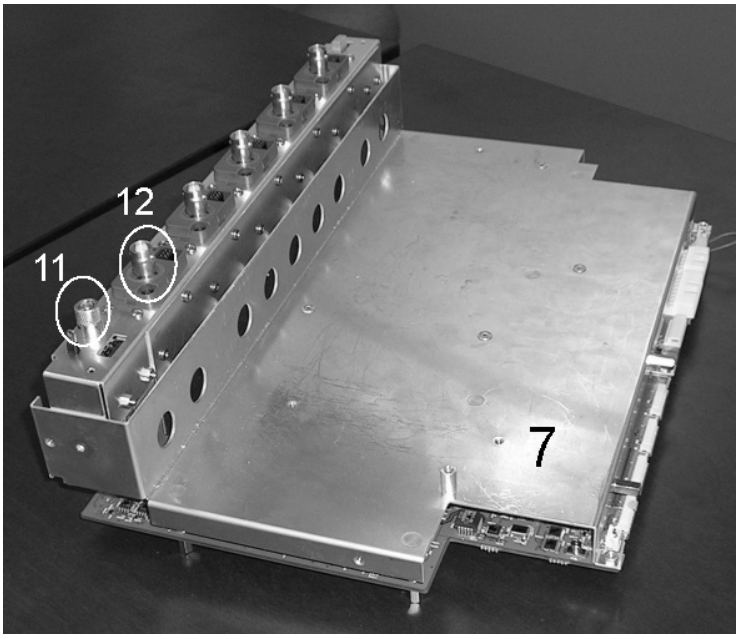
I. Removal of the MAIN Board

- Remove the connector (REAR OUT PUT) on the main chassis. I2
- Remove the two KB(+)3x6 screws (Item Fig No.1) on the main chassis. I1

[I1]



[I2]

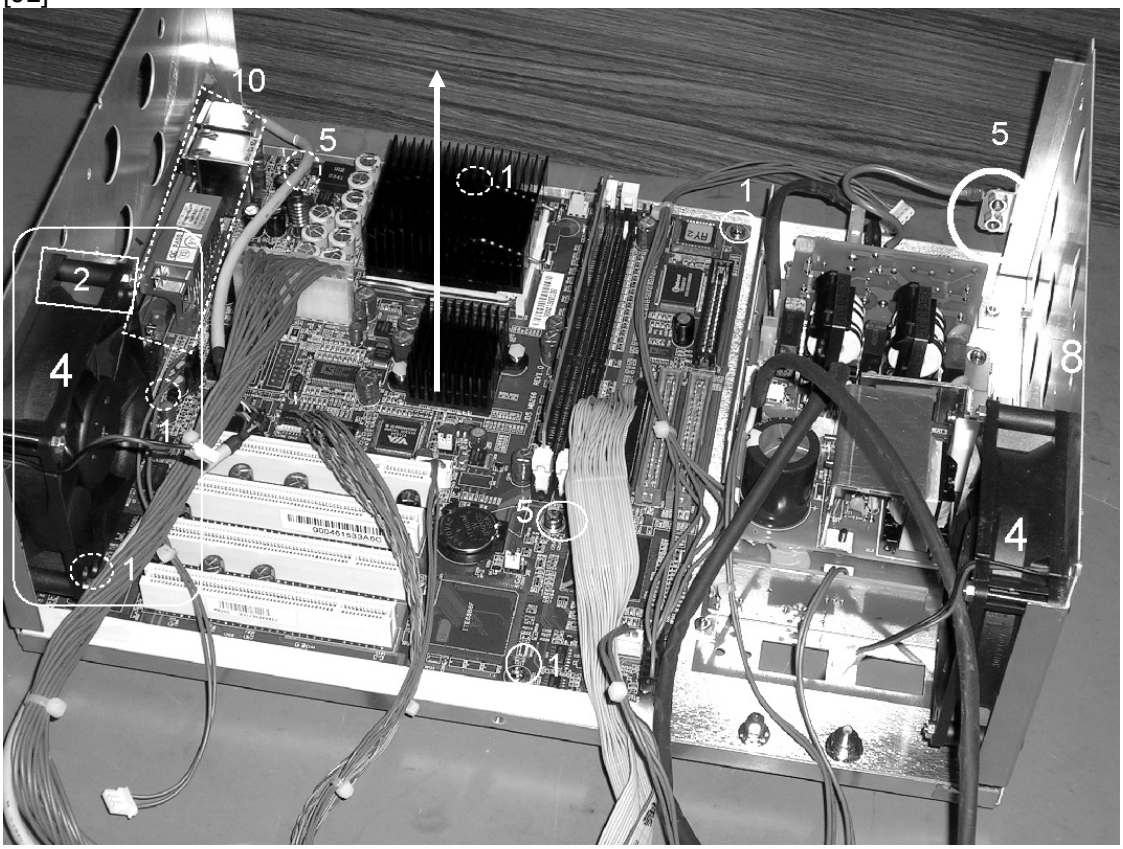


J. Removal of the CPU Board

- Remove the four KP(+)3x30 (Item Fig No.2) screws which connect the fan to the CPU frame. J1
- Remove the seven screws(five KP3x6 Item Fig No.1 and KP4x8 Item Fig No.5) on the CPU board. J1

