9410 DIGITAL OSCILLOSCOPE

SERVICE MANUAL

LeCroy

Innovators in Instrumentation

9410 DIGITAL OSCILLOSCOPE

SERVICE MANUAL

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Version 1

December 1991

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TABLE OF CONTENTS

W A R N I N G

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

ACKNOWLEDGEMENTS

We would like to thank Texas Instruments, Motorola and Signal Processing Technologies (Honeywell) for their kind permission in allowing us to reproduce drawings from their technical literature.

Chapter 1

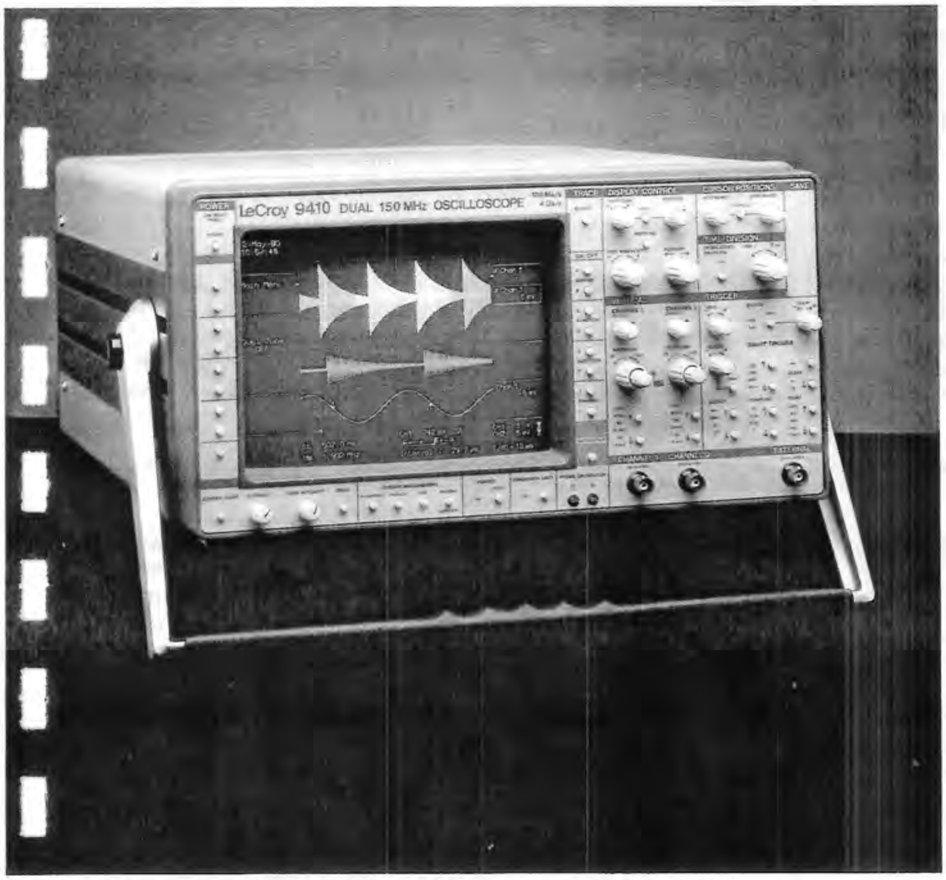
SPECIFICATIONS

DIGITAL OSCILLOSCOPE
150 MHz BANDWIDTH, 100 Ms/s, 4 Gs/s

LeCroy

MODEL 9410 PORTABLE DUAL–CHANNEL OSCILLOSCOPE

9410



- **Advanced Triggering**
- **Sensitivity up to 100 μV/div**
- **Long 10K Memories per Channel**
- **Time and Frequency Domain Analysis**
- **High–speed GPIB for Plotters, Printers and PCs**
- **Optional 512K Credit Card Memory**

reveal fine signal details, often missed by conventional digital oscilloscopes, the 9410 uses ng 10K acquisition memories. Above, two different portions of the top trace are expanded (up to 200 times).

THE INTELLIGENT TEST INSTRUMENT

The 9410 Dual–channel Digital Oscilloscope delivers unrivaled capture and analysis capabilities for signals up to 150 MHz in frequency. Precision flash ADCs are used to digitize single–shot events at rates up to 100 megasamples/sec (4 gigasamples/sec for repetitive waveforms). The unit's long 10K acquisition memories ensure excellent timing resolution to reveal the finest signal details on any time–base setting. Live, stored or processed waveforms can be expanded up to 200 times for maximum timing accuracy.

Advanced triggering capabilities which detect glitches, timing violations or even logic patterns, make catching rare or complex events easy. Waveforms and measurements are presented instantly on the screen and can be transferred directly to a wide variety of plotters and printers, archived onto PCs, or stored on an optional credit card memory facility. Additional firmware packages are available to extend the oscilloscope's processing capabilities in both time and frequency domains.

FEATURES

High sensitivity – For detecting and monitoring small signal variations the 9410 offers continuously variable (and calibrated) sensitivity from 1 mV/div up to 2.5 V/div with 8–bit vertical resolution. Vertical expansion and signal processing can also be used to lower the sensitivity to an astounding 100 µV/division.

SMART triggering – For stable display and easy acquisition of complex signals, triggering capabilities include pre– and post–triggering, hold–off by time or event, delay by time or event, TV, logic (pattern of three inputs), state qualified, time/event qualified, glitch and time–interval modes.

Automated measurements – Up to ten signal characteristics (risetime, falltime, RMS voltage, etc.) can be automatically calculated on displayed, stored, expanded and processed waveforms. High–speed processing is used to instantly update results with each new acquisition. Auto–setup can be used to identify and display repetitive waveforms in under a second.

Signal processing – The 9410's built–in processing includes mathematics (add, subtract and invert), XY display with ratio and multiplication cursor read–out, and summation averaging (up to 1000 sweeps). Additional firmware can be installed in the 9410 to allow filtering, EXTREMA, complex mathematics and FFT spectral analysis.

Remote control – All front–panel controls (including cursor positions) are fully programmable over GPIB and RS–232–C interfaces. Waveform data and measurements can be transferred to computers in binary or ASCII formats or output directly to digital plotters and printers.

Mass storage – A credit card memory system can be added to the 9410 for applications requiring high–speed data logging and non–volatile waveform storage. Waveform data can be stored at rates unmatched in the industry onto 128– or 512–Kbyte cards.

FUNCTIONAL DESCRIPTION

The 9410 Dual–channel Digital Oscilloscope is a general purpose instrument which brings precision waveform acquisition and measurement within the reach of engineers working in all areas of electronics. Featuring a design that optimizes performance but keeps cost to a minimum, the 9410 can be used in almost any application where signal frequencies of up to 150 MHz are monitored.

LOW COST WITHOUT COMPROMISE

Seeing fine signal details with accuracy and precision is a difficult task for most of today's analog and digital oscilloscopes. In an attempt to catch transient signals, analog oscilloscopes use storage techniques that are costly and cumbersome. The results are poor and the waveform display is of a very low quality. In contrast, digital oscilloscopes offer much better measurement precision, easy transient capture and the possibility of automation. These benefits, however, are usually obtained at a much higher price. In order to compete with analog oscilloscopes, low–cost digital instruments sacrifice performance by compromising on features (sampling rate, vertical resolution, record length, DC accuracy, sensitivity etc.) that are crucial to good waveform acquisition and all–round usability. The Model 9410 is the first digital oscilloscope to offer a low entry price without compromising on performance.

PRECISION ACQUISITION

The 9410 combines all the key elements (low–noise amplification, quality ADCs, long memories, precision time base, high sensitivity and outstanding display) required for accurate waveform acquisition. Each channel contains a high–resolution flash ADC which digitizes transient events at up to 100 megasamples/sec and repetitive signals at up to 4 gigasamples/sec. To ensure maximum timing accuracy (even for measurements between channels), the ADCs are driven simultaneously with a high–precision time base. Vertical resolution is 8 bits (0.4% of full scale) and can be extended as high as 12 bits (0.025%) using averaging and filtering techniques. These features are combined with genuine 1 and 2 millivolt sensitivity settings and a big, crisp display to let you see the finest signal structure.

LONG MEMORIES

Only long memories give you high–fidelity recording over extended periods of time. In fact, on equal time–base settings, the 9410, with 10K of memory per channel, will sample waveforms up to 10 times faster than an oscilloscope with only 1K of memory. With improved timing resolution on slower time–base settings, users can analyze waveforms by expanding them up to 200 times!

CATCH THE EVENTS YOU WANT

Two levels of triggering make catching difficult signals an easy task for the 9410. The standard trigger functions such as pre– and post–triggering, level, slope, mode and coupling are all accessed directly from the front panel with rotary knobs that make adjustment a pleasure. Icon trigger graphics show the current setup at a glance. And just a touch of a button accesses the SMARTest trigger in any portable scope.

SMART trigger modes are designed to help track and monitor complex and rare phenomena. Trigger techniques include FASTGLITCH mode for triggering on glitches down to 5 nsec in width, TV mode for NTSC, PAL and SECAM signals, PATTERN mode for fast logic testing, and TIME/EVENT QUALIFIED mode for ranging

Standard Trigger

Sources: CHAN1, CHAN2, EXT, EXT/10, LINE. CHAN1, CHAN2 and EXT have independent trigger circuits allowing slope, coupling and level to be set individually for each source.

Slope: Positive, negative.

Coupling: AC, LF REJ, HF REJ, DC.

Modes:

Auto: Automatically re–arms after each sweep. If no trigger occurs, one is generated at an appropriate rate.

Normal: Re–arms after each sweep. If no trigger occurs after a reasonable length of time, the warning message "No or Slow Trigger" is displayed.

Single (hold): Holds display after a trigger occurs. Re–arms only when the "single" button is pressed again.

Sequence: Stores multiple events in segmented acquisition memories.

SMART Trigger

Single–source trigger operational modes:

Hold–off by time: 25 nsec to 20 sec.
Hold–off by events: 0 to 10^9 events.

Width–based trigger modes:

Pulse width < (FASTGLITCH): Triggers on opposite slopes of pulses narrower than a value in the range 5 nsec to 20 sec.
Pulse width >: Triggers on opposite slopes of pulses wider than a value in the range 5 nsec to 20 sec.
Interval width <: Triggers on similar slopes of signals narrower than a value in the range 10 nsec to 20 sec.
Interval width >: Triggers on similar slopes of signals wider than a value in the range 25 nsec to 20 sec.

Multi–source trigger operational modes:

Pattern: Triggers on the logic AND of CHAN1, CHAN2 and EXT, where each source can be defined as high (H), low (L) or don't care (X). The trigger can be selected at the beginning (entered) or at the end (exited) of the specified pattern.

Bi–level: This is a special condition of pattern trigger which allows the 9410 to trigger on any signal that exceeds a certain pre–set high or low trigger level. The signal must be connected simultaneously to two inputs. The third input must be set to don't care (X).
State qualified: Allows the 9410 to trigger on any source (CHAN1, CHAN2 or EXT), while requiring that a certain pattern of the other two inputs is present or absent. In addition, a delay by time or by number of events can be selected from the moment the pattern is valid.

Time/Event qualified: Allows the 9410 to trigger on any source (CHAN1, CHAN2 or EXT), as soon as a certain pattern of the three inputs is entered or exited. From the moment of validity, a delay can be defined in terms of time or number of events.

TV: Allows stable triggering on TV signals that comply with PAL, SECAM or NTSC standards. Selection on both line (up to 1500) and field number (up to 8) is possible. Active on EXT only.

DISPLAY

CRT: 12.5 × 17.5 cm (5 × 7 inches); magnetic deflection; vector type.

Resolution: 4096 × 4096 points.

Real–time clock: Date, hours, minutes, seconds.

Grid: Internally generated; separate intensity control for grid and waveforms. Single, dual and pulse parameter measurement grid mode.

XY mode: Plots any two sources (CHAN1, CHAN2, MEMORY C or D, FUNCTION E or F and EXPAND A or B) against one another. Operates on live waveforms with cursor readout.

Hard copy: Single– or multi–pen digital plotters as well as IBM, HP QuietJet, HP ThinkJet, HP LaserJet and EPSON printers can be used to make hard copies of the display. Screen dumps are activated by a front–panel button or via remote control. Supported plotters include: the HP 7400 and 7500 series, Philips PM 8151, Graphtek FP 5301, and compatible models. Plotting is done in parallel with normal 9410 operation.

Graphics: All waveforms and display information are presented using vector (linear) graphics. Expanded waveforms use LeCroy's DOT–LINEAR graphics that highlight actual data points and interpolate linearly between them.

Menus: Waveform storage; acquisition parameters; memory status; save/recall front–panel configurations; SMART trigger; waveform parameters; XY mode; RS–232–C configuration; hardcopy setup and real–time clock setup; averaging and arithmetic.

Cursors

Relative time: Two cursors provide time measurements with a resolution of ± 0.05% of full scale for unexpanded traces; up to 10% of the sampling interval for expanded traces. The corresponding frequency information is also provided.

Relative voltage: Two horizontal bars measure voltage differences to ± 0.2% of full scale.

Absolute time: A cross–hair marker measures absolute voltage versus signal ground, as well as the time relative to the trigger.

Absolute voltage: A reference bar measures absolute voltage with respect to ground.

Pulse parameters: Two cross–hair cursors are used to define a region of interest for which pulse parameters will be calculated automatically.

AUTO–SETUP

Pressing the auto–setup button automatically scales the time–base, trigger and sensitivity settings to display a wide range of repetitive input signals.

Type of signals detected: Repetitive signals with amplitudes between 2 mV and 8 V, frequency above 50 Hz and a duty cycle greater than 0.1%.

Auto–setup time: Approximately 1 sec.

WAVEFORM PROCESSING

Waveform processing routines are called and set up via menus. These include arithmetic functions (add, subtract and invert), and summation averaging (up to 1000 signals).

Pulse parameters: Based on ANSI/IEEE Std 181–1977 "Standard on Pulse Measurement and Analysis by Objective Techniques". The terminology is derived from IEEE Std 194–1977 "Standard Pulse Terms and Definitions".

Automatic measurements determine:

Maximum	Period
Minimum	Pulse width
Mean	Risetime
Standard deviation	Falltime
RMS	Delay

Sources: CHAN1, CHAN2, MEMORY C or D, FUNCTION E or F, EXPAND A or B. Cursors define the measurement zone. When more than one pulse is present in the measurement zone, averaged results for period, width, risetime and falltime are presented.

REMOTE CONTROL

Front–panel controls, including variable gain, offset, position controls and cursors, as well as all internal functions are programmable.

RS–232–C port: For computer/terminal control or plotter connection. Asynchronous up to 19200 baud.

GPIB port: (IEEE–488). Configured as talker/listener for computer control and fast data transfer (up to 380 kbytes/sec). Address switches on rear panel. Command syntax and data formats follow IEEE–488.2 standards.

Local/remote: Remote control can be interrupted for local (manual) control at any time (except when in remote control with the lock–out state selected) by pushing a button on the front panel.

PROBES

Model: Two 94XX–P01 (×10,10 MΩ // 15 pF) probes supplied.

Probe calibration: 1 kHz square wave, 1 V p–p.

Probe power: Two rear–panel power outlets for use with active probes provide ± 15 V, + 5 V DC.

SELF TESTS

Auto–calibration ensures specified DC and time accuracy.

GENERAL

Temperature: 5 to 40° C (41 to 104° F) rated; 0 to 50° C (32 to 122° F) operating.

Humidity: < 80%.

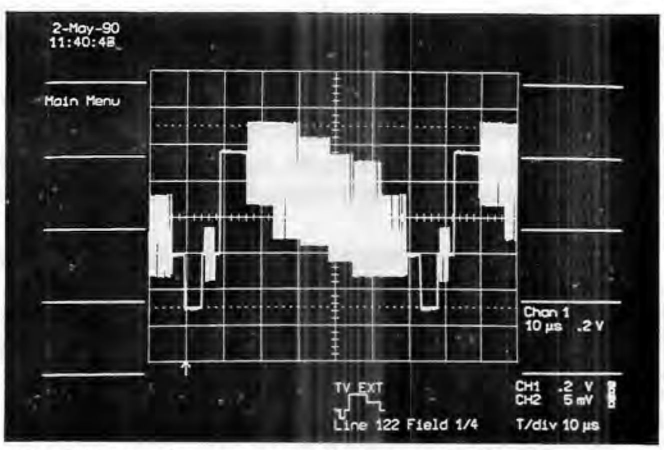
Power Required: 110 or 220 V AC, 45 to 440 Hz, 150 W.

Battery Backup: Lithium batteries maintain front–panel settings for 2 years.

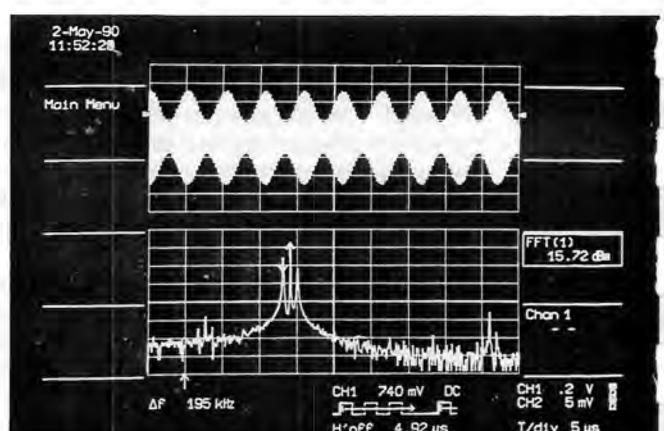
Dimensions: (HWD) 19.2 × 37 × 49.5 cm, (7 1/2 × 14 1/2 ×19 1/2 inches).

Weight: 13.5 kg (30 lb) net, 19 kg (42 lb) shipping.

Warranty: 2 years



The TV trigger allows selection of both line and field number on PAL, SECAM or NTSC signals.



The optional WP02 Spectrum Analysis Firmware allows the 9410 to compute a 1000–point FFT in less than a second. The picture above shows a modulated signal (top trace) analyzed in frequency domain. Side lobes 195 KHz from the fundamental frequency are clearly visible on the bottom trace.

applications or tracking timing violations. Other trigger features include HOLD–OFF by time or number of events, BI–LEVEL and INTERVAL modes of operation.

REMOTE CONTROL AND MASS STORAGE

High–speed GPIB, on–board processing and credit card storage facilities all add up to make the 9410 an ideal instrument for automated testing applications. For remote control, the 9410 offers both RS–232–C and GPIB interfaces. All front–panel controls and internal processing functions can be controlled. For applications where throughput is critical, the 9410's GPIB interface can be used to transfer hundreds of waveforms per second. Acquisition rates that most digital oscilloscopes cannot even match internally! The optional credit card system is ideal for applications requiring non–volatile storage or for field work. Up to 512K of information (waveforms or panel settings) can be stored on a single card.

SPECIFICATIONS

VERTICAL ANALOG SECTION

Bandwidth (– 3 dB):
@ 50 Ω: DC to 150 MHz for 5 mV/div to 2.5 V/div
DC to 125 MHz for 1 mV/div to 5 mV/div
@ 1 MΩ: DC to 125 MHz at probe (94XX–P01) tip.

Input impedance: 1 MΩ // 25 pF and 50 Ω ± 1%.

Channels: Two independent channels; standard BNC connector inputs.

Sensitivity range: 1 mV/div to 2.5 V/div; continuously variable up to 2.5 times the fixed setting. Fixed settings range from 1 mV/div to 2 V/div (in a 1, 2, 5 sequence). Sensitivity can be extended to 25 V/div using a D9010 High Impedance divider connected to the input BNLs.

Vertical expansion: Up to 5 times (with averaging, up to 10 times or 100 μV/div sensitivity).

Scale factors: Probe attenuation factors of ×1, ×10, ×100, ×1000 and ×10000 may be selected and are remotely programmable.

Offset: ±12 times the fixed sensitivity setting in 0.02 division increments up to ±12 V max.; ±24 div @ 5mV/div; ± 60 div @ 2 mV/div; ± 120 div @ 1 mV/div.

DC accuracy: ± 2% full scale for ≥ 5 mV/div;
± 3% for < 5 mV/div.

Bandwidth limiter: 15 MHz (– 3 dB) typical.

Max Input voltage: 250 V (DC + peak AC ≤ 10 kHz) at 1 MΩ, ± 5 V DC (500 mW) or 5 V RMS at 50 Ω.

VERTICAL DIGITAL SECTION

ADCs: One per channel, 8–bit flash.

Conversion rate: Up to 100 megasamples/sec for transients, up to 4 gigasamples/sec for repetitive signals, simultaneously on both channels.

Aperture uncertainty: ±10 psec.

Acquisition memories, Channels 1 and 2: Memories of 10 kilowords per channel can be segmented into 2, 5, 10, 20 or 50 blocks.

Reference memories, C and D: 10K, 16–bit word memories which store one acquired or processed waveform, or up to 50 segmented waveforms.

Function memories, E and F: Two 10K, 16–bit word memories for waveform processing.

Peak and glitch detection

Minimum and maximum peaks, as fast as 0.01% of the record length (minimum 10 nsec), are captured and displayed with 100% probability.

Using LeCroy's new FASTGLITCH trigger technique (see trigger section below), glitches faster than 5 nsec can be detected on all time–base settings.

HORIZONTAL SECTION

Time Base

Range: 2 nsec/div to 1000 sec/div.
Clock accuracy: ≤ ± 0.01%.
Interpolator resolution: 5 psec.
Trigger–time accuracy: 20 psec RMS.

Acquisition Modes

Random Interleaved Sampling (RIS) for repetitive signals from 2 nsec/div to 5 μsec/div.

Single shot for transient signals and repetitive signals from 50 nsec/div to 200 msec/div.

Roll for slowly–changing signals from 500 msec/div to 1000 sec/div.

Sequence mode divides the acquisition memory into 2, 5, 10, 20 or 50 segments.

Horizontal expansion: DUAL ZOOM mode allows two different signals or two different sections of the same signal to be expanded up to 200 times.

Trigger

Pre–trigger recording: Adjustable in 0.2% increments to 100% of full scale (grid width).

Post–trigger delay: Adjustable in 0.02 division increments up to 10,000 divisions.

External trigger input: 1 MΩ, < 25 pF, 250 V max. (DC + peak AC ≤ 10 kHz).

External trigger range: ± 20 V.

Rate: Up to 200 MHz.

Timing: Trigger timing (date and time) is listed in the memory status menu. The timing of subsequent triggers in sequence mode is measured with 0.1 sec absolute resolution, or nanosecond resolution relative to the time of the first trigger.

ORDERING INFORMATION

Oscilloscope and Options

Code	Description
9410	Digital Oscilloscope
9410WP01	Waveform Processing
9410WP02	FFT Processing

Oscilloscope Accessories

OM9410	Operator's Manual
9410–FC	Front Cover
9410–MC01	Card Reader + 128K Memory Card
9410–MC02	128K Memory Card
9410–MC04	512K Memory Card
CA9001	Camera (using Polaroid film) and Hood.
CA9002	Camera Adapter (35 mm) with Hood

Oscilloscope Accessories (cont'd)

DC/GPIB–2	2–meter GPIB Cable
DP9001	Digital Plotter, 8–pen A4 size
DP9003	Epson Printer
SG9001	High Voltage Protector
OC9001	Oscilloscope Cart
94XX–P01	10:1 Oscilloscope Probe
P9011	10:1/1:1 Oscilloscope Probe
P9100	100:1 Oscilloscope Probe
RM9400	Rackmount
TC9001	Transit Case
TC9002	Carrying Bag

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Osaka (0081) 6 330 0961
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Norway: Avantec AS (02) 630520
Pakistan: Electronuclear Corp., (021) 418087
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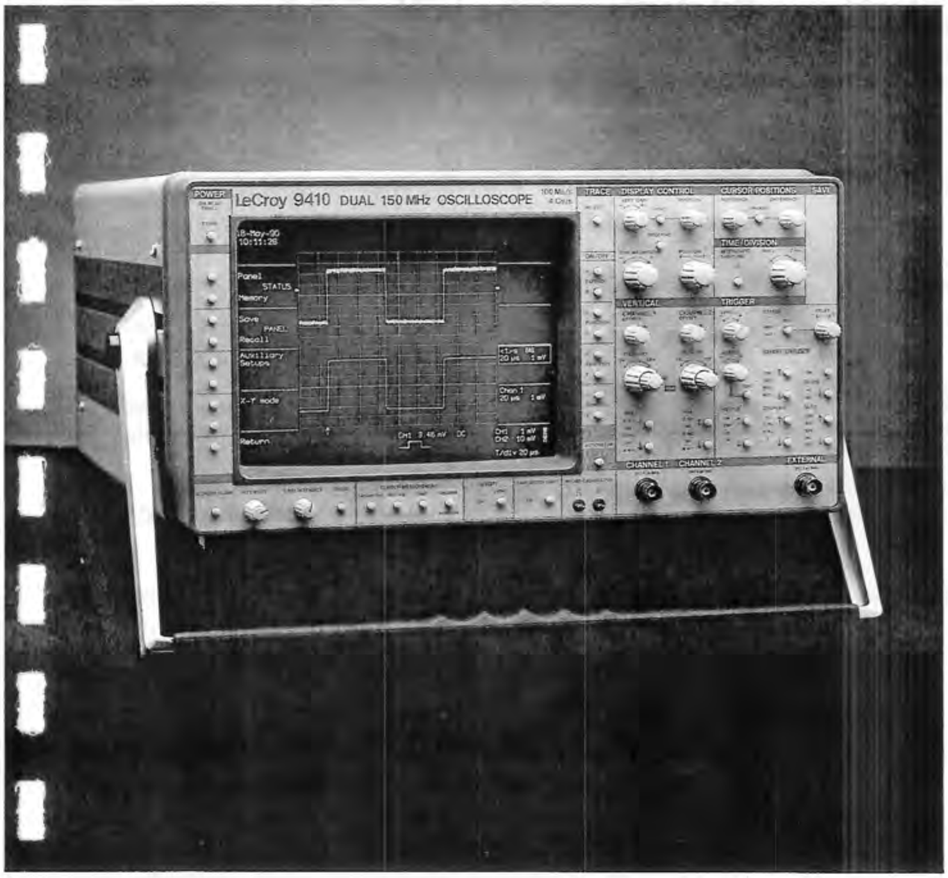
WP01 WAVEFORM PROCESSING FIRMWARE FOR MODEL 9410 DIGITAL OSCILLOSCOPE

9410 WP01



:dded as a factory option or retrofitted in the field, the WP01 Waveform Processing Package adds gh–speed averaging, filtering and mathematical capabilities to the Model 9410 digital oscilloscope.

- **Averaging – Summation and Continuous**
- **Arithmetic – incl. Addition, Subtraction, Ratio and Multiplication**
- **Functions – including Integration, Differentiation, Log, Exp, ABS and Square Root**
- **Extrema Mode – Storage of Extreme Positive and Negative Values**
- **Enhanced–Resolution Mode for 11–bit Performance**

FOR SIGNAL CHARACTERIZATION AND ANALYSIS

The LeCroy WP01 Waveform Processing package offers powerful routines that extend the processing capabilities of the Model 9410 Digital Oscilloscope. All processing is built in to eliminate the need for external computers and controllers. High–speed microprocessors are used to ensure that computed waveforms are displayed instantly on the screen. The package is fully programmable over the GPIB or RS–232–C interface and hard copies can be directly made on a wide range of digital plotters or printers.

FEATURES

Extensive Signal Averaging – Two operation modes:

- Summation averaging up to 1,000,000 waveforms.
- Continuous averaging with weighting factors up to 127.

Average speed up to 300,000 points/sec in summation averaging mode.

Offset Dithering – Improves the vertical resolution for low–noise measurements by several bits in summation averaging mode. Reduces the effect of ADC differential non–linearities.

Artifact Rejection – Rejects waveforms that exceed the dynamic range of the ADC to ensure statistical validity of summed average results.

Extrema Mode – Keeps track of time and amplitude drift by storing extreme positive and negative values, such as glitches, over a programmable number of sweeps.

Powerful Arithmetic – Processes identity, negation and reciprocal on single waveforms as well as addition, subtraction, multiplication or division on pairs of waveforms stored in the 9410's memory location CH1, CH2, A, B, C, D, E and F. Waveform data can be normalized by additive or multiplicative constants.

Mathematical Functions – Computes integration, differentiation, square, square root, absolute value, exponential and log on single waveforms stored in the 9410 memory locations CH1, CH2, A, B, C, D, E and F. Waveform data can be normalized by additive or multiplicative constants.

Enhanced Resolution – Allows filtering of the digitized signals, whether they are single–shot or repetitive, in order to increase the resolution of the displayed trace from 8 bits to 11 bits in steps of 0.5 bits.

Vertical Expansion – Provides vertical scale expansion by a factor of up to 10.

Chaining of Operations – Automatically chains two operations:
Example: F(E) = Average (CH1–CH2).

An indefinite number of operations can be performed sequentially, either manually or via remote control.

Remote Control – Controls remotely all front–panel settings, as well as all waveform processing options via either GPIB or RS–232–C interfaces.

Color Archiving – Copies screen in color using a wide range of digital plotters or printers.

FUNCTIONAL DESCRIPTION

The WP01 waveform processing package for the Model 9410 Digital Oscilloscope is optimized for processing signals in real time. A powerful 68020 microprocessor and a 68881 co–processor enable very rapid representation of results such as averages, integrations, exponentials and multiplications.

Waveform operations can be performed on live, stored, processed or expanded waveforms. They are selected through simple menus that allow functions to be chained together allowing more complex computations. For example, it is possible to perform the integration of an averaged waveform or the multiplication of a differentiated waveform.

All processing occurs in function memories E and F which may be displayed on the screen by simply pressing the appropriate function button. Processing is fully automatic and is simultaneous whenever more than one function has been selected.

SIGNAL AVERAGING

WP01 offers two powerful, high–speed averaging modes that can be used to reduce noise and improve the signal–to–noise ratio. Vertical resolution can be extended by several bits to improve dynamic range and increase the overall input sensitivity to as much as 100 μV/division.

Summed Averaging consists of the repeated addition (with equal weight) of recurrences of the selected source waveform. The number of acquisitions averaged can be selected between 2 and 1,000,000 sweeps with the accumulation automatically stopping when the number is reached. Signals exceeding the range of the oscilloscope's ADC can be automatically rejected to ensure valid summed averaging results.

The user may choose to "dither" the programmable offset of the input amplifier after each acquisition. Dithering uses slightly different portions of the ADC for successive waveforms so that the differential non–linearities are also averaged. As a result, in low–noise applications, the measurement precision and dynamic range are improved.

Continuous Averaging, sometimes called exponential averaging, is the repeated weighted average of the source waveform with the previous average. Averaging goes on indefinitely with each new acquisition and the effect of previous waveforms gradually tends to zero. Relative weighting factors can be chosen from 1:1 to 1:127. The method is particularly useful for monitoring noisy signals which may change slowly over a period of time.

ENHANCED RESOLUTION

The WP01 package provides a selective filtering technique that improves vertical resolution for reduced bandwidth applications. By effectively removing high-frequency noise, with digital smoothing functions, waveforms can be analyzed with resolution from 8 to 11 bits. The technique can be used with both single-shot and repetitive signals and provides an ideal method for smoothing transient phenomena.

EXTREMA MODE

Tracking rare glitches or monitoring signals drifting in time and amplitude is made easy with EXTREMA mode. EXTREMA waveforms are produced by repeatedly comparing acquisitions of a source waveform with a stored waveform that contains previous maximum and/or minimum excursions. Whenever a given data point of a new acquisition exceeds the existing data point of the stored waveform, the old data point is replaced by the new. In this way the envelope of all waveforms is accumulated for up to a maximum of 1,000,000 sweeps.

ARITHMETIC

WP01 offers basic arithmetic operations such as addition, subtraction, division and multiplication. These arithmetic functions can be performed on any source waveform on a point by point basis. Different vertical gains and offsets of the source waveforms are automatically taken into account in the computed result.

MATHEMATICAL FUNCTIONS

Functions including differentiation, integration, square, square root, logarithm (base 10 and e), exponential and absolute value may be performed on any source waveform. The waveforms may be multiplied by a constant factor or offset by a constant. Arithmetical and mathematical functions can also be chained together to construct more complex processing routines.

SPECIFICATIONS

SUMMATION AVERAGING

Number of sweeps: 1 to 1,000,000.
Number of input points: 50 to 10,000.
Offset dithering: only on acquisition channels; ON /OFF.
Artifact rejection: ON/OFF.
Vertical expansion: 10 × maximum.
Maximum sensitivity: 500 µV/div after vertical expansion.
Speed: up to 200,000 points/sec.

CONTINUOUS AVERAGING

Possible weighting factors: 1:1, 1:3, 1:7, 1:15, 1:31 and 1:127.
Number of input points: 50 to 10,000.
Vertical expansion: 10 × maximum.
Maximum sensitivity: 100 µV/div after vertical expansion.

ARITHMETIC

Identity, negation and reciprocal of any waveform. Addition, subtraction, multiplication, and ratio on any two waveforms.
Number of input points: 50 to 10,000.
Multiplicative constant on first input: from 0.001×10^{-33} to 999.999×10^{33}.
Additive constant on first input: from -999.999×10^{33} to 999.999×10^{33}.
Vertical expansion: 5 × maximum.

FUNCTIONS

Integration, differentiation, square, square root, logarithm and exponential (base e and 10).

Number of input points: 50 to 10,000.
Multiplicative constant on input: from 0.001×10^{-33} to 999.999×10^{33}.
Additive constant on input: from -999.999×10^{33} to 999.999×10^{33}.
Vertical expansion: 5 × maximum.

ENHANCED RESOLUTION

Choice of four low-pass filters for vertical resolution improvement from 8 to 11 bits at reduced bandwidth.

Vertical expansion: 10 × maximum.
Maximum sensitivity: 100 µV/div after vertical expansion.
Maximum bandwidth (for 11 bit resolution):
RIS mode: 32 MHz.
Single-shot mode: 800 kHz
Speed: from 50,000 points/sec up to 200,000 points/sec.

EXTREMA

Logs all extreme values of a waveform over a programmable number of sweeps. Maxima and minima can be displayed together, or separately by choosing ROOF or FLOOR traces.
Number of sweeps: 1 to 1,000,000.
Number of input points: 50 to 10,000.
Glitches as short as 0.01% of the time base down to 10 nsec are displayed.
Vertical expansion: 5 × maximum.

CHAINING OF OPERATIONS

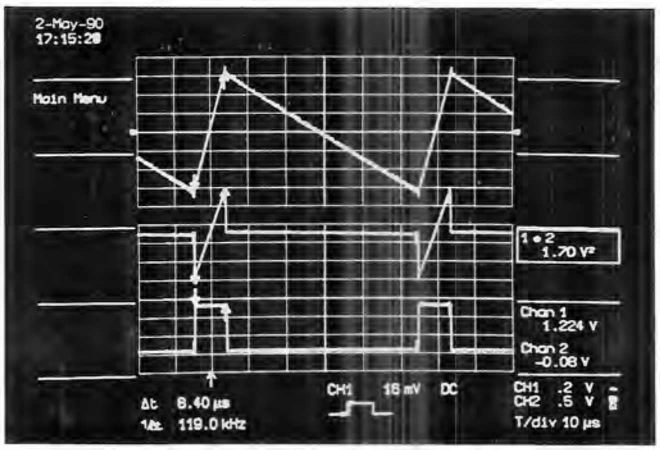
Two functions can be automatically chained using Functions E and F. Using memory C and D for intermediate results, any number of operations can be chained manually or via remote control.

REMOTE CONTROL

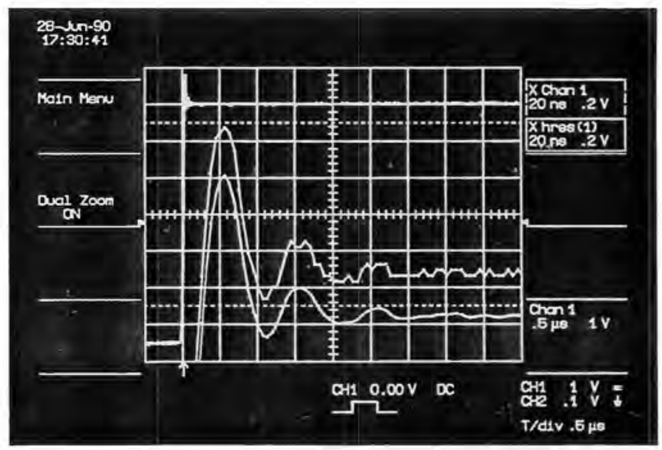
All controls and waveform processing functions are fully programmable using the oscilloscope's GPIB or RS–232–C interfaces. Simple English–like commands are used.

STORED FRONT PANELS

Up to 7 front–panel setups, including WP01 settings, can be stored in non–volatile memory and recalled using the menu buttons at the left side of the screen or via remote control.



Whether it's sophisticated functions (like integration, differentiation or logarithm) or simple mathematics (like addition, subtaction and multiplication), the WP01 package can calculate the results with just a touch of a button. Above, a ramp (top trace) and a square wave (lower trace) are multiplied together. The result is shown in the middle trace complete with cursor readout.



The WP01 package performs digital filtering techniques that allow improved vertical resolution and sensitivity. The above example shows the ringing on a step response (top trace) expanded 5 times vertically and 25 times horizontally (middle trace). The lower trace shows the same expansion but with 9–bit resolution. The second and third oscillations are now clearly visible.

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FAST FOURIER PROCESSING PACKAGE
10,000 POINT TRANSFORMS, SPECTRAL AVERAGING

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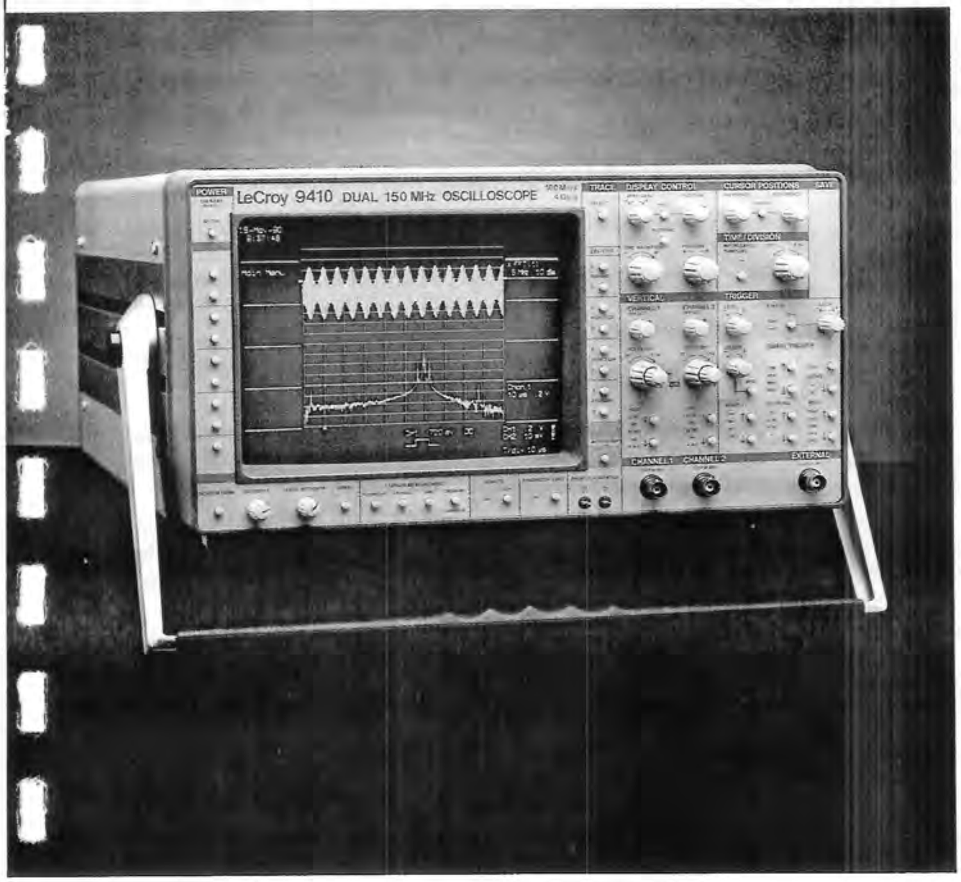
WP02 SPECTRUM ANALYSIS FIRMWARE FOR MODEL 9410 DIGITAL OSCILLOSCOPE

9410 WP02



Adding the WP02 Spectrum Analysis Package to the Model 9410 digital oscilloscope provides a fast and economical solution to users with frequency domain applications.

- **10,000 point FFTs over Two Channels Simultaneously**
- **Frequency Range from DC to >150 MHz**
- **Frequency Resolution down to 1 mHz**
- **Up to 4Gs/sec Sampling Rates**
- **Frequency Domain Averaging**
- **Wide Selection of Display Formats and Window Functions**
- **1,000–point FFTs in less than 0.5 sec!**

FREQUENCY DOMAIN MEASUREMENTS AND ANALYSIS

The WP02 Spectrum Analysis Package extends the range of measurement capabilities of the Models 9410, two–channel Digital Oscilloscope. Fast Fourier Transforms (FFTs) rapidly convert time domain waveforms into frequency domain records to reveal valuable spectral information such as phase, magnitude and power. The package is fully programmable over GPIB and RS–232–C interfaces. Hard copies can be directly made on a wide range of plotters and printers. As the package is a firmware option which is installed inside the oscilloscope, it eliminates the need for any external controller and is easy to retrofit.

FEATURES

Long record transforms – Long record FFTs (up to 10,000 points) provide significant signal–to–noise ratio improvement.

Wide–band frequency analysis – DC to 150 MHz bandwidth with high resolution.

High sampling rates – Up to 4 gigasamples/sec effectively eliminates aliasing errors.

Broad spectrum coverage – Up to 5,000 spectral components.

Multi–channel analysis – All input channels can be analyzed simultaneously to allow comparison of independent signals for common frequency–domain characteristics.

Versatile display formats – Frequency–domain data may be presented as magnitude, phase, real, imaginary, complex, log–power and log–PSD (Power Spectral Density). These display formats can all be selected via menu options .

Standard window functions – Rectangular for transient signals; von Hann (Hanning) and Hamming for continuous waveform data; Flattop for accurate amplitude measurements; Blackman–Harris for maximum frequency resolution.

Calibrated vertical scaling – Flattop truncation window provides precisely calibrated vertical scaling for all spectral components.

Frequency domain averaging – Up to 50,000 FFT results may be averaged to reduce base–line noise and enable analysis of phase–incoherent signals or signals which cannot be triggered on.

Time–domain averaging – Averaging real–time signals prior to FFT execution can increase the dynamic range up to 70 dB.

Frequency cursors – Cursors give up to 0.02% frequency resolution and measure power or voltage differences to 0.2% of full scale.

Automatic DC suppression – DC signal components may be suppressed automatically prior to FFT execution (menu selected).

Full documentation – The oscilloscope's status in the frequency domain is fully documented on one comprehensive display page which specifies parameters such as Nyquist frequency, number of points, vertical scaling and window function.

Chaining of operations – Two operations can be automatically chained, e.g., Function F = FFT of (CH1 × CH2). Any number of operations can be performed sequentially, either manually or via remote control.

Full remote control – All front–panel settings and waveform processing functions are programmable via GPIB or RS–232–C interfaces. Acquired and processed waveforms can be down–loaded to a computer and can later be retrieved and displayed on the oscilloscope.

Color archiving – Provides color hard copies of the screen using a wide range of digital plotters.

Processing of expansions – Up to two regions of the same waveform, or of different waveforms, can be expanded and processed simultaneously.

FFT on segmented waveforms – Individual waveform segments can be expanded and then analyzed using FFT. Time and date information is automatically recorded for each segment.

FUNCTIONAL DESCRIPTION

FOURIER PROCESSING

Fourier processing is a mathematical technique which enables a time–domain waveform to be described in terms of frequency–domain magnitude and phase, or real and imaginary spectra. It is used, for example, in spectral analysis where a waveform is sampled and digitized, then transformed by a Discrete Fourier Transform (DFT). Fast Fourier Transforms (FFTs) are a set of algorithms used to reduce the computation time (by better than a factor of 100 for a 1000 point FFT) needed to evaluate a DFT. The principal advantage of FFT is the speed with which it can analyze large quantities of waveform samples. Using standard measurement techniques, FFT converts a time–domain measurement instrument into a digital spectrum analyzer.

The Spectrum Analysis package enhances the outstanding features of the LeCroy Model 9410 . It provides high resolution and wide–band spectrum analysis together with sophisticated window functions and fast processing.

FFT AND LeCROY OSCILLOSCOPES

In FFT mode, LeCroy oscilloscopes provide measurement capabilities superior to those of common swept spectrum analyzers. It is now possible to perform spectral analysis on repetitive and single events at an attractive price. Users can obtain time and frequency values simultaneously and compare phases of the various frequency components with each other.

Rather than the commonly used "power of two" record lengths, the routines used in the WP02 package feature decimal record lengths which can be selected in a 1, 2, 5 sequence. Resulting spectra are also calibrated in convenient decimal Hertz values.

The WP02 package is supported by the exceptional acquisition characteristics which are the hallmark of LeCroy oscilloscopes (± 2% DC accuracy, high effective bits, improved resolution through averaging). Computations are made using 16–bit processing that allows high accuracy, stability and repeatability.

With LeCroy oscilloscopes, signals may be acquired from CH1 and CH2 and processed simultaneously using Function E and F. This is particularly useful for network characterization or when looking for common frequency–domain characteristics on multiple signals.

IMPROVED RESOLUTION

The Fast Fourier Transform calculates equally–spaced frequency components from DC to the full instrument bandwidth. By lowering the sampling rate, it is possible to make measurements with 0.1 mHz resolution up to 0.5 Hz (Nyquist). By increasing the sampling rate to 4 gigasamples/sec (250 psec/point) in random interleaved sampling mode, the widest resolution becomes 50 MHz and the Nyquist frequency 2.0 GHz, comfortably above the highest frequency components recordable by the oscilloscope, thus virtually eliminating aliasing effects.

VERSATILE WINDOW FUNCTIONS

The WP02 FFT software provides a selection of window functions designed to minimize leakage and to maximize spectral resolution of single and non–cyclic events. These include the rectangular or unmodified window typically used for transient events, the von Hann (Hanning) and Hamming windows for continuous signals, and also the Flattop and Blackman–Harris windows for more precise amplitude (power) measurements or strong suppression of side lobes respectively.

SPECIFICATIONS

MEMORIES

Acquisition memory: 10K, 8–bit word memories per channel.
Reference and function memories: for the 9410 – 2 x 10K,16–bit word reference memories which can each store one acquired or processed waveform (or up to 50 segmented waveforms) and 2 x 10K, 16–bit word function memories for waveform processing.

FREQUENCY

Frequency range: DC to > 150 MHz.
Frequency resolution: 0.1 mHz to 50 MHz.
Nyquist frequency range: 0.5 Hz to 2 GHz.
Frequency scale factors: 0.05 Hz/div to 0.2 GHz/div in a 1–2–5 sequence.
Frequency accuracy: 0.01%
Horizontal expansion: up to 200 times.
Selection of the transform size: 50 to 10,000 data points in 8 steps in a 1–2–5 sequence. The transform size defines the decimation applied to the signal after the acquisition.
The Nyquist frequency can be adjusted and optimized after signal acquisition and prior to FFT execution.

AMPLITUDE AND PHASE

Amplitude accuracy: better than 2%. Amplitude accuracy may be modified by the window function (see the window functions table below).
Signal overflow: a warning is provided at the top of the display when the input signal exceeds the ADC range.
DC suppression: selected via the menu (ON/OFF). It removes the DC component prior to FFT execution.
Number of traces: Time domain and frequency domain data can be displayed simultaneously (up to 4 waveforms).
Phase range: – 180° to + 180°.
Phase accuracy: ± 5° (for amplitude > 1.4 div).
Phase scale factor: 50° /division.
Zero base line: 0 div (center of screen).

Spectrum Display Formats and Scaling

Frequency scale: linear, real, imaginary or complex spectrum, in V/div, zero base line at 0 div (center of screen).
Power spectrum in dBm (1 mW into 50 Ω).
Power spectral density (PSD) in dBm.
Phase display: linear.
Magnitude display: linear.
Power and PSD spectra displays have 80 dB range (10 dB/div), expandable to 5, 2 or 1 dB/div.

Frequency Domain Power Averaging

Summation averaging of power, PSD or magnitude for up to 50,000 spectra.

Vertical Expansion

All spectral formats, up to 10 times, in a 1–2–5 sequence.

Window Functions

Rectangular, von Hann (Hanning), Hamming, Flattop and Blackman–Harris. The table below indicates the filter pass–band shape and the resolution:

FILTER PASS BAND AND RESOLUTION

Window type	Filter bandwidth at –6 dB [freq. bins]	Highest side lobe [dB]	Scallop loss [dB]	Noise band–width [freq.bins]
Rect–angular	1.21	–13	3.92	1.0
von Hann	2.00	–32	1.42	1.5
Hamming	1.81	–43	1.78	1.36
Flattop	1.78	–44	0.01	2.96
Blackman–Harris	1.81	–67	1.13	1.71

Definitions

Filter bandwidth at –6 dB characterizes the frequency resolution of the filter.
Highest side lobe indicates the reduction in leakage of signal components into neighboring frequency bins.
Scallop loss is the maximum loss of amplitude accuracy of the magnitude spectrum.
Noise bandwidth is the bandwidth of an equivalent rectangular filter.

CURSORS

Absolute (crosshair) and relative (arrow) cursors provide frequency and amplitude (phase, power, power density) measurements.
Horizontal bars provide absolute and relative amplitude, and power and power density measurements.

FFT EXECUTION TIME

100 points in less than 0.05 sec.
1000 points in less than 0.5 sec.
10,000 points in less than 5 sec.

REMOTE CONTROL

All WP02 processing functions are fully programmable via the GPIB and RS–232–C interfaces. Simple English–like commands are used.

Remote read and write

All waveform formats including complex can be read by computer for storage or further processing.
Externally generated waveforms can be written into Memories C and D for FFT or other processing.

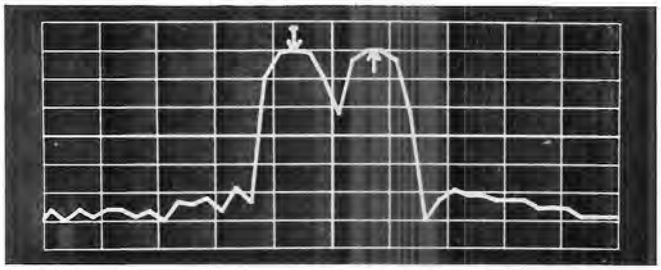
STORED FRONT PANELS

Up to 7 front–panel setups, including WP02 menu settings can be stored in non–volatile memory and recalled by the menu buttons at the left side of the screen.

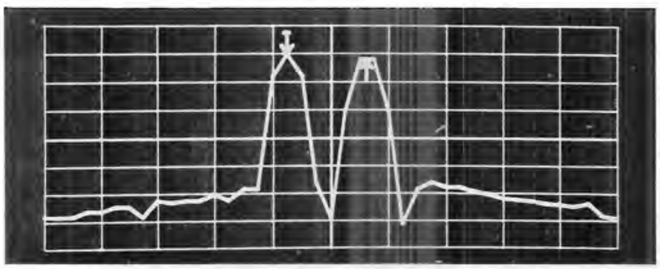
WP02 INSTALLATION

A WP02 package may be retrofitted to a LeCroy 9410 Digital Oscilloscope.

Blackman–Harris

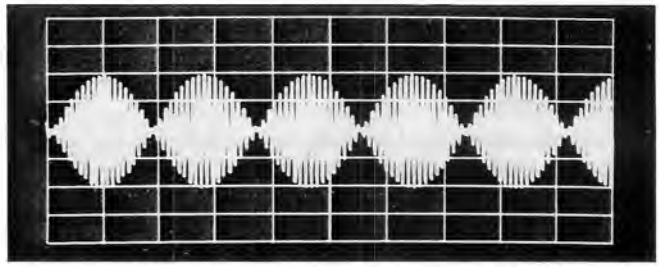


Flattop



Hamming

von Hann (Hanning)



The sum of two sinusoids of 500 kHz and 527.5 kHz is digitized over 200 points and transformed to the frequency domain. Four different window functions are applied to indicate their effect on leakage suppression and spectral resolution.

ORDERING INFORMATION

Oscilloscopes and Options

Code	Description
9410	2–channel, 150 MHz Oscilloscope, 100 Ms/s
9410WP01	Waveform Processing for 9410
9410WP02	FFT Firmware for 9410

Oscilloscope Accessories

OM 9410	Operator's Manual
9410–FC	Front Cover
9410–MC01	Card Reader + 128K Memory Card
9410–MC02	128K Memory Card
9410–MC04	512K Memory Card
94XX–P01	10:1 Oscilloscope Probe
CA9001	Camera (Polaroid film) and Hood
CA9002	Camera Adapter (35mm) with Hood
D9010	High Impedance Divider 10:1
DC/GPIP–2	2–meter GPIB Cable
DP9001	Digital Plotter, 8–pen A4 size
DP9003	Epson Printer
OC9001	Oscilloscope Cart
P9011	10:1/1:1 Oscilloscope Probe
P9100	100:1 Oscilloscope Probe
RM9400	Rackmount for portable oscilloscopes
SG9001	High Voltage Protector
TC9001	Transit Case
TC9002	Carrying Bag

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MEMORY CARD SYSTEM FOR MODELS 9410, 9414, 9424, 9430 DIGITAL OSCILLOSCOPES

- **Ultra–fast Throughput Rates**
- **Automatic Waveform Storage**
- **New PCMCIA Standard (DOS–compatible)**
- **128K Byte – or 512K Byte – cards available**
- **Ideal for automatic PASS/FAIL Testing**

FEATURES

Versatility – The memory card is mainly used to save and retrieve either waveforms (acquired or processed) or instrument settings.

Autostore – Waveforms can be automatically stored to the card after every acquisition. The user can choose to stop the automatic storage when the card is full, or to perform "wraparound" storage, discarding the oldest waveforms in a first–in–first–out manner.

PASS/FAIL Testing – The oscilloscope's new PASS/FAIL feature allows for automatic storage of failure data to the memory card.

High Efficiency – Select up to 8 different traces (10 traces on 4–channel scopes) to save with just one keystroke. This feature is also available in "Autostore" configurations.

User–friendliness – A convenient "Replay" function helps the user to visualize the waveforms stored on the card.

Fully Featured with Remote Control – All the front–panel commands used to drive the memory card system are available through remote control. This allows testing time to be cut significantly in ATE applications, thanks to the memory card's extremely fast transfer speed.

Standard PCMCIA/JEIDA Format – PCMCIA is the memory card standard agreed upon by all the major PC manufacturers.

SPECIFICATIONS

Formatted MC Size: 506K for MC04, 122K for MC02

Front–Panel File Size: 2K Bytes

Waveform Size: A 10000–points waveform will use 2 bytes per point in word format plus 346 bytes of waveform descriptor, for a total of 20346 bytes.

Template Size: 22K Bytes

Throughput Performance Examples:

Waveform Length	Transfer Time
1000	22 msec
10000	82 msec
50000	322 msec

ORDERING EXAMPLE

To order a memory card system with one 128K card and one 512K card for a Model 9410 oscilloscope:

9410–MC01 for the Memory Card firmware.
9410–MC02 for the 128K Memory Card.
9410–MC04 for the 512K Memory Card.

800–5–LeCroy (1–800–553–2769):
automatically connects you to your local sales office.

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Innovators in Instrumentation

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TDS 071/001

Chapter 2

BASIC OPERATION

AND

BLOCK DIAGRAMS

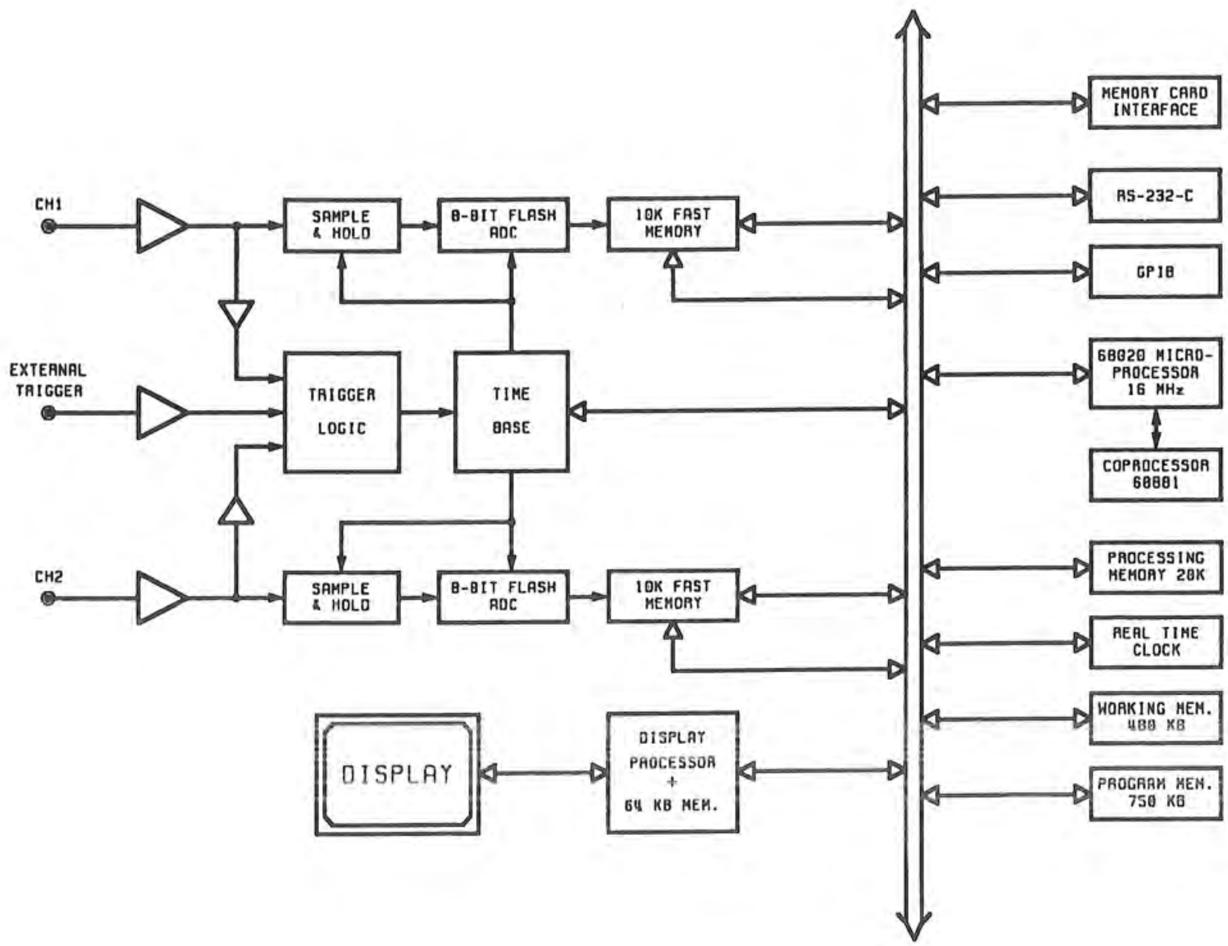
2.1 9410 Sub-assemblies

F9424-1	Base Board
F9451-1 or	Power Supply
94XX-PS1701	Power Supply
F9424-2	Support for Memory Card
F9450-2	Display
F9410-3	Dual channel ADC
F9420-4	Time Base
F9410-5	Front Panel
F9410-6	Processor
F9430-7	Dual channel front end
F9420-8	Clock bus
F9410-9	Rear panel
M9424	Mechanical for 9410

Table of contents

Section

9410 HARDWARE OVERVIEW



LeCroy CORPORATION

DRAWN KROLUBSKI-B	SCHEMATIC DIAGRAM OVERVIEW
CHKD SEIGNOBOSC-C	DWG NO: SCHEMA-BLK — SIZE C
APPVD 13-OCT-88	SH 1 OF 1 — ECO NO ----

2.2 F9450-2 Display Board

2.2.1 General Description

This board is designed to display a monochrome 10" CRT image. The image is composed of instructions downloaded from the processor board 9410-6 into the resident memory via the internal 9410 bus.

The image is a vector type display. The principle of a vector display is to move the spot with intensity ON or OFF between two XY positions of the screen. This represents the major use of the display board. For special applications, the capability of a pseudo-raster mode has been added. This mode is realized by turning the beam spot ON or OFF according to a downloaded bit mask while moving the spot in the x-direction.

The spot position is controlled by the monolithic display processor MDS403. It is a LeCroy proprietary gate array. The data and address busses are 16n bits wide. The processor supports instructions like JMP, JSR, RTS, and 12 bit X, Y or XY vector instructions.

The resident display memory is a static 32K*16 RAM. It can be R/W accessed via the internal 9410 bus, or read only by the MDS403.

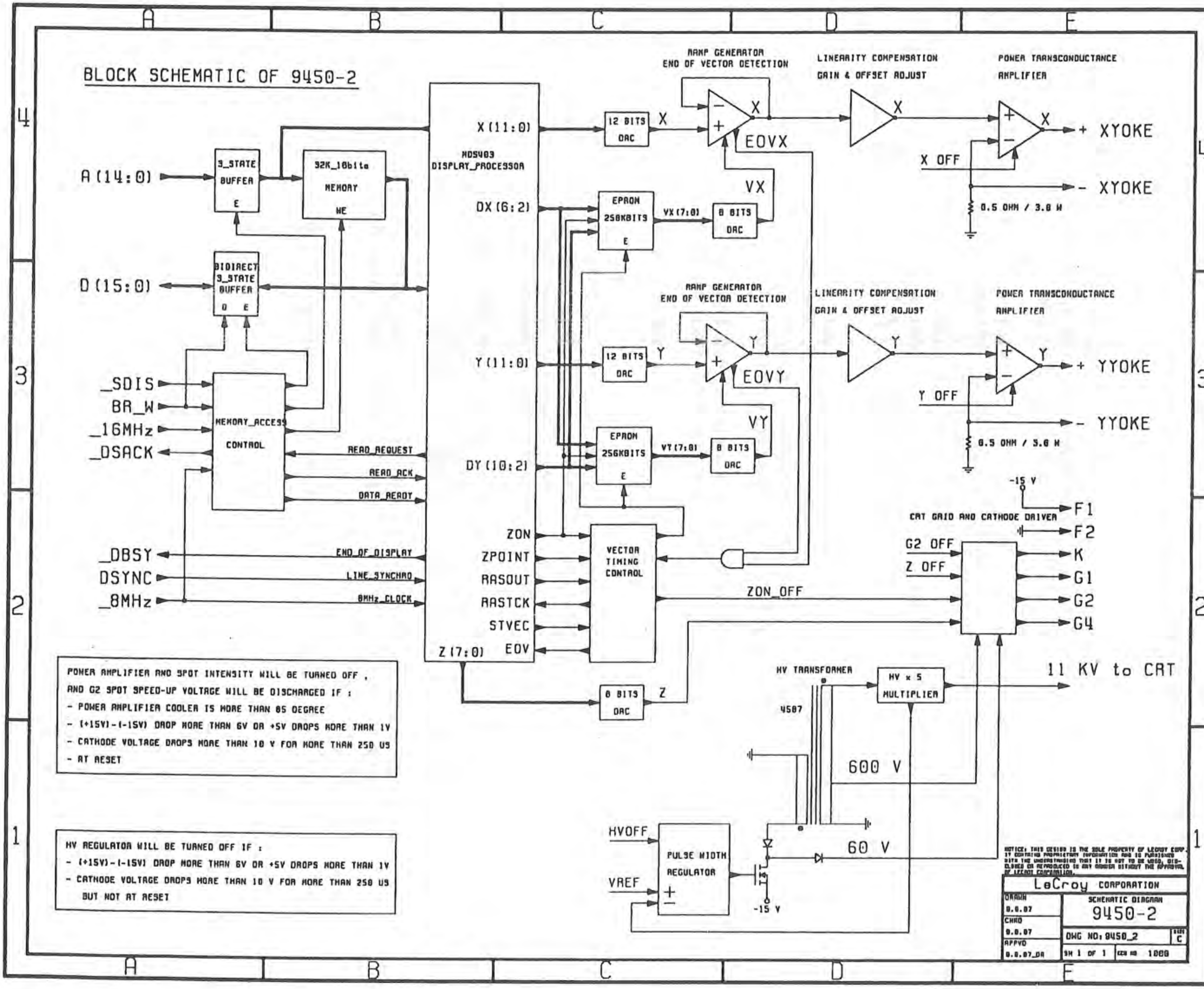
The digital X, Y coordinates output from the MDS403, are converted to analog signals by two 12-bit DACs.

In order to generate a constant spot velocity (intensity) over the screen, there are two rate controlled integrators, one for the X and one for the Y axis. The rate is calculated by table look-up using two EPROMS addressed by delta X and delta Y simultaneously.

For each axis there is a non-linear correction amplifier, one gain and one offset control amplifier, and one transconductance power amplifier to drive the current through the magnetic deflection coil.

The high voltage needed for the CRT is generated with a fly-back mode switching regulator through a high voltage transformer and a diode high voltage multiplier.

Last not least comprehensive protection circuitry is implemented.


BLOCK SCHEMATIC OF 9450-2
A (14:0)
3_STATE BUFFER E
32K_16bits MEMORY WE
D (15:0)
BIDIRECT 3_STATE BUFFER D E
_SDIS
BR_W
_16MHz
_DSACK
MEMORY_ACCESS CONTROL
READ_REQUEST
READ_ACK
DATA_READY
_DBSY
DSYNC
_8MHz
END_OF_DISPLAY
LINE_SYNCHRO
8MHz_CLOCK
MOS403 DISPLAY_PROCESSOR
X (11:0)
DX (6:2)
Y (11:0)
DY (10:2)
ZON
ZPOINT
RASOUT
RASTCK
STVEC
EOV
Z (7:0)
12 BITS DAC
EPROM 256KBITS E
VX (7:0)
VY (7:0)
8 BITS DAC
VECTOR TIMING CONTROL
RAMP GENERATOR END OF VECTOR DETECTION
EOVX
EOVY
VX
VY
LINEARITY COMPENSATION GAIN & OFFSET ADJUST
POWER TRANSCONDUCTANCE AMPLIFIER
X OFF
Y OFF
+ XYOKE
- XYOKE
+ YYOKE
- YYOKE
0.5 OHM / 3.8 W
-15 V
CRT GRID AND CATHODE DRIVER
G2 OFF
Z OFF
ZON_OFF
F1
F2
K
G1
G2
G4
HV TRANSFORMER
4507
HV x 5 MULTIPLIER
11 KV to CRT
600 V
60 V
HVOFF
VREF
PULSE WIDTH REGULATOR
POWER AMPLIFIER AND SPOT INTENSITY WILL BE TURNED OFF ,
AND G2 SPOT SPEED-UP VOLTAGE WILL BE DISCHARGED IF :
- POWER AMPLIFIER COOLER IS MORE THAN 85 DEGREE
- (+15V)-(-15V) DROP MORE THAN 6V OR +5V DROPS MORE THAN 1V
- CATHODE VOLTAGE DROPS MORE THAN 10 V FOR MORE THAN 250 US
- AT RESET
HV REGULATOR WILL BE TURNED OFF IF :
- (+15V)-(-15V) DROP MORE THAN 6V OR +5V DROPS MORE THAN 1V
- CATHODE VOLTAGE DROPS MORE THAN 10 V FOR MORE THAN 250 US
BUT NOT AT RESET
LeCroy CORPORATION
SCHEMATIC DIAGRAM
9450-2
DRAWN 8.8.87
CHKD 8.8.87
APPVD 8.8.87_DR
DWG NO: 9450_2
SIZE C
SH 1 OF 1
1000
A B C D E
4 3 2 1

2.2.2. Input Interface and Display Memory

All data and instructions are written into the resident memory by the main processor via the internal bus. The 9410 main processor can read back the display memory in order to plot the screen contents via the external printer port or for test purposes. The dispaly processor can only read the memory to control the display.

The PAL (16R4) RAMACC controls the memory access and timing. One of its flip-flop selects the memory user. Priority is given to the 9410 main processor. All timings are set for memories with maximum access time of 120 nsec.

2.2.2.1 The PAL RAMACC

The line BCK is the 16 MHZ master clock from the F9410-6 processor board.
CK8M is BCK divided by two. The external bus R/W access are synchronous to the BCK clock. The MDS403 read cycles are synchronous to the CK8M clock.

The line G244 controls the address driver output state. A high level disables the outputs. The line G245 controls the data driver output state. A High level disables the outputs.

The line BR_W controls the direction of data: '1' to read from memory and '0' to write to memory. The line WE256 is set low during a write cycle to enable the memory data load.

The four lines SDIS, BAS, BR_W and DSACK are to control the R/W timing between the external bus and the memory.

The line SDIS is generated on the F9424-1 base board by decoding the address lines BA19 to BA24. The display address space is hex 178xxxx.

The three lines RREQ, RDACK and RDRDY are to control the read cycle of the MDS403.

2.2.2.2 External Bus to Memory Access Timing

a. The memory is available. This is the fastest access:

For a read cycle, the line WE256 will remain high for the entire cycle.

When the external user wants to access the memory, SDIS is set to '0'. The access is given at state A0 of the PAL. If the state is A0 and SDIS low, the state will change to A1 at the next trailing edge BCK.

The states A1, A2, A3 and A4 are always two BCK periods long.

The signal G244 will go low and enable the outputs of the external address driver during states A0 through A3 for SDIS low.

The signal G245 will go low and enable the external data driver, according to BR_W, from A1 through A3

The signal WE256 will go low if the memory access is a write cycle, simultaneously with G245. It will remain high for a read cycle.

The ready answer line DSACK is low during the state A2 and A3.

b. The memory is in use:

All signals will remain high (except for BAS and SDIS) until the PAL comes to state A0. The cycle will then be exactly the same. Therefore the maximum number of wait states is 8.

2.2.2.3 MDS403 Memory Access Timing

a. The memory is available. This is the fastest access:

The gate array has read-only memory access. The entire cycle is minimum 500 nsec (8 BCK clock periods).

When the MDS403 wants to access the memory, it sets RREQ to '1'. Access will be granted at the end of state A0 if the external user is not requesting access. Priority is given to the external user. If the memory is not busy and state is A0, access will be given at the next occurence of CK8M low, at the trailing edge of BCK.

The state will then change to A5 and the signal RDACK will enable the MDS403 to drive the address lines until RREQ returns low.

The states A5 and A6 are always two BCK periods, and the state A7 is always one.

The sigal RDRDY goes high at the beginning of state A6 and returns low at the end of state A7. This signal is synchronized in the MDS403 at the falling edge of CK8M and is named 'Rdys'. 'Rdys' enables the MDS403 to load data at the next trailing edge of CK8M. This is two BCK periods after the beginning of the state A6.

The signal RREQ returns low when the data are loaded.

b. The memory is in use:

All signals except RREQ remain low until access can be granted. The cycle is then exactly the same.

2.2.2.4 Reset and Frame Synchronization

At power-on or reset, the beam intensity is set OFF and the spot is positioned to the screen center. The display processor is set in a wait state. The address bus is internally set to hex0000, but the outputs are put into the high impedance state.

The display processor waits until the user enables it to access the memory by sending the first frame synchro. At this moment the processor starts to read data from memory address hex0000. It is the user's responsibility to make sure that the data in the memory makes sense to the display processor.

2.2.3 Display Processor

The MDS403 is a LeCroy proprietary 3K gate array in a ceramic package with 120 pins.

2.2.4 Principle of Vector Display

A vector is a linear displacement of the beam spot between two X,Y positions: the current position and the position to go. Due to the flatness of the screen, the X,Y position of the spot is proportional to the tangent of the respective X,Y deflection currents. This makes a slightly non-linear behaviour which a good display must account for and correct. This is accomplished in the simplest way by a non-linear correction applied to the analog signal amplifier.

A vector is generated by a composition of two X and Y linear current ramps. The start level of both represent the current X,Y position, and the end level represent the X,Y coordinate to go. Two kind of vectors are distinguished: one-axis vectors where the spot moves only along X or Y direction, and two-axis vectors where the spot moves in both the X and Y direction.

The displacement velocity is limited by the power supply and the inductance of the deflection yoke. If one neglects the losses in the yoke and the yoke driver, the maximum attainable velocity is:

$$di/dt = U/L$$

where U is the applied voltage and L the yoke inductance.

In Order to get a constant spot velocity for a constant spot intensity, the rate of the X and Y ramps are not the same for all vectors. They depend on the ratio between X and Y displacement.

The rate for a either one-axis vector is equal to the maximum spot velocity Vspot.

For two-axis vectors, the individual X and Y rates are calculated using look-up tables contained in two EPROMs. They are addressed by both DX and DY combined and output the resulting X and Y velocities Vx and Vy. For this computation the MDS403 always outputs DX and DY, the difference of current to new spot position.

The combined DX/DY address space and the resulting memory size becomes rapidly very large with increasing DX and DY. This limits the length of two-axis vectors possible in pratice, as outlined in the next paragraphe.

2.2.5 Practical Limitation of Two-axis Vectors

The limit is imposed by the size of the EPROM to be used and the desired X, Y velocity accuracy.

If we decide to use the largest possible DX, DY we need
2048*2048 = 4.2 mega times 10 bits for 1 per 1000 precision.
This makes 42 megabits of EPROM and is certainly not realistic.

The design of the analog X and Y ramp generator limits the precision to about 1%. Therefore the X and Y rate DAC outputs are chosen 8 bits wide.

The X and Y position DACs are 12 bits. The least significiant bit represents 0.04 mmm on the screen. Therefore the two LSBs are not used.

Two-axis vectors are needed to draw characters which don't require large vectors. For drawing traces, only small DX values are needed. The final choice on the DX/DY size is to use bits 2 to 10 of DY and bits 2 to 6 of DX. This results in the following limitation:

- +/- 31 counts for DX and DY for the instructions MOXY and DRXY (move and draw XY)

- +/- 127 for DX and +/- 2047 for DY, for the four auto X increment instructions (MYAX, DYAX, PYAX and DPYX)

This makes a memory size of 16 Kbytes. As the signal ZON is also input as a memory address, the final EPROM size used is 32 Kbytes, one each for VX and VY rate.

2.2.6 Vector by MDS403

When the beam spot has reached the final XY position, the signal EOV (end of vector) becomes true and the MDS403 is enable to load the next XY position. The strobe VECSTR indicates that a new XY value is loaded. AT the same time it loads the signals DX, DY, VMAX, ZON, ZPOINT and RASOUT.

The signal EOV must be tied to low directly after the signal VECSTR goes high, until the XY position has reached the final value. EOV will be high again, and enables the MDS403 to send a new XY position.

2.2.7 Spot Intensity Control and Timing Principle

Of the 12 bits available for the spot intensity (ZC0 to ZC11), only 8 are used. The ZC register, internal to the MDS403, is not reloaded with a new value until the vector in progress is completed (i.e. EOV high). There is, however, a delay of about 600 nsec between the end of vector at the output of the ramp generator and the actual yoke current change. This is accounted for by adjustable start-of-vector and end-of-vector delays, as described in paragraph 10.

The 8 intensity bits are converted to analog current by an 8-bit DAC. This current controls via an amplifier the cathode voltage of the CRT. It is 42 V for OFF and about 15 V for full intensity (hexff).

The digital ON/OFF control at the beginning and end of vectors is done by the ZCTR signal output from the PAL INTCTR.

A special hardware feature of the F9450-2 diaplay is the "pointed" vectors with an intensified point at the end, used to highlight the actual digitized data points out of the linear interpolation. This is realized by increasing the beam ON control timing by 500 nsec. During this extra time the spot does not move and gives therefore rise to the intensified point.

2.2.8 The Ramp Generator

The X and Y outputs, 12 bits each, from the MDS403 processor are converted to analog voltage by two 12-bit DACs, A13 and A14. The VX and VY outputs of the two rate EPROMs are converted to analog current by two 8-bit DACs, A10 and A11.

The voltage Vout at the capacitor (C74 and C75 in circuit) represents the current spot position, and Vin the final spot position at the end of a vector to be drawn. While Vin and Vout are different, the capacitor is charged or discharged with a rate given by Iin, the integrator current, until Vout reaches Vin. The analog X/Y positions are connected to the positive input of the X or Y ramp generator. The analog rate signal XINT and YINT are connected to the current control of the respective ramp generator.

In order to allow for sufficient look-up time for the VX and VY rates from the EPROMs, a delay of 250 nsec is generated after the new X,Y positions are loaded (VECSTR from MDS403 to the PAL VECTIM, and OESPEED from the PAL to enable the EPROM outputs). During this delay, the analog rates are held at zero which keeps the analog X/Y positions stable.

The analog signal WRVEC, "end of vector", goes low when the spot has reached the final position. In the PAL VECTIM the falling edge of WRVEC gives rise to EOV high which enables the MDS403 processor to load the next X, Y position or intensity value, and, after a seperate delay, turns OFF the intensity (ZCTR). EOV is further delayed if the draw mode "pointed vector" is enabled.

2.2.9 Vector Timing

After the display processor has loaded a new X, Y position, a delay is generated to allow for the EPROM look-up time of the VX, VY rates. After that delay, the vector is drawn on the screen. When the spot reaches its final position, the EOV line goes high and enables the processor to output the next X, Y position. The intensity ON/OFF control line ZCTR is subject to additional delays to account for the inertia of the yoke current changes.

In raster mode, the intensity ON/OFF bits are shifted out of the display processor while the beam is moving, using an extra asynchronous raster clock (C96, R54, R219 next to PAL VECTIM). A divider by two, three or four is used (PAL RASTCK). It is controlled by the size of the possible X-increments, bits DX5 to DX7.

The timing is controlled by the asynchronous clock generated with the PAL VAZTIM in conjonction with a counter (A8) which is reset to 0 at each start of a new vector. The rate enable is OFF from state 0 to state 3 included. At state 4, the rate is enabled and the vector drawn. For "move" vectors, the rate is not set OFF from state 0 to 3. The signal ZON goes low at the same time. It returns high when the signal WRVEC goes low. After a delay defined by the yoke inertia, ZCTR enables the intensity of the spot. For raster vectors, the signal ZON follows inverted the raster intensity control line RASOUT from the MDS403.

2.2.9.1 Timing Diagram for Draw Mode

The two delays SVD and EVD have, in addition to the fixed digital delay, a small analog adjust range provided by potentiometers R45 and R46.

For "move" type vectors, the signal OESPEED remains low and the signal ZON, ZCTR remains high. Both WRVEC and EOV are the same as for draw vectors.

2.2.9.2 Timing Diagram for Point Mode

For "point" vectors, the intensity is set ON at the end of the vector for about 1 usec. The signal EOV goes high after the intensity is OFF again. The extra timing for point vectors is an analog fixed delay in the PAL VAZTIM.

2.2.9.3 Raster Mode Timing

There are three raster steps available. The selection is made by loading the auto-increment register of the gate array. The increment may be positive or negative. For a better display timing, it is preferable to implement a raster display with lines drawn in the positive and negative horizontal direction. In this way there is no time lost by returning the spot to the start of the next line. For a raster command, the first intensity bit out of the gate array is always bit d0, regardless of the direction. (positive or negative horizontal)

The intensity bits are shifted out of the gate array with the clock RCKOUT from PAL RASTCK (A29). This clock gets automatically set to the frequency corresponding to the step selected.

The timing is the same as for the draw mode, except for ZON and ZCTR which follow the intensity bits out of the display processor.

For each raster instruction there are eight clock pulses on the line RCKOUT to output the intensity bits. The period depends on the Xinc step selected.

2.2.10 Velocity and Position: Digital to Analog Correspondence

For all move vectors, the X and Y rates are maximum and equal to 255 hex.

For one-axis draw vectors, the maximum rate is different for X and Y because the length in millimeters on the screen of the same deltaX and deltaY is different. The maximum X rate is CC hex, and the maximum Y rate is FF (1.44 mA and 1.6 mA).

For a CRT high voltage of 11 kV.

2.2.11 Deflection Non-Linearity

In a CRT the deflection angle is proportional to the deflection coil current. On a flat screen, the spot position is proportional to the tangent of the current. This effect is accounted for by two (X and Y) nonlinear amplifiers, using diode characteristics in the feed-back loop.

2.2.12 X/Y Power Transconductance Amplifier

These amplifiers provide the current for the deflection coils. The current is measured through a shunt resistor of 0.44 Ohm.

The bandwidth depends on the transconductance of the output power MOSFET which changes with the drain-source current.

The amplifier is provided with an OFF command to disable it in case of overheat or when the protection circuitry detects a problem.

The left side panel of the 9410 box is used as the heat sink.

2.2.13 High Voltage Power Supply

The switching fly-back regulator generates 3 voltages: 2.2Kv which is divided by 1000 for the feed-back loop, 600 V and 60 V. The 11 kV is made through a high voltage times five multiplier.

In operation, the current drawn from the 11 kV supply (anode current) may be up to 300 uA. The current causes a voltage drop due to the internal output impedance of the multiplier, up to 500 V. The deflection angle depends slightly on the anode voltage. To compensate for this, the reference point of the regulator is increased proportional to the current drawn.

In order to improve the efficiency, the switching frequency of the regulator is automatically adjusted to the self-resonant frequency of the high voltage transformer which is about 80 kHz.

The supply is equipped with an OFF control line to disable its operation when the protection circuitry detects a fault condition (+- 15 V power drop, +5 V power drop, HV supply defective).

2.2.14 Deflection Yoke

The deflection is realized by a symmetrical coil which represents a 250 uH inductance. It's resonant frequency is 1.2 MHz. In parallel a 1 KOhm resistor is added. The value is given by:

$$R = 0.5 \ \mathrm{SQRT}\ (L/C)$$

It corresponds to the critical damping.

Attached to the coil are four permanent magnets to compensate for the pin cushion effect caused by the coil and the CRT.

2.2.15 Cathode Ray Tube

It is a "10", 90 deg rectangular CRT with a 20 mm neck diameter. The screen is antireflecting. The useful area is 189 * 149 mm^2. The phosphor is orange L5C.

2.2.16 Screen Protection Circuitry

In order to prevent damage to the CRT screen, the intensity Control is set OFF, grid 2 speed-up voltage is set to 0 V and the power amplifier is turned off under one of the following conditions:

- power amplifier temperature above 85 deg centigrade
- +15 and -15 V drops by more than 6 V
- +5 V drops by more than 1 V
- cathode voltage drops by more than 10 V for more than 300 usec
- at reset

In addition, the high voltage regulator is turned off under one of the following conditions:

- +15 V or -15 V drop by more than 6 V
- +5 V drops by more than 1 V
- cathode voltage drops by more than 10 V for more than 300 usec

During the time the reset signal is low, the HV regulator is not turned off in order to allow it to come up.

2.2.17 Operation Status Lines

The ON/OFF state of the power amplifier, HV power supply and the intensity and grid 2 voltage is controlled by four comparators (A22). They drive lines SHUT and ZAMPOFF. The signals XOFF, YOFF and INTOFF are the same and controlled by ZAMPOFF through transistors Q68 to Q70. HVREGOFF is controlled by the line SHUT. Therefore there are two different signals which control the status of the board: ZAMPOFF and SHUT.

The signal SHUT has priority over ZAMPOFF. The line SHUT may pull down ZAMPOFF through diodes D37 to D9. The inverse is not possible.

The line SHUT is the wired OR of the three comparator outputs:

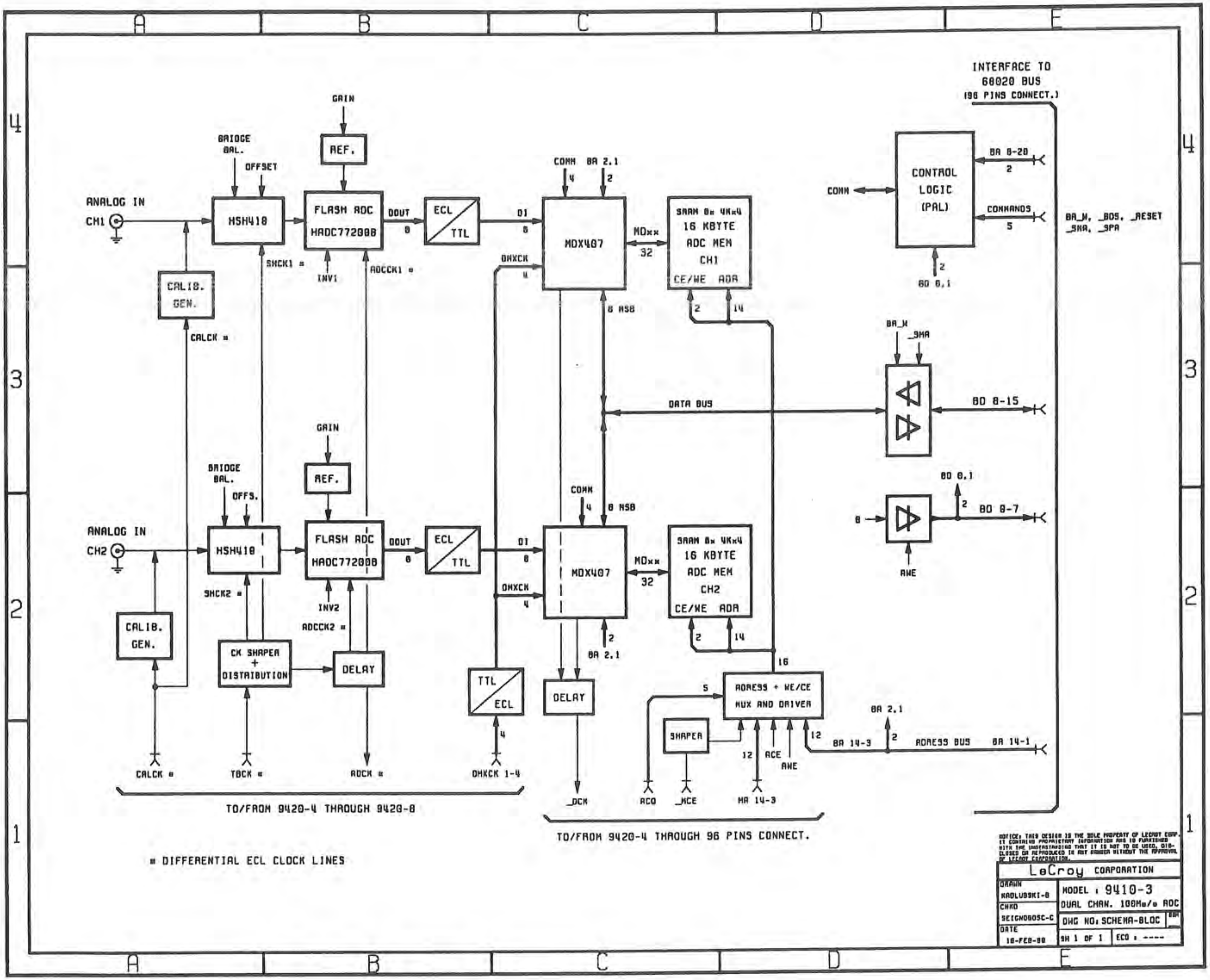
- pin 22 of A22: low if +5 V is less than 4V
- pin 14 of A22: low if +15 V or -15 V drop by more than 6 V
- pin 1 of A22: low if cathode voltage is less than 30 V for more than 300 usec after reset. The time constant is realized by R33, R271, R214 and C1, C131. The input to the comparator, pin 6 of A22, is low at -15 V while the reset is low.

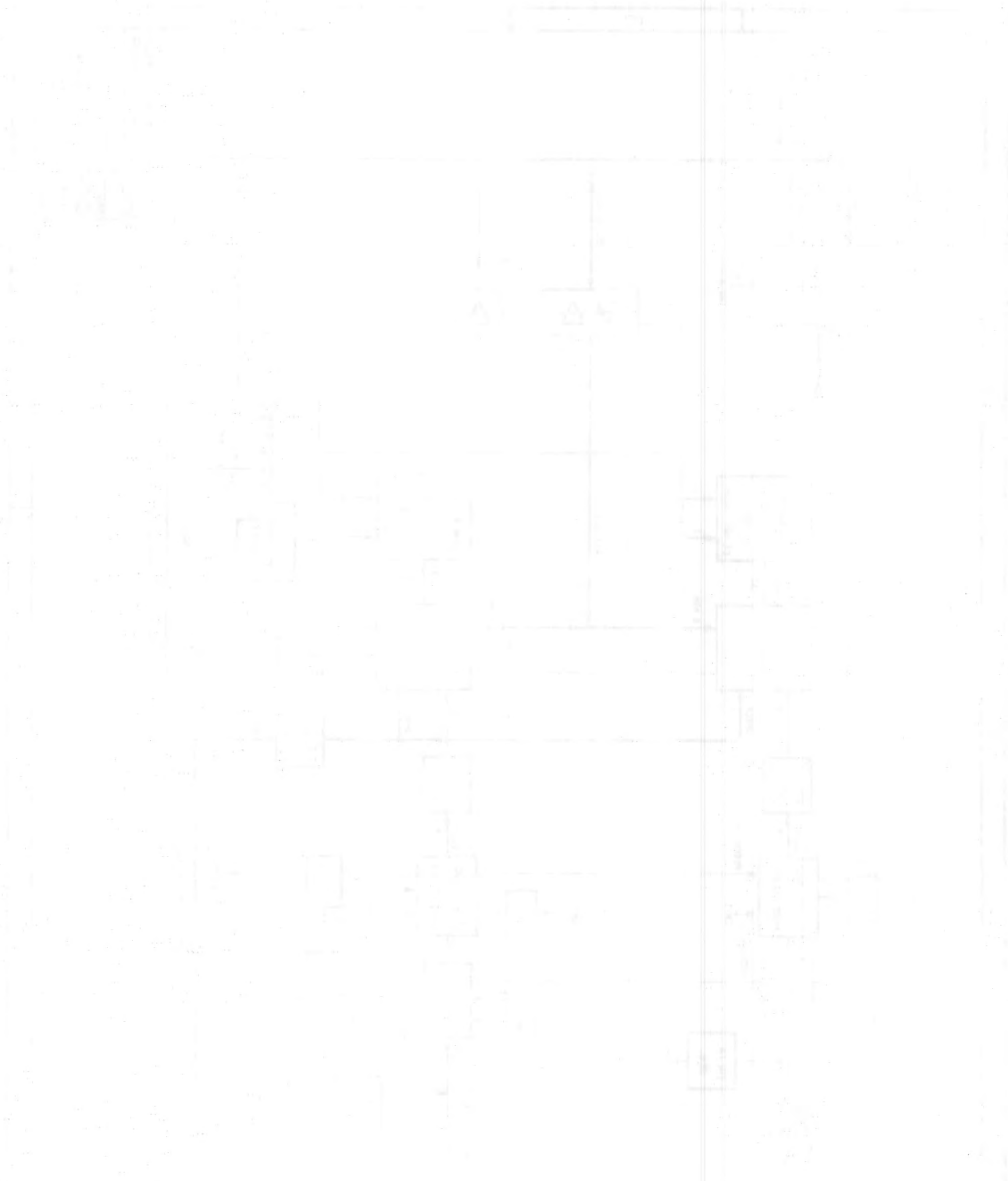
If one of these three lines is low, SHUT is low. If all three lines are high (about -10 V), SHUT is high (-10 V).