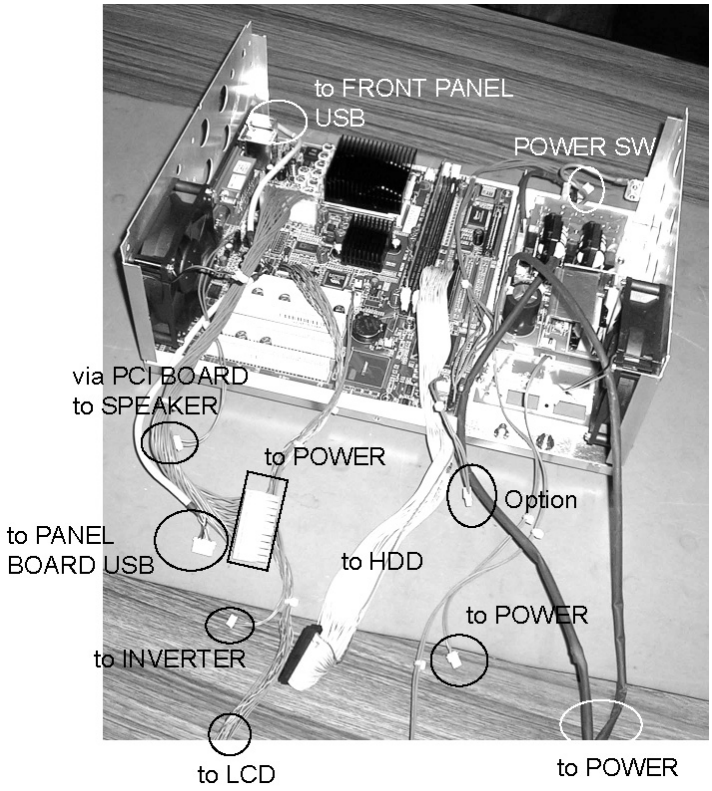
Caution : Batteries are mounted, so care should be taken to prevent short-circuiting.

[J1]

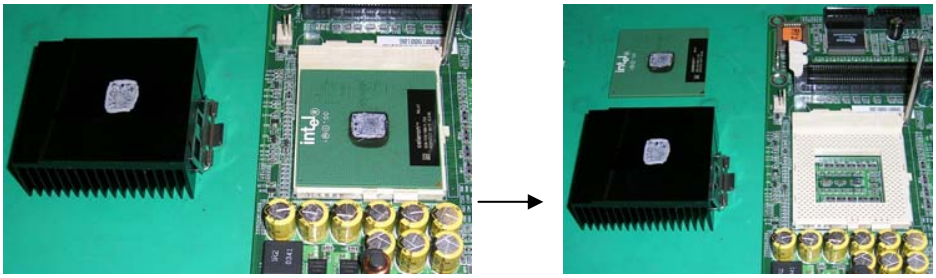


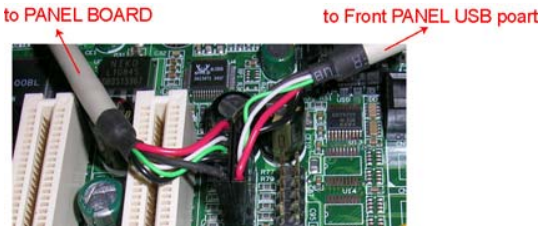
NOTE: The four KP(+)3x30 screws is used per a FAN.
The 4 is in the Over All table, FAN MOTOR DMT620781.
When CPU board is removed, it is possible to assemble the connectors without a mistake as fastening a tag.

[J2] CPU Board Cables



[J3] CPU & USB

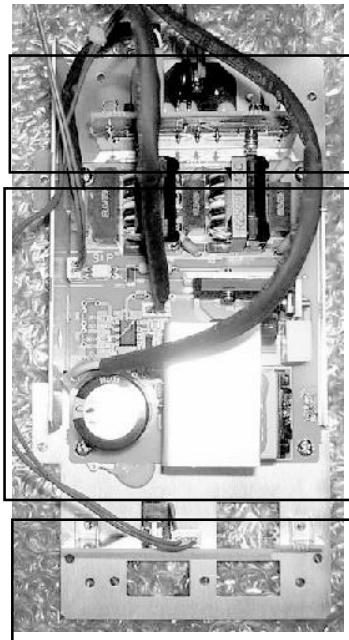




Please note the direction of the CPU heat sink stopper.

CAUTION:
Before connecting the USB cables, make sure that the power supply of the USB connector (red) is different by FRONT and SIDE PANEL.

K Remove of the PFC CIRCUIT



INLET CIRCUIT: IW211857916

PFC CIRCUIT: IW211857915

EXT OUTPUT CIRCUIT

Assembly Note :

Reassemble the unit in the reverse order, check that all screws are used and verify that all cables are correctly connected.

- **Fan**: Check the fan cable direction. Note the air flow, the fan extracts air from the unit and expels it.