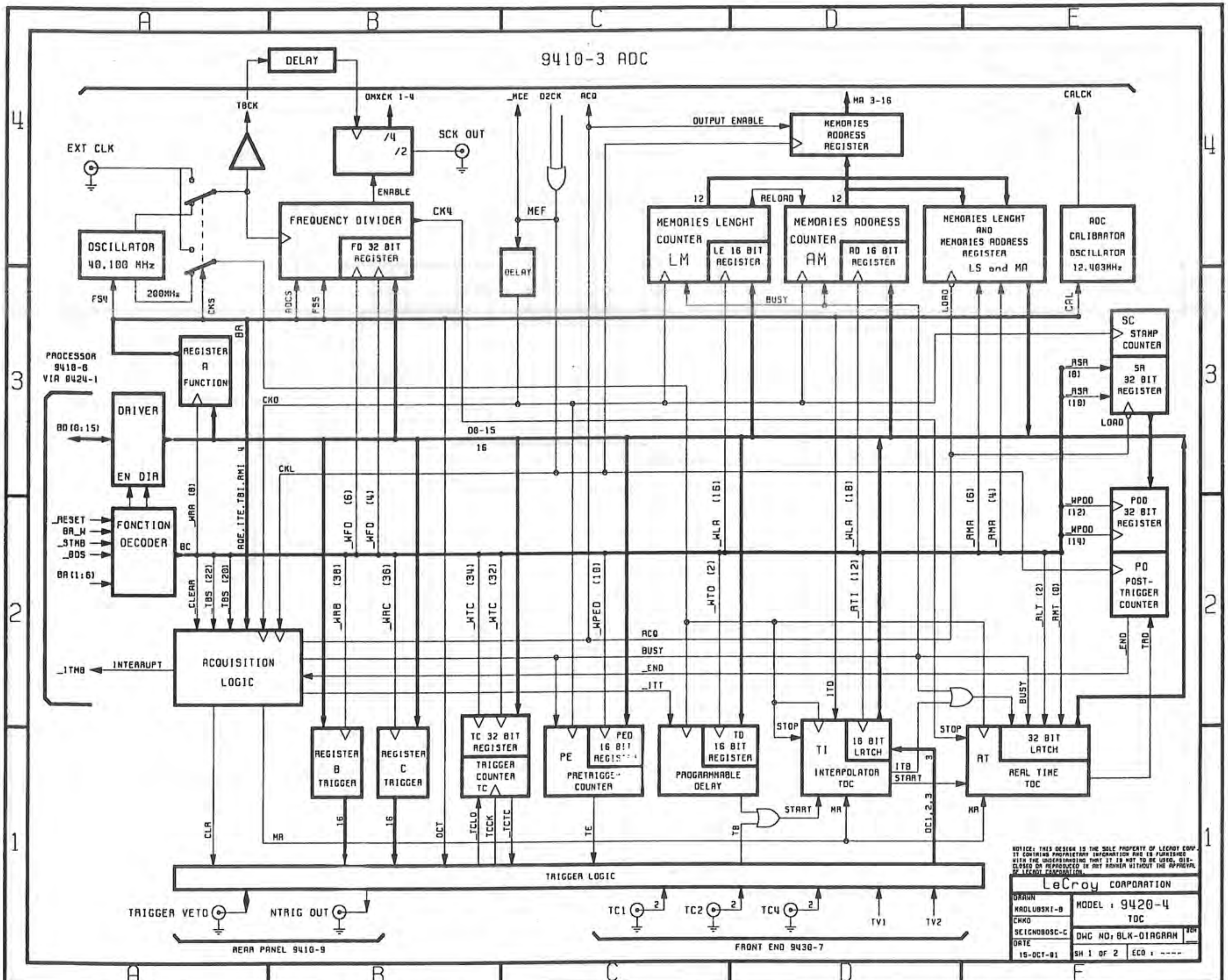
The line ZAMPOFF is the wired OR of the three following signals:

- Thermal switch: pulls down ZAMPOFF if the power amplifier exceeds 85 degree centigrade.
- pin 2 of A22: pulls down ZAMPOFF while reset is low.
- signal SHUT: pulls down ZAMPOFF if low.

If one of these lines is low (-15 V), ZAMPOFF is low. If all three are high (about -10 V), ZAMPOFF is high (about -10 V).


ANALOG IN
CH1
ANALOG IN
CH2
BRIDGE BAL.
OFFSET
OFFS.
HSH418
GAIN
REF.
FLASH ADC
HADC77200B
DOUT
8
ECL
TTL
INV1
INV2
SHCK1 *
SHCK2 *
ADCCK1 *
ADCCK2 *
CALIB. GEN.
CALCK *
CK SHAPER + DISTRIBUTION
DELAY
CALCK *
TBCK *
ADCK *
DHXCK 1-4
TO/FROM 9420-4 THROUGH 9420-8
* DIFFERENTIAL ECL CLOCK LINES
DI
DHXCK
COMM
BA 2.1
MDX407
8 MSB
MDxx
32
SRAM 8x 4Kx4
16 KBYTE
ADC MEM
CH1
CH2
CE/WE ADR
DATA BUS
_DCK
ACQ
_WCE
MA 14-3
SHAPER
ADRESS + WE/CE
MUX AND DRIVER
ACE
AWE
ADRESS BUS
BA 14-3
BA 14-1
BA 2.1
TO/FROM 9420-4 THROUGH 96 PINS CONNECT.
INTERFACE TO
68020 BUS
(96 PINS CONNECT.)
CONTROL
LOGIC
(PAL)
BA 0-20
COMMANDS
BA_W, _BDS, _RESET
_SHA, _SPA
BD 0,1
BA_W
_SMA
BD 8-15
BD 0-7
B
AWE
LeCroy CORPORATION
DRAWN
WADLUBSKI-B
CHKD
SEIGNOBOSC-C
DATE
18-FEB-88
MODEL : 9410-3
DUAL CHAN. 100Ms/s ADC
DWG NO: SCHEMA-BLOC
SH 1 OF 1
ECO : ----





9410-3 ADC
DELAY
TBCK
OMXCK 1-4
/4
/2
SCK OUT
EXT CLK
ENABLE
FREQUENCY DIVIDER
FD 32 BIT REGISTER
CK4
OSCILLATOR
40,100 MHz
200MHz
FS4
CKS
ADCS
FS5
_MCE
D2CK
ACQ
MEF
DELAY
OUTPUT ENABLE
MEMORIES ADDRESS REGISTER
MA 3-16
RELOAD
12
MEMORIES LENGHT COUNTER
LM
LE 16 BIT REGISTER
MEMORIES ADDRESS COUNTER
AM
AD 16 BIT REGISTER
MEMORIES LENGHT AND MEMORIES ADDRESS REGISTER
LS and MA
ADC CALIBRATOR OSCILLATOR 12.403MHz
CALCK
BUSY
LOAD
CAL
SC STAMP COUNTER
SA 32 BIT REGISTER
_ASA (8)
_ASA (10)
PROCESSOR
9410-6
VIA 8424-1
REGISTER A FUNCTION
BA
CKO
DRIVER
EN DIR
BD(0:15)
D0-15
16
CKL
_WRA (8)
ADE,ITE,TBI,AMI 4
_WFD (6)
_WFD (4)
_WLA (16)
_WLA (18)
_AMA (6)
_AMA (4)
_WPDD (12)
_WPDD (14)
PDD 32 BIT REGISTER
PD POST-TRIGGER COUNTER
_RESET
BR_W
_STMB
_BDS
BA(1:6)
FONCTION DECODER
BC
_CLEAR
_TBS (22)
_TBS (20)
_WRB (38)
_WRC (36)
_WTC (34)
_WTC (32)
_WPED (18)
_WTD (2)
_ATI (12)
_ALT (2)
_AMT (0)
ACQ
BUSY
_END
_ITT
_ITHB
INTERRUPT
ACQUISITION LOGIC
ITD
STOP
BUSY
_END
TAD
REGISTER B TRIGGER
REGISTER C TRIGGER
TC 32 BIT REGISTER
TRIGGER COUNTER
TC
PE
PED 16 BIT REGISTER
PRETRIGGER COUNTER
TD 16 BIT REGISTER
PROGRAMMABLE DELAY
TI
16 BIT LATCH
INTERPOLATOR TDC
ITB
START
3
AT
32 BIT LATCH
REAL TIME TDC
START
MA
CLA
MA
16
DCT
_TCLO
TCCK
_TCTC
TE
TB
DC1,2,3
TRIGGER LOGIC
TRIGGER VETO
NTRIG OUT
REAR PANEL 9410-9
TC1
TC2
TC4
2
TV1
TV2
FRONT END 9430-7
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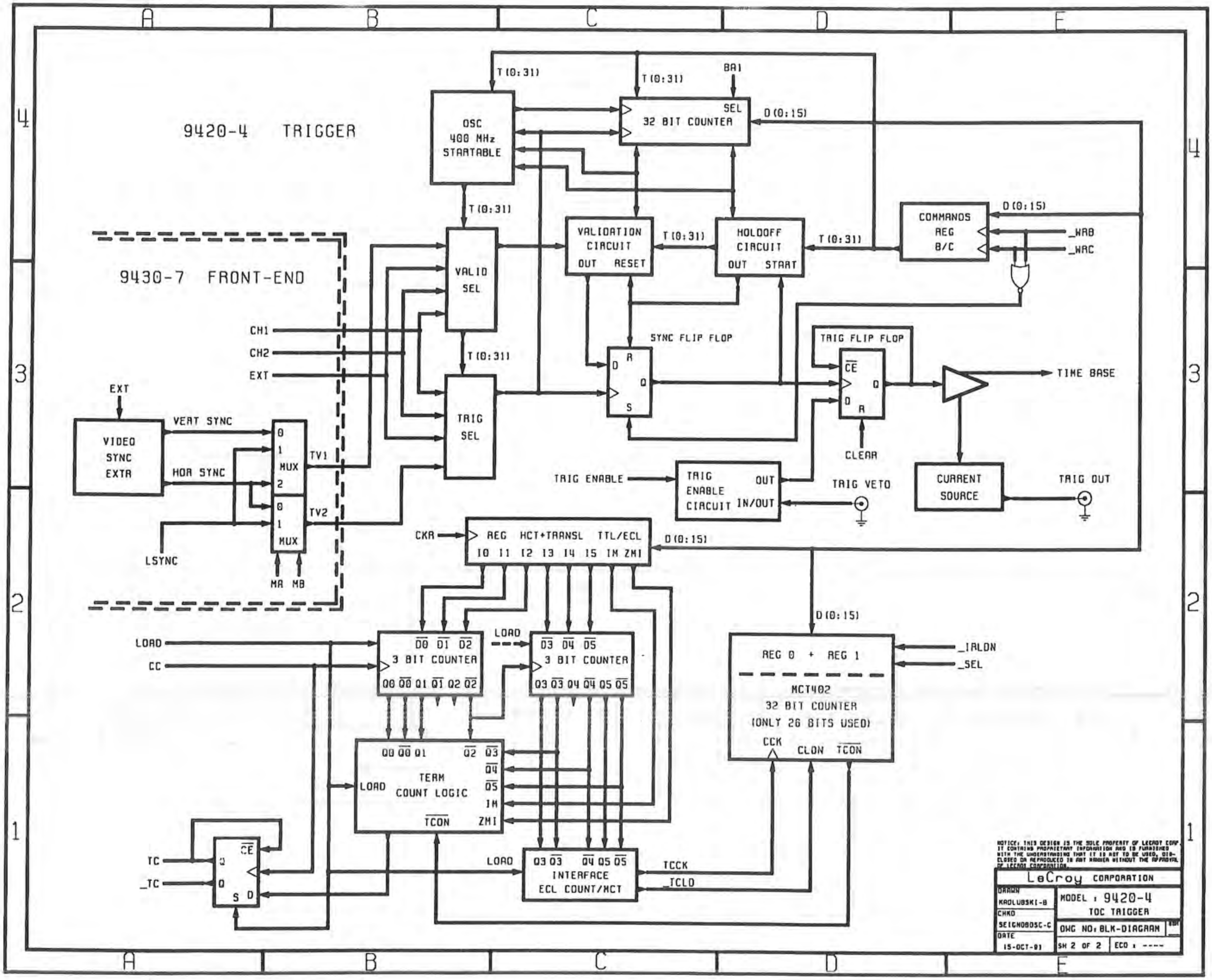
LeCroy CORPORATION
DRAWN
KADLUBSKI-B
CHKD
SEIGNOBOSC-C
DATE
15-OCT-91
MODEL : 9420-4
TDC
DWG NO: BLK-DIAGRAM
SH 1 OF 2
ECO : ----
A
B
C
D
E
1
2
3
4


9420-4 TRIGGER
9430-7 FRONT-END
OSC
400 MHz
STARTABLE
32 BIT COUNTER
SEL
BA1
T(0:31)
D(0:15)
VALIDATION
CIRCUIT
OUT RESET
HOLDOFF
CIRCUIT
OUT START
COMMANDS
REG
B/C
_WAB
_WAC
VALID
SEL
TRIG
SEL
CH1
CH2
EXT
VIDEO
SYNC
EXTR
VERT SYNC
HOR SYNC
LSYNC
MUX
TV1
TV2
MA MB
SYNC FLIP FLOP
TRIG FLIP FLOP
CE
CLEAR
TIME BASE
TRIG ENABLE
TRIG
ENABLE
CIRCUIT
OUT
IN/OUT
TRIG VETO
CURRENT
SOURCE
TRIG OUT
CKR
REG HCT+TRANSL TTL/ECL
I0 I1 I2 I3 I4 I5 IM ZMI
LOAD
CC
3 BIT COUNTER
TERM
COUNT LOGIC
TCON
ZMI
INTERFACE
ECL COUNT/MCT
TCCK
_TCLO
TC
_TC
REG 0 + REG 1
MCT402
32 BIT COUNTER
(ONLY 26 BITS USED)
CCK
CLON
_IALDN
_SEL
NOTICE: THIS DESIGN IS THE SOLE PROPERTY OF LECROY CORP. IT CONTAINS PROPRIETARY INFORMATION AND IS FURNISHED WITH THE UNDERSTANDING THAT IT IS NOT TO BE USED, DISCLOSED OR REPRODUCED IN ANY MANNER WITHOUT THE APPROVAL OF LECROY CORPORATION.
LeCroy CORPORATION
DRAWN KAOLUBSKI-B
CHKD SEIGNOBOSC-C
DATE 15-OCT-91
MODEL : 9420-4
TOC TRIGGER
DWG NO: BLK-DIAGRAM
SH 2 OF 2
ECO : ----

F9410-3 ADC

2.3.1 Introduction:

There are two ADC channels on one board, with their respective connector (SMB), sample & hold (HSH410), 8-bit flash converter and acquisition memory.
Compared to the 9420-3, the 9410-3 has less memory (16 Kbyte adc memory, no buffer memory) and no TMS / Minmax.

There is a common address / data bus and clock distribution for both channels.

The board is divided in two parts:
- analog
- digital

2.3.2 Analog part:

FOR EACH CHANNEL:

The analog signal (+/- 160 mV) enters through the SMB connector into the sample and hold (hybrid HSH410), a differential pair receives a calibration signal.
The HSH410 is clocked by a differential SHCKx signal, track to hold transition is when SHCKx goes high.
The hybrid's output is able to drive the flash capacitive input directly through a damping resistor.

COMMON TO BOTH CHANNELS:

The reference clock, TBCK, comes from the time base through the top connector (F9420-8). It is put into the right shape for both HSH410 (SHCKx, about 3ns track) and delayed for the flash ADC's. A delayed clock signal, ADCK, goes back to the time base for sychronisation of the digital part (DMXCKj).

2.3.2.1 Digital part:

The digital output of the flashes is two's complement coded.

The transfer function can be either inverting or non-inverting, commanded by the "sign" latch. (Default is inverting)

The data is then clocked into the memory demultiplexer (MDX407) internal registers by the (DMXCKj) clock signals coming from the time base through the top connector.

Addresses come from the time base during acquisition and from the main 68020 bus during read. ACQ signal from time base is on during acquisition and MCE is the write pulse. The DCK signal is a delayed clock used by the time base for exact timing.

The data can also be read on the fly for roll mode purpose.

Writing into ADC memory can be done by the 68020 for test purpose, but only by blocks of 4 consecutive identical data and for both channels simultaneously, (The two lowest address bits are not decoded). Data format is 8 bits on the high byte, low byte set to 00.

Internal data bus is buffered (bi-directional) from the main bus (68020)

Control is decoded by 1 PAL.

2.3.3 Address

note on data: W= 16 bits word
H= high byte
L= low byte
-= no Data

ADC board nr.1 (ch. 1&2) (by 68020, byte address base):

address	data	description
0188 0040	L	"sign" latch
0200 0000 0200 7ffe	W	CH1 ADC data memory (16k, low byte = 00)
0210 0000 0210 7ffe	W	CH2 ADC data memory (16k, low byte = 00)

ADC board nr.2 (ch.3&4) (by 68020, byte address base);

address	data	description
0190 0040	L	"sign" latch
0280 0000	W	CH3 ADC data memory
0290 0000 0290 7ffe	W	CH4 ADC data memory

Note: Since the decoding logic had to be as simple as possible to fit into 1 PAL, the addresses are not fully decoded. That means that the only difference made inside the memory space allowed for the ADC boards (0200 0000 -> 027f fffe, resp 0280 0000 -> 02ff fffe) is the selection of CH1 / CH2 (BA20).

Special care must therefore be taken for the software, since any writing at other usual ADC memory space (buffer, minmax, look-up or even going beyond the 16k allowed) <u>will overwrite the ADC acquisition memory</u>!

<u>"SIGN" command</u>: (latch, write only)

bit 0 low -> CH 1 (3) inverting (default)
bit 0 high -> CH 1 (3) non-inverting
bit 1 low -> CH 2 (4) inverting (default)
bit 1 high -> CH 2 (4) non-inverting

Default mode is inverting for both channels (forced by RESET), as used for 9420 / 9424.

2.3.4

BIT MAP

ADDRESSES CH1	D7	D6	D5	D4	D3	D2	D1	D0
12000000 12000008	A16 15	A16 14	A16 13	A16 12	A24 12	A24 13	A24 14	A24 15
12000002 1200000A	A23 13	A23 12	A23 14	A23 15	A15 12	A15 13	A15 14	A15 15
12000004 1200000C	A22 13	A22 12	A22 14	A22 15	A14 12	A14 13	A14 14	A14 15
12000006 1200000E	A21 12	A21 13	A21 14	A21 15	A13 12	A13 13	A13 14	A13 15

ADDRESSES CH2	D7	D6	D5	D4	D3	D2	D1	D0
12100000 12100008	A20 15	A20 14	A20 13	A20 12	A28 12	A28 13	A28 14	A28 15
12100002 1210000A	A27 13	A27 12	A27 14	A27 15	A19 12	A19 13	A19 14	A19 15
12100004 1210000C	A26 13	A26 12	A26 14	A26 15	A18 12	A18 13	A18 14	A18 15
12100006 1210000E	A25 12	A25 13	A25 14	A25 15	A17 12	A17 13	A17 14	A17 15

Important note!

The MFE409 has a particuliar behaviour in the sense that it inverts the signal for sensitivities from 20mV/div to 100mV/div and not for sensitivities from 1mV/div to 10mV/div (see table 1). As the outputs are complementary the sign of the trigger ouput is each time opposite to the ADC ouput one. See pargraph 2.4 set the correct slope sign for a given setting.

2.4) Trigger circuit

The trigger pick-off circuit uses the MTR408. More details can be found in the data sheet of this chip. The different trigger couplings are (see table 2):

* DC
* AC: cut off frequency is almost 10 Hz
* LF REJ: set a single pole high pass filter with a cut off frequency at 50 KHz
* BWL: single pole low pass filter at 15 MHz.

The amplitude of the MTR408's input is the same than the ADC one (320mV FS) but the sign is the opposite. The threshold level can be varied between +/- 0.5V for a +/-10V control DAC range. The sensitivity to a positive or a negative slope can be selected by the SLOPE bit (see table 3).

coupling	control bits			
	DC_TRIG	AC_TRIG	HFREJ	BWL_TRIG
DC	H	L	L	L
DC + BWL	L	L	L	H
AC	H	H	L	L
AC + BWL	L	H	L	H
LF REJ	H	L	H	L
LF REJ + BWL	L	L	H	H
HF REJ	L	L	H	L
NO COUPLING	L	L	L	L

Table 2: trigger coupling command

MFE sens.	signal	MFE ADCOUT	FLASH OUT	MFE TRIGOUT	SLOPE	VTH
1 to 10mV	/	/	/	\	L	-
20 to 100mV	/	\	/	/	H	+

Table 3: setting of slope and threshold control to trigger on a positive slope relative to the gain setting. Invert all to trigger on a negative slope.

Important note!

For the HF REJ coupling SLOPE and VTH must be inverted relative to the table 3! This due to the particular design of the MTR408.

The convention adopted to define a positive slope is: the logical ouput (TCi) switch from low to high (from -1.6V to -0.8V in ECL) when a positive going signal cross the comparator level. However to be compatible with the 9450/20/24 family, the F9430-7 does just the opposite...

3) External and TV trigger (see fig.3)

The input impedance is 1MOhm. Maximum amplitude is +/-2V or +/-20V if the relay switched attenuator is set. As this path is not calibrated, a special HZ buffer was designed. Its offset is small (<1mV) and its DC gain is set to 0.92. In counter part the gain is slighly frequency dependent (<5%). The buffer drives by a 9.2 voltage divider the same trigger circuit as implemented in the channels. Refer to table 2 for setting the different coupling. The full scale analog input of the MTR408 is +/- 200 mV (+/- 160 mV for channels) as shown in fig.3.

The TV trigger uses a commercial chip (LM1881) and provides 2 ouputs, TV1 and TV2 (see table 4). This circuit is able to trigger on different TV line number standards (see table 5).

bits		video trigger signal	
MB	MA	TV1	TV2
L	L	line sync.	line sync.
L	H		comp. sync.
H	L	odd/even	"
H	H	vert. sync.	"

Table 4: video triggering possibilities

bits		line number
SET875	SETHDTV	
H	H	525 (TVLO)
L	H	875 (MED)
H	L	1225 (HI)
L	L	2500 (SUPER)

Table 5: control of line number

4) Analog and digital channel controls (see fig.4)

4.1) Digital controls

Each channel has two 8 bit shift registers. Their allocation is as follows:

address	MSB							LSB
128 001E	SCAL	OFFSET %10	2mV	5mV	10mV	20mV	50mV	100mV
128 0020	HFREJ	AC TRIG	DC TRIG	BWL TRIG	SLOPE	%10	AC	HZ

Channel 1

128 005E same map

128 0060 Channel 2

The action of each bit is:

Bit	low state	high state
SCAL	signal to HZ buffer	VCAL to HZ buffer
OFFSET%10	offset range is +/-1.5V	offset range is +/-0.15V
2mV to 100 mV	see table 1	
HF REJ, AC_TRIG, DC_TRIG, BWL_TRIG	see table 2	
SLOPE	see table 3	
%10	attenuator in %10 pos.	attenuator in %1 pos.
AC	AC coupling	DC coupling
HZ	1M Ohm	50 Ohm

4.2) <u>Analog controls</u> (see fig. 4)

One precision DAC and an associate circular memory (main board) drives and refreshs a multiple sample-and-hold system. Each channel has 4 analog controls. VOFFSET and VTH are voltage controls and the DAC dynamic range (+/- 10V) is scaled to the proper range by means of resistor dividers and thus the conversion can be said to be linear. The gain controlled amplifiers inside the MFE409 needs current mode controls. A voltage to current converter follows the sample-and -hold and provides the appropriate range. This conversion, combined with the gain control of the amplifier itself, is not purely linear, especially at both ends of the range. Here are some formulas to approximate the DAC to analog control value:

DAC values are in volt

$$\mathrm{VOFFSET} = \frac{\mathrm{DAC}}{6.6}\ [\mathrm{V}] \quad \text{or} \quad \frac{\mathrm{DAC}}{66}\ [\mathrm{V}]$$ (note 1) precision: +/-2%

$$\mathrm{VTH} = \frac{\mathrm{DAC}}{20.1}\ [\mathrm{V}]$$ (at the comparator input, inside the MTR408) " +/-2%

$$\mathrm{IVGAIN1} = \frac{7.4 - \mathrm{DAC}}{20.5}\ [\mathrm{mA}] \text{ for DAC} < 7.4\ [\mathrm{V}]$$ " +/-3%

$$0 \qquad \text{for DAC} > 7.4\ [\mathrm{V}]$$

$$\mathrm{IVGAIN2} = \frac{7.4 - \mathrm{DAC}}{16.5}\ [\mathrm{mA}] \text{ for DAC} < 7.4\ [\mathrm{V}]$$ " +/-3%

$$0 \qquad \text{for DAC} > 7.4\ [\mathrm{V}]$$

It is recommanded to put the DAC at +10V to insure 0 mA for IVGAIN1 and IVGAIN2.

$$\mathrm{VCAL} = \frac{\mathrm{DAC}}{6.6667}\ [\mathrm{V}] \quad \text{or} \quad \frac{\mathrm{DAC}}{66.667}\ [\mathrm{V}]$$ (note 1) precision: +/-0.1%

address	analog control
170 0000	IVGAIN1_CH1
170 0002	VOFFSET_CH1
170 0004	IVGAIN2_CH1
170 0006	VTH_CH1
170 0008	IVGAIN1_CH2
170 000A	VOFFSET_CH2
170 000C	IVGAIN2_CH2
170 000E	VTH_CH2
170 0010	
170 0012	
170 0014	
170 0016	VCAL
170 0018	
170 001A	
170 001C	
170 001E	VTH_EXT

Table 6: analog controls addresses

5) External trigger and common controls

5.1) Digital controls

The bit allocation are:

Address

128 0120	HFREJ EXT	AC EXT	DC EXT	BWL EXT	SLOPE EXT	%10 TRIG		
	MSB		external trigger					LSB

128 0160	BWL	VCAL %10			SET HDTV	SET 875	MB	MA
	MSB		common controls + TV trigger					LSB

Bit	low state	high state
HFREJ_EXT AC_EXT DC_EXT BWL_EXT	see table 2	
SLOPE	see table 3	
%10	attenuator in %10 pos.	attenuator in %1 pos.
BWL	filter off	filter on
VCAL/10	VCAL range=+/-1.50V	VCAL range=+/-0.15V
SETHDTV SET875 MB MA	see table 5	

There is a register on the main board which gives some information about the front-end state.

Address

1680000 (hexa)	_OVL4	_OVL3	_OVL2	_OVL1	OC4	OC3	OC2	OC1
	MSB		front end state register					LSB

OVL1-4 are the overload indicator. Only OVL1 and OVL2 are effective on this front-end (2 channels). A low state indicate that overlaod is detected. OC1-4 are used to code the front-end hardware version or option:

OC4	OC3	OC2	OC1	version
L	L	L	L	9430_7 REVB, REVC, REVD, REVE
H	L	L	L	REVF, REVG extanded VCAL and VOFFSET range

5.2) Analog controls

2 sample-and-hold fed by the precision DAC provide the threshold level for the external trigger and the calibration source. One voltage divider is to be trimmed to 10% 6.6667=1.5 and a second (%10 +/- 0.1%) can be switched to reduce the DAC range to +/- 0.15V.

(note 1): since REVF

$$\text{VOFFSET} = \frac{\text{DAC}}{4.62}\ [\text{V}] \quad \text{or} \quad \frac{\text{DAC}}{46.2}\ [\text{V}]$$

$$\text{VCAL} = \frac{\text{DAC}}{4.1000}\ [\text{V}] \quad \text{or} \quad \frac{\text{DAC}}{41.000}\ [\text{V}]$$

precision: +/-0.1%

2.6 DSO 9430-7 Front-End Card

1) General description

This documentation refers to the following figures.

Fig.1: Front-end block diagram Fig.2: Channel block diagram Fig.3: External trigger block diagram Fig.5: External trigger and common controls block diagram.

The front-end card provide the signal conditioning for the ADC card and the time base card. Its main functions are:

* input protection and coupling (AC/DC, 1 MOhm/50 Ohm)
* amplitude normalisation for the ADC: at the BNC the dynamic range is 8mV to 20V FS (full scale) in a 1-2-5 step sequence and the ADC input is 320mV FS.
* fine gain control to fill up the fixed vertical sensitivities
* offset control
* bandwidth limit filter at 15 MHz
* 2 channels triggering with standard coupling and 1 external trigger
* channel calibration with software control

2) Channel description (see fig.2)

Channel 1 and 2 are indentical, thus only one channel will be described here.

2.1) Input coupling and protection

Relay RL1 sets the 1 MOhm coupling. A diode circuit senses the temperature elevation of the 50 Ohm termination resistor and sets the OLV bit (see fig.5) to "0" if overheating is detected. The hardware disconnects automaticaly the 50 Ohm resistor!

Relay RL2 sets the AC/DC coupling

Relay RL3 sets the 1Mohm attenuator in the direct (/1) or in the /10 position. The DC precision is 0.1% and needs no calibration.

SCAL is an electronic switch which connects the input of the HZ buffer to the offset control.

2.2) HZ buffer

A0 is an high impedance buffer. It's gain is <1. The same buffer is used for the offset control.

2.3) Gain stage

The MFE409 is an monolithic circuit which features the following functions:

* a differential input with 6 fixed sensitivities (2mV/div to 100mV/div in a 1-2-5 sequence). The positive input is fed with the signal and the negative input with the offset control source.

* a continuously variable gain amplifier with gain ratio of almost 3.5. Its gain=1 when IVGAIN1=0mA and 3,5 for 0,8mA. A1 is designed to operate with a nominal gain of 3.0 (IVGAIN1=0.5mA) at fixed sensitivities.

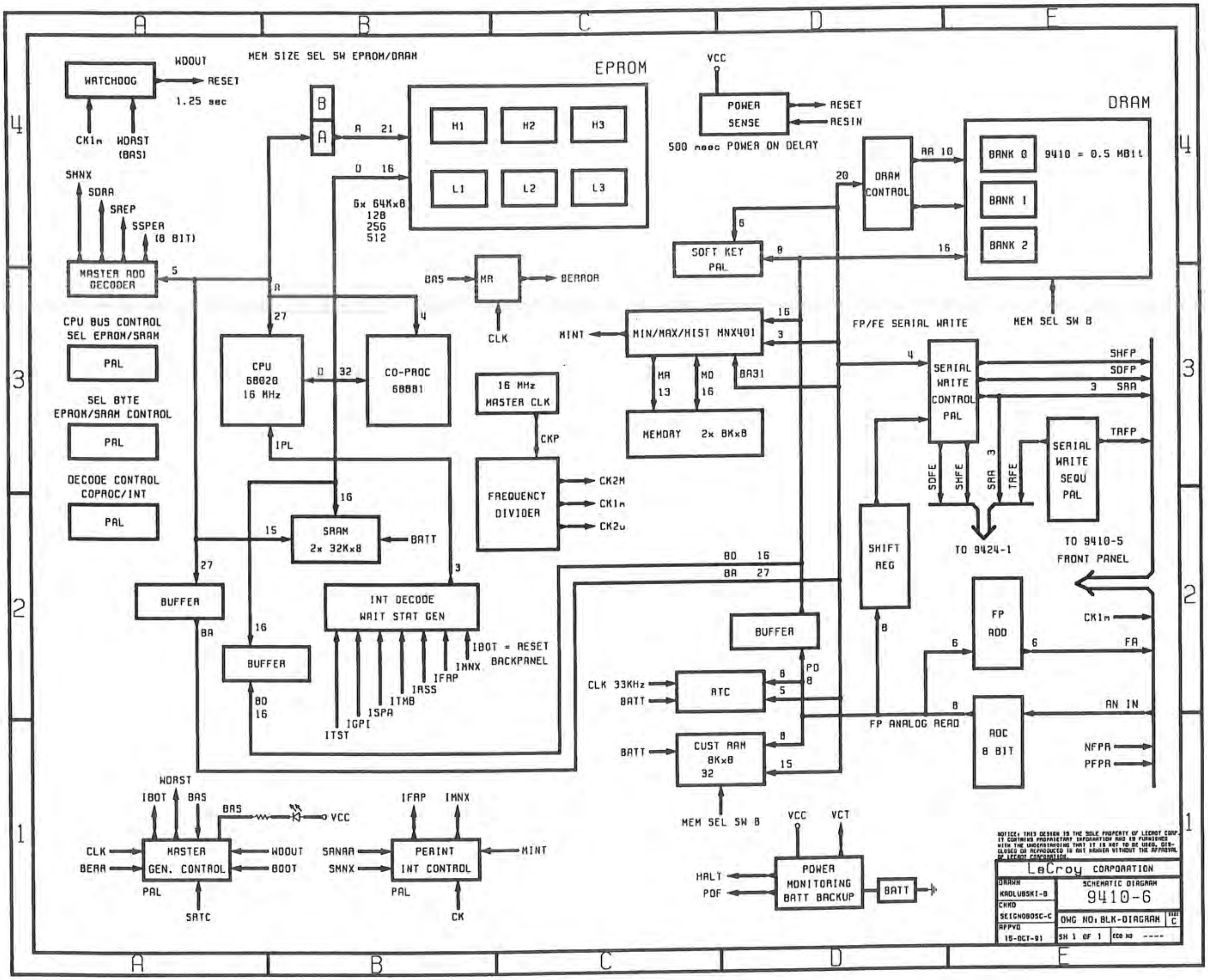
* A3 can be trimed for gain and linearity. Typically, A1 will be set with 20mV/div and a gain of 3.0, A2 with a gain of 2.0 and A3 will be trimed to have 320 mV FS into the 50 ohm ADC input with the lower non-linearity. A3 delivers 2 complementary outputs, one for the ADC and one for the trigger circuit.

The bandwidth control is implemented with a one pole RC filter with a -3dB cut-off frequency of almost 15 MHz. The setting of the BWL filter does not affect the dc calibration. this signal path doesn't need to be calibrated. the bwl control is common for the channels and the external trigger.

front panel /div	Offset range [v]	IVGAIN1 [mA]	IVGAIN2 [mA]	gain to 50 Ohm ADC
1mV	+-0.12	0.5	~0.6	40
2mV	"	"	~0.3	20
5mV	"	"	0	8
10mV	"	"	0	4
20mV	+/-1.2	"	0	-2
50mV	"	"	0	-0.8
0.1V	"	"	0	-0.4
0.2V	+/-12	"	0	-0.2
0.5V	"	"	0	-0.08
1.0V	"	"	0	-0.04
2.0V	"	~0.15	0	-0.02

front panel /div	control bits							
	%10	Off/10	2mV	5mV	10mV	20mV	50mV	100mV
1mV	H	H	H	L	L	L	L	L
2mV	H	H	H	L	L	L	L	L
5mV	H	H	L	H	L	L	L	L
10mV	H	H	L	L	H	L	L	L
20mV	H	L	L	L	L	H	L	L
50mV	H	L	L	L	L	L	H	L
0.1V	H	L	L	L	L	L	L	H
0.2V	L	L	L	L	L	H	L	L
0.5V	L	L	L	L	L	L	H	L
1.0V	L	L	L	L	L	L	L	H
2.0V	L	L	L	L	L	L	L	H

table 1: front-end gain and offset range



MEM SIZE SEL SW EPROM/DRAM
WATCHDOG
WDOUT
RESET
1.25 sec
CK1m
WDRST (BAS)
SMNX
SDRA
SREP
SSPER (8 BIT)
MASTER ADD DECODER
CPU BUS CONTROL SEL EPROM/SRAM
PAL
SEL BYTE EPROM/SRAM CONTROL
PAL
DECODE CONTROL COPROC/INT
PAL
EPROM
H1
H2
H3
L1
L2
L3
6x 64Kx8 128 256 512
CPU 68020 16 MHz
CO-PROC 68881
IPL
SRAM 2x 32Kx8
BATT
BUFFER
INT DECODE WAIT STAT GEN
IBOT = RESET BACKPANEL
IMNX
IFRP
IRSS
ITMB
ISPA
IGPI
ITST
BAS
MR
BERROR
CLK
16 MHz MASTER CLK
CKP
FREQUENCY DIVIDER
CK2M
CK1m
CK2u
VCC
POWER SENSE
RESET
RESIN
500 msec POWER ON DELAY
SOFT KEY PAL
MINT
MIN/MAX/HIST MNX401
BA31
MEMORY 2x 8Kx8
DRAM CONTROL
DRAM
BANK 0
BANK 1
BANK 2
9410 = 0.5 MBit
MEM SEL SW B
FP/FE SERIAL WRITE
SERIAL WRITE CONTROL PAL
SHFP
SDFP
SRA
SDFE
SHFE
TRFE
TRFP
SERIAL WRITE SEQU PAL
TO 9424-1
TO 9410-5 FRONT PANEL
SHIFT REG
BD
BA
BUFFER
PD
CLK 33KHz
BATT
RTC
CUST RAM 8Kx8 32
MEM SEL SW B
FP ANALOG READ
FP ADD
ADC 8 BIT
CK1m
FA
AN IN
NFPR
PFPR
VCC
VCT
POWER MONITORING BATT BACKUP
BATT
HALT
POF
WDRST
IBOT
BAS
CLK
BERR
MASTER GEN. CONTROL
PAL
SATC
WDOUT
BOOT
VCC
IFRP
IMNX
SANAR
SMNX
PERINT INT CONTROL
PAL
CK
MINT
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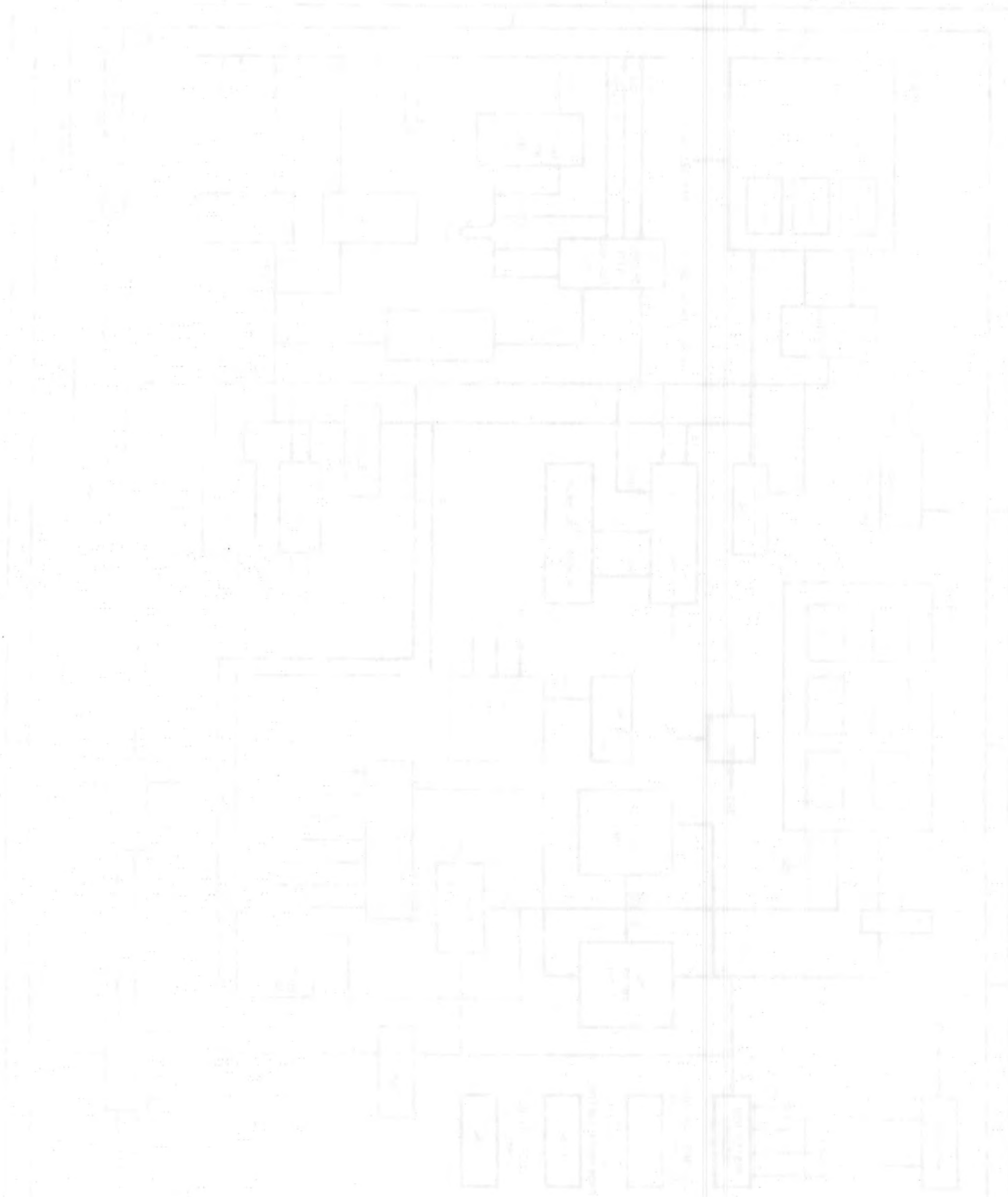
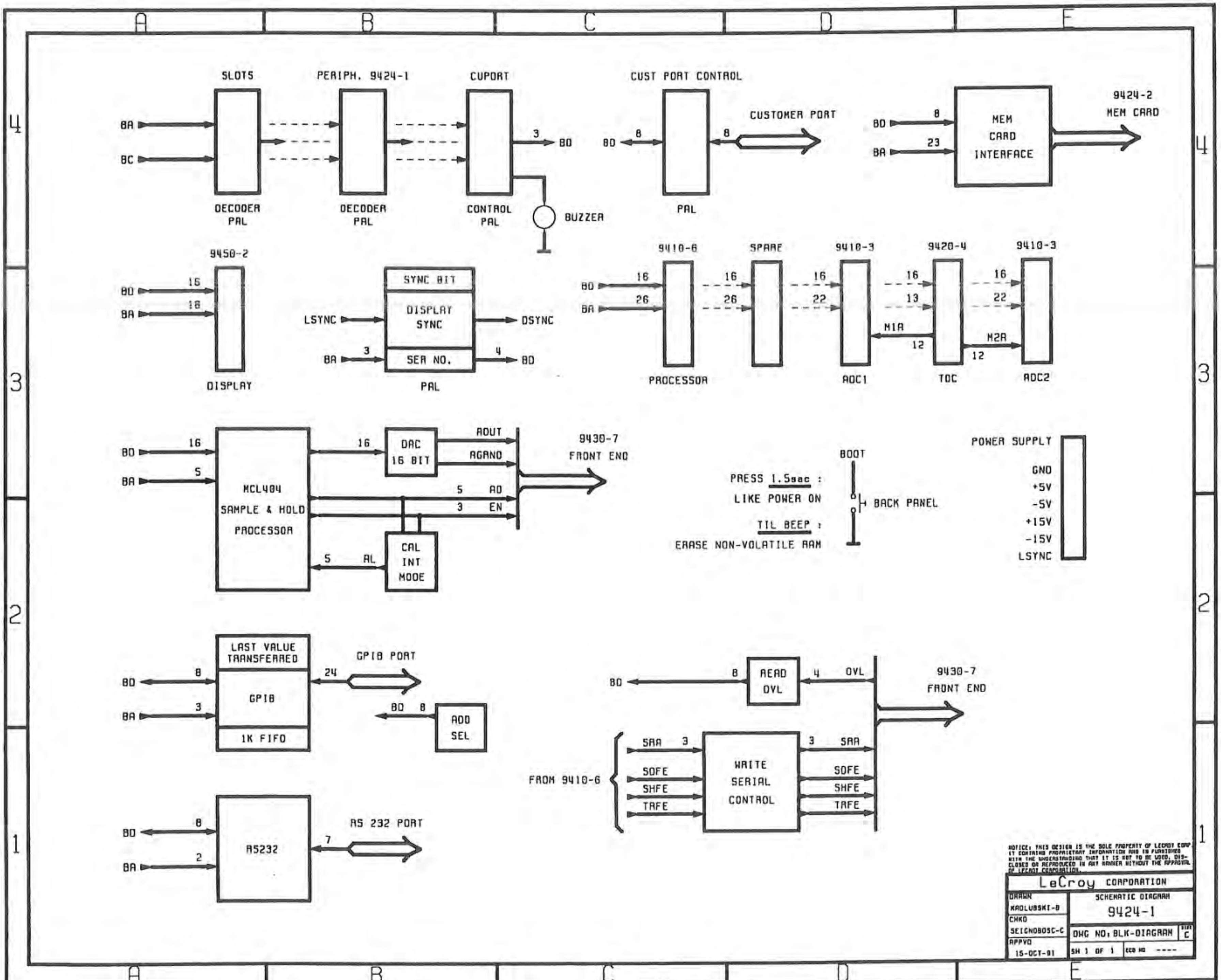
LeCroy CORPORATION
SCHEMATIC DIAGRAM
9410-6
DRAWN KAOLUBSKI-B
CHKD SEIGNOBOSC-C
APPVD 15-OCT-91
DWG NO: BLK-DIAGRAM
C
SH 1 OF 1
ECO NO ----




SLOTS
PERIPH. 9424-1
CUPORT
CUST PORT CONTROL
CUSTOMER PORT
9424-2
MEM CARD
MEM
CARD
INTERFACE
BA
BC
BD
DECODER
PAL
CONTROL
PAL
BUZZER
PAL
9450-2
DISPLAY
SYNC BIT
DISPLAY
SYNC
SER NO.
LSYNC
DSYNC
9410-6
SPARE
9410-3
9420-4
9410-3
PROCESSOR
ADC1
TDC
ADC2
M1A
M2A
MCL404
SAMPLE & HOLD
PROCESSOR
DAC
16 BIT
AOUT
AGRND
AD
EN
CAL
INT
MODE
AL
9430-7
FRONT END
BOOT
BACK PANEL
PRESS 1.5sec :
LIKE POWER ON
TIL BEEP :
ERASE NON-VOLATILE RAM
POWER SUPPLY
GND
+5V
-5V
+15V
-15V
LSYNC
LAST VALUE
TRANSFERRED
GPIB
1K FIFO
GPIB PORT
ADD
SEL
READ
OVL
OVL
WRITE
SERIAL
CONTROL
FROM 9410-6
SAA
SOFE
SHFE
TRFE
RS232
RS 232 PORT
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LeCroy CORPORATION
DRAWN
KADLUBSKI-D
CHKD
SEIGNOBOSC-C
APPVD
15-OCT-91
SCHEMATIC DIAGRAM
9424-1
DWG NO: BLK-DIAGRAM
C
SH 1 OF 1
ECO NO ----

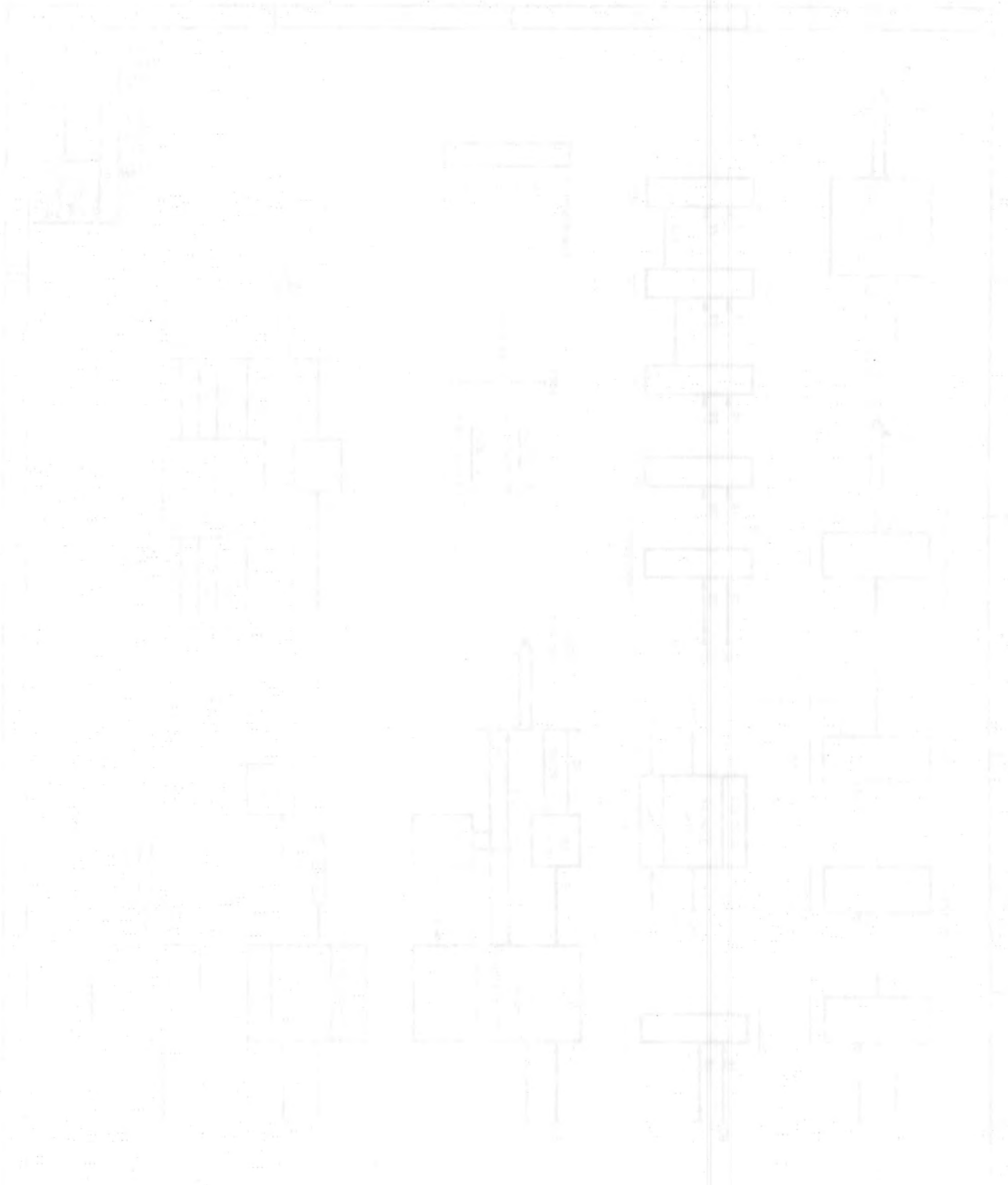


FIG.1 : FRONT-END BLOCK DIAGRAM

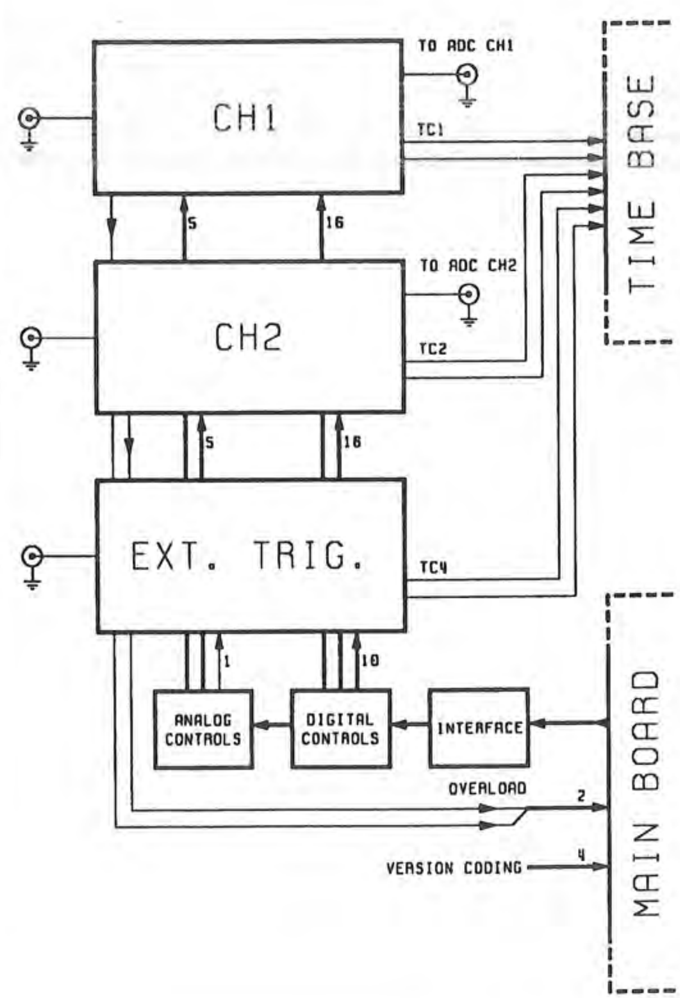


FIG.4 : ANALOG AND DIGITAL CHANNEL CONTROLS

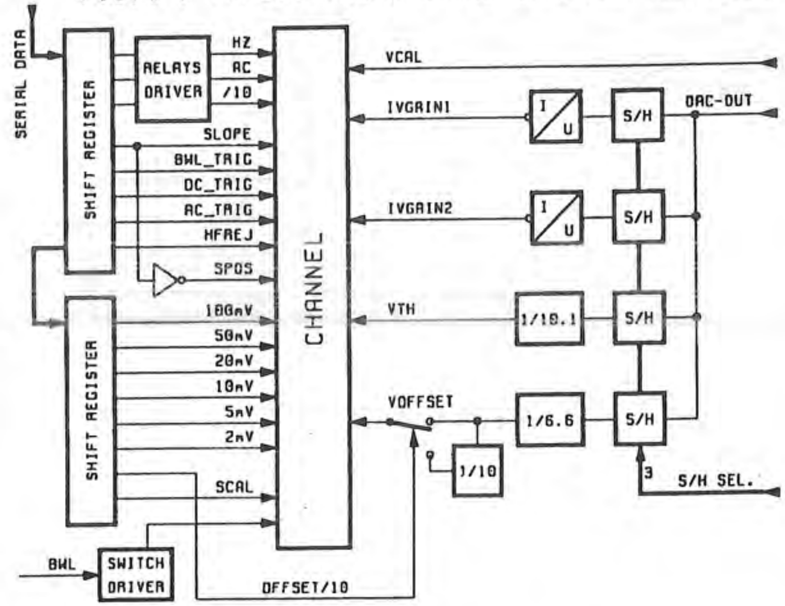
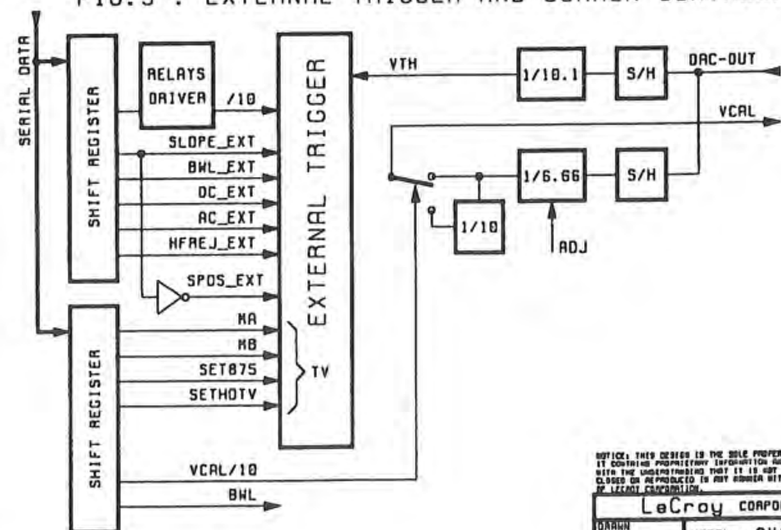


FIG.5 : EXTERNAL TRIGGER AND COMMON CONTROLS



LeCroy CORPORATION	
DRAWN KAOLUBSKI-B	MODEL : 9430-7 2 CH. 150MHz FRONTEND
CHKD BOLLI-J-L	DWG NO: SCHEMA-BLOCK --
DATE 31-JUL-88	SH 1 OF 2 / ECO : ---

FIG.2 : CHANNEL BLOCK DIAGRAM

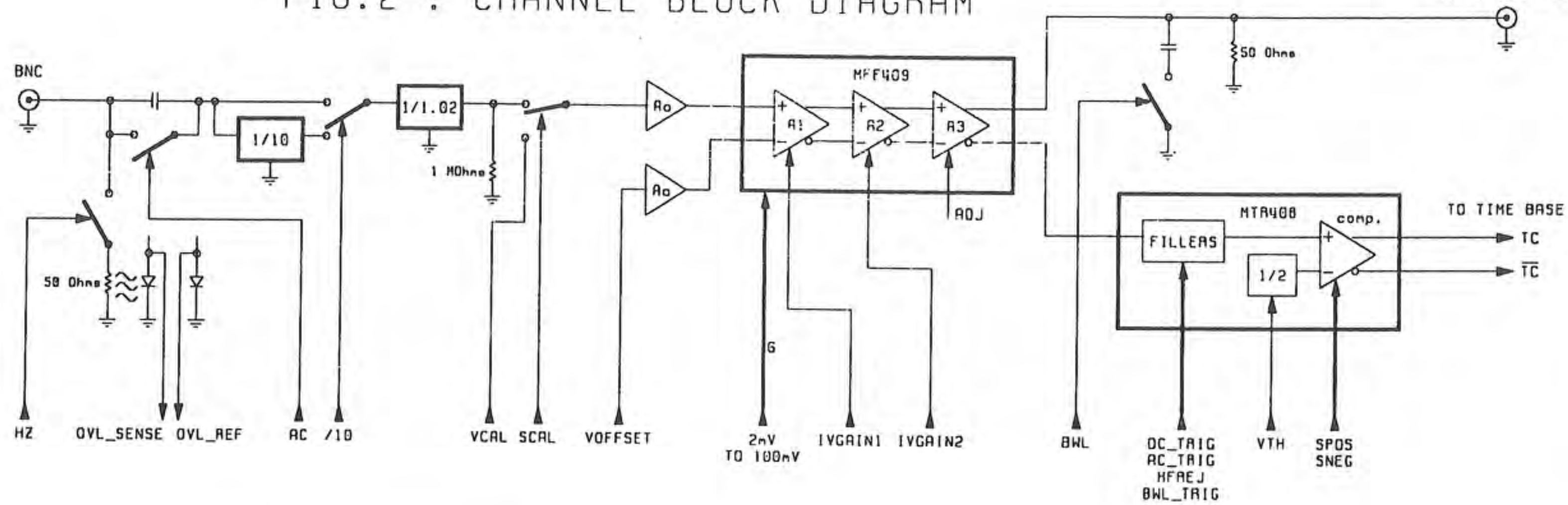
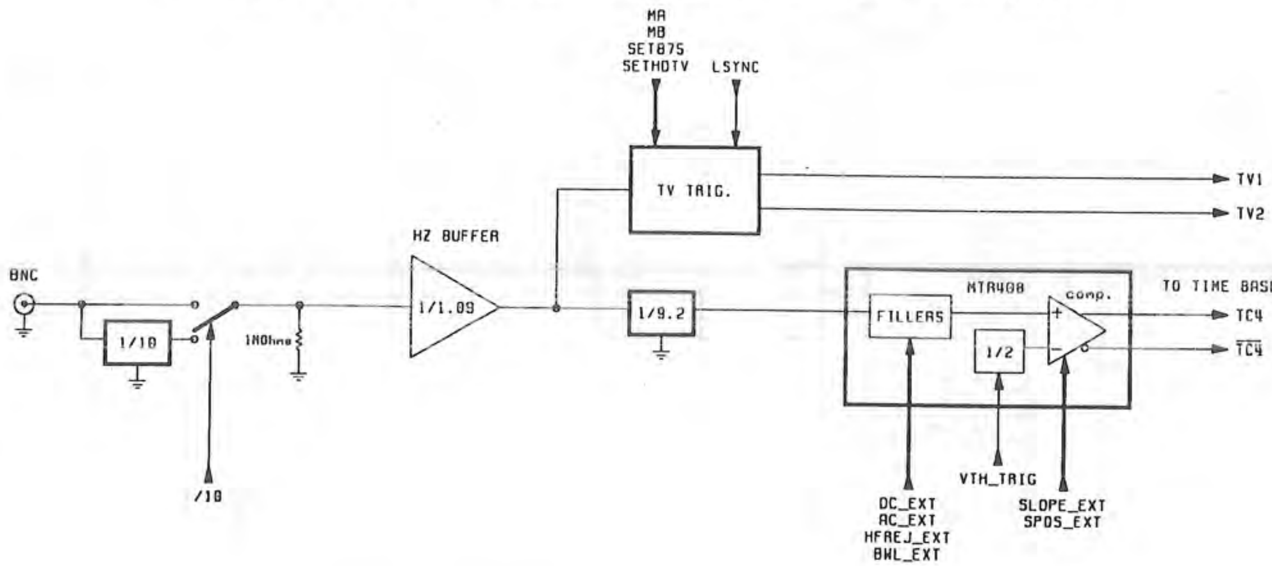


FIG.3 : EXTERNAL TRIGGER BLOCK DIAGRAM



LeCroy CORPORATION	
DRAWN KAOLUBSKI-B	MODEL : 9430-7
CHKD BOLLI-J-L	2 CH. 150MHz FRONTEND
DATE 30-JUL-90	DWG NO: SCHEMA-BLOCK
	SH 2 OF 2 ECO : ---

9410 SAMPLING CLOCK RATES vs TIME/DIV

Single-shot:

Sampl. Rate Ms/sec	Sample Intvl nsec	Time/div
100	10	50 nsec
.	.	.
.	.	.
100	10.0	10 µsec
40	25	20 µsec
20	50	50 µsec
10	100	.1 msec
4	250	.2 msec
2	500	.5 msec
1	1000 nsec	1 msec
0.4	2500 nsec	2 msec
0.2	5000 nsec	5 msec
.	.	.
.	.	.
1 Hz	1 sec	5 Ksec

RIS:

Sampl. Rate Ms/sec	Equiv. rate Gs/sec	Sample Intvl.	Time/div
100	4	250 psec	2 nsec
100	4	250 psec	5 nsec
100	4	250 psec	10 nsec
100	4	250 psec	20 nsec
100	4	250 psec	50 nsec
100	4	250 psec	0.1 µsec
100	4	250 psec	0.2 µsec
100	2	500 psec	0.5 µsec
100	1	1 nsec	1 µsec
100	0.4	2.5 nsec	2 µsec
100	0.2	5 nsec	5 µsec

TIME BASE	SAMPLING RATE TIME/POINT		DISPLAYED RECORD LENGTH (Points)	
TIME/DIV	RIS	SS	RIS	SS
2 nsec	250 psec	---	80	---
5 nsec	250 psec	---	200	---
10 nsec	250 psec	---	400	---
20 nsec	250 psec	---	800	---
50 nsec	250 psec	10 nsec	2000	50
0.1 µsec	250 psec	10 nsec	4000	100
0.2 µsec	250 psec	10 nsec	8000	200
0.5 µsec	500 psec	10 nsec	10000	500
1 µsec	1 nsec	10 nsec	10000	1000
2 µsec	2.5 nsec	10 nsec	8000	2000
5 µsec	5 nsec	10 nsec	10000	5000
10 µsec		10 nsec		10000
20 µsec		25 nsec		8000
50 µsec	---	50 nsec	---	10000
0.1 msec	---	0.1 µsec	---	10000
0.2 msec	---	0.25 µsec	---	8000
0.5 msec	---	0.5 µsec	---	10000
1 msec	---	1 µsec	---	10000
2 msec	---	2 µsec	---	8000
5 msec	---	5 µsec	---	10000
10 msec	---	10 µsec	---	10000
20 msec	---	20 µsec	---	8000
50 msec	---	50 µsec	---	10000
0.1 sec	---	0.1 msec	---	10000
0.2 sec	---	0.2 msec	---	8000
		ROLL MODE		
0.5 sec	---	0.5 msec	---	10000
1 sec	---	1 msec	---	10000
2 sec	---	2 msec	---	8000
5 sec	---	5 msec	---	10000
10 sec	---	10 msec	---	10000
20 sec	---	20 msec	---	8000
50 sec	---	50 msec	---	10000
100 sec	---	0.1 sec	---	10000
200 sec	---	0.2 sec	---	8000
500 sec	---	0.5 sec	---	10000
1 ksec	---	1 sec	---	10000

LIST of SAMPLING MODES, SAMPLING RATE,
and DISPLAYED RECORD LENGTH for each TIME-BASE SETTING

MODEL 9451-1 POWER SUPPLY

Specifications

Input voltage:	90 to 132 V_{AC}, 180 to 264 V_{AC}, selected by the user
Input frequency:	45 to 440 Hz
Inrush current:	max. 10 A at start-up
Operating temperature range:	0° C to 65° C at full load
Hold-up time:	min. 20 msec, at full load and minimal input
Conducting EMI:	VDE 0871 curve B, IEC 801
Isolation:	VDE 0411/0730/0804/0806, IEC 348/380/435
	3750 V_{AC}, 4000 V_{DC}
	input lines to ground leakage current <5 mA_{AC}, 50 Hz
Input over-voltage protection:	yes
Outputs:	four, with common return (ground)
Output voltage:	out 1, +15 V: +15.00 V ±1%, nom. 3.2 A_{RMS}
	out 2, -15 V: -15.04 V ±1%, nom. 3.8 A_{RMS}
	out 3, +5 V: +5.07 V ±1%, nom. 8.6 A_{RMS}
	out 4, -5 V: -5.16 V ±1%, nom. 10.8 A_{RMS}
Output voltage adjustment:	min. ±5%
Output over-voltage protection:	no
Line regulation:	max. 0.1% at any load
Output voltage regulation:	+15 V and -15 V: ±1% 1.5 A to 4.5 A load
	+5 V: ±1% 6 A to 11 A load
	-5 V: ±1% 9 A to 13 A load
Transient response (100 Hz):	+15 V and -15 V: <0.5 V, 500 µsec: 2 A to 4.5 A
	+ 5 V: <0.2 V, 500 µsec: 6 A to 11 A

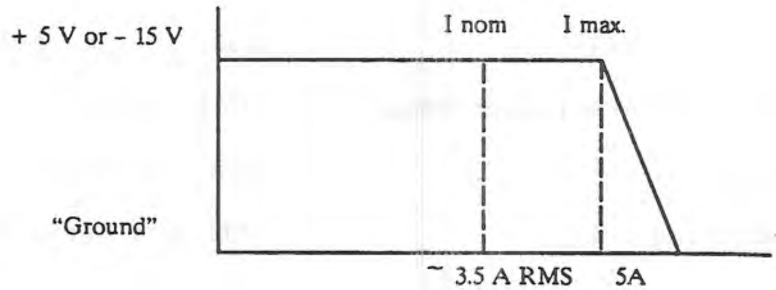
Output ripple and noise: +15 V and -15 V: max. 100 mV_{pp} (100 MHz)

+5 V and -5 V: max. 80 mV_{pp} (100 MHz)

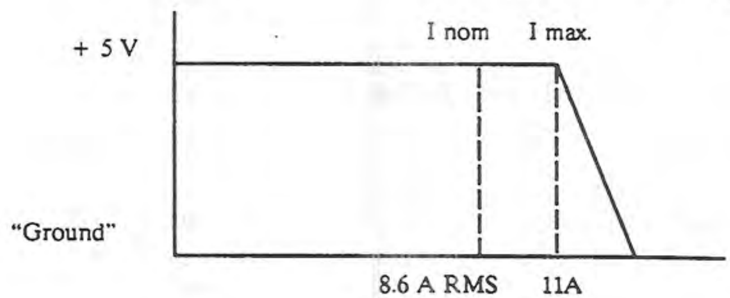
50 Hz output ripple: max. 5 mV

Maximum output current:

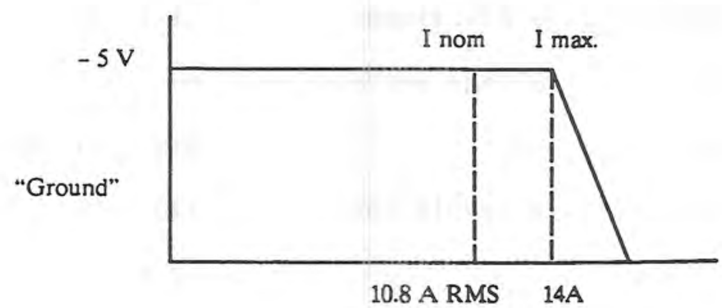
+ 15 V and - 15 V : I max. = $5\,A^{-0}_{+1}$



+ 5 V : I max. = $11\,A^{-0}_{+1}$

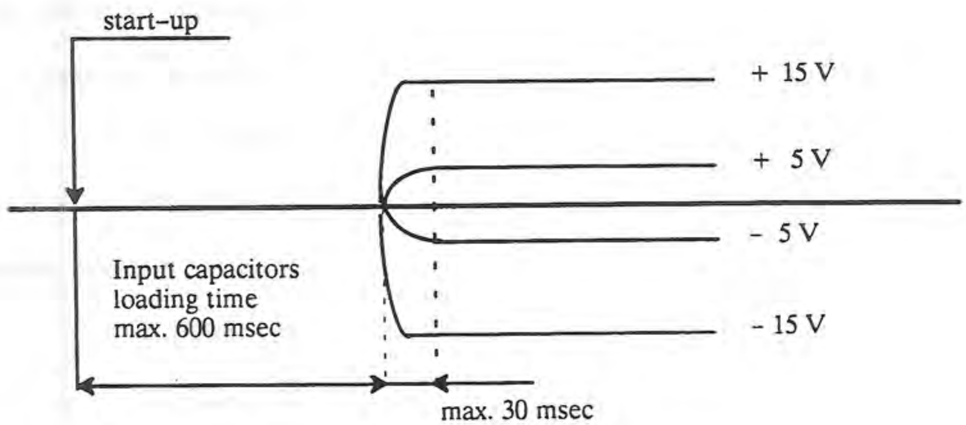


+ 5 V : I max. = $14\,A^{-0}_{+1}$



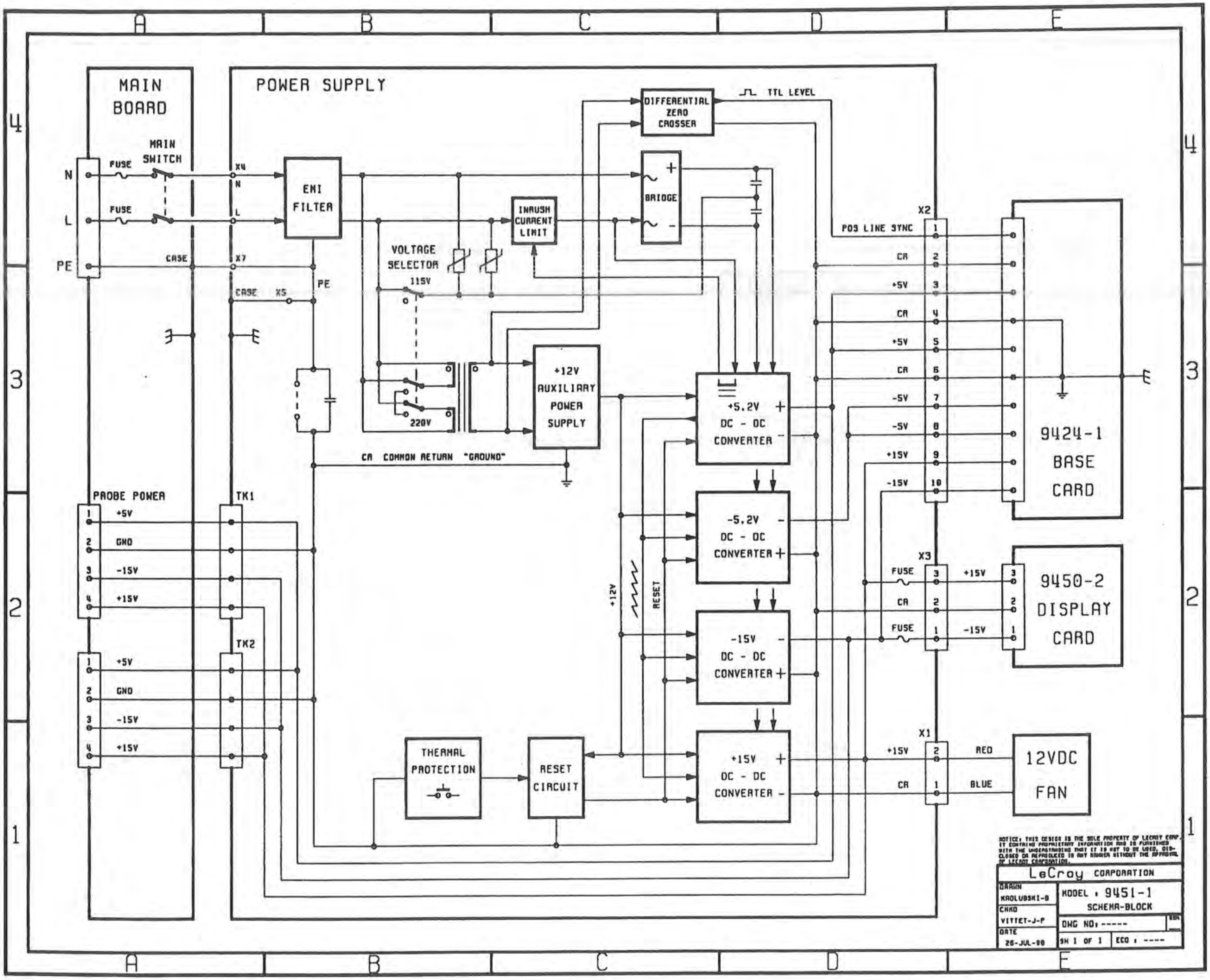
Max. output current adjustment: min. ±20%

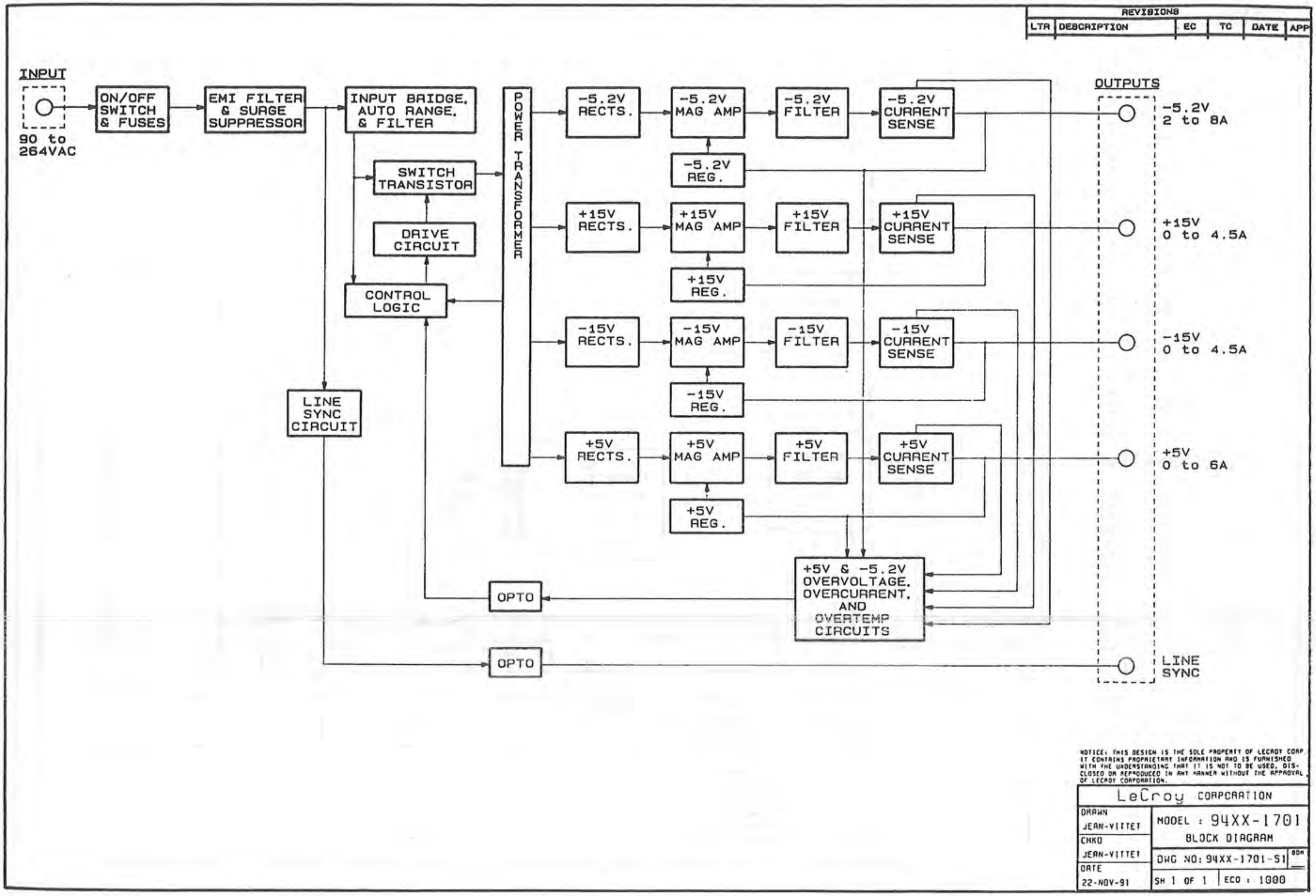
Soft-start: input 90 V_{AC}, 45 Hz: outputs $I_{nominal}$



Power output:	nominal 204 W
	maximum 240 W
Line sync output:	square signal, duty cycle 50%, 45 to 440 Hz
	levels: 0 = 0 V , 1 = +5 V
	rise and fall time <100 nsec
	isolation: line-line sync output 2.5 kV_{AC}
Fan power supply output:	15 V_{DC}, max. 0.15 A
Safety:	designed to meet the following international safety requirements: VDE 0411/0730/0804/0806, IEC 348/380/435
Line input connector:	CEE 22/VI (XIV), ASE type 113

X2 Base card connector:	header 10 pins 94V0 material AMP pin assignment 1: positive line sync 2: common return 3 to 5: +5 V 7 to 8: -5 V 4 to 6: common return 9: +15 V 10: -15 V
X3 display cord connector:	header 3 pins, 94V0 material AMP 350789-1 pin assignment 1: -15 V, with fuse slow 2 A 2: common return 3: +15 V, with fuse slow 2 A
X1 Fan connector:	header 2 pins, 94V0 material AMP 350786-1 pin assignment 1: common return 2: +15 V
Probe power connector:	two, located on the switchboard LEMO RA 0304 N pin assignment 1: +5 V 2: ground, common return 3: -15 V 4: +15 V


MAIN BOARD
POWER SUPPLY
FUSE
MAIN SWITCH
N
L
PE
CASE
X4
X7
X5
EMI FILTER
VOLTAGE SELECTOR
115V
220V
INRUSH CURRENT LIMIT
BRIDGE
DIFFERENTIAL ZERO CROSSER
TTL LEVEL
POS LINE SYNC
+12V AUXILIARY POWER SUPPLY
CR COMMON RETURN "GROUND"
+5,2V DC - DC CONVERTER
-5,2V DC - DC CONVERTER
-15V DC - DC CONVERTER
+15V DC - DC CONVERTER
+12V
RESET
THERMAL PROTECTION
RESET CIRCUIT
PROBE POWER
TK1
TK2
+5V
GND
-15V
+15V
X2
CR
-5V
X3
FUSE
X1
RED
BLUE
9424-1 BASE CARD
9450-2 DISPLAY CARD
12VDC FAN
LeCroy CORPORATION
MODEL : 9451-1
SCHEMA-BLOCK
DRAWN KROLUBSKI-B
CHKD VITTET-J-P
DATE 26-JUL-88
DWG NO: -----
SH 1 OF 1
ECO : ----


REVISIONS
LTR
DESCRIPTION
EC
TC
DATE
APP
INPUT
90 to
264VAC
ON/OFF SWITCH & FUSES
EMI FILTER & SURGE SUPPRESSOR
INPUT BRIDGE, AUTO RANGE, & FILTER
SWITCH TRANSISTOR
DRIVE CIRCUIT
CONTROL LOGIC
LINE SYNC CIRCUIT
POWER TRANSFORMER
-5.2V RECTS.
-5.2V MAG AMP
-5.2V REG.
-5.2V FILTER
-5.2V CURRENT SENSE
+15V RECTS.
+15V MAG AMP
+15V REG.
+15V FILTER
+15V CURRENT SENSE
-15V RECTS.
-15V MAG AMP
-15V REG.
-15V FILTER
-15V CURRENT SENSE
+5V RECTS.
+5V MAG AMP
+5V REG.
+5V FILTER
+5V CURRENT SENSE
+5V & -5.2V OVERVOLTAGE, OVERCURRENT, AND OVERTEMP CIRCUITS
OPTO
OPTO
OUTPUTS
-5.2V
2 to 8A
+15V
0 to 4.5A
-15V
0 to 4.5A
+5V
0 to 6A
LINE
SYNC
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LeCroy CORPORATION
DRAWN
JEAN-VITTET
CHKD
JEAN-VITTET
DATE
22-NOV-91
MODEL : 94XX-1701
BLOCK DIAGRAM
DWG NO: 94XX-1701-S1
SH 1 OF 1
ECO : 1000

Chapter 3

BASIC PERFORMANCE TEST PROCEDURE

AND

INTERNAL DIAGNOSTICS AND CALIBRATION

Table of contents:

3.1 Basic Performance Test Procedure for the 9410 digital oscilloscope

3.1.1 Turn-On

Before switching on the digital oscilloscope (DSO), check that the correct line voltage is set at the rear-panel power selector. Switch on the power using the power switch on the rear panel. Then check:

- that the display turns on after about 10 seconds
- that the display is stable
- that the range of INTENSITY and GRID INTENSITY is reasonable

Wait for about 20 minutes for the scope to reach a stable operating temperature.

3.1.2 Noise on the Inputs

This is to verify the proper operation of all front-end components. With no signal connected to the inputs, set the DSO as follows:

- turn on traces CH1 and CH2
- Grid: single
- Input couplings CH1 and CH2: 1 MΩ DC
- Input gain: 5 mV/div
- Trigger:

SMART Trigger:	OFF
Source:	LINE
Coupling:	AC
Mode:	NORM

- Time/div:	10 msec/div
- BWL:	OFF

Check:

- displayed waveforms should have a constant band of less than 1 minor division
- there is no discernible periodic structure

See figure 1:

Repeat the test for Time/div = 5 msec/div, 2 msec/div, 1 msec/div, and .5 msec/div and check as above.

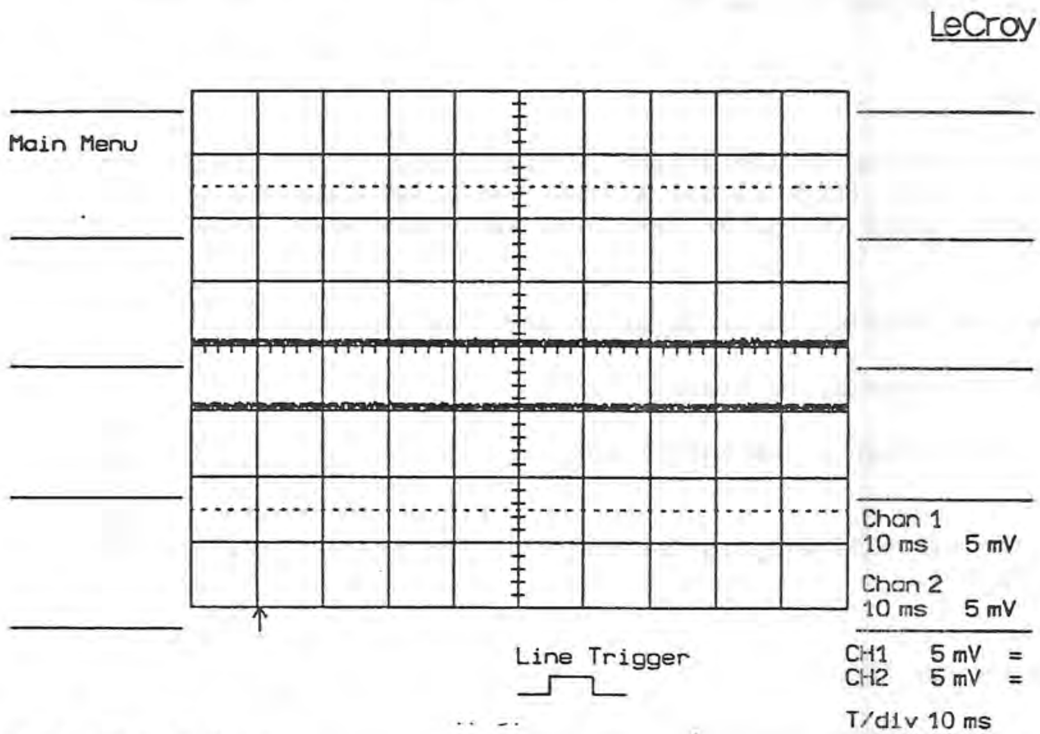


Figure 1

3.1.3 Test of the ADCs

This is to verify proper operation of the ADCs at the two nominal sampling frequencies: 100 and 40 Ms/sec.

With both Channel 1 and Channel 2 inputs open, set the DSO as follows:

- turn on the CH1 trace
- Grid normal
- Input couplings CH1 and CH2: 1 MΩ DC
- Input gain 50 mV/div, offset zero
- Trigger:

SMART Trigger:	OFF
Source:	LINE
Coupling:	AC
Mode:	NORM

- Time/div = 10, 50 µsec/div

For each of the two time bases above, check for CH1 and CH2:

- displayed waveform should lie within a band of less than 1 minor division.
- using the offset control, move the trace for CH1 and CH2 slowly through the entire range and check that there is no significant change in the displayed trace. Repeat for channel 2.

3.1.4 Offset

Set the DSO as follows:

- turn on the trace for CH1
- Grid normal
- Input set to GND
- Input gain 5 mV/div, offset zero
- Trigger:

SMART Trigger:	OFF
Source:	LINE
Coupling:	AC
Mode:	NORM

- Time/div = 50 µsec/div
- BWL OFF

Switch between 50 Ω DC and GND, and 1 MΩ DC and GND.
Check:

- the trace should not move more than a minor division or 1 mV

Repeat the same test for CH2.

3.1.5 Input Impedance

Set the DSO CH1 input to 1 MΩ DC 50mV/div with any time base.
Check with an ohmmeter:

- input impedance must be 1 MΩ ± 1%
- repeat 1Mohm test for 200mV/div

Set DSO CH1 input to 50 Ω, 20 mV/div with any time base.
Check:

- input impedance must be 50 Ω ± 1%

Repeat all impedance checks for CH2.

3.1.6 Front-End

Set the DSO as follows:

- turn on the trace for CH1
- Grid normal
- Input 50 Ω, gain 100 mV/div, offset zero
- Trigger:

SMART Trigger: OFF
Source: CH1
Coupling: DC
Mode: NORM
Delay: 50%
Level: zero

- Time/div = .1 µsec/div
- BWL OFF

Apply a 600 mV p-p 1 MHz square wave from a fast (less than 1 nsec) risetime function generator (for example TEK PG502) to CH1 input. Press the Interleaved Sampling button on the oscilloscope to turn on the RIS mode.

Check:

- There should be no large overshoot at the rising and falling edge:

  50 Ω: less than 8% overshoot

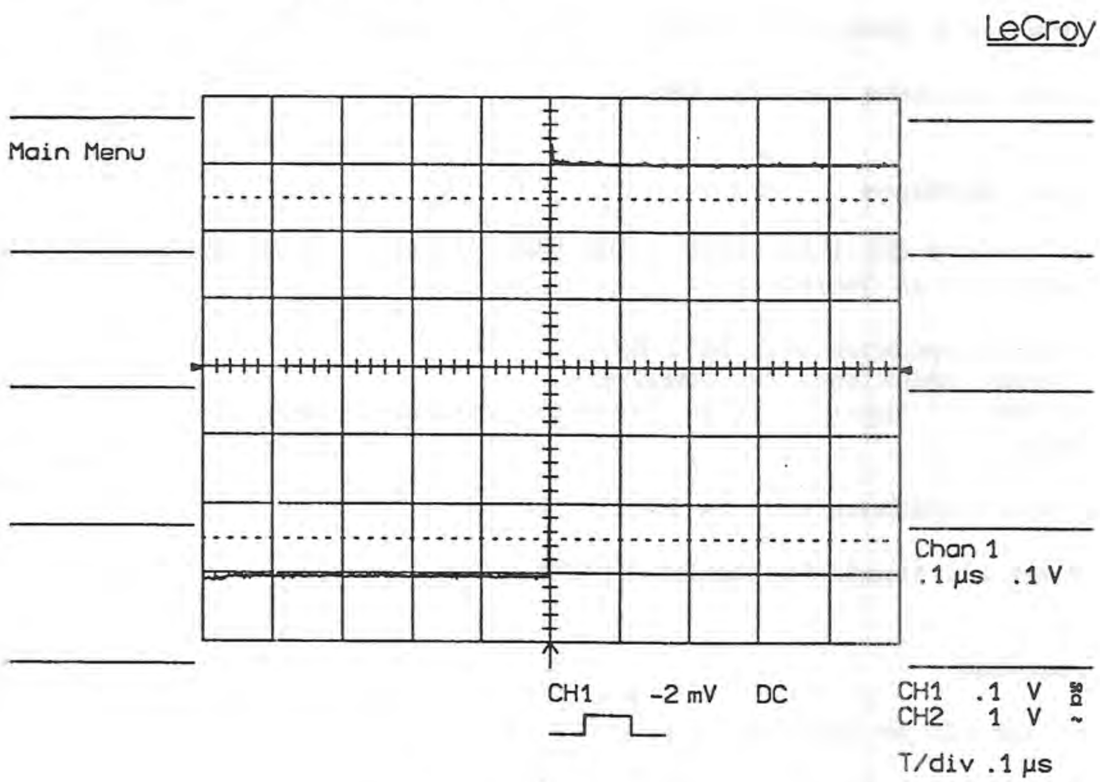


Figure 2

- Check the same at 200 mV/div, input 1.2V p-p

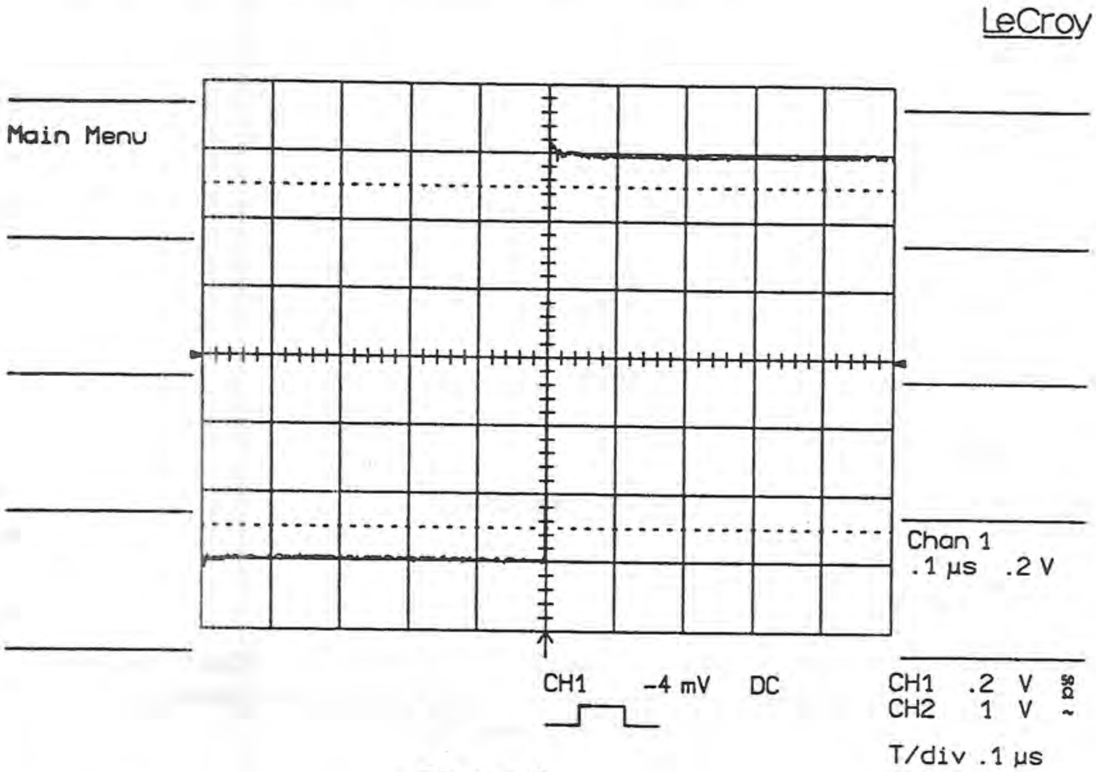


Figure 3

- Repeat the above for CH2, trigger source CH2

3.1.7 Bandwidth at 50Ω input impedance

The purpose of this test is to ensure that the entire 9410 system has a bandwidth of at least 150 MHz at 50Ω input impedance.

Set up a leveled Sine Wave Generator (for example Marconi 2019A):
- Frequency .5 MHz
- Amplitude 2.8 V p-p (maximum for Marconi)

Connect the generator output to CH1 input.

Turn off all the traces, except CH1.

Set the trigger:

SMART Trigger:	OFF
Source:	CH1
Coupl:	DC
Mode:	NORM
Delay:	zero
Level:	zero

Set input CH1:

Coupl:	50 Ω
Gain:	0.5V/div
Var Gain:	1
Offset:	zero

Set the time base:

-Time/div	.5 µsec/div
-Interleaved	ON

Bandwidth limit:	OFF

Adjust the generator output amplitude and CH1 offset to get a 5 divisions p-p sine wave, or maximum possible from the generator for the large V/div gains (Marconi 2.8 V p-p maximum).

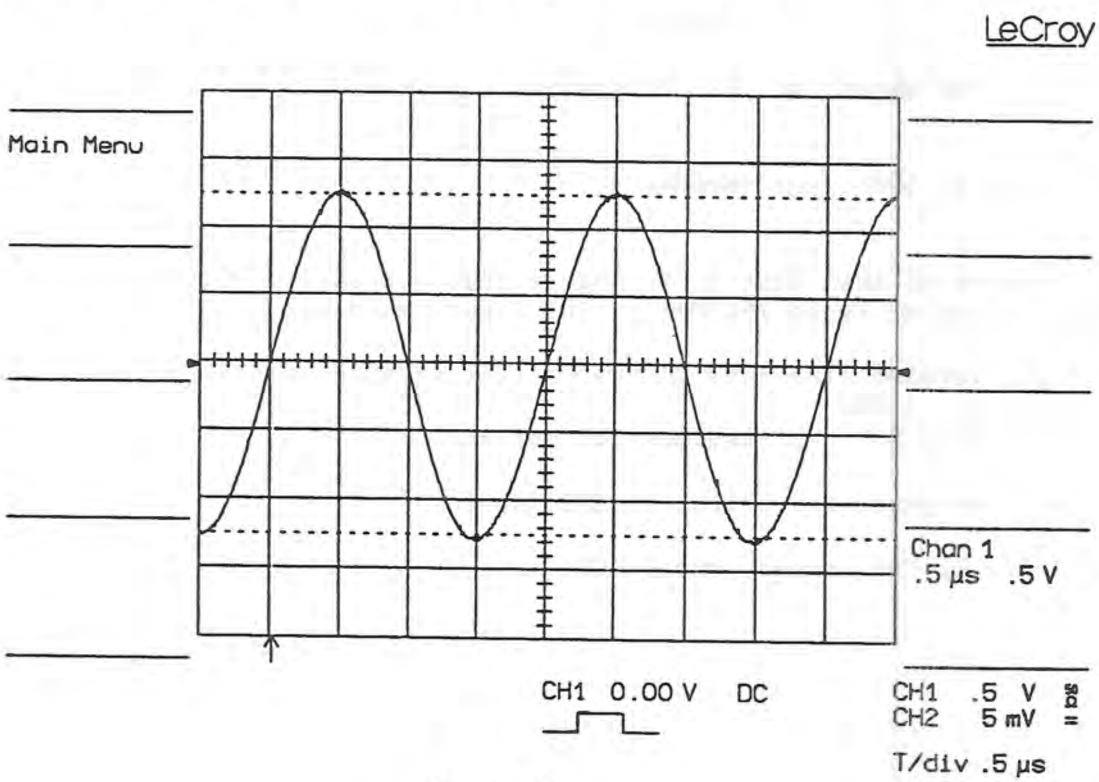


Figure 4

Increase the generator frequency, while decreasing the Time/div until the sine wave p-p amplitude is .7 * 5 divisions = 3.5 divisions (3 dB point), or 70% of the initial amplitude at .5 MHz.

Check:

- the frequency of the generator must be at least 150 MHz

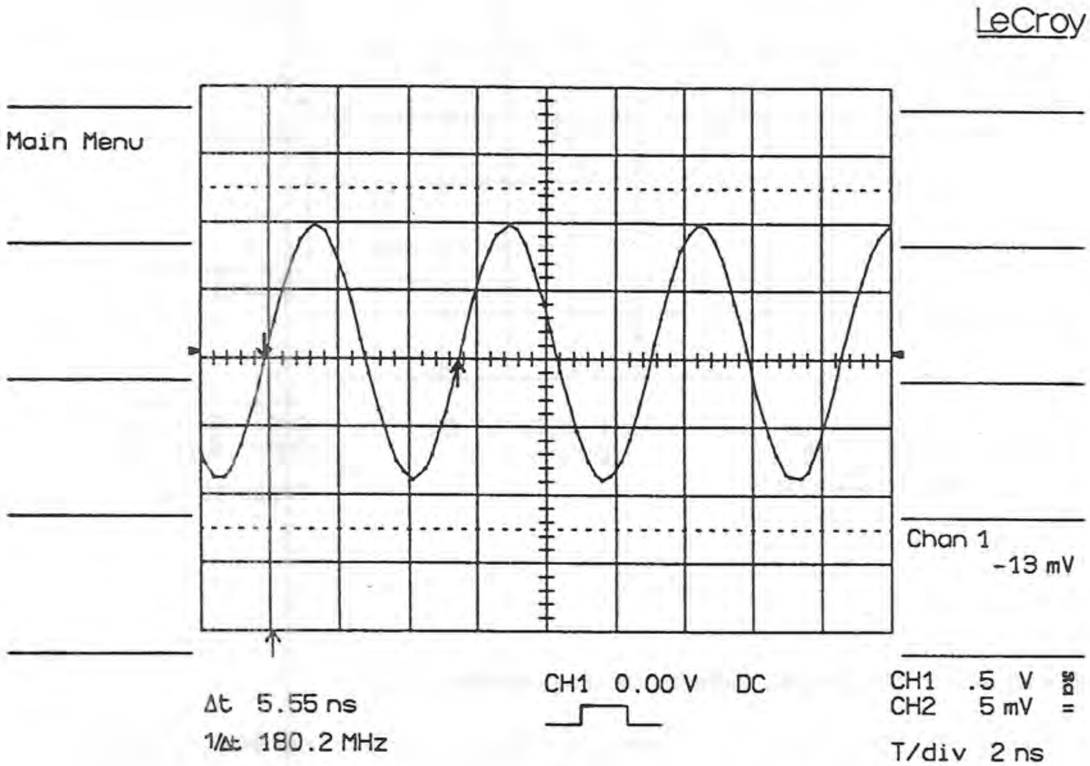


Figure 5

Repeat the above for CH1 and CH2 for input Volts/div = .2 V, .1 V, 50 mV, 20mV, 10 mV, 5 mV.

Set the bandwidth limiter ON.

Repeat the same test as for the bandwidth limiter OFF.

Check:

- the frequency of the generator at the 3 dB point must be 15 MHz ± 20%

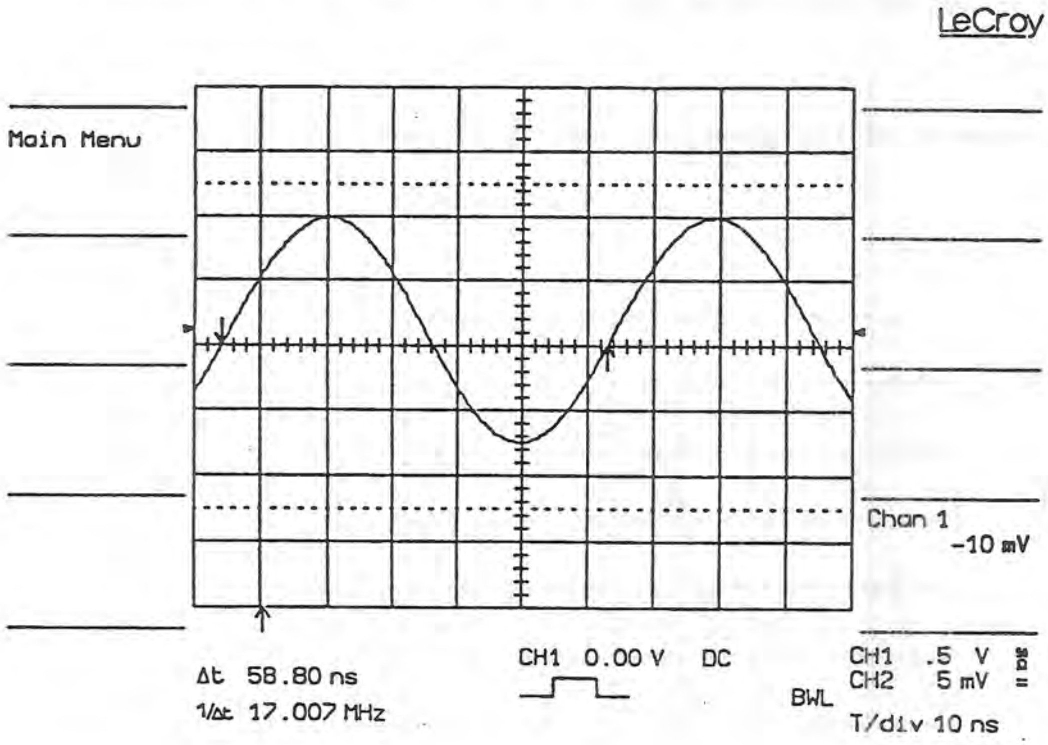


Figure 6

3.1.8 Bandwidth at 1 MΩ Input Impedance (at Probe Tip)

The purpose of this test is to ensure that the entire 9410 system has a bandwidth of at least 125 MHz at probe tip at 1 MΩ input impedance.

Set up a Tektronix SG 503 Leveled Sine Wave Generator or equivalent (note for the Marconi that the maximum amplitude is smaller than 5 V):

- Frequency .5 MHz
- Amplitude 5 V p-p

Terminate the output of the SG 503 via a 50 Ω feedthrough and connect it to the CH1 input through a 10 MΩ /10 probe using the probe tip - BNC jack. Make sure the probe is perfectly adjusted, low frequency and high frequency (see brochure enclosed with probe).

Turn off all the traces except CH1.

Trigger:

SMART Trigger:	OFF
Source:	CH1
Coupl:	DC
Mode:	NORM
Delay:	zero
Level:	zero

Set the input of CH1:

- Coupl:	1 MΩ AC
- Gain:	.1 V/div
- Var:	Gain 1
- Offset:	zero

Set the time base:

- Time/div	.5 μsec/div
- Interleaved	ON

Bandwidth limit OFF

Adjust the SG 503 output amplitude and the CH1 offset to provide a 5 divisions p-p sine wave.

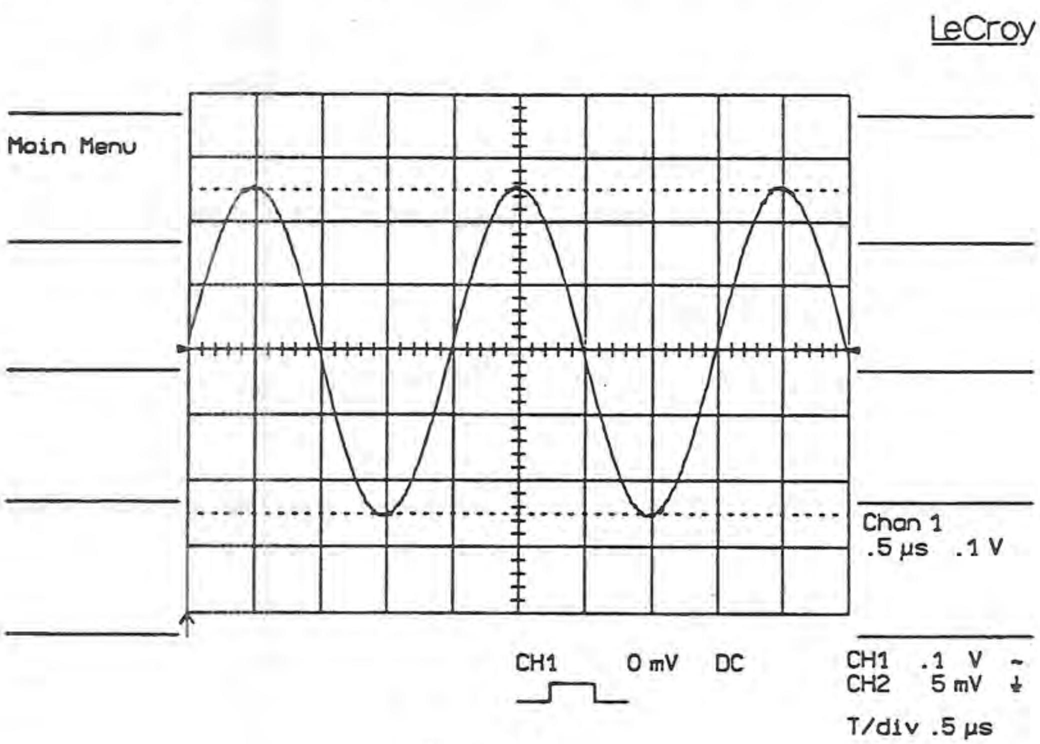


Figure 7

Increase the SG 503 frequency, while decreasing the Time/div until the sine wave p-p amplitude is .7 * 5 divisions = 3.5 divisions (3 dB point).

Check:

- the frequency of the SG 503 must be at least 125 MHz

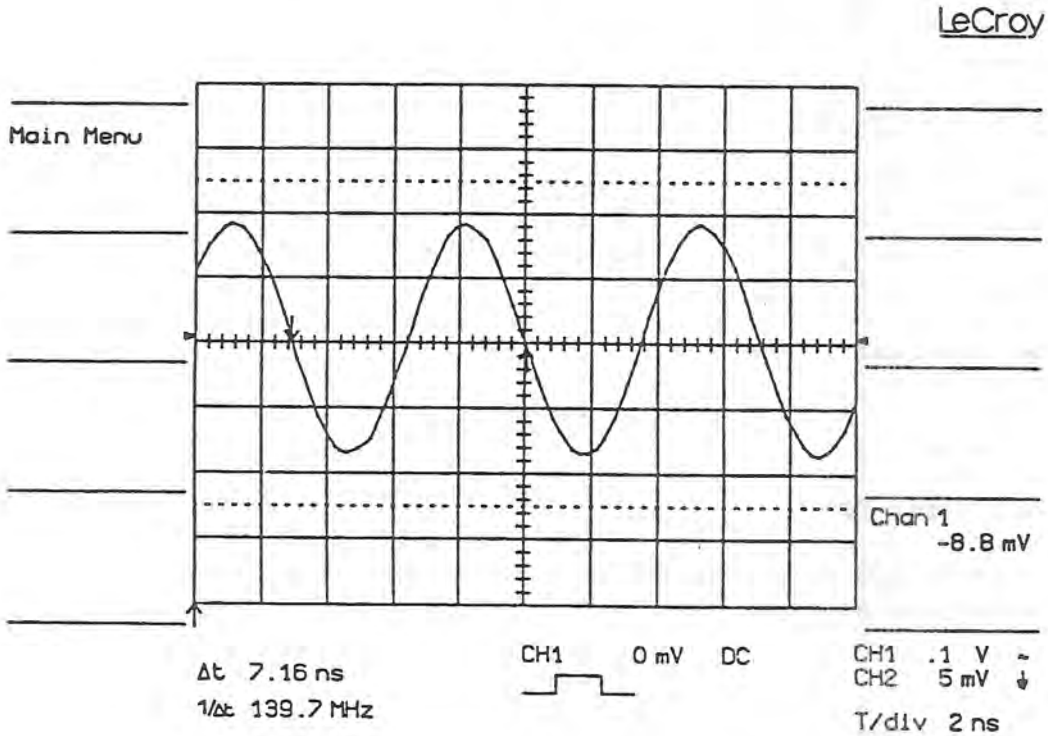


Figure 8

Repeat the above for CH1 and CH2 for input Volts/div = 50 mV, 20 mV, 10 mV, and 5 mV.

Set the bandwidth limiter ON.

Repeat the same test as for bandwidth limiter OFF.

Check:

- the frequency of the SG 503 at the 3 dB point must be 15 MHz ± 20%

3.1.9 Manual linearity test using an external high precision voltage source

In absence of the computer automated calibration system based on CALSOFT2 for the 9410 model oscilloscope , the manual Performance Test Procedure can be followed for establishing an NIST traceable calibration, provided the measurement instruments used are NIST traceable calibrate.

For an NIST calibration, follow the manual linearity test procedure using a calibrated and certified high precision (better than 0.1%) voltage source, for example TEK PS5004 supported by CALSOFT2.

Manual linearity Test Procedure

Set scope to:

Single Grid ON
CH to be tested ON, offset 0

2 msec/div
BWL ON
Pulse parameters ON
LINE trigger
SMART trigger OFF

For each V/div and both 50 Ohm and 1 M Ohm DC coupling and for all channels separately, check the following:

Apply to the CH to be tested a DC voltage from the high precision voltage source with the following three values one after the other: 0, + 3 major screen divisions, - 3 major screen divisions. For each point, read off the 'Mean' parameter voltage and compare to the digital read-out of the voltage reference. The difference of the two values in volts should be within 2% of full scale of the scope.

3.1.10 Trigger level for DC and HFRej

Set up any sine wave generator, capable of generating sine waves to 500 Hz, for example Intron IFG-422 or Topward TFG-8101:

- frequency 500 Hz

Connect the output of the generator to EXT input and to CH1 via a coaxial T-connector. The cable length from EXT to CH1 must be short, at most 2 nsec.

Set up the DSO:

Turn off all the traces except CH1.

Set the trigger:

SMART Trigger:	OFF
Source:	CH1
Coupl:	DC
Mode:	NORM
Delay:	50% Pretrigger
Level	zero

Set the input CH1:

- Coupl:	1 MΩ, DC
- Gain:	.5 V/div
- Var:	Gain 1
- Offset:	zero

Set the time base:

- Time/div:	.2 msec/div

Adjust the sine wave generator's output amplitude to get 8 divisions p-p, corresponding to a 2 V amplitude. It is important that the offset of the input is set to zero (use Panel Status to verify). Use the offset adjustment of the sine wave generator to center the signal with respect to the screen. Later, the test on the EXT trigger level requires that the signal has an absolute range of ± 2 V.

Check:

- the sine wave must pass through the horizontal center of the screen (50% pretrigger line) at the vertical position zero (vertical center) within ± 2 minor divisions

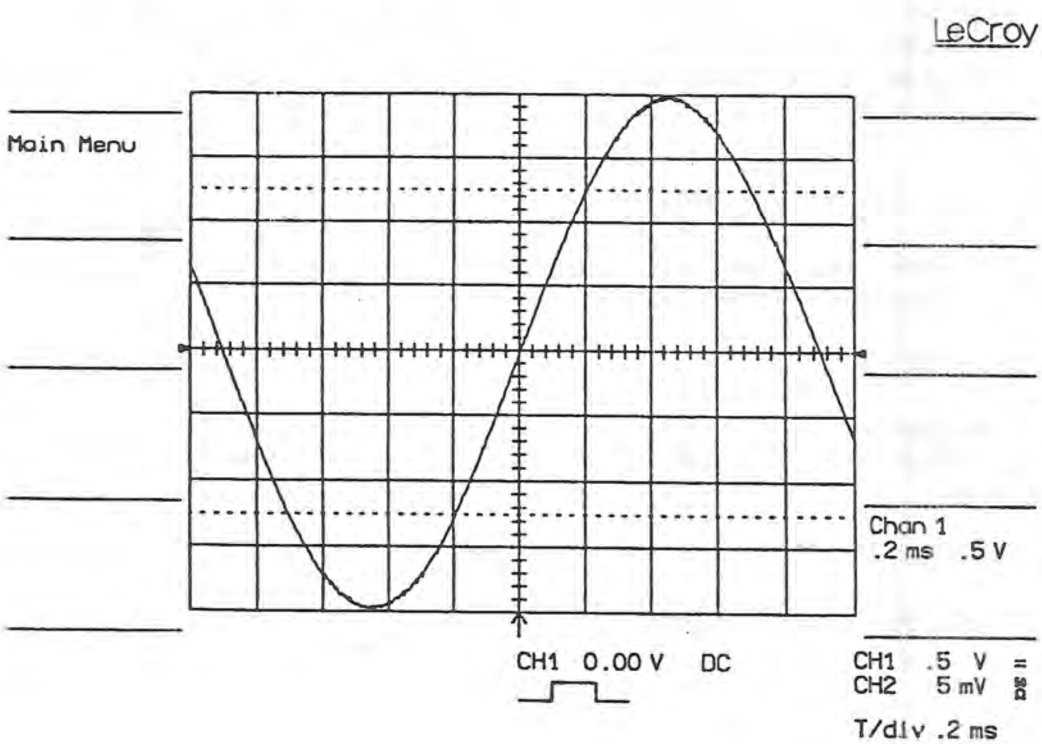


Figure 9

Repeat for the following conditions:

- trigger slope POS and NEG (verify slope at check point)
- trigger coupling DC and HFRej

Set the trigger level to + 1.5 V.

Check:

- the sine wave must pass the horizontal center at + 3 divisions within ± 2 minor divisions

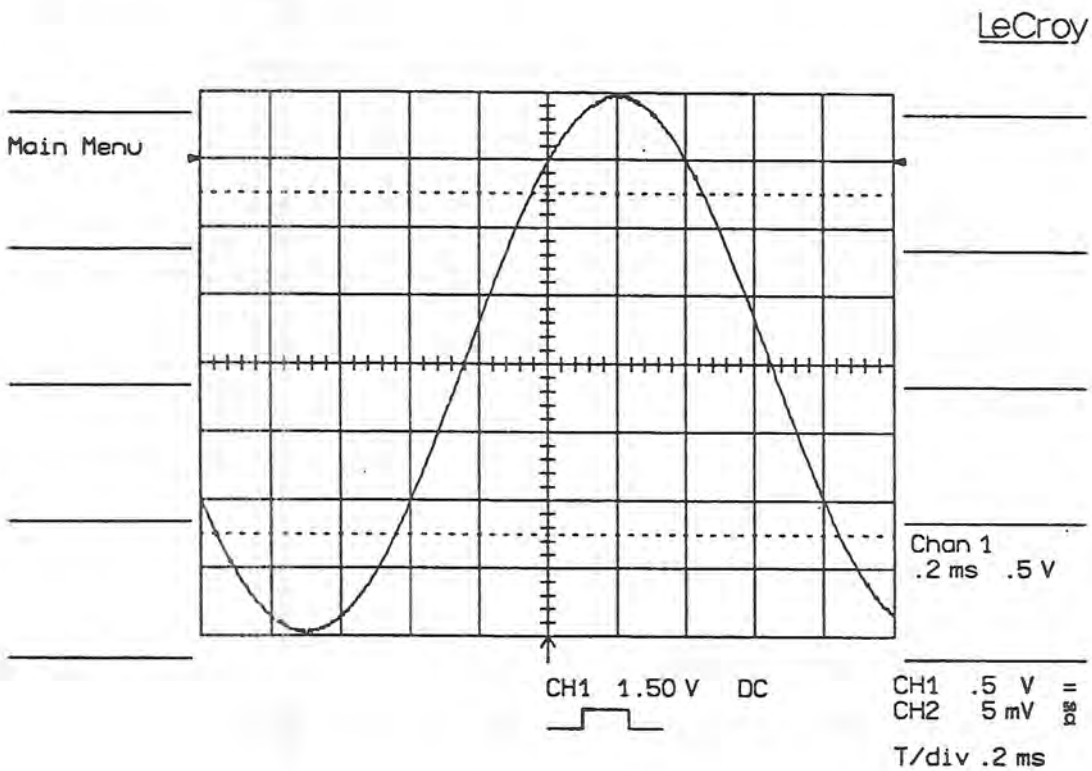


Figure 10

Repeat for the following conditions:

- trigger slope POS and NEG (verify slope at check point)
- trigger coupling DC and HFRej

Set the trigger level to - 1.5 V.

Check:

- the sine wave must pass the horizontal center at - 3 divisions within ± 2 minor divisions

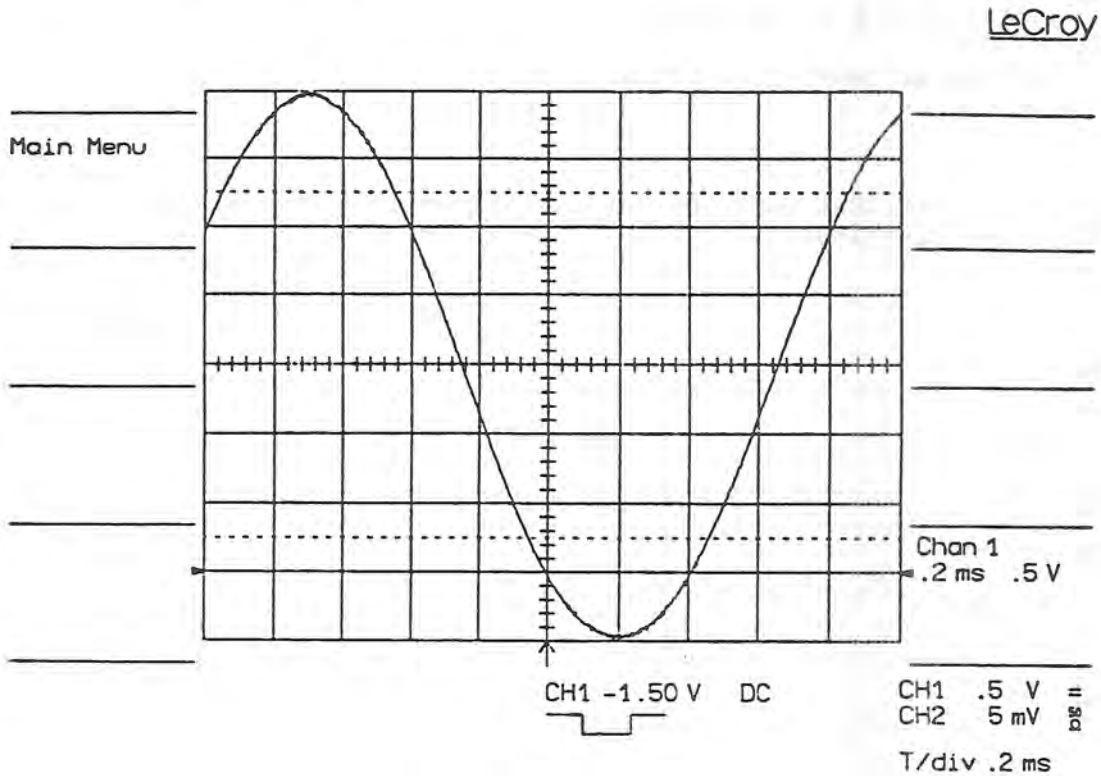


Figure 11

Repeat for the following conditions:

- trigger slope POS and NEG (verify slope at check point)

- trigger coupling DC and HFRej

Disconnect the input from CH1 and connect it to input of CH2.

Turn off all the traces except for CH2.

Set input CH2:

- Coupl:	1 MΩ, DC
- Gain:	.5 V/div
- Var:	Gain 1
- Offset:	zero

5) <u>External trigger and common controls</u>

5.1) Digital controls

The bit allocation are:

Address

Address	MSB							LSB
128 0120	HFREJ EXT	AC EXT	DC EXT	BWL EXT	SLOPE EXT	%10 TRIG		

MSB external trigger LSB

Address	MSB							LSB
128 0160	BWL	VCAL %10			SET HDTV	SET 875	MB	MA

MSB common controls + TV trigger LSB

Bit	low state	high state
HFREJ_EXT AC_EXT DC_EXT BWL_EXT	see table 2	
SLOPE	see table 3	
%10	attenuator in %10 pos.	attenuator in %1 pos.
BWL	filter off	filter on
VCAL/10	VCAL range=+/-1.50V	VCAL range=+/-0.15V
SETHDTV SET875 MB MA	see table 5	

There is a register on the main board which gives some information about the front-end state.

Address

Address	MSB							LSB
1680000 (hexa)	_OVL4	_OVL3	_OVL2	_OVL1	OC4	OC3	OC2	OC1

MSB front end state register LSB

OVL1-4 are the overload indicator. Only OVL1 and OVL2 are effective on this front-end (2 channels). A low state indicate that overlaod is detected. OC1-4 are used to code the front-end hardware version or option:

OC4	OC3	OC2	OC1	version
L	L	L	L	9430_7 REVB, REVC, REVD, REVE
H	L	L	L	REVF, REVG extanded VCAL and VOFFSET range

5.2) Analog controls

2 sample-and-hold fed by the precision DAC provide the threshold level for the external trigger and the calibration source. One voltage divider is to be trimmed to 10% 6.6667=1.5 and a second (%10 +/- 0.1%) can be switched to reduce the DAC range to +/- 0.15V.

(note 1): since REVF

$$\text{VOFFSET} = \frac{\text{DAC}}{4.62}\ [\text{V}] \quad \text{or} \quad \frac{\text{DAC}}{46.2}\ [\text{V}]$$

$$\text{VCAL} = \frac{\text{DAC}}{4.1000}\ [\text{V}] \quad \text{or} \quad \frac{\text{DAC}}{41.000}\ [\text{V}]$$

precision: +/-0.1%

Set the trigger source to CH2.

Repeat the above check procedure for CH2.

Leave the input connected to CH2, leave the trace of CH2 on.

Set trigger source to EXT.

Repeat the above check procedure for EXT trigger, but observing the effect on CH2. The tolerance for the level crossing is ± 4 minor divisions for the EXT trigger level.

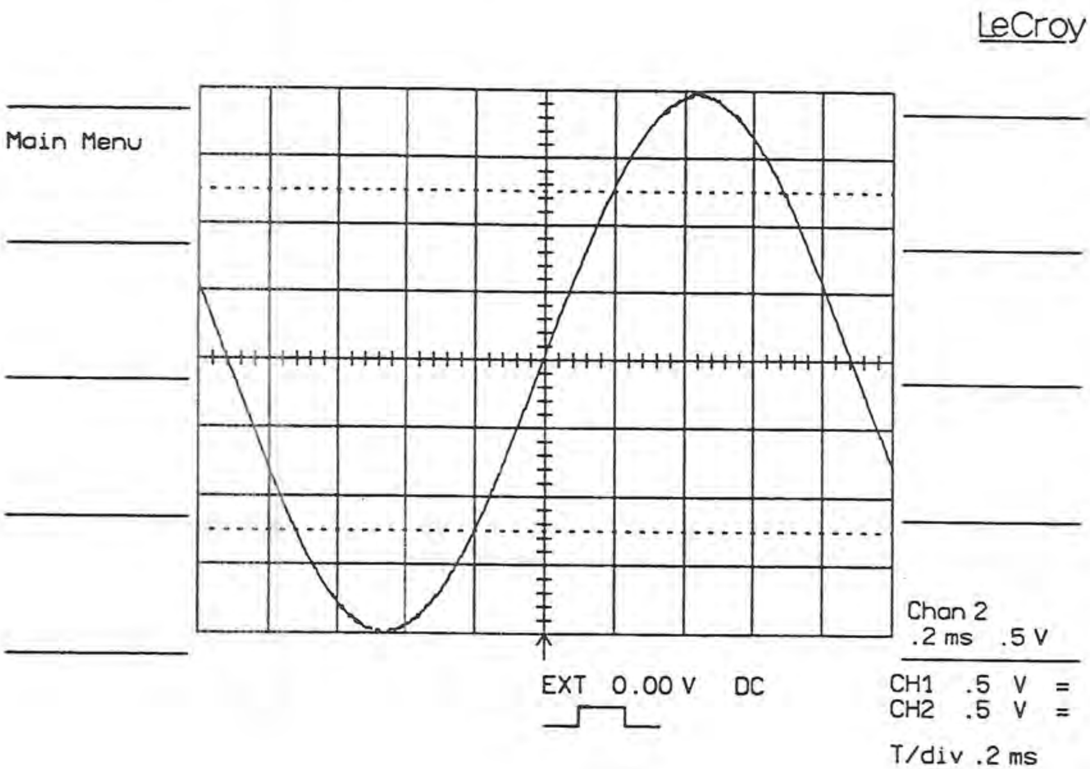


Figure 12

3.1.11 Bandwidth for EXT Trigger

Set up a sine wave generator (for example Marconi 2019A):

- Frequency 200 MHz
- Amplitude 2.8 V p-p (maximum for Marconi)

Connect the output of the generator to EXT input and to CH1 using a coaxial T-connector. The cable length between EXT and CH1 must be short (at most 2 nsec).

Set up the DSO:

Turn off all the traces, except CH1.

Set the trigger:

SMART Trigger: OFF	
Source:	EXT
Coupl:	DC
Mode:	NORM
Delay	50%
Level	zero

Set input CH1:

- Coupl	50 Ω
- Gain	.5 V/div
- Var	Gain 1
- Offset	zero

Set time base:

- Time/div	5 nsec/div
- Interleaved ON	

Check:

- The scope must keep triggering in a stable way (i.e., a smooth 200 MHz sine wave must be visible on the display).

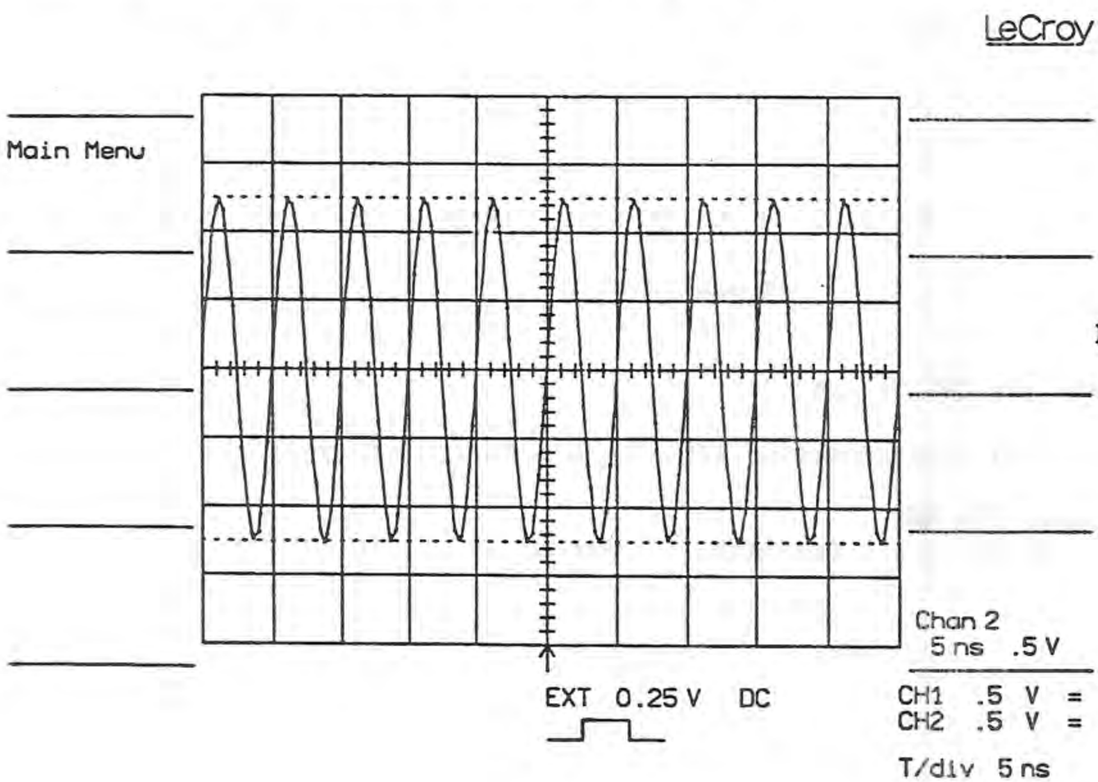


Figure 13

3.1.12 **Smart Trigger**

3.1.12.1 **Trigger on Pulse Width >, <**

Set up the DSO:

Turn off all the traces except CH1.

Set the trigger:

Smart Trigger:	ON
Trigger Type:	SINGLE SOURCE
Width Type:	PULSE WIDTH
Source:	CH1
Coupl:	AC
Slope:	+
Level:	zero
Delay:	20% Pretrigger

Set the input of CH1:

- Coupl:	50 Ω
- Gain:	.5 V/div
- Var:	Gain 1
- Offset:	zero

Set the time base:

- Time/div:	20 nsec/div
- Interleaved:	ON

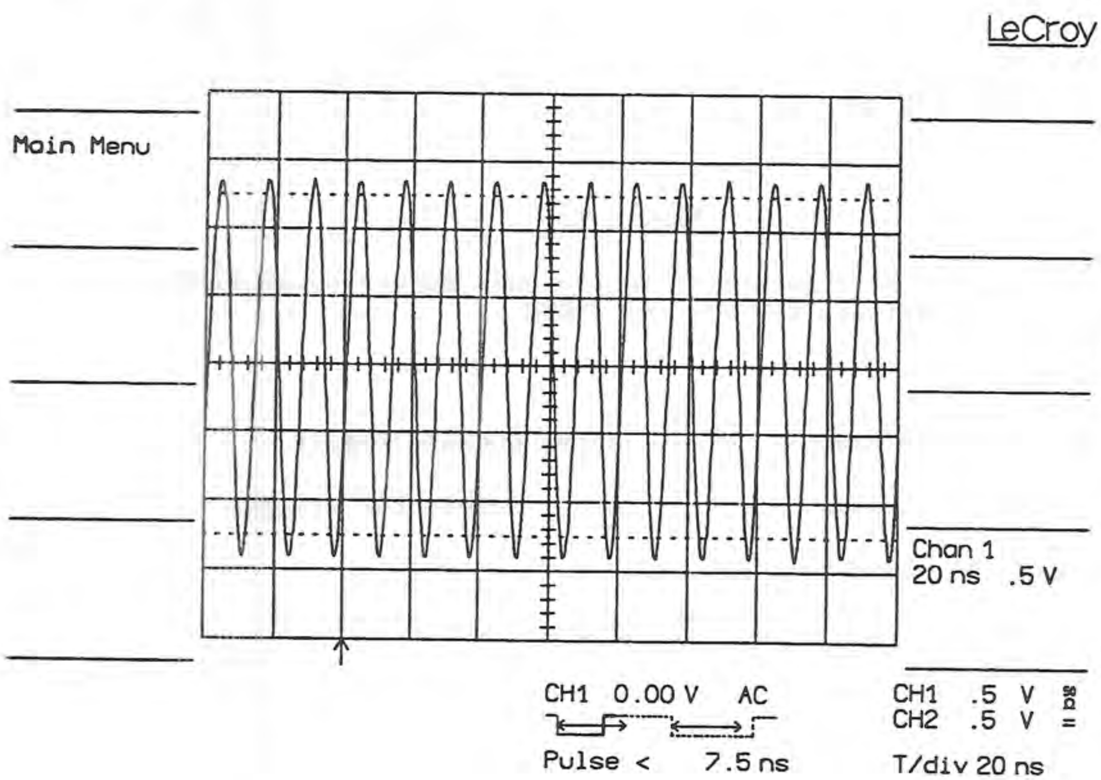


Figure 14

Apply a sine wave signal 2.8 V p-p of 75 MHz. Adjust PULSE Width to 7.5 nsec for both < and >, and switch between WIDTH < and WIDTH >.

Check:

- Width < 7.5 nsec — scope should trigger
- Width > 7.5 nsec — scope should NOT trigger

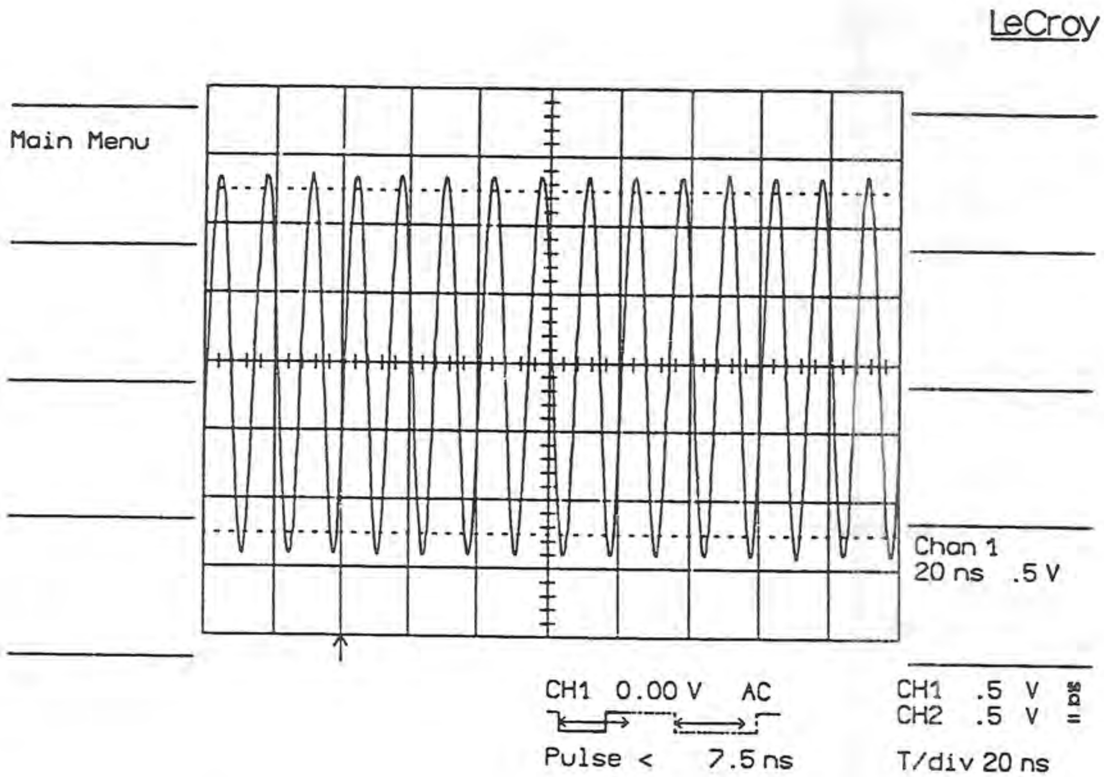


Figure 15

Set the sine wave generator to 230 MHz. Adjust PULSE WIDTH to 2.5 nsec and switch between WIDTH < and WIDTH >.

Check:

- Width < 2.5 nsec — scope should trigger
- Width > 2.5 nsec — scope should NOT trigger

Repeat the above test for CH2.

3.1.12.2 Trigger on Interval Width <

Set up the DSO:

Turn off all the traces except CH1.

Set trigger:

- Smart Trigger	ON
- Trigger Type	SINGLE SOURCE
- Width Type	INTERVAL WIDTH
- Source	CH1
- Coupl	AC
- Slope	+
- Level	zero
- Delay	20% Pretrigger

Set the input of CH1:

- Coupl	50 Ω
- Gain	.5 V/div
- Var	Gain 1
- Offset	zero

Set the time base:

- Time/div	2 nsec/div
- Interleaved ON	

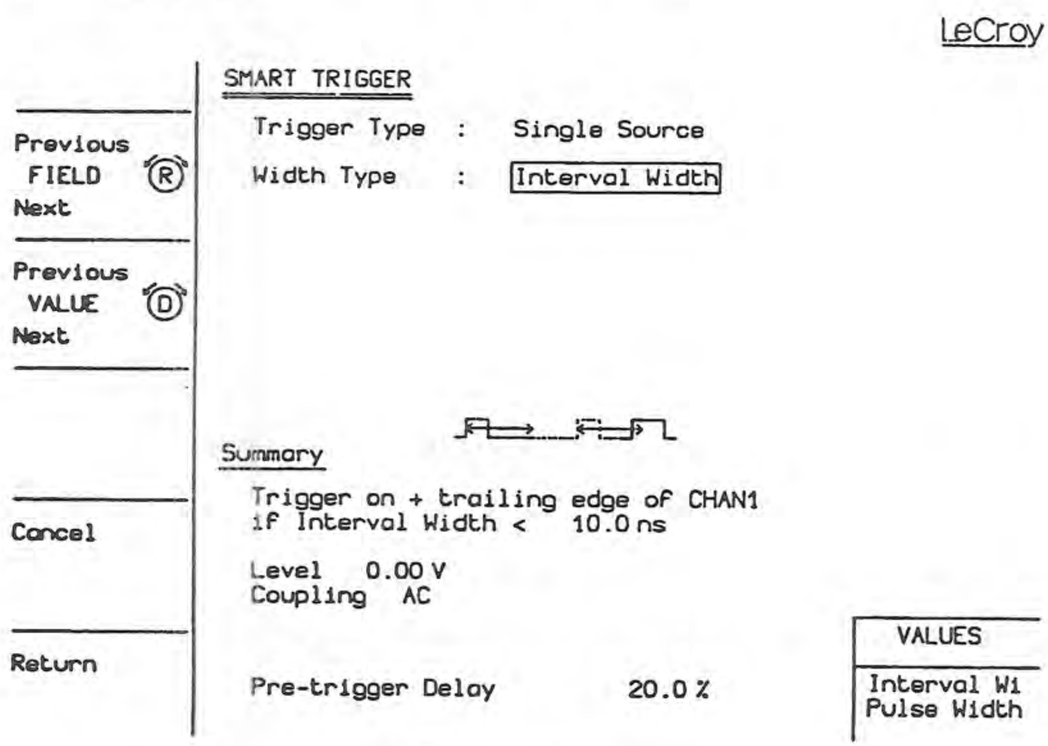


Figure 16

Apply a sine wave signal 2.8 V p-p of 200 MHz to CH1. Turn to INTERVAL Width < and adjust width to 10 nsec.

Check:

- 200 MHz: Width < 10 nsec, scope should trigger

- 110 MHz: Width < 10 nsec, scope should trigger

- 91 MHz: Width < 10 nsec, scope should NOT trigger

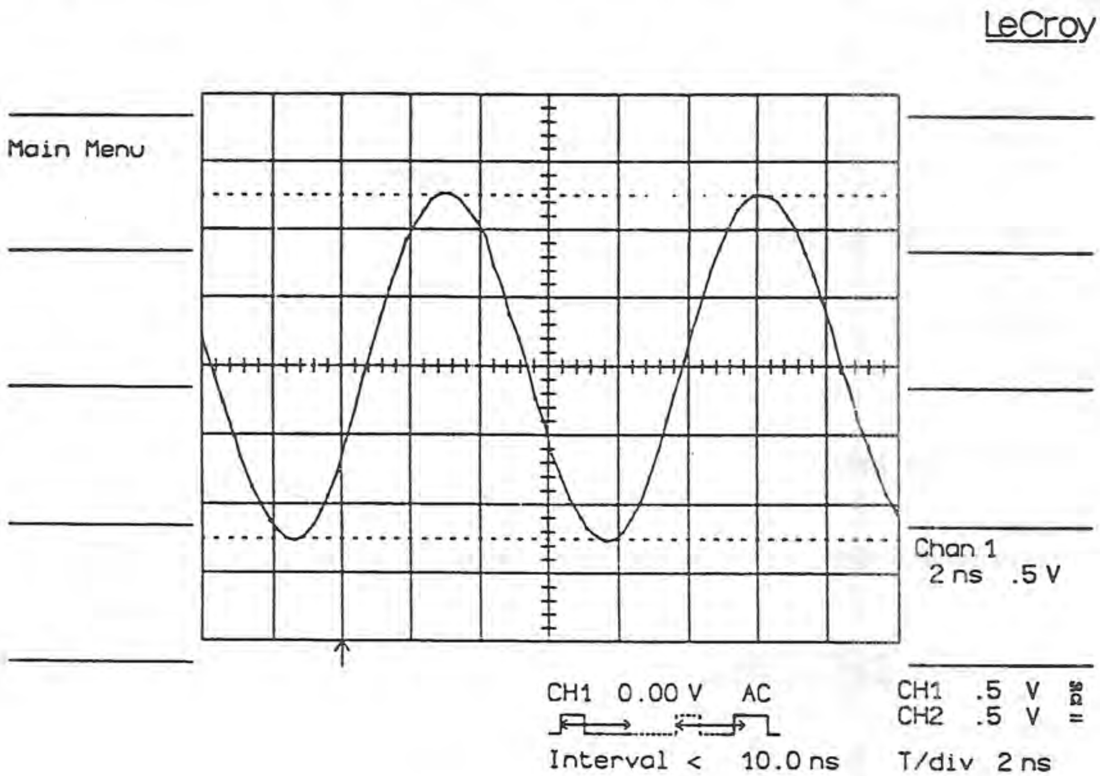


Figure 17

Set frequency to 74 MHz and INTERVAL Width to < 15 nsec.

Check:

- 74 MHz: Width < 15 nsec, scope should trigger

- 61 MHz: Width < 15 nsec, scope should NOT trigger

3.1.12.3 Trigger on Interval Width >

Set up the DSO:

Turn off all the traces except CH1.

Set the trigger:

- Smart Trigger	ON
- Trigger Type	SINGLE SOURCE
- Width Type	INTERVAL WIDTH
- Source	CH1
- Coupl	AC
- Slope	+
- Level	zero
- Delay	20% Pretrigger

Set the input of CH1:

- Coupl	50 Ω
- Gain	.5 V/div
- Var	Gain 1
- Offset	zero

Set the time base:

- Time/div	5 nsec/div
- Interleaved	ON

Apply sine wave signal 2.8 V p-p of 100 MHz to CH1. Turn to INTERVAL Width > and adjust width to 25 nsec.

Check:

- 100 MHz: Width > 25 nsec, scope should NOT trigger

- 44 MHz: Width > 25 nsec, scope should NOT trigger

- 37 MHz: Width > 25 nsec, scope should trigger

See figure 18.

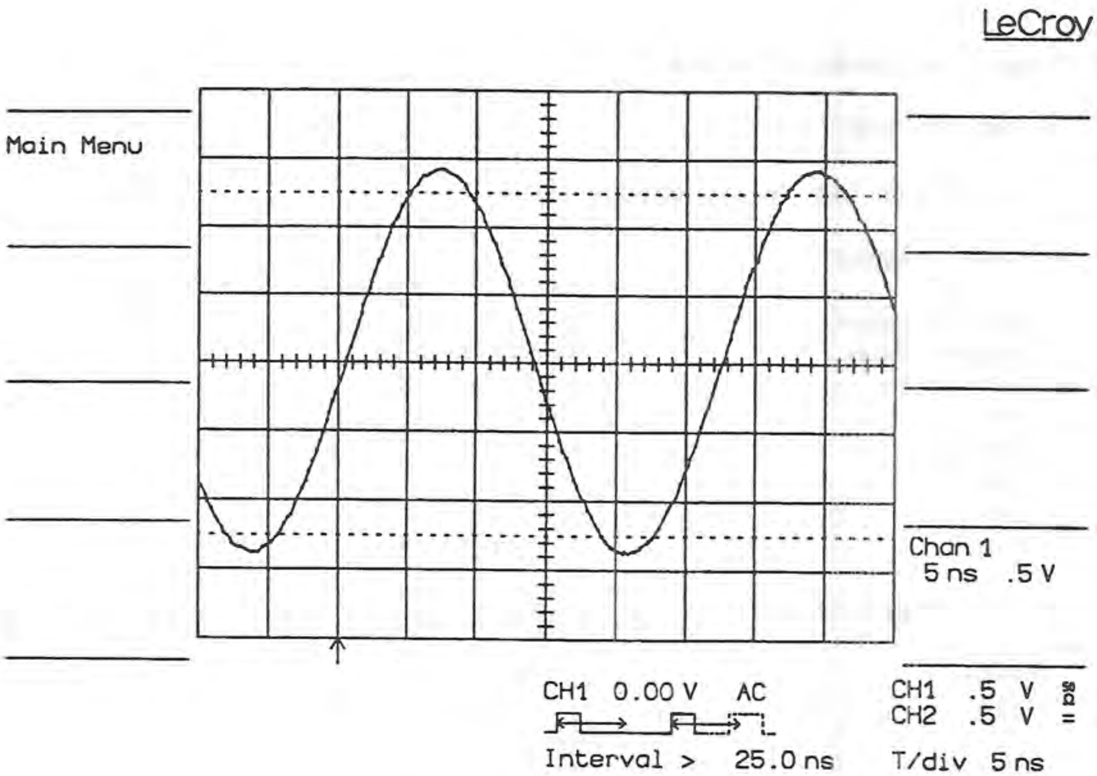


Figure 18

Set the frequency to 40 MHz and INTERVAL Width to > 27.5 nsec.

Check:

- 40 MHz: Width > 27.5 nsec, scope should NOT trigger

- 33 MHz: Width > 27.5 nsec, scope should trigger

Repeat the above test for CH2.

3.1.13 Time Base Accuracy

In order to verify the time base, use a sine wave generator of 1 MHz with a frequency accuracy of better than 10 ppm (for example Marconi 2019A).

Set up the DSO:

Turn off all the traces except CH1.

Set the trigger:

- SMART Trigger	OFF
- Source	CH1
- Coupl	DC
- Mode	NORM
- Slope	+
- Delay	0%
- Level	zero

Set the input of CH1:

- Coupl	50 Ω
- Gain	.5 V/div
- Var	Gain 1
- Offset	zero

Set the time base:

- Time/div	2 μsec/div
- Interleaved	ON

Set the sine wave generator to 1 MHz and put a signal on to CH1. Adjust amplitude to get about a 6 divisions p-p signal.

Select trigger mode SINGLE (HOLD).

Turn DUAL GRID ON.

Turn ON EXPAND A with CH1 as the source.

Adjust TIME MAGNIFIER to .1 μsec/div.

Turn horizontal POSITION on DISPLAY CONTROL to select the 3rd period of the displayed waveform.

Put the expanded trace on the second grid using the vertical POSITION knob, see Figure 19.

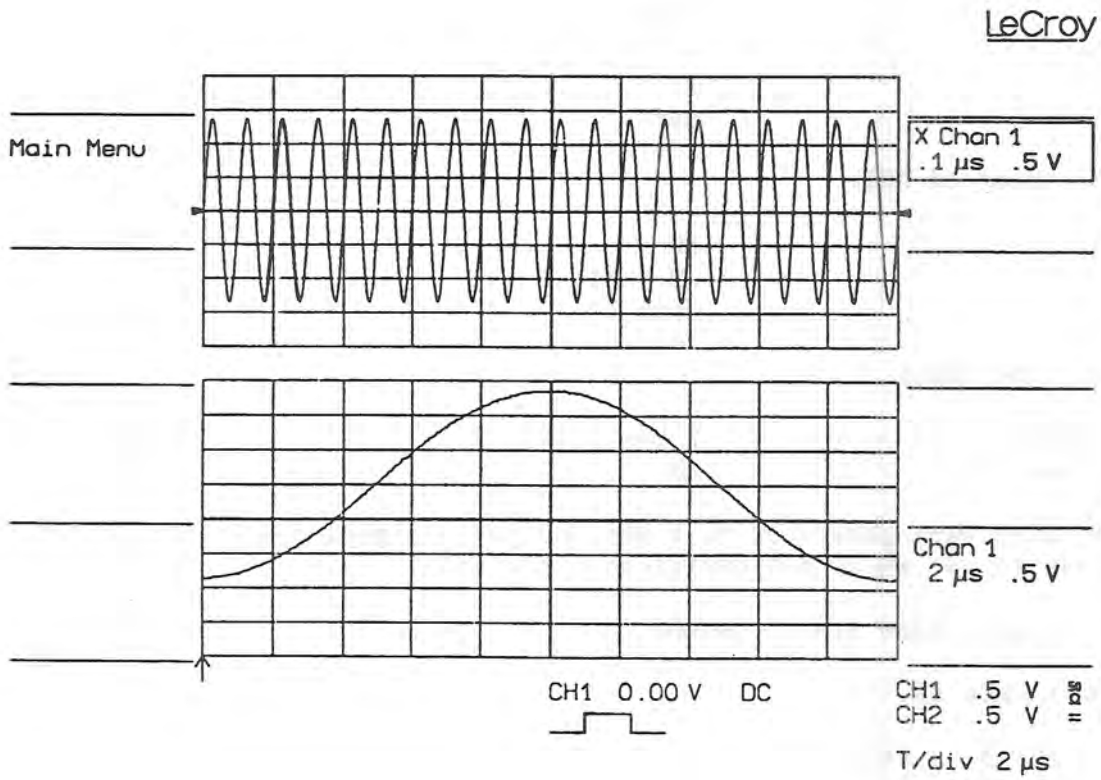


Figure 19: 3rd Period Expanded

Turn ON EXPAND B with CH1 as the source.

Adjust TIME MAGNIFIER to .1 µsec/div.

Turn the horizontal POSITION on DISPLAY CONTROL to select the 13th period.

Overlay the 2 expanded traces on the lower grid using vertical and horizontal POSITION knobs on DISPLAY CONTROL, see Figure 20.

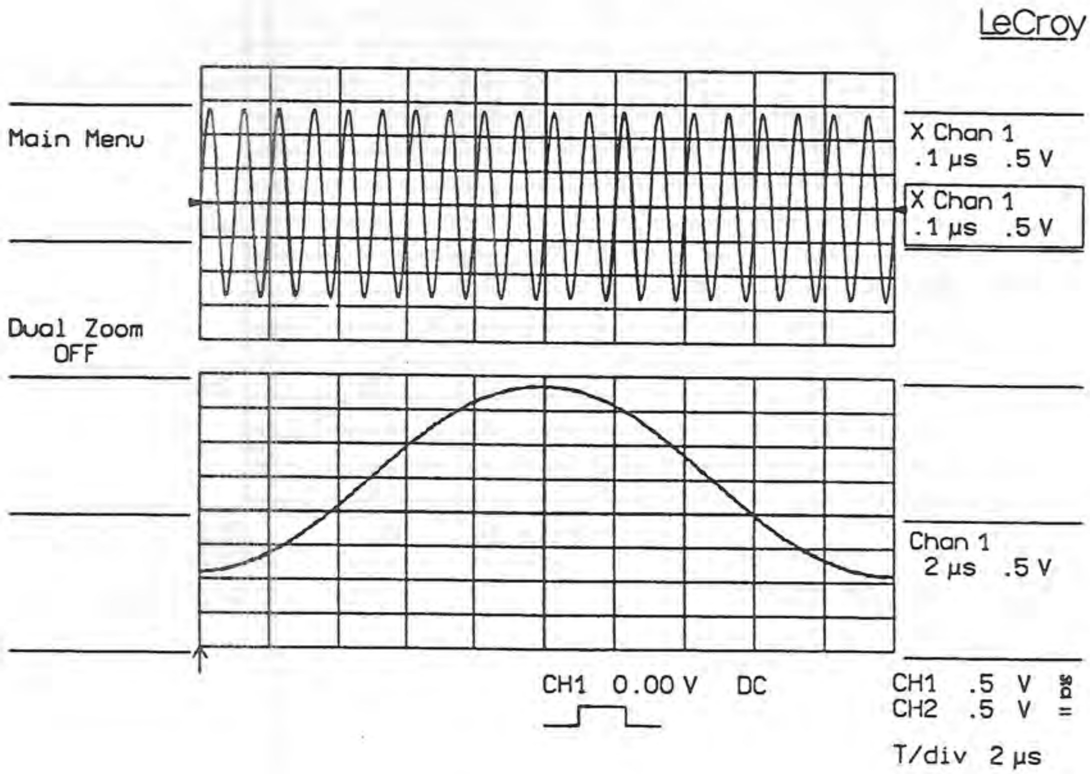


Figure 20: 3rd and 13th period overlaid

Measurement of the time difference:

- turn the RELATIVE TIME CURSORs ON
- put the REFERENCE cursor on top of the 3rd period (check on upper grid)
- Put the DIFFERENCE cursor on top of the 13th period (check on upper grid) and adjust alignment of the two cursors (check on lower grid), see Figure 21.

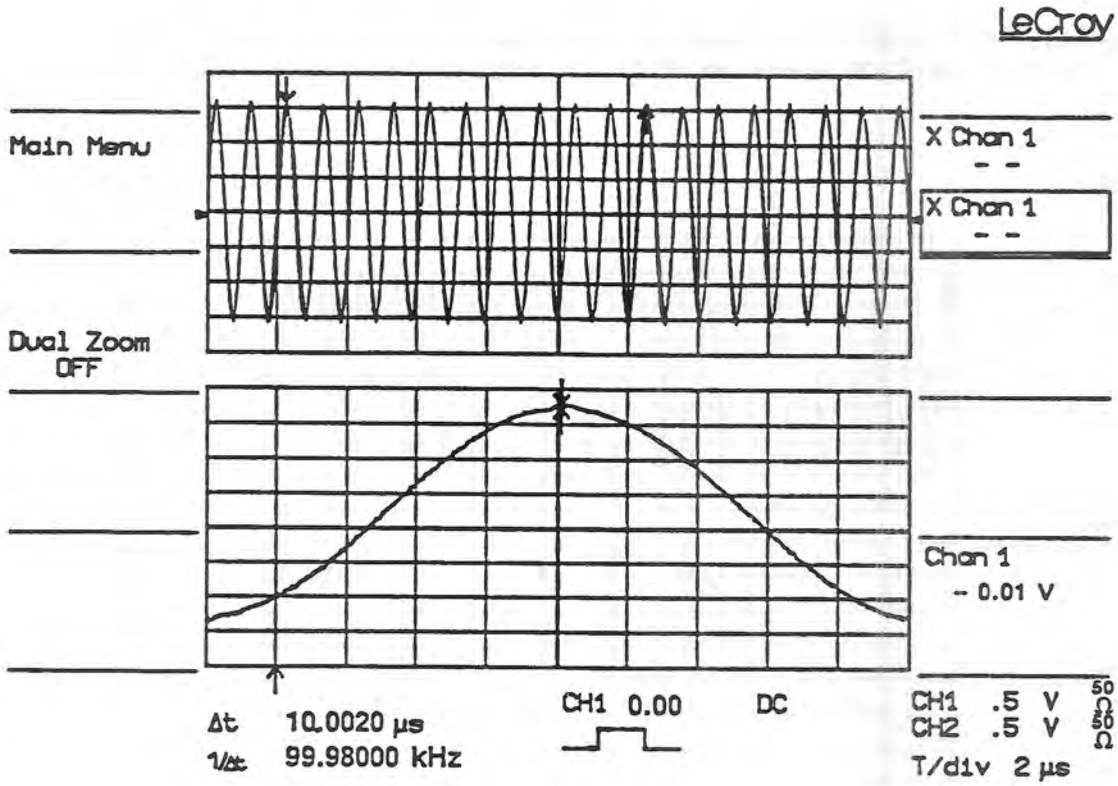


Figure 21: Aligned cursors

Turn DUAL ZOOM ON.

Turn TIME MAGNIFIER (DISPLAY CONTROL) to select the maximum expansion. Refine adjustment of the two cursors, see Figure 22.

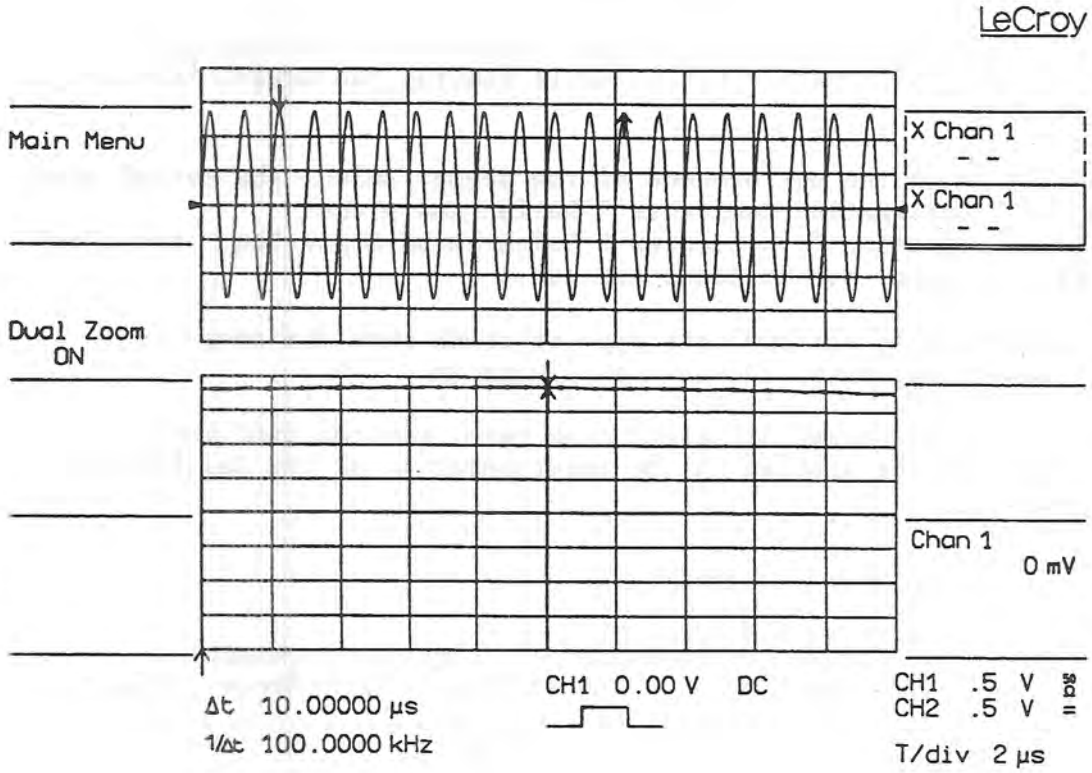


Figure 22: Alignment of cursors with maximum expansion.

Check:

The difference time reading must be within 9.998 and 10.002 µsec

3.2 Internal Diagnostics and Calibration

The 9410 Internal Diagnostics and Calibration menu is entered by pressing the " Main Menu " button while keeping the lowest menu button depressed.

To quickly check the performance of the scope, select the secret menu, press the " Calibration Constants " button and press " Full Recalibration " then enter " Calibration Error Log " and check that all the error status codes are zero.

It is advisable to perform this type of check when the scope is in a stable condition, after 20 minutes of warm up.

If you find error codes different from zero, you can find more information on the problem in the interpretation of the Calibration Error Log.

```
               | CALIBRATION ERROR LOG
               |
_______________| Vertical Calibration
               | 4 nibbles=(curves)(verify)(high gain)(unused)
Chan 1+2       | (8=Offset Range, 4=Offset Conv, 2=Gain Range, 1=Gain Conv)
  Calib Const  |
               |                  CHAN1       CHAN2
               |  5 mV              0           0
_______________| 10 mV              0           0
Chan 1+2       | 20 mV              0           0
     Full Test | 50 mV              0           0
               | .1  V              0           0
               |  1 mV              0           0
_______________|  2 mV              0           0
Full Re-       |
calibration    | ADC/TMS State  Working     Working
               |
Calibration    |    4 nibbles = (unused) (unused) (100Ms) (40Ms)
Error Log      |
_______________|
Manual FE      | Trigger Cal.      0           0
DAC Control    |
               |                   0           0  (2=No BWL, 1=BWL)
More Consts    |
               |                   0           0
_______________|
Return         | TDC Calibration               0
               |
```

Figure 1 : Calibration Error Log

3.2.1 Calibration Error Log

This is a handy tool to perform a quick but comprehensive internal performance check, without touching the acquisition settings.
Just push " Full Recalibration " then go to " Calibration Error Log ".

The gain and offset results displayed for channel 1 and channel 2 are independent of the following conditions :

- 50 Ohm or 1 MOhm input impedance
- BWL ON or OFF
- Variable gain
- Trigger mode and coupling
- Offset

The calibration results depends of the acquisition settings :

- Sampling rate : 40 Ms/s or 100 Ms/s
- Sensitivity : 1mV, 2mV, 5mV, 10mV, 20 mV, 50mV, 0.1V

The 50 Ohm input is not checked by the calibration, and the three ranges 0.2V, 0.5V, 1V are not calibrated because they use an attenuator by 10, which has an accuracy of 1/1000.

3.2.1.1 Vertical calibration

The error conditions are coded into binary bits, each bit set represents a certain error. The error status is represented in a hexadecimal number, for each acquisition condition.

The 4 error bits have the following meaning:

1 = Gain Convergence : One or more points of the gain curve can not be measured. The gain curve is the dependence of the front end variable gain on the 16 bit DAC.
The 16 bit DAC controls the variable gain.
During 5 minutes after the power on or after a full recalibration, the second variable gain IVgain2 use for the 1mV and 2mV range is verified.
If one error occurs, the error status gives 0010.

2 = Gain Range : The control of the variable gain is checked by software to be between < 0.95 and >2.75. see Figure 2 : Calibration constants

DAC 0 : < 0.95
DAC 9 : > 2.75

Push "CH1+2 Calib Const" to see the errors. The result displayed depends of the Sampling Rate selected 40 Ms/s or 100Ms/s.

4 = Offset Convergence : The offset curve cannot be measured. The dependence of the offset as seen by the user on the offset control voltage is described by three parameters.

One or all parameters cannot be determined.

8 = Offset Range : The maximum offset is + 1.2V and the minimum is - 1.2 V.

The calibration verify that the DAC can reach +/- 1.2 V offset.

The 4 nibbles or columns, where the error status are displayed correspond to the following conditions:

curves	verify	high gain	unused
X000	0X00	00X0	000X
1= Gain Convergence	Fail gain verify	Find high gain	
2= Gain range	Fail offset verify	IVgain2	
4= Offset convergence			
8= Offset Range			

Examples:

error code 8000 : Offset range problem
error code 2000 : Gain range problem
error code 0010 : Calibration problem on the second variable gain (IVgain2) use for the 1mV and 2mV sensitivity

```
               | Calibration Constants          100Ms/s   .2 µs/div
---------------|
Chan 1+2       | variable gain                   C1 (.1  V)   C2 (.1  V)
  Calib Const  | dac 0 (ffff= 0.8488mA)           0.8373        0.7794
               | dac 1 (f332= 0.8000mA)           0.8549        0.8008
               | dac 2 (d8f4= 0.7000mA)           0.9079        0.8561
               | dac 3 (beb7= 0.6000mA)           0.9820        0.9316
---------------| dac 4 (a47a= 0.5000mA)           1.0872        1.0341
Chan 1+2       | dac 5 (8a3c= 0.4000mA)           1.2345        1.1755
    Full Test  | dac 6 (6fff= 0.3000mA)           1.4513        1.3842
               | dac 7 (55c2= 0.2000mA)           1.7887        1.7066
               | dac 8 (3b84= 0.1000mA)           2.3756        2.2562
---------------| dac 9 (2148= 0.0000mA)           3.2495        3.0265
Full Re-       |
calibration    | offset
               | C1 (.1  V)  o0:-2.1513 o1:-0.369 o2: 6.71e-05  [ 0.0098± 2.1980]
Calibration    | C2 (.1  V)  o0:-2.2315 o1: 0.071 o2: 6.72e-05  [-0.0237± 2.2007]
Error Log      |
---------------|
Manual FE      | C1 current dac settings (.1  V* 1.00, 1.62e-01; 100Ms/s)
DAC Control    |   high gain      0000 =   -0.1576 mA
               |   gain adjust    baee =    0.5856 mA
More Consts    |   offset         88b9 = -1.48e-01 V
---------------|
Return         | C2 current dac settings (.1  V* 1.00, 1.20e-01; 100Ms/s)
               |   high gain      0000 =   -0.1576 mA
               |   gain adjust    accd =    0.5317 mA
               |   offset         8867 = -1.42e-01 V
```

Figure 2 : Calibration Constants

3.2.2 ADC / TMS STATE

The status must be " working ", no memory is indicated in the column if the ADC F9410-3 is not present.

3.2.3 Trigger calibration

The tests report problems for each of the two possible sampling rate, 100 Ms/s and 40 Ms/s, with BWL ON or BWL OFF, selected by the user.

1 = BWL ON

2 = BWL OFF

If the error code is not equal zero, the Hyst on the F9430-7 front end is not within the correct range 0.15/ 0.25 div, or the board has a complete failure.

See " More Consts " and " Trig Calibr Constants ". The adjustment of the trigger level is described in the test and calibration procedure of the F9430-7 front end.

Examples :

Code 20 : Trigger Calibration problem ,BWL OFF, at 100 Ms/s

Code 1 : Trigger Calibration problem at 40 Ms/s, BWL ON

Trig Calibr Constants

TDC Calibr

Recalibrate Trig Counter

Chan 1+2 Gain Test

RIS-FIR Corr ON/OFF

Return

Calibration Constants 100Ms/s .2 µs/div

C1 trigger threshold level

AC	t2:-3.82e-04	t1: 12.65	hyst.	-0.18	[0.127±-12.52]
LF REJ	t2:-3.65e-04	t1: 12.05	hyst.	-0.19	[0.076±-11.97]
HF REJ	t2: 3.64e-04	t1:-11.73	hyst.	0.19	[0.211± 11.94]
DC	t2:-3.67e-04	t1: 12.38	hyst.	-0.19	[0.363±-12.01]

C2 trigger threshold level

AC	t2:-4.11e-04	t1: 13.58	hyst.	-0.20	[0.118±-13.47]
LF REJ	t2:-3.94e-04	t1: 13.03	hyst.	-0.20	[0.107±-12.92]
HF REJ	t2: 3.92e-04	t1:-12.43	hyst.	0.20	[0.407± 12.84]
DC	t2:-3.97e-04	t1: 13.63	hyst.	-0.20	[0.620±-13.01]

trigger counter interval 2.541 ns

Figure 3 : Trigger Calibration Constants

3.2.4 TDC calibration

The TDC interpolator is calibrated at 40 Ms/s and 100 Ms/s.
If it is ok, The error code is zero.

Enter "More Consts" and press "TDC Calibr".

TDC CALIBRATION ANALYSIS

Trig Calibr
Constants
TDC Calibr

Recalibrate
Trig Counter

Chan 1+2
Gain Test

RIS-FIR Corr
ON/OFF

Return

Sampl. Frequency	40 Ms/s	100Ms/s
TDC offset in ns	-14.253	-5.757
TDC gain in ps/LSB	12.61	5.08
# in lower peak	487	177
# in upper peak	513	323
# outside histo	0	0
1st lower edge	1130	1128
2nd lower edge	1131	1138
Final lower edge	1130	1133
Final upper edge	2121	2117
Calibration	OK	OK

RIS FIR Correction Factors

CHAN1	CHAN2
-1.02%	0.29%

Figure 4 : TDC Calibration Constants

3.2.5 Non linearity

The DC non-linearity is analyzed for the sampling rate, BWL ON, BWL OFF 50 Ohm or 1 MOhm input, the user has set.

The test should be done for the two possible sampling rates 40 Ms/s and 100 Ms/s.

In order to change the sampling rate one has to leave the menu and set the time/div appropriate to the required sampling rate.

One vertical division represent 1/2 % of the full scale.

At present the variations should stay within +/- 1%.

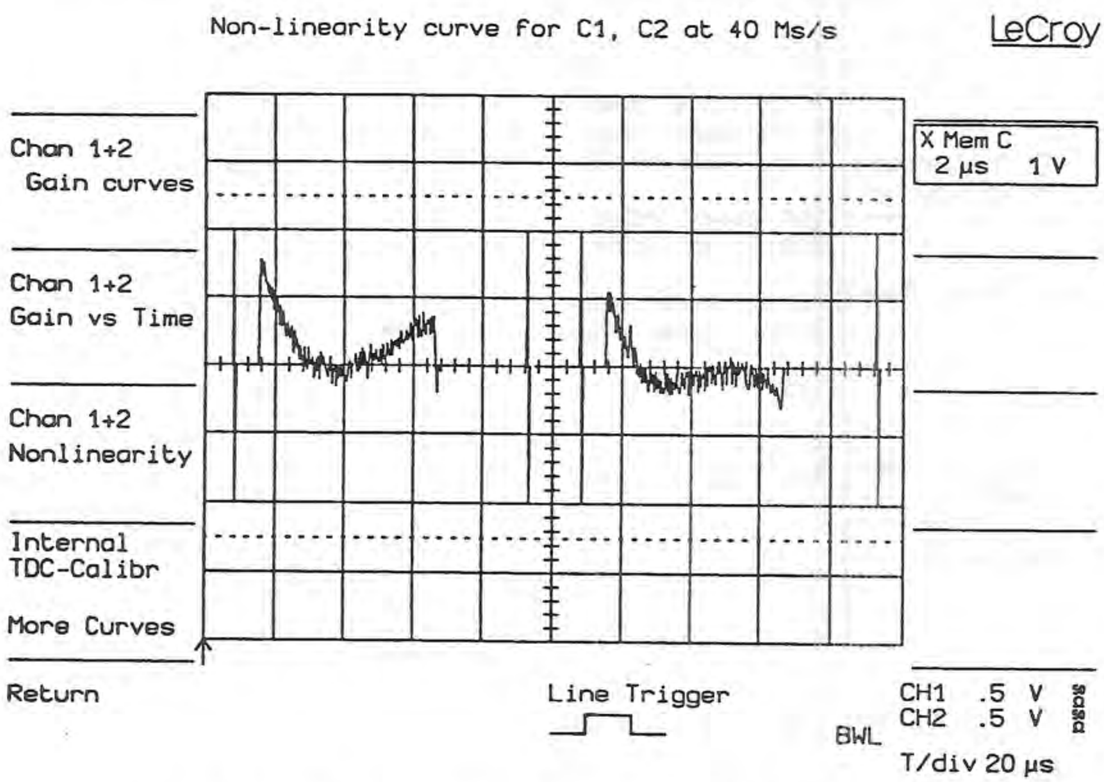


Figure 5 : Non Linearity Curve at 40 Ms/s

3.2.6 Internal TDC calibration

This test allows the user to check the calibration of the time base board F9420-4.

Press "Curves Calibration", and "Internal TDC-Calibr".

Check that the distribution contains two peaks

The amplitude and the width of the two peaks are not important.

The test should be done for the two possible sampling rates.

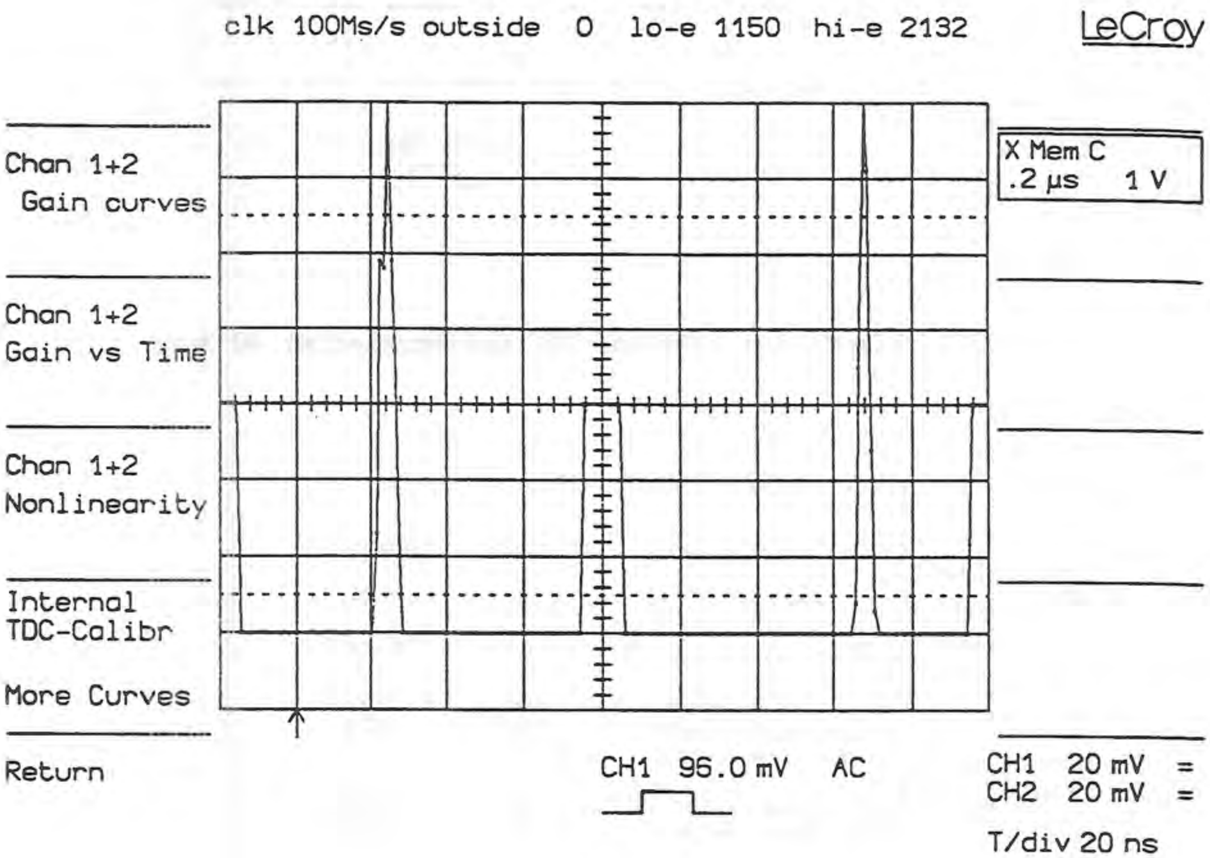


Figure 6 : Internal TDC Calibration at 100Ms/s

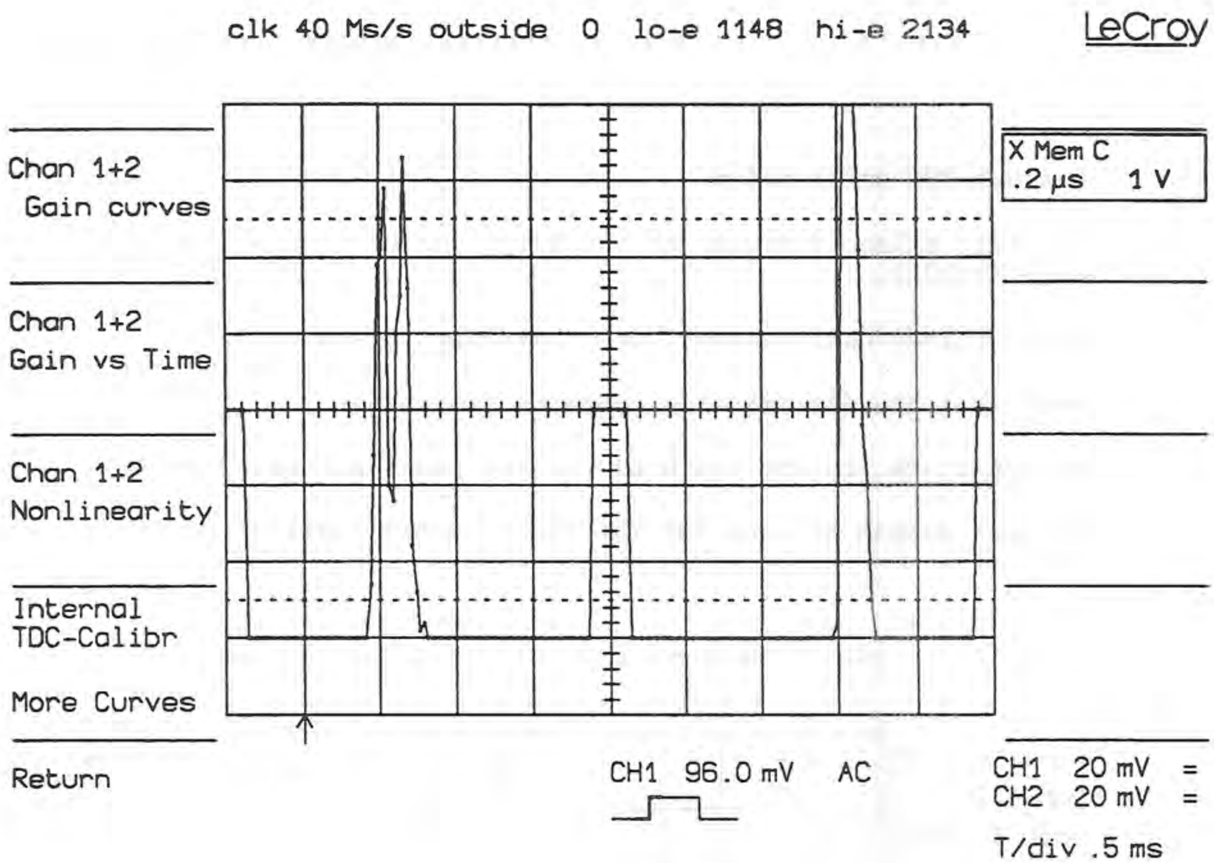


Figure 7 : Internal TDC Calibration at 40 Ms/s

Trig Calibr Constants
TDC Calibr

Recalibrate Trig Counter

Chan 1+2 Gain Test

RIS-FIR Corr ON/OFF

Return

TDC CALIBRATION ANALYSIS

Sampl. Frequency	40 Ms/s	100Ms/s
TDC offset in ns	-14.253	-5.757
TDC gain in ps/LSB	12.61	5.08
# in lower peak	487	177
# in upper peak	513	323
# outside histo	0	0
1st lower edge	1130	1128
2nd lower edge	1131	1138
Final lower edge	1130	1133
Final upper edge	2121	2117
Calibration	OK	OK

RIS FIR Correction Factors

CHAN1	CHAN2
-1.02%	0.29%

Figure 8 : TDC Calibration Analysis

Chapter 4

SERVICE INFORMATION

AND

PROCEDURES

TABLE OF CONTENTS

4.1 Disassembly and Assembly Procedure

The disassembly and assembly procedures detailed below refer to the assembly and disassembly diagram and the view of figure 4.1.,4.2.,4.3.

Please study the diagram and figures before attempting disassembly.

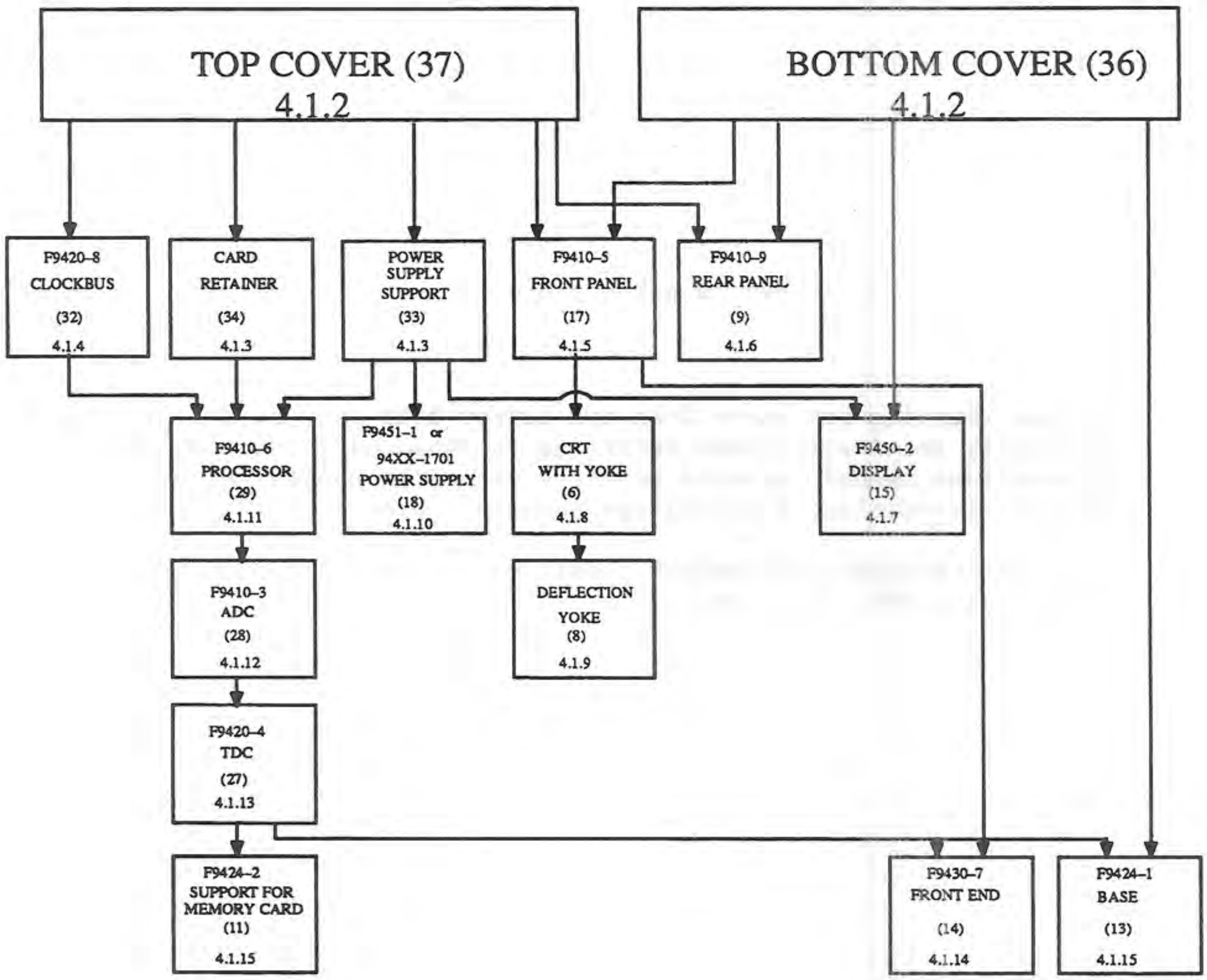
*** W A R N I N G ***

Before removing any parts from the LeCroy 9410 DSO, be sure to read carefully the instructions referring to those parts, noting any precautions needed to avoid problems caused by mechanical behavior, static electricity, high-voltage supplies, etc...

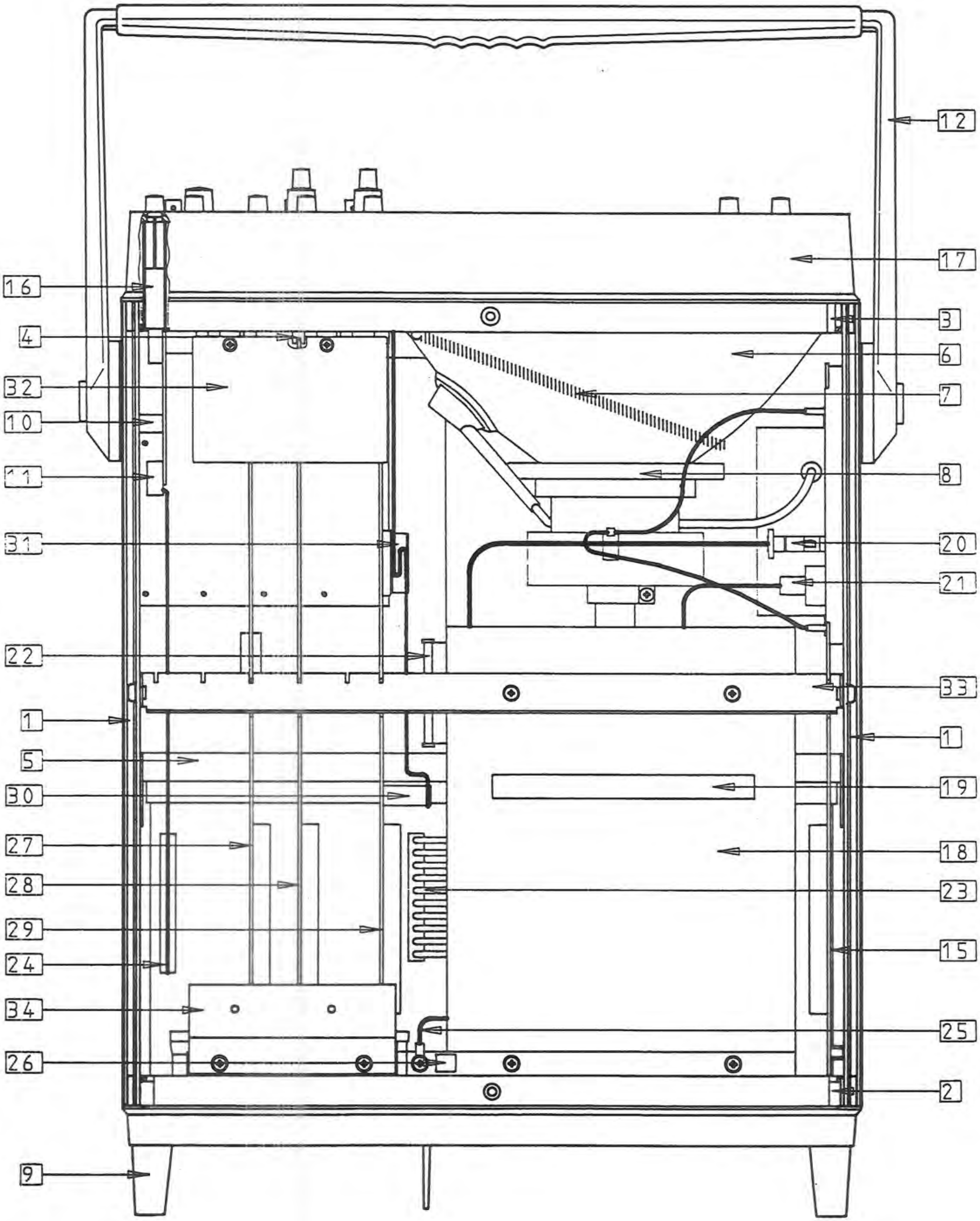
The usual precautions against static electricity are required (antistatic MAT, foam, bag)

4.1.1 Disassembly and Assembly Diagram

Disassembly: Any board can be removed only if any items higher in the diagram and connected by a line are already out.



Assembly: The reassembly procedure is the inverse of the disassembly procedure.



12
17
16
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4
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32
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33
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26
2
9

Figure 4.1

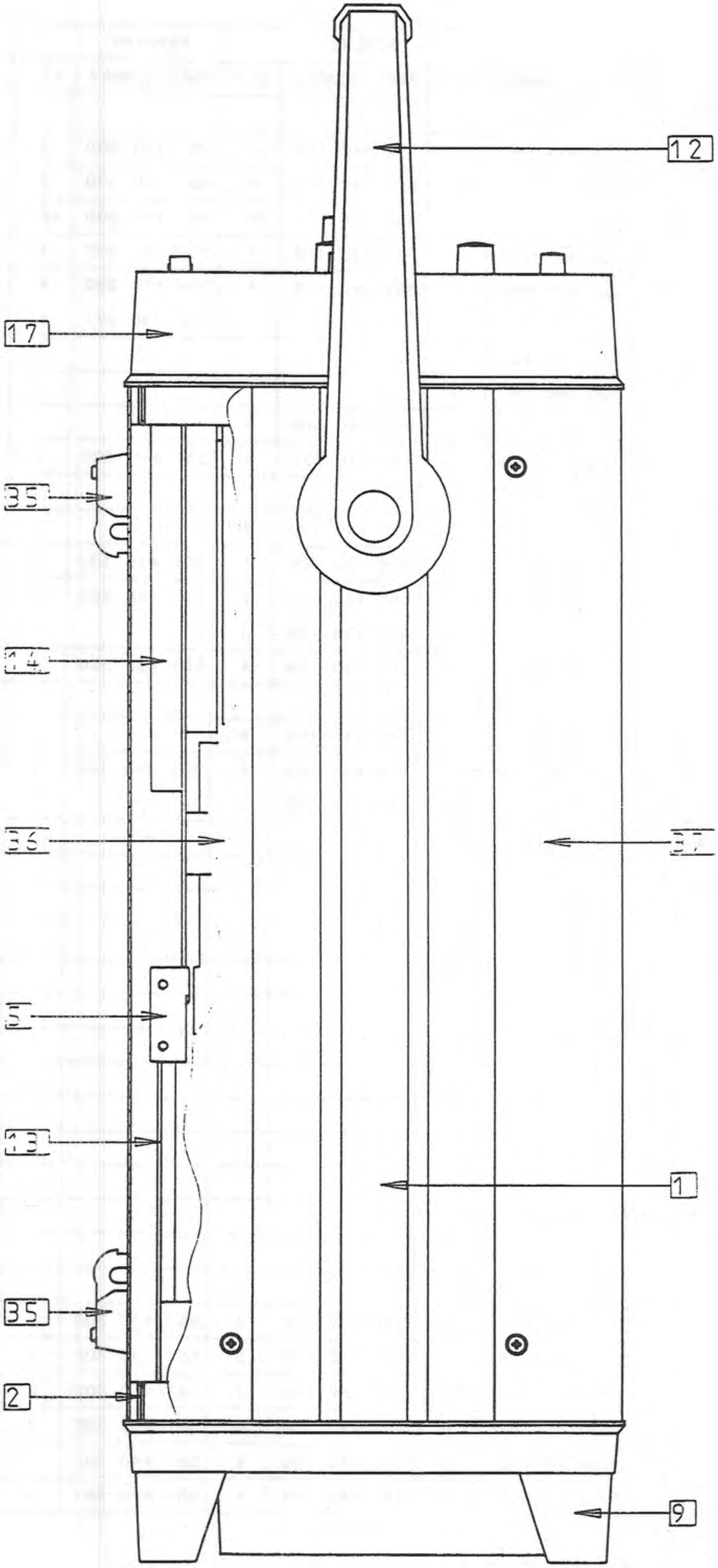


Figure 4.2

ASSEMBLAGE SEQUENCE OF PARTS				SCREWS		WASHERS		NUTS	
POS	DESCRIPTION	PART NUMBER	QTY	PART NUMBER	QTY	PART NUMBER	QTY	PART NUMBER	QTY
1	SIDE PANEL	709 424 021	2						
2	REAR SUPPORT	709 424 041	1	550 440 108	4	551 440 300	4		
3	DISPLAY SUPPORT	709 424 031	1	550 440 108	4	551 440 300	4		
4	CARD GUIDE	530 410 001	5	550 430 104	10	551 430 300	10		
5	MOTHER CARD SUPPORT	709 424 051	1	550 440 108	4	551 440 300	4		
6	CRT ORANGE	321 220 009	1	550 440 416	4	554 440 202 709 450 071	4 4	552 440 100	4
7	SPRING EXT TYPE 190mm	554 310 001	1						
8	DEFLECTION YOKE	300 090 001	1						
9	REAR PANEL FOR 9410	F9410-9	1	550 440 406	6				
10	SPACER INSERT GUIDE	709 424 098	1	550 440 120	1	551 440 300	1	709 424 011	1
11	SUPPORT FOR MC	F9424-2	1						
12	HANDLE	530 301 005	1	550 440 120	2			709 424 011	2
13	94XX-1 WITH MC LOGIC	F9424-1	1	550 430 106	4	551 430 300	4		
14	DUAL CHANNEL FRONTEND	F9430-7	1	550 430 106 550 430 108	2 3	551 430 300	5		
15	DISPLAY CARD FOR 94XX	F9450-2	1	550 430 106	4	551 430 300	4		
16	INSERTION GUIDE MC	709 424 098	1						
17	DUAL CHANNEL FP CARD	F9410-5	1	550 440 406	6				
18	POWER SUPPLY 9451-1	315 040 015	1	550 440 105 550 440 506	4 2	551 440 300	4		
18	POWER SUPPLY 94XX-1701	94XX-1701	1						
19	LABEL 'DANGER---ONLY	377 051 005	1						
20	DISPLAY POWER CABLE	780 210 030	1						
21	CRT CABLE	780 299 025	1						
22	FRONTEND BASE CABLE	780 231 120	1						
23	BASE CARD POWER CABLE	780 220 015	1						
24	MEMORY CARD CABLE	780 231 131	1						
25	GROUND CABLE	780 544 512	1						
26	LABEL GROUND SYMBOL	377 131 001	1						
27	TIMEBASE CARD	F9420-4	1						
28	DUAL CHANNEL	F9410-3	1						
29	PROCESSOR CARD	F9410-6	1						
30	FRONT PANEL CABLE	780 411 236	1						
31	CABLE CLIP AD BACK	594 230 002	1						
32	CLOCK-BUS	F9420-8	1	550 430 106	2	551 430 300	2		
33	POWER SUPPLY SUPPORT	709 424 061	1	550 430 106	2	551 430 300	2		
34	CARD RETAINER	709 424 095	1	550 440 108	2	551 440 300	2		
35	FOOT	530 010 024	4	550 440 110	4	551 440 300	4	552 440 100	4
36	LOWER COVER	709 424 081	1	550 440 708	4	551 440 501	4		
37	UPPER COVER	709 424 071	1	550 440 708	4	551 440 501	4		

Figure 4.3

4.1.2 Removal of upper and lower covers

The top (37) and bottom (36) covers are each secured by four M4X8 screws and washers. To remove the bottom (36) cover turn the handle (12) to the forward position. See figure 4.1 and 4.2

Removal of the top cover (37) gives access to the following boards:

11	-	F9424-2	Support for Memory Card
15	-	F9450-2	Display Board
18	-	F9451-1	Power Supply or 94XX-1701
27	-	F9420-4	Time Base
28	-	F9410-3	Dual ADC
29	-	F9410-6	Processor
32	-	F9420-8	Clock Bus

while removal of the bottom cover (36) gives access to:

13	-	F9424-1	Base
14	-	F9430-7	Front End

when working on the DSO it is useful to remove both covers, also to access to:

9	-	F9410-9	Rear Panel
17	-	F9410-5	Front Panel

4.1.3 Removal of the power supply support and card retainer

The power supply support (33) and the card retainer (34) hold the F9450-2 (15), F9410-6 (29), F9410-3 (28) F9420-4 (27), and the F9451-1 or 94XX-1701 (18) power supply in place and must be removed if any of these boards is to be removed. They are fixed with screws and washers see figure 4.1 and 4.2.

4.1.4 Removal of the F9420-8 clock bus

This is the little board (32) at the front right of the DSO across the top of the ADC board (28) and the TDC board (27). It is attached to the display support (3) with two screws and lock washers. Be careful to replace it after any work on the boards, and make sure that the two connectors are well aligned before pushing it home.

4.1.5 Removal of the F9410-5 front panel

In order to remove this board, first remove both covers (36), (37). (4.1.2)
Next remove the ribbon front panel cable (30) from the F9410-6 processor board (29).

Remove the six screws at the top, bottom, left and right of the front panel (17).

Now the front panel assembly can be removed from the DSO. If any parts need to be changed on the board F9410-5, the plastic front panel must be separated from the board. All the rotary knobs must be removed, which means taking off all the caps (careful, soft plastic) and loosening the screws and nuts. Then the 13 screws can be removed which frees the board. When replacing a push button,take great care to achieve good alignment, to avoid sticking when the button is used.

To change the fine gain potentiometers remove the 9430-52 by removing the four screws and washers.

4.1.6 Removal of the F9410-9 rear panel

Remove the 6 screws at the top, bottom, left and right of the plastic rear panel (9).

Disconnect the fan cable from the F9451-1 or 94XX-1701 power supply (18). The rear panel assembly can be removed from the DSO.

4.1.7 Removal of the F9450-2 display board

The display board (15) is situated along the left side of the DSO.

To remove it, first remove the top and bottom covers, and the power supply support (33). There are five cables connected to the F9450-2.

- Remove the two cables which lead to the deflection yoke.
- Remove the display power cable (20)
- Remove the CRT cable (21)
- Remove the EHT plug from the receptable at the right side of the CRT (6)

Touch the free end of the cable to the display support (3), this ensures that no significant charge remains. The CRT must be discharged similarly, using a tool or a long screw driver which is first placed to the metallic display support and on the CRT receptable, repeat until no spark is seen or heard.

Remove the four screws which secure the F9450-2 to the left panel and the board can now be removed vertically from the DSO, making sure that the EHT cable is kept away from boards, as some charge may remain.

*** W A R N I N G ***

The remaining electric field around the HV cable to the CRT can damage components on the F9410-6 (Eproms, 68020 co-processor) and front panel boards when it comes close to the processor board or the flat cable going to the front panel.

For this reason the HV cable has to be led around the top of the CRT as far away as possible from the boards and flat cable.

4.1.8 Removal of the CRT with the deflection yoke

Remove the following:

- Top and bottom covers 4.1.2
- F9410.5 Front panel 4.1.5
- EHT plug, the CRT cable and the two cables which lead to the deflection yoke, from the F9450-2 display board (15).
- Long helical grounding spring (7) which runs diagonally across the back of the bulb.
- Four screws, washers, and nuts on the front.

The tube (6) with the deflection yoke (8) can now, with care, be removed without any other boards having to be moved.

Hold the CRT very carefully or place soft padding under it.

4.1.9 Removal of the deflection yoke

Remove the following:

- Top and Bottom cover 4.1.2
- Front Panel 4.1.5
- CRT 4.1.8

Loosen the screw on the yoke ring holder.

The deflection yoke can be removed from the cathode ray tube.

4.1.10 Removal of the F9451-1 or 94XX-1701 power supply

Ensure the line power cable is disconnected.

Remove the following:

- Top cover of 9410 4.1.2
- Power supply support 4.1.3
- Two screws from the F9410-9 rear panel (9)
- Two screws, washers from the rear support (2)
- One screw, washer, and nut from the ground cable (25)

Disconnect the following:

- Fan power supply cable
- Display power cable (20)
- Base Card power cable (23)

The F9451-1 or 94XX-1701 power supply can be removed from the DSO.

4.1.11 Removal of the F9410-6 processor board

Remove the following:

- Top cover 4.1.2
- Power supply support 4.1.3
- Card retainer 4.1.3
- F9420-8 Clock bus 4.1.4

Disconnect the flat ribbon cable (30) from the F9410-6 processor (29) the board can now be removed vertically from the F9424-1 base board (13).

4.1.12 Removal of the F9410-3 dual ADC board

Remove the following:

- Top cover 4.1.2
- Power supply support 4.1.3
- Card retainer 4.1.3
- F9420-8 Clock bus 4.1.4
- F9410-6 Processor 4.1.11

Disconnect the two signal input cables from the ADC board (28). The F9410-3 can be removed vertically from the F9424-1 base board (13)

4.1.13 Removal of the F9420-4 TDC board

Remove the following:

- Top cover 4.1.2
- Power supply support 4.1.3
- Card retainer 4.1.3
- F9420-8 Clock bus 4.1.4
- F9410-6 Processor 4.1.11
- F9410-3 ADC 4.1.12

If the 9410 is equipped with the trigger out and trigger veto option, disconnect the two SMD cables from the TDC board connectors J2 and J3. If the 9410 has the clock in, and clock out option, disconnect the two SMD cables from the TDC connectors J10 and J7.
Now the F9420-4 can be removed vertically from the F9424-1 base board (13) and the F9430-7 front end (14).

4.1.14 Removal of the F9430-7 front end

Remove the following:

- Top and bottom covers 4.1.2
- Power supply support 4.1.3
- Card retainer 4.1.3
- F9420-8 Clock bus 4.1.4
- F9410-6 Processor 4.1.11
- F9410-3 ADC 4.1.12
- F9420-4 TDC 4.1.13
- Two screws and washers from the mother card support (5)
- Three screws and washers which secure the F9430-7 to the right panel.
- Front End Base Cable (22)

Now the front end can be removed forward.

4.1.15 Removal of the F9424-1 base board

Remove following:

- Top and bottom covers 4.1.2
- Power supply support 4.1.3
- Card retainer 4.1.3
- F9420-8 Clock bus 4.1.4
- F9410-6 Processor 4.1.11
- F9410-3 ADC 4.1.12
- F9420-4 TDC 4.1.13
- Front End base cable (22)
- Base card cable (23)
- Memory card cable (24)
- Four screws and washers from the mother card support (5)

At this stage the F9424-1 base board can be removed forward from the 9410.

4.1.16 Removal of the F9424-2 support for Memory card

Remove the following:

-	Top cover	4.1.2
-	Power supply support	4.1.3
-	Card retainer	4.1.3
-	F9420-8 clock bus	4.1.4
-	F9410-6 processor	4.1.11
-	F9410-3 ADC	4.1.12
-	F9420-4 TDC	4.1.13

Disconnect the memory card cable (24) from the F9424-2 connector. The screws and washers which secure the board to the right panel can be removed.
Slide the board out of the F9410-5 front panel.

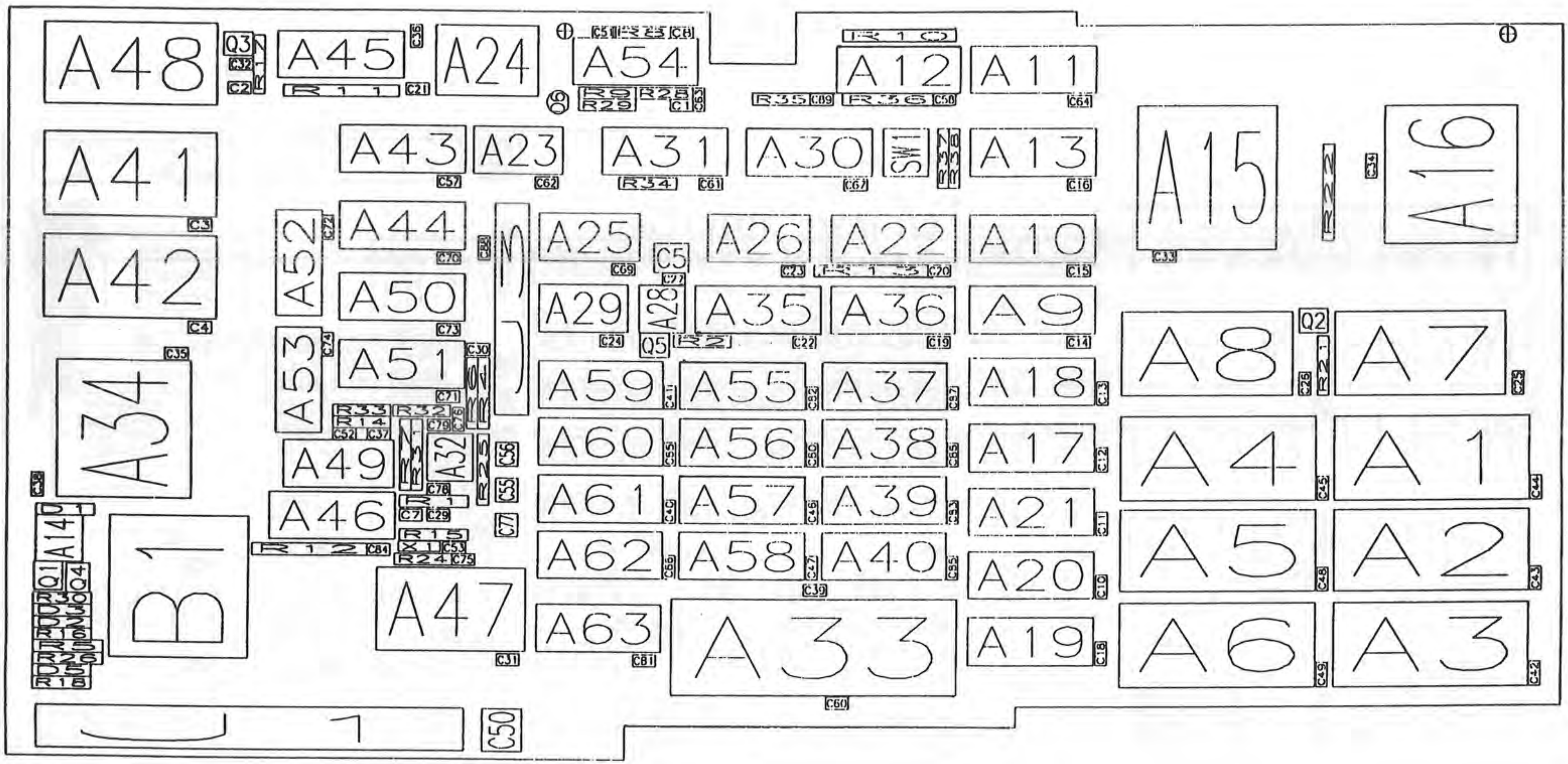
4.2 Software upgrade procedure

4.2.1 Changing Eproms

These six Eproms are on the F9410-6 processor (29) board, and access is possible only by removing the board.
Follow 4.1.11 procedure: removal of the F9410-6 processor board.
The precautions against static electricity are required.
Do not place the solder side of the board directly on an antistatic foam or mat, which are slightly conducting and can discharge the battery.
The Eproms can be removed using an IC extractor.
Replace the Eproms at location A1 to A6 see figure 4.4. and 4.5 with the latest version.
Make sure that the guiding notch in the chip is aligned with the PCB reassemble scope and check that it boots up properly.

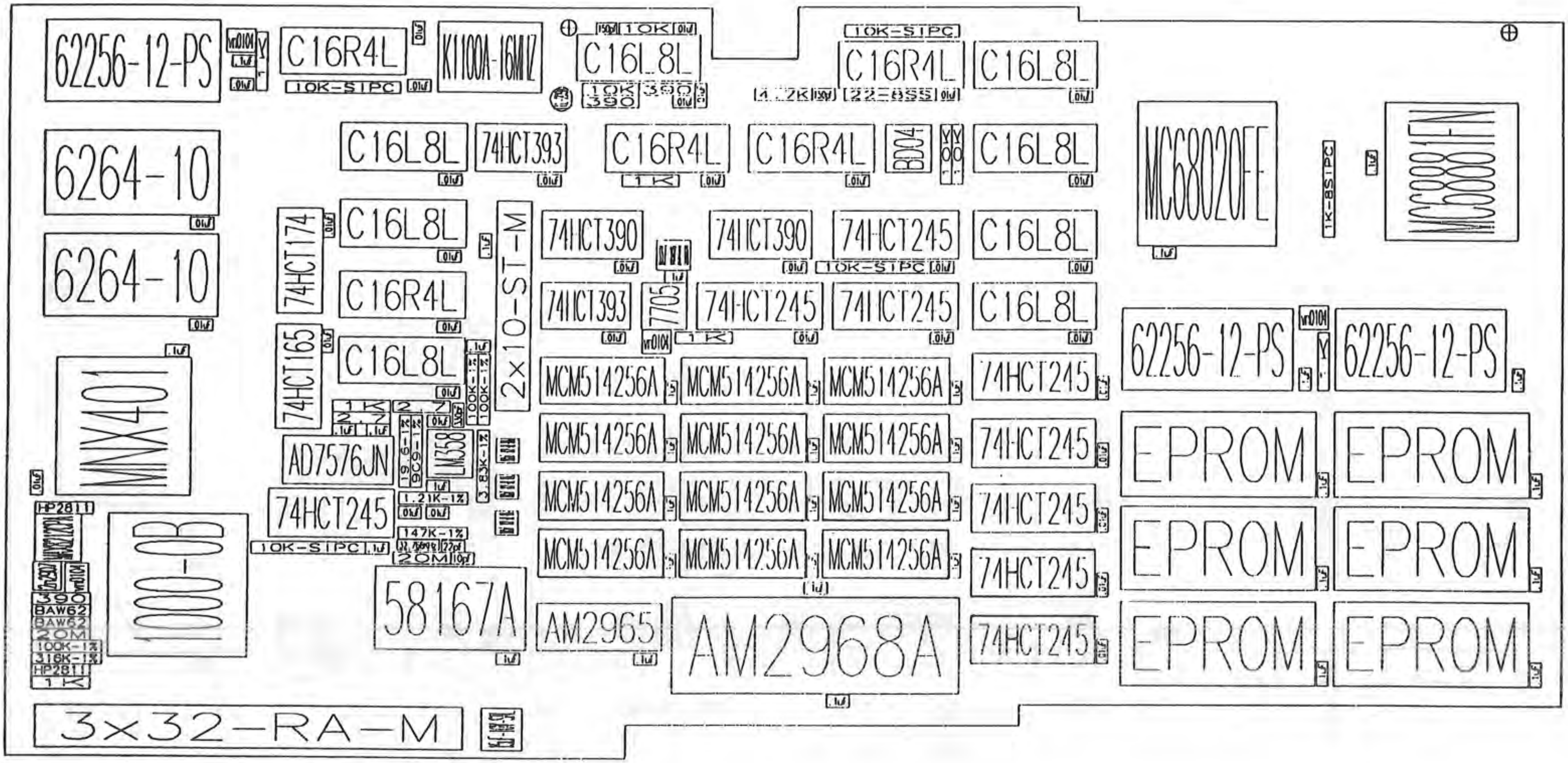
4.2.2 Changing software selection PAL

The software option selection PAL is located on the F9410-6 processor board in socket A45 (top left) see figure 4.4. and 4.5 follow 4.1.11 procedure and 4.2.1. Insert or replace the PAL into location A45.
Watch out to match the orientation notch.
Reassemble the boards and check that the scope boots correctly.



94XX_6 Rev:A

Figure 4.4



94XX_6 Rev:A

Figure 4.5

4.3 Software option selection PAL

The available software option selection PAL

0000:	standard:	Pal not necessary
0001:	WP01 :	Basic function package
0002:	WP02 :	Basic FFT package
0004:	WP03 :	Extented pulse parameter and histograms.
0008:	WP04 :	ATE support
0100:	MATE :	MATE remote control
0200:	CARD :	Memory card
0400:	ECLK :	External clock In/Out

See figure 4.6

OPTIONS						PAL Description
MATE	CARD	WP04	WP03	WP02	WP01	
	-	-	-	-	-	Standard PAL not necessary
	-	-	-	-	X	PG0001
	-	-	-	X	-	PG0002
	-	-	-	X	X	PG0003
	-	-	X	-	-	PG0004
	-	-	X	-	X	PG0005
	-	-	X	X	-	PG0006
	-	-	X	X	X	PG0007
	-	X	-	-	-	PG0008
	-	X	-	-	X	PG0009
	-	X	-	X	-	PG000A
	-	X	-	X	X	PG000B
	-	X	X	-	-	PG000C
	-	X	X	-	X	PG000D
	-	X	X	X	-	PG000E
	-	X	X	X	X	PG000F
X		-	-	-	-	PG0100
X		-	-	-	X	PG0101
X		-	-	X	-	PG0102
X		-	-	X	X	PG0103
X		-	X	-	-	PG0104
X		-	X	-	X	PG0105
X		-	X	X	-	PG0106
X		-	X	X	X	PG0107
X		X	-	-	-	PG0108
X		X	-	-	X	PG0109
X		X	-	X	-	PG010A
X		X	-	X	X	PG010B
X		X	X	-	-	PG010C
X		X	X	-	X	PG010D
X		X	X	X	-	PG010E
X		X	X	X	X	PG010F
						PG0100
	X	-	-	-	-	PG0200
	X	-	-	-	X	PG0201
	X	-	-	X	-	PG0202
	X	-	-	X	X	PG0203
	X	-	X	-	-	PG0204
	X	-	X	-	X	PG0205
	X	-	X	X	-	PG0206
	X	-	X	X	X	PG0207
	X	X	-	-	-	PG0208
	X	X	-	-	X	PG0209
	X	X	-	X	-	PG020A
	X	X	-	X	X	PG020B
	X	X	X	-	-	PG020C
	X	X	X	-	X	PG020D
	X	X	X	X	-	PG020E
	X	X	X	X	X	PG020F

Figure 4.6

4.4 Board exchange procedure

4.4.1 F9424-1 Base board

This card carry the programmable array logic (PAL) which is specific to the DSO serial number (S/N):

PAL XXXX in location A22
XXXX = DSO serial number

WARNING: The replacement board is supplied without this PAL.

Therefore you have to transfer the existing PAL from the faulty board to the new board.

4.4.2 F9410-6 Processor board

The processor carry Eproms (LOC A1 to A6) and software option selection PAL (LOC A45).

see figure 4.5 and 4.6

PAL PG XXXX_R

XXXX = software option.
R = release

see figure 4.6

The Eproms and PAL can be removed using an IC extractor. The usual precautions against static electricity are required.

WARNING: The replacement board is supplied without PAL neither Eproms

Therefore you have to transfer the existing PAL and Eproms from the faulty board to the new board.

4.5 F9451-1 Power Supply Adjustment Procedure

The +/- 5V, +/- 15 V can be adjusted to the nominal values in the following way. The reference for the measurements are the pins on connector J7 on the F9424-1 Base Board.

From top to bottom

-15v pin 10, +15v pin 9, -5v pin 8, +5v pin 5, Gnd pin 6

Have the scope turned on. For safety reasons, unplug the mains cable from the outlet without turning the scope off.

Follow the F9451-1 power supply disassembly procedure 4.1.10.

The adjustment potentiometers are situated on the small power supply PCB next to the F9450-2 display board.
In order to get access for adjustment, put the scope on its rear feet and pivot the power supply unit slightly away from the display board. Make sure the mains cable stays plugged into the line filter.

Plug the mains cable back into the outlet and wait for the scope to turn on.

Proceed to voltage adjustments with a very small screwdriver.
The four potentiometers are arranged on the PCB in the following order:

```
                          top

          ---------------------------------------
          |    x         x         x        x    |
     rear |                                      | front
          |   +5V       -5V      +15V     -15V   |
          |                                      |
          ---------------------------------------
```

Note the nominal voltages with their tolerances given in the specifications.

```
+ 15.00 V  +/- 1%
- 15.04 V  +/- 1%
+  5.07 V  +/- 1%
-  5.16 V  +/- 1%
```

Unplug the mains cable from the outlet. Reassemble the power supply unit to the scope.

4.5.1 94XX-1701 Adjustments

The four tensions are adjustable by +/- 5% of the nominal value. The reference for the measurements are the pins on connector J7 located on the F9424-1 base board.

From top to bottom:

pin 10: -15V   pin 9: +15V   pin 8: -5V   pin 6: Gnd   pin 5: +5V

The four potentiometers are easily accessible from the front with a small screwdriver, and are arranged on the PCB in the following order:

```
----------------------------------------------
|                                            |
|     X          X          X          X     |
|                                            |  right
|   -15V       +15V        -5V        +5V    |
|                                            |
----------------------------------------------
                    bottom
```

From left to right:

R306:	- 15.1 V	(min = -14.85 V, max = - 15.15 V)
R206:	+ 15.1 V	(min = +14.85 V, max = + 15.15 V)
R108:	- 5.2 V	(min = - 5.15 V, max = - 5.25 V)
R407:	+ 5.2 V	(min = + 5.15 V, max = + 5.25 V)

The current limiter (R18) is adjusted by the manufactured in production, this adjustment cannot be done in the field.

The +/- 15.1 V for the display board are protected by two slow blow fuses: 2A/ 250 V.

****** WARNING ******

The two large heat sink mounted on components Q3 and Q4 are connected to 220 Vac. For safety reasons do not touch them.

4.6 F9430-7 Front End Test and Calibration Procedure

4.6.1 Power Supplies

Check with a voltmeter on Test Point TP1 (12 pins) the following voltages :

Pin 1 - 2 (-)	:	+ 12 V	+/- 0.50 V	
Pin 3 - 4 (-)	:	+ 8 V	+/- 0.35 V	
Pin 5 - 6 (-)	:	+ 5 V	+/- 0.20 V	Direct from Connector J10
Pin 7 - 8 (-)	:	- 5 V	+/- 0.20 V	" " " "
Pin 9 - 10(-)	:	- 8 V	+/- 0.35 V	
Pin 11 - 12(-)	:	- 12 V	+/- 0.50 V	

Maximum Currents :

+ 15 V	:	I Max = 0.4 Amp
+ 5 V	:	I Max = 0.4 Amp
- 5 V	:	I Max = 0.3 Amp
- 15 V	:	I Max = 0.3 Amp

4.6.2 Input Impedance

Set DSO CH1 input to 50 Ohm, DC Coupling, with any Time Base and Gain, Check with an ohmmeter:

- input impedance must be 50 Ohm +/- 1%

Set DSO CH1 input to 1 mOhm, DC Coupling, 50 mV/div (divider by 1), with any Time Base. Check:

- input impedance must be 1 mOhm +/- 1%

Repeat 1 mOhm test for 200 mV/div (divider by 10)

- input impedance must be 1 mOhm +/- 1%

Repeat all impedance checks for CH2, External Trigger, and External/10 (1mOhm only)

4.6.3 Leakage Currents

With a high precision DMM, type PM2525 measure the leakage currents in 50 Ohm, 1 mOhm divider by 1, and 1 mOhm divider by 10, on CH1 and CH2. Check also the External Trigger.
Set the DSO to DC Coupling, and connect the DMM in DC mode to the input.

- CH1 and CH2 in 50 Ohm should be zero
- CH1 and CH2 in 1 mOhm, 100 mV/ div : should not be larger than +/- 100 uV
- CH1 and CH2 in 1 mOhm, 200 mV/ div : " " " " " " "
- External Trigger : should not be larger than +/- 500 uV

4.6.4 Variable Gain Adjustment

The following adjustments have to be made after the F9430-7 Front-End has been mounted into the scope.

In the secret menu select " CALIBRATION CONSTANTS ", enter " CALIBRATION ERROR LOG " and check that all the error status are zero.

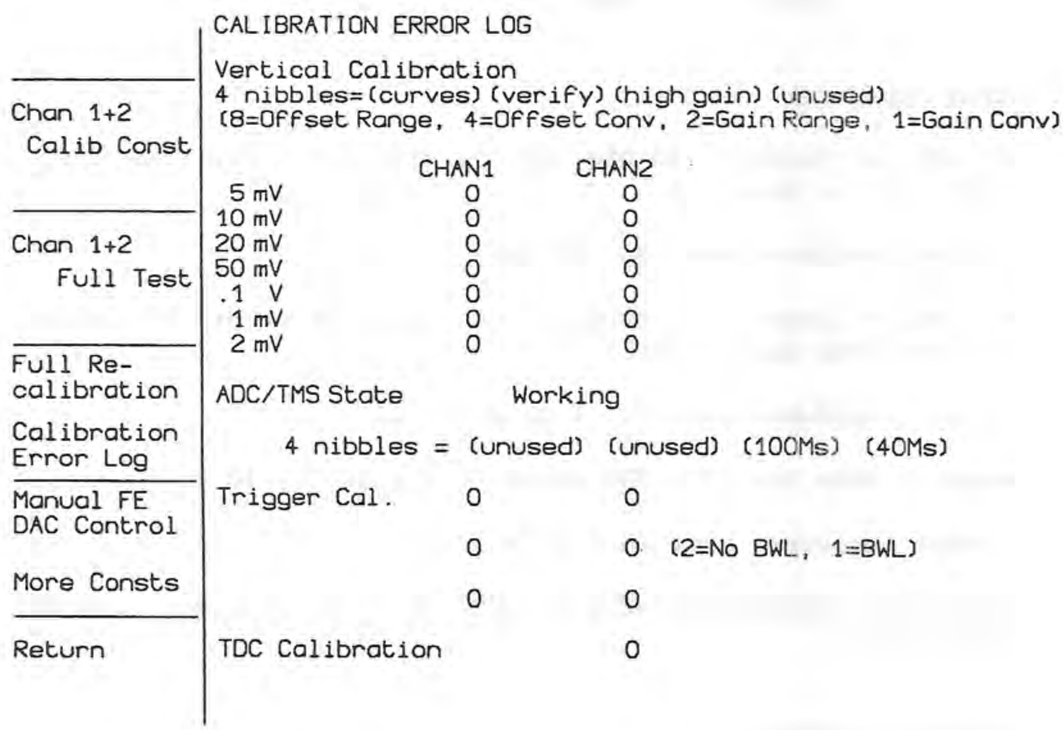


Figure 1 : Calibration Error Log

- Set DSO CH1 and CH2 input to 50 ohm DC, 20 mV/div, 10usec/div, 100 Ms/s Sampling Rate.

- Enter " CH 1+2 CALIB CONST ",

- Adjust potentiometer R161 on CH1 and R261 CH2 in order to get:

  DAC 4 (0.5 mA) C1 = 1.05 C2 = 1.05

- Push " FULL RECALIBRATION " and check that for the sensitivities 1mV, 2mV, 5mV, 10mV, 20mV, 50mV, 0.1V the variable Gain is :

  DAC 0 (0.8488 mA) C1 < 0.95 C2 < 0.95

  DAC 9 (0.0000 mA) C1 > 2.75 C2 > 2.75

- Set scope to 40 Ms/s Sampling Rate (0.1ms/Div), and recheck that for the ranges up to 0.1V, DAC 0 and DAC 9 on C1 and C2 are within the limits.

- Readjust the two potentiometers until it pass in all configurations.

- The three ranges 0.2V, 0.5V, 1V are not checked by the calibration, because they use an attenuator by 10 which has an accuracy of 1/1000.

```
                     Calibration Constants        100Ms/s   10 µs/div

Chan 1+2          variable gain                   C1 (20 mV)   C2 (20 mV)
  Calib Const     dac 0 (ffff= 0.8488mA)          0.7885       0.7887
                  dac 1 (f332= 0.8000mA)          0.8151       0.8126
                  dac 2 (d8f4= 0.7000mA)          0.8731       0.8692
                  dac 3 (beb7= 0.6000mA)          0.9517       0.9521
                  dac 4 (a47a= 0.5000mA)          1.0579       1.0548
Chan 1+2          dac 5 (8a3c= 0.4000mA)          1.2022       1.2025
    Full Test     dac 6 (6fff= 0.3000mA)          1.4161       1.4163
                  dac 7 (55c2= 0.2000mA)          1.7460       1.7502
                  dac 8 (3b84= 0.1000mA)          2.3027       2.3010
                  dac 9 (2148= 0.0000mA)          3.0826       3.0387
Full Re-
calibration       offset
                  C1 (20 mV)  o0:-1.5505  o1: 0.026  o2: 4.74e-05   [ 0.0035± 1.5535]
Calibration       C2 (20 mV)  o0:-1.5613  o1: 0.143  o2: 4.72e-05   [-0.0127± 1.5457]
Error Log
                  C1 current dac settings (20 mV* 1.00, 0.00e+00; 100Ms/s)
Manual FE            high gain     0000 =   -0.1576 mA
DAC Control          gain adjust   b110 =    0.5480 mA
                     offset        7fb4 =  3.49e-03 V
More Consts
                  C2 current dac settings (20 mV* 1.00, 0.00e+00; 100Ms/s)
Return               high gain     0000 =   -0.1576 mA
                     gain adjust   b066 =    0.5454 mA
                     offset        8114 = -1.28e-02 V
```

Figure 2 : Calibration Constants

4.6.5 DAC Calibration

- Set DSO to Auto Trigger during the adjustments.
- Enter " CALIBRATION CONSTANTS " go to " MANUAL FE DAC CONTROL "
- Press " CALIBRATION 7FFF "

4.6.5.1 Set code 7FFF with CH1 or CH2 offset button

- On board revision C,D, E DAC 7FFF = 0.00015259 V : 22.889 uV
- On board revision G DAC 7FFF = 0.00015260 V : 37.22 uV
- With a high precision DMM type PM2525 (+/- .1%)
  adjust potentiometer R12 in order to get between pin 8 (+) and pin 4 (-) of TP2:
- On Rev C,D,E 23 uV +/- 50 uV
- On Rev G 37 uV +/- 50 uV

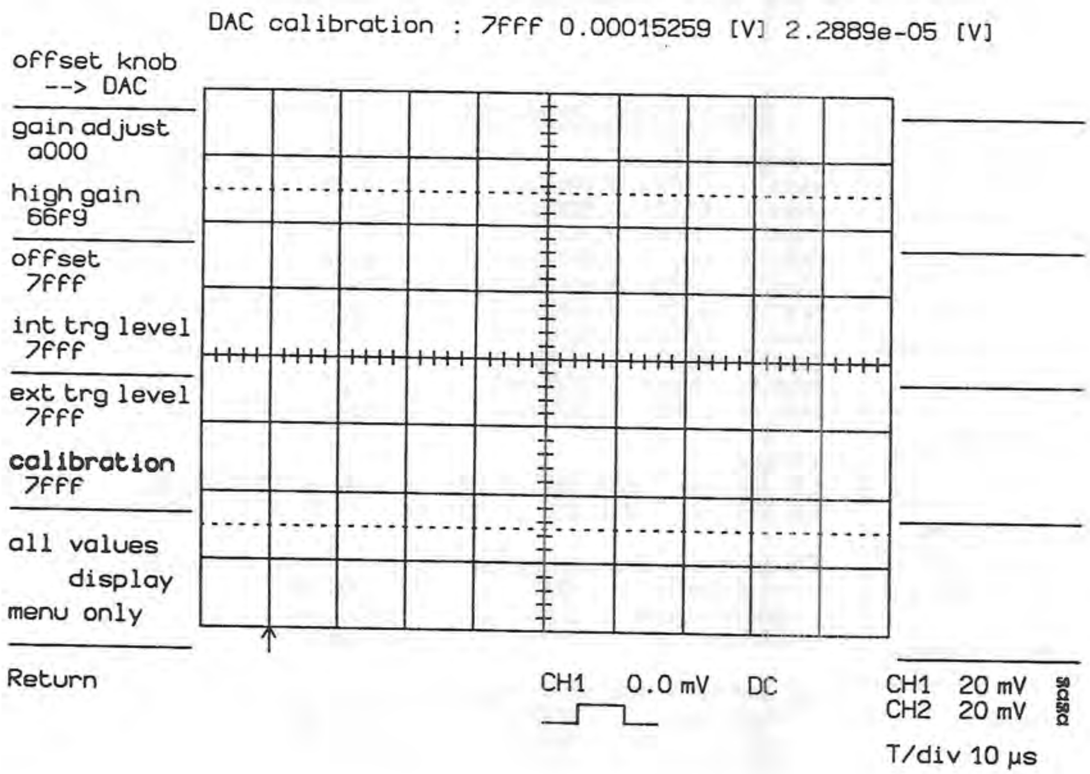


Figure 3 : DAC Calibration code 7FFF

4.6.5.2 On board revision C, D, E

- Set code 2AAA with CH1 or CH2 offset button

  DAC 2AAA = + 6.6668 V : + 1V

- Adjust potentiometer in order to get :

  + 1.000 V +/- 1mV between pin 8 and pin 4 of TP2

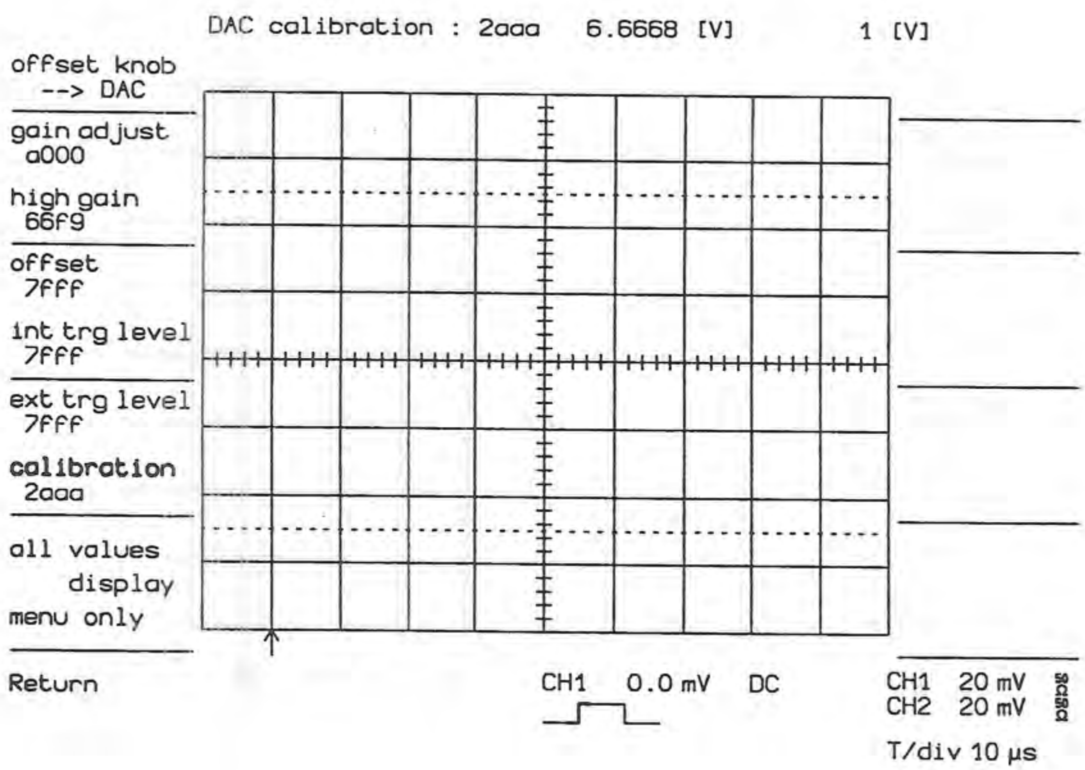


Figure 4 : DAC Calibration code 2AAA

4.6.5.3 On board revision G

- Set code 4B85 with CH1 or CH2 offset button

  DAC 4B85 = + 4.1V : + 1V

- Adjust potentiometer R18 in order to get :

  + 1.000V +/- 1 mV between pin 8 and pin 4 of TP2

4.6.5.4 On board revision C, D, E

- Set code D555 with CH1 or CH2 offset button

  DAC D555 = - 6.6668 V : - 1 V

- Check with a DMM that the reading is :

  - 1.000 V +/- 1 mV between pin 8 and pin 4 of TP2

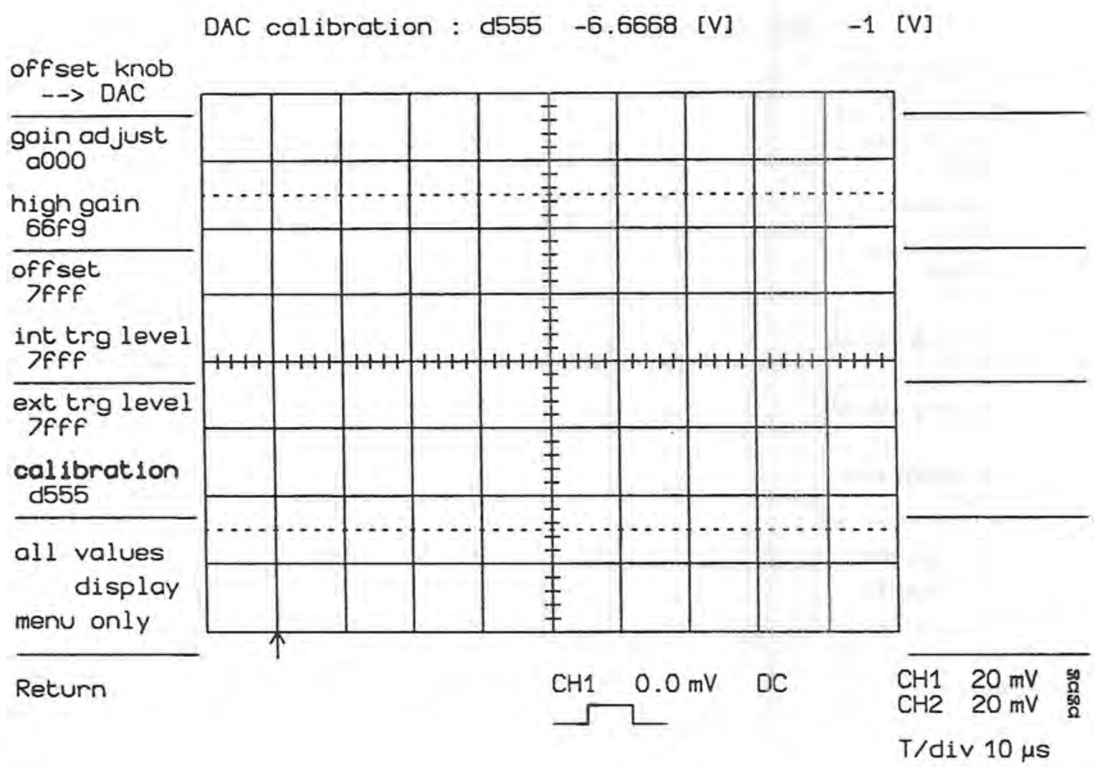


Figure 5 : DAC Calibration code D555

4.6.5.5 On board revision G

- Set code B47A with CH1 or CH2 offset button

  DAC B47A = - 4.1V : - 1 V

- Check with a DMM that the reading is :

  - 1.000 V +/- 1mV between pin 8 and pin 4 of TP2

4.6.6 CH1 and CH2 Trigger Adjustment

- Set DSO CH1 and CH2 to 50 Ohm, DC, 100 mV/div
- Enter "CALIBRATION CONSTANTS", press "MORE CONSTS"
- Go to "TRIG CALIBR CONSTANTS"
- Adjust potentiometer R178 on CH1 and R278 on CH2 in order to get:

  Hyst = 0.22

  Limits: 0.30 < HYST > 0.15

- When performing the adjustment, one has to leave the menu and make a full recalibration to get the new Hyst value on the screen.
- The test should be done with BWL ON, BWL OFF, at the two possible Sample rates 40 Ms/s = 20 us/div, and 100 Ms/s = 10 us/div.

Trig Calibr Constants

TDC Calibr

Recalibrate Trig Counter

Chan 1+2 Gain Test

RIS-FIR Corr ON/OFF

Return

Calibration Constants 100Ms/s 10 µs/div

C1 trigger threshold level

AC	t2:-3.92e-04	t1: 12.99	hyst. -0.20	[0.156±-12.83]
LF REJ	t2:-3.68e-04	t1: 12.23	hyst. -0.21	[0.168±-12.06]
HF REJ	t2: 3.66e-04	t1:-11.75	hyst. 0.23	[0.249± 12.00]
DC	t2:-3.70e-04	t1: 12.70	hyst. -0.19	[0.585±-12.12]

C2 trigger threshold level

AC	t2:-3.84e-04	t1: 12.64	hyst. -0.21	[0.066±-12.57]
LF REJ	t2:-3.71e-04	t1: 12.24	hyst. -0.23	[0.092±-12.15]
HF REJ	t2: 3.66e-04	t1:-11.49	hyst. 0.23	[0.512± 12.00]
DC	t2:-3.75e-04	t1: 12.99	hyst. -0.22	[0.697±-12.29]

trigger counter interval 2.502 ns

Figure 6 : Trigger Calibr Constants at 100Ms/s BWL OFF

4.6.7 CH1 and CH2 Non Linearity

- The DC non-linearity is analyzed for the sampling rate 40 Ms/s or 100 Ms/s, BWL ON or BWL OFF, 50 Ohm or 1 Mohm that the user has set.

- Turn potentiometer R156 on CH1 and R256 on CH2 fully clockwise

- This adjustment affects the Bandwidth and the Gain calibration

- Check that you get at 40 Ms/s and 100 Ms/s the following curves :

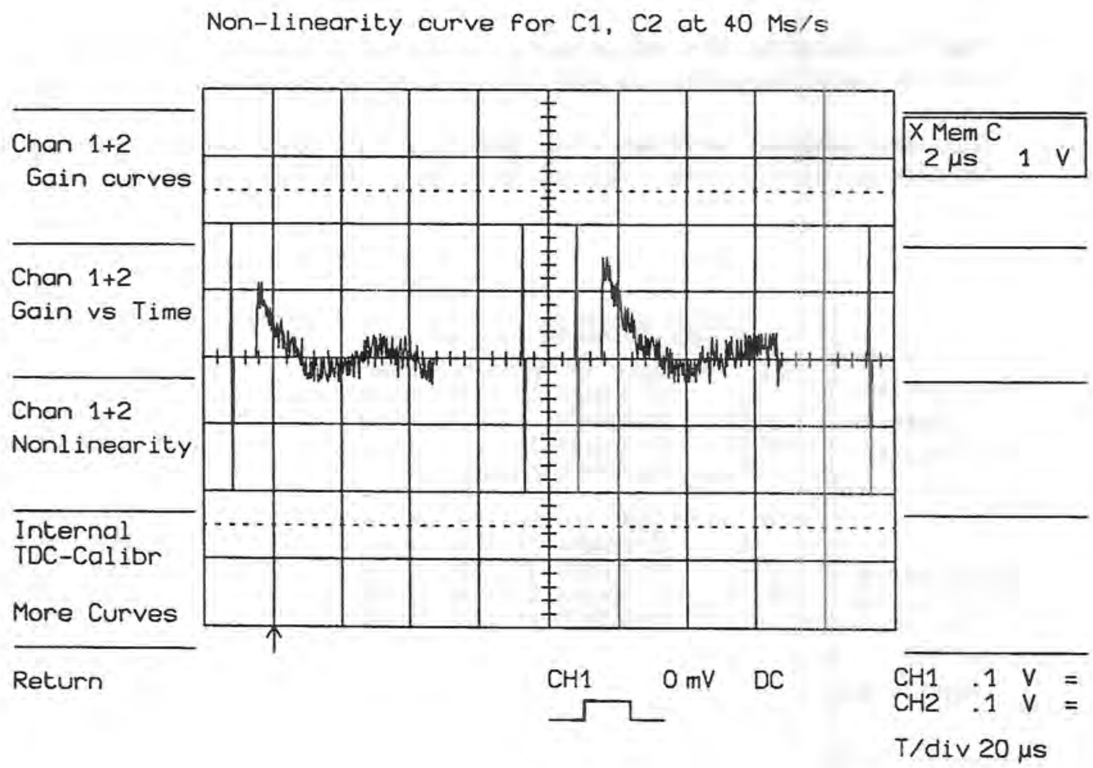


Figure 7 : Non Linearity curves at 40 Ms/s

- One vertical division represent 1/2 % of Full Scale.

- At present the variations should stay within +/- 1 %

- After the Non linearity adjustment is done, recheck the variable Gain calibration (see 4.6.4).

4.6.8 Channel 1 HF Compensation

- Apply the fast risetime generator LeCroy 4969 (typical < 700 psec) set to 62.5 Ms period, through one 9.1 KOhm resistor to CH1.

- Set DSO to 1 Mohm, 0.2 V/div, 5 us/div.

- Use Function E in Average mode type Summed or Continuous with weigh 1:7.

- Multiply the vertical gain of the Function E, by a factor 10.

- Set trigger to Neg slope in order to display on the screen the trailing edge of the pulse.

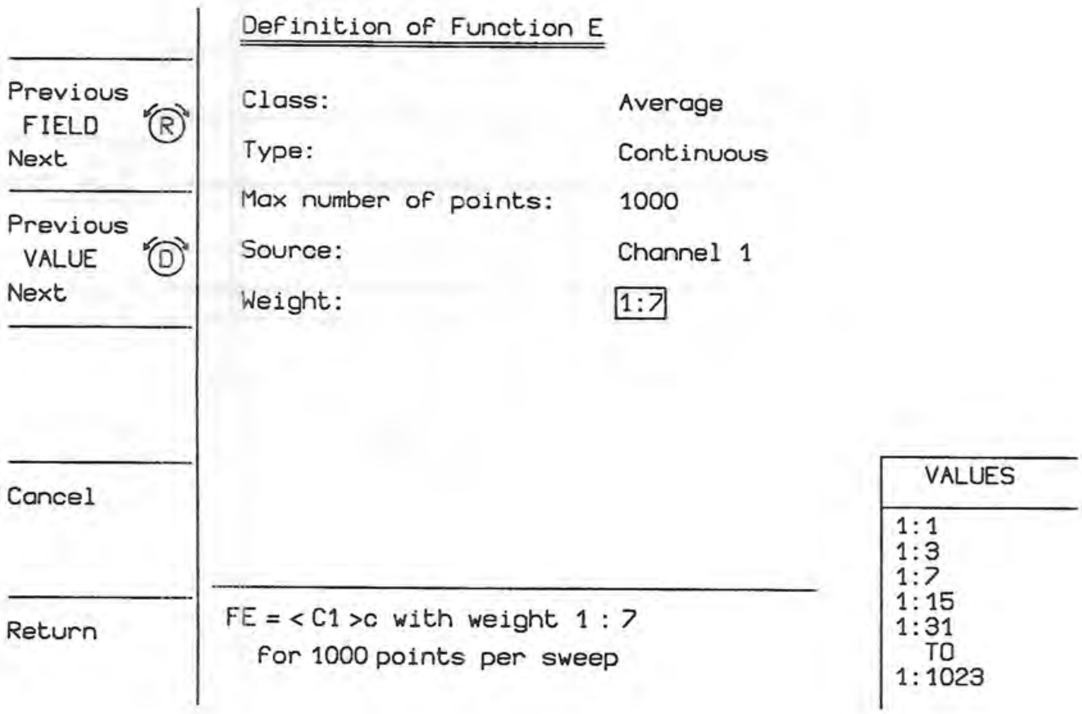


Figure 8 : Definition of Function E

- Adjust the variable capacitor C101 to get a flat square wave without over/undershoot.

- This cap adjust the flatness of the attenuator / 10.

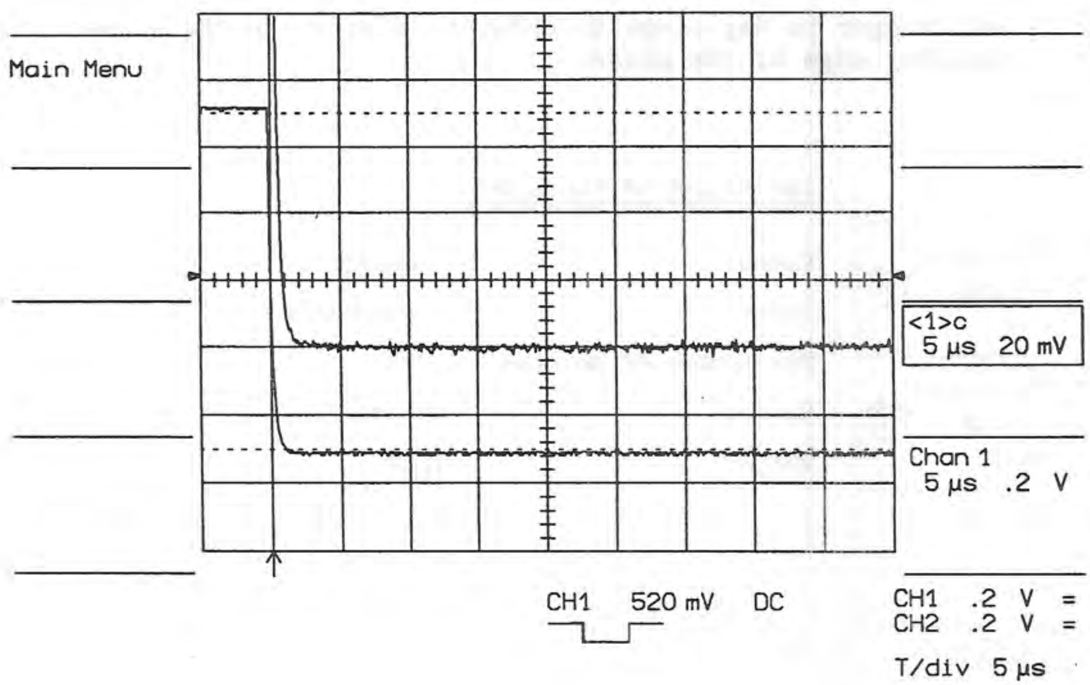


Figure 9 : CH1 Flatness adjustment with C101

- Select 0.5 us/div, 0.2 V/div,(divider by 10)
- Turn on the pulse parameters, with parameters source on Function E.
- Note the fall time. It corresponds to the input capacitor of the attenuator by 10.
- 20 ns corresponds to 1pf.
- The reading should be between 500 and 600 ns. Typical 500 ns.
- Check that the region of interest markers are properly set around the pulse edge.

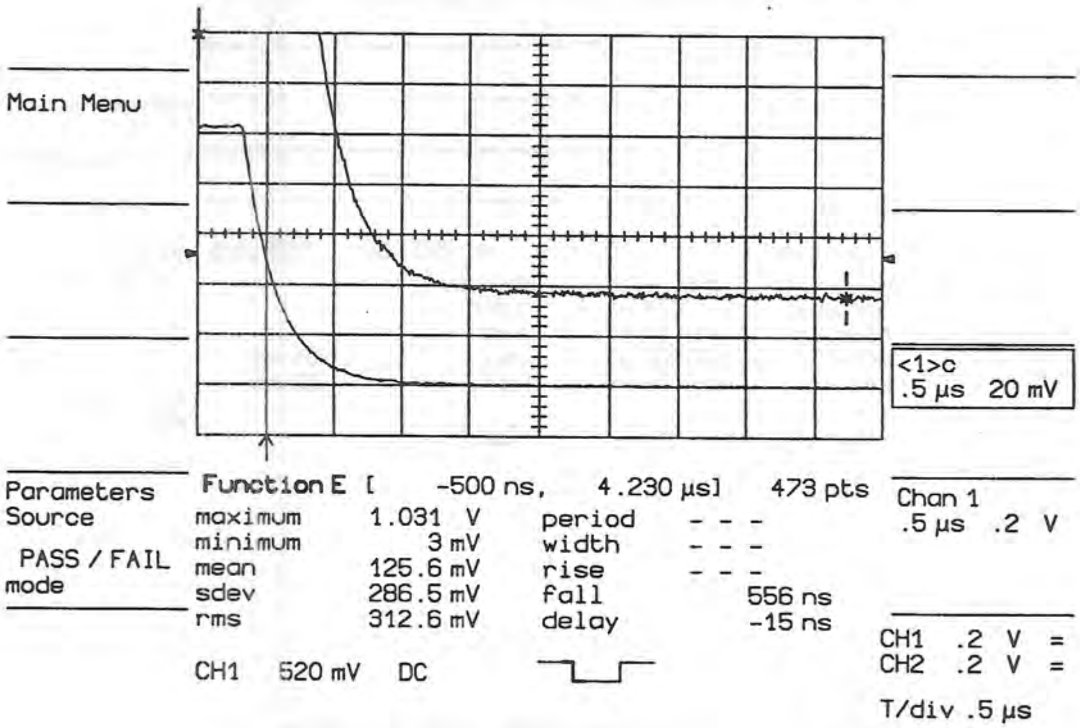


Figure 10 : CH1 Fall time in 0.2 V/div

- Set 0.1 V/div (divider by 1).

- Put a 6db attenuator between the 4969 pulser and the 9.1K resistor.

- Adjust the variable cap C108 in order to get the same Fall time at +/- 20 ns, than in the range using the divider by 10.

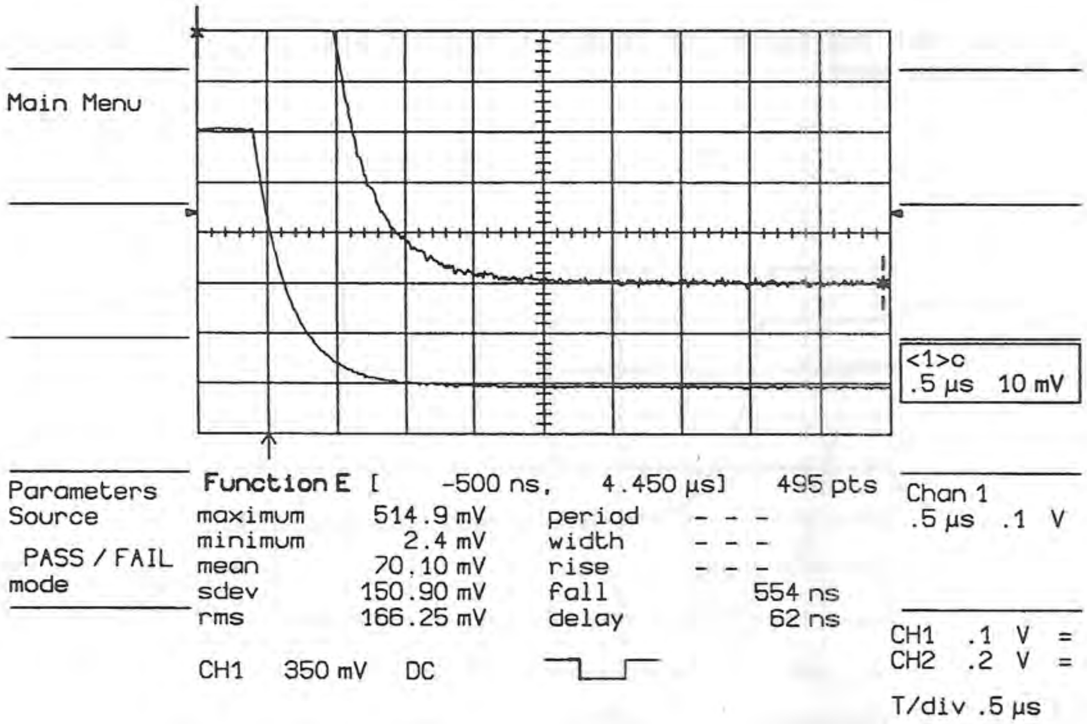


Figure 11 : CH1 Fall Time in 0.1 V/div

- Recheck with C101 that you get a flat square wave

4.6.9 Channel 2 HF Compensation

- Apply the fast risetime generator LeCroy 4969 (typical < 700 psec) set to 62.5 Ms period, through one 9.1 KOhm resistor to CH2.
- Set DSO to 1 Mohm, 0.2 V/div, 5 us/div.
- Use Function F in Average mode type Summed or Continuous with weigh 1:7.
- Multiply the vertical gain of the Function F, by a factor 10.
- Set trigger to Neg slope in order to display on the screen the trailing edge of the pulse.

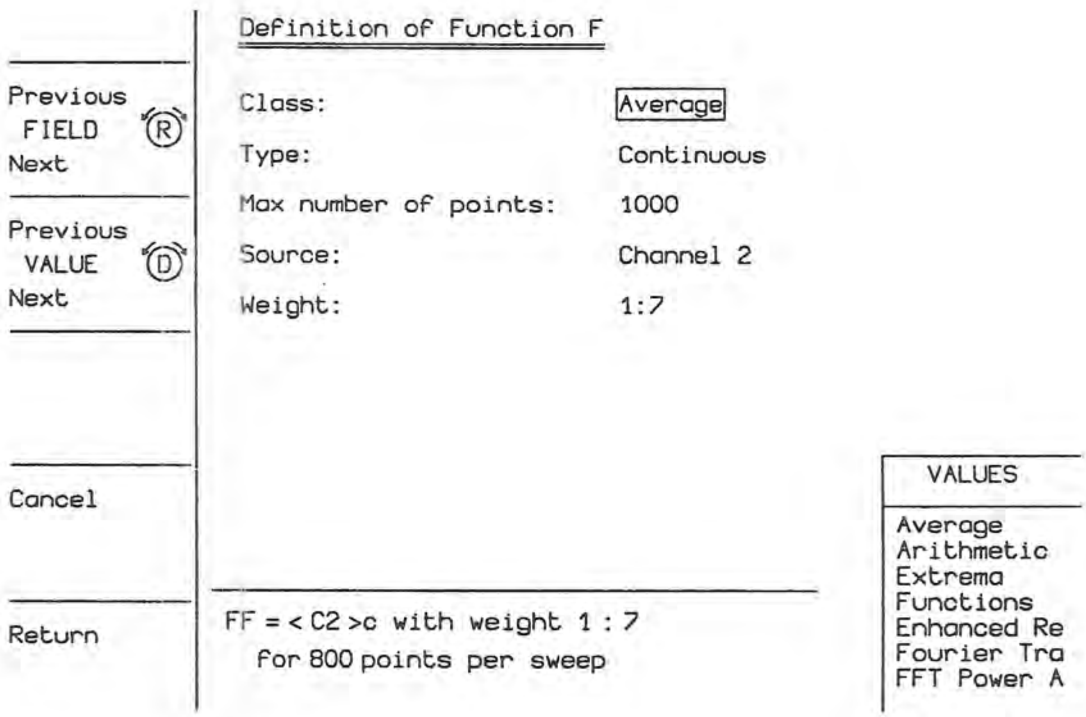


Figure 12 : Definition of Function F

- Adjust the variable capacitor C201 to get a flat square wave without over/undershoot.

- This cap adjust the flatness of the attenuator / 10.

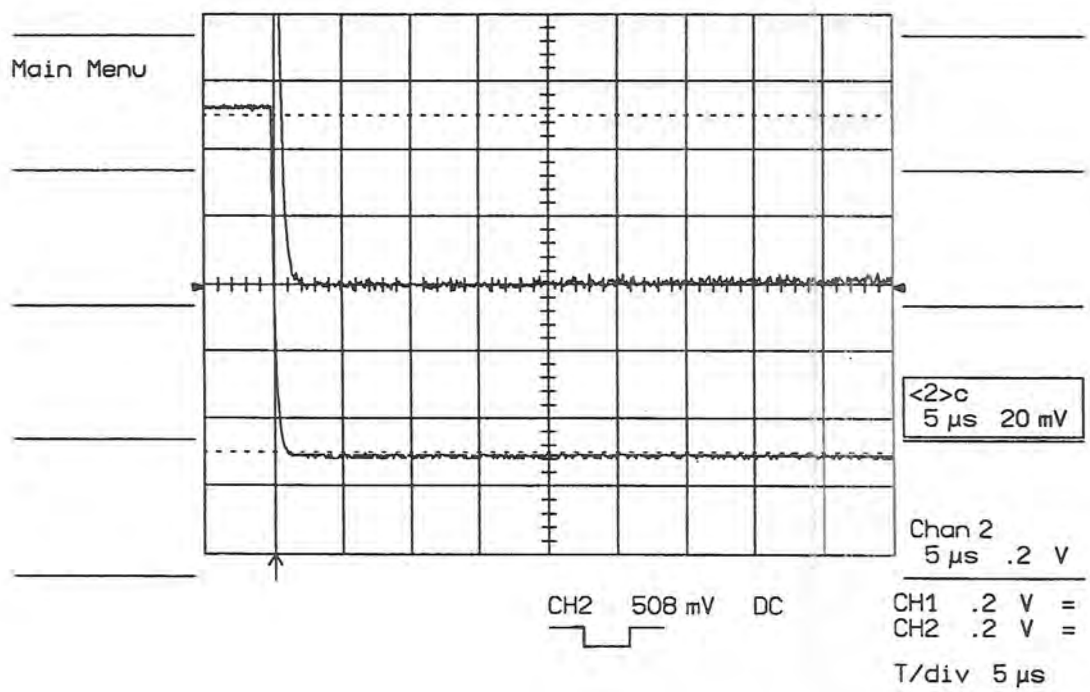


Figure 13 : CH2 Flatness adjustment with C201

- Select 0.5 us/div, 0.2 V/div,(divider by 10)
- Turn on the pulse parameters, with parameters source on Function F.
- Note the fall time. It corresponds to the input capacitor of the attenuator by 10.
- 20 ns corresponds to 1pf.
- The reading should be between 500 and 600 ns. Typical 500 ns.
- Check that the region of interest markers are properly set around the pulse edge.

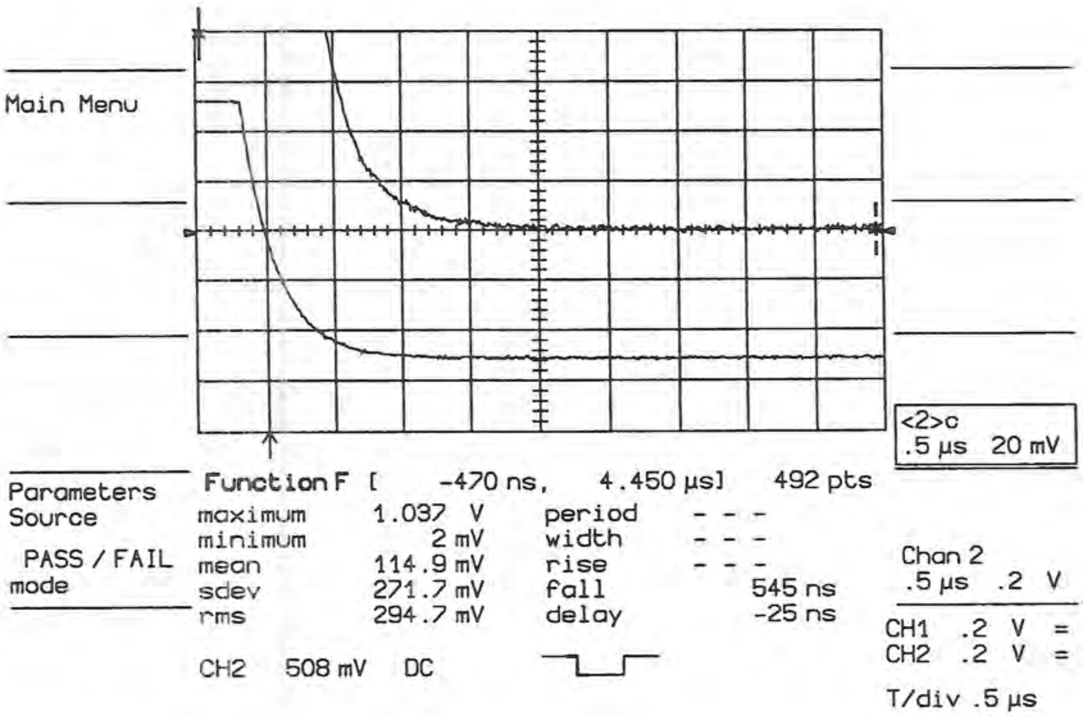


Figure 14 : CH2 Fall time in 0.2 V/div

- Set 0.1 V/div (divider by 1).

- Put a 6db attenuator between the 4969 pulser and the 9.1K resistor.

- Adjust the variable cap C208 in order to get the same Fall time at +/- 20 ns, than in the range using the divider by 10.

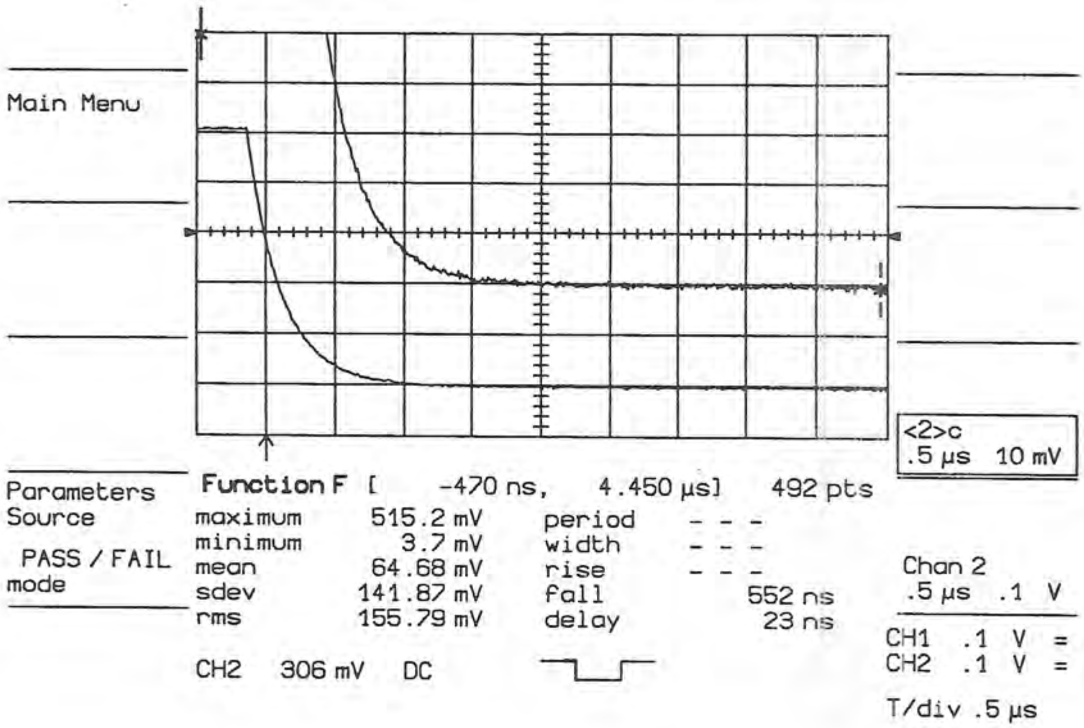


Figure 15 : CH2 Fall Time in 0.1 V/div

- Recheck with C201 that you get a flat square wave

4.6.10 External Trigger level Adjustment

- Set scope to CH2 50 ohm, 0.5 V/div, offset zero, 2us/div, BWL OFF
- Trigger on EXT/10, DC, level 0.0 V, delay 50 %
- Apply 50 KHz sine wave, 2.5V amplitude with zero offset to CH2 through External Trigger input.

	ACQUISITION PARAMETERS
Modify Smart Trig	VERTICAL — Channel 1 / Channel 2 Fixed V/div .5 V / .5 V Total V/div 500 mV / 500 mV Offset 0.00 V / 0.00 V Coupling DC 50 Ω / DC 50 Ω BW Limit OFF
Channel 1 ATTENUATOR Channel 2	TIME BASE Time/div 2 µs Time/pt 10 ns Pts/div 200 RIS OFF
Modify # Segments	For SEQNCE mode: # Segments 5 Time/pt 10 ns Pts/seg 2000
Special Modes	TRIGGER Standard Mode AUTO Pre-trigger Delay 50.0% Trigger on + edge of EXT10 Level 0.0 V Coupling DC
Return	The currently preselected Smart Trigger Class is 'Single Source'

Figure 16 : Acquisition Parameters

- Set External Trigger /10 on POS slope,

- Store CH2 in MEM C

- Set External Trigger /10 on NEG slope,

- Using the Voltage Cursor Measurement, compare CH2 NEG slope with MEM C (POS slope)

- Adjust Ext trigger level with potentiometer R414 in order to get between the POS and NEG slope, an HYST of 0.8 V at Trigger point.

  Limits : 1 V < HYST > 0.6 V

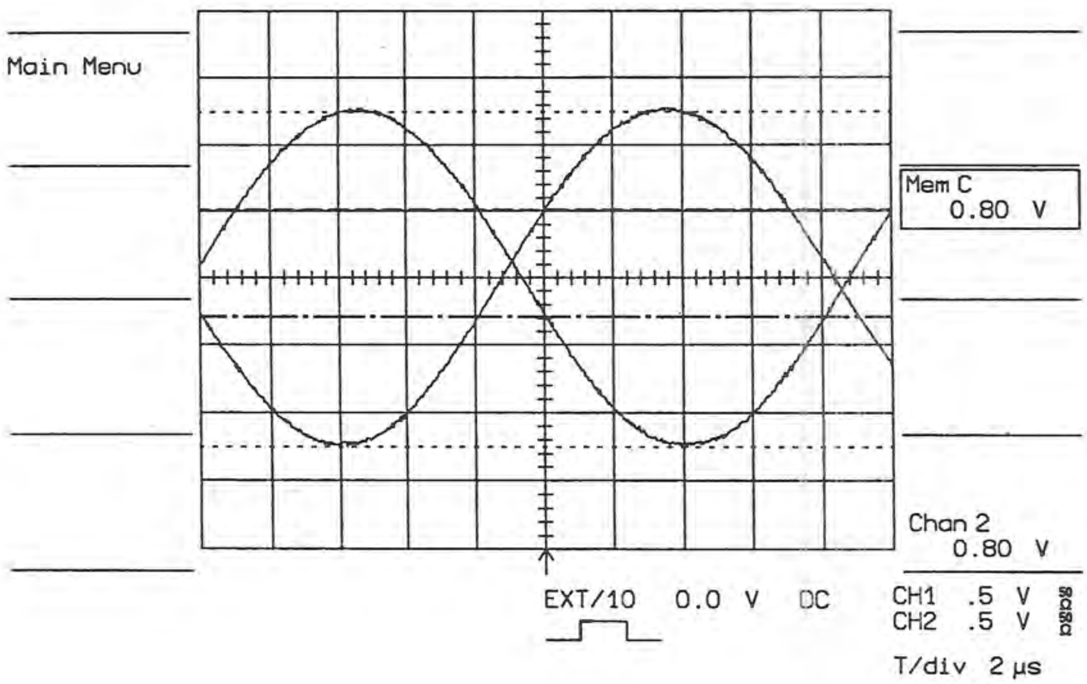
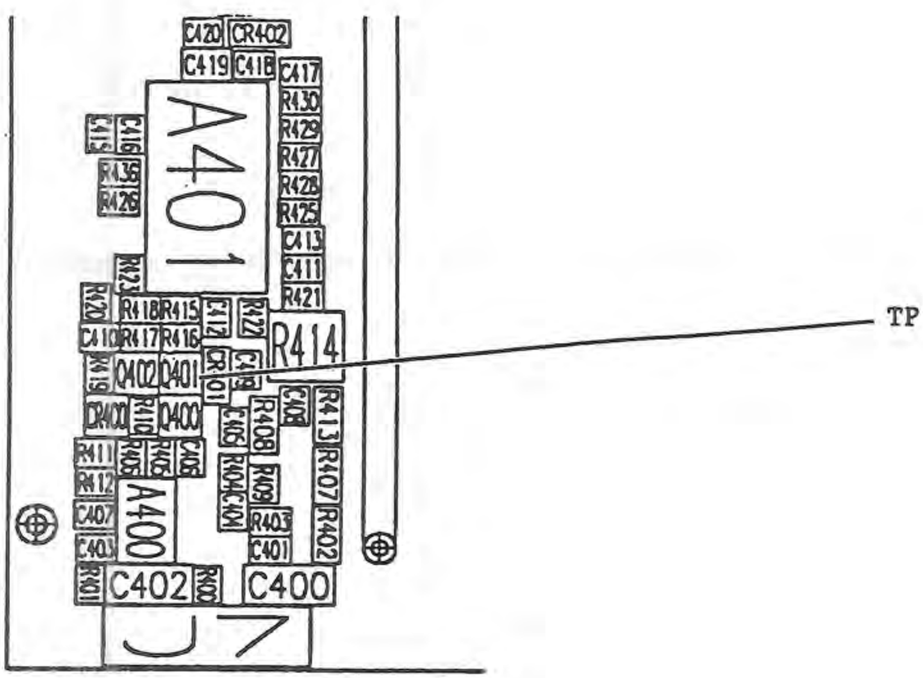


Figure 17 : External Trigger Level Adjustment

4.6.11 External Trigger HF Compensation

- Apply a fast risetime pulse (<700ps), 1KHz, 5V amplitude, through one 9.1 kOhm resistor to External Trigger.
- Set time base to 5 us/div, trigger to Ext/10, Neg slope.
- Probe on CH1 or CH2 with a probe /1, and a good ground the emitter of Q401.
- Set Function E or F to Average mode, type Summed or Continuous with weigh 1:7.
- Multiply the vertical gain of the Function by 10.
- Adjust the variable cap C400 to get a slight positive slope, typical 2%. (2 Divisions)



TP = Wired point between R416, R417, R418, R423 and Emitter of Q401

Figure 18 : External Trigger Test Points

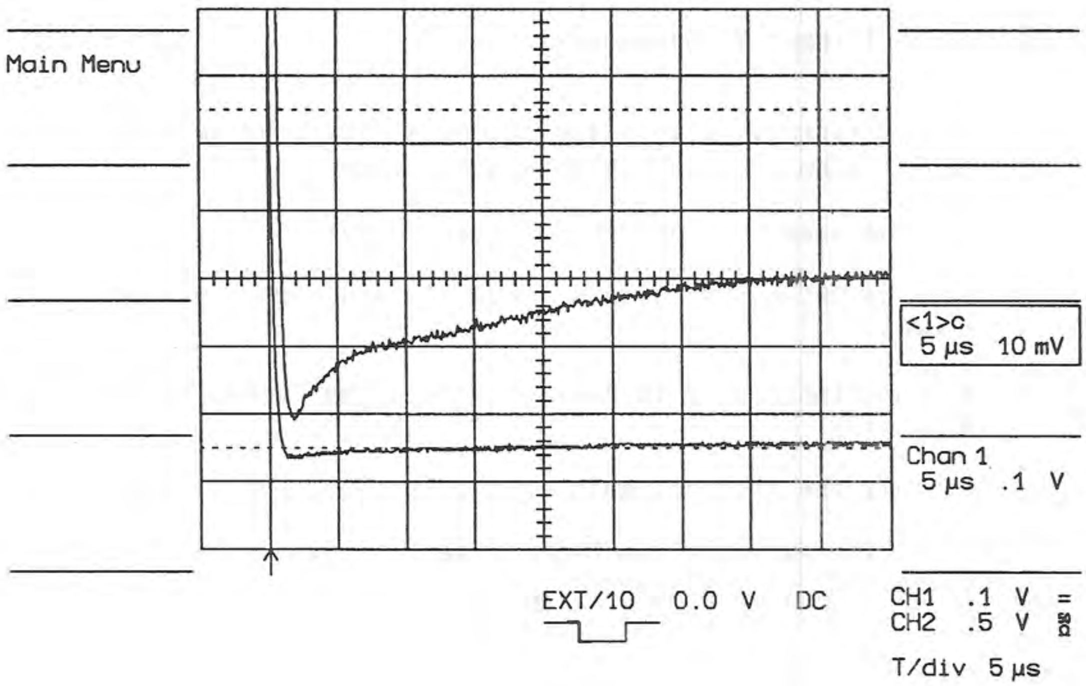


Figure 19 : External Trigger/10 HF Compensation

- Select 0.5 us/div

- Turn on the pulse parameters, with parameters source on Function E

- Note the Fall Time, and adjust the variable cap C402 to get the same fall time at +/- 30 ns, than the average value of CH1 and CH2.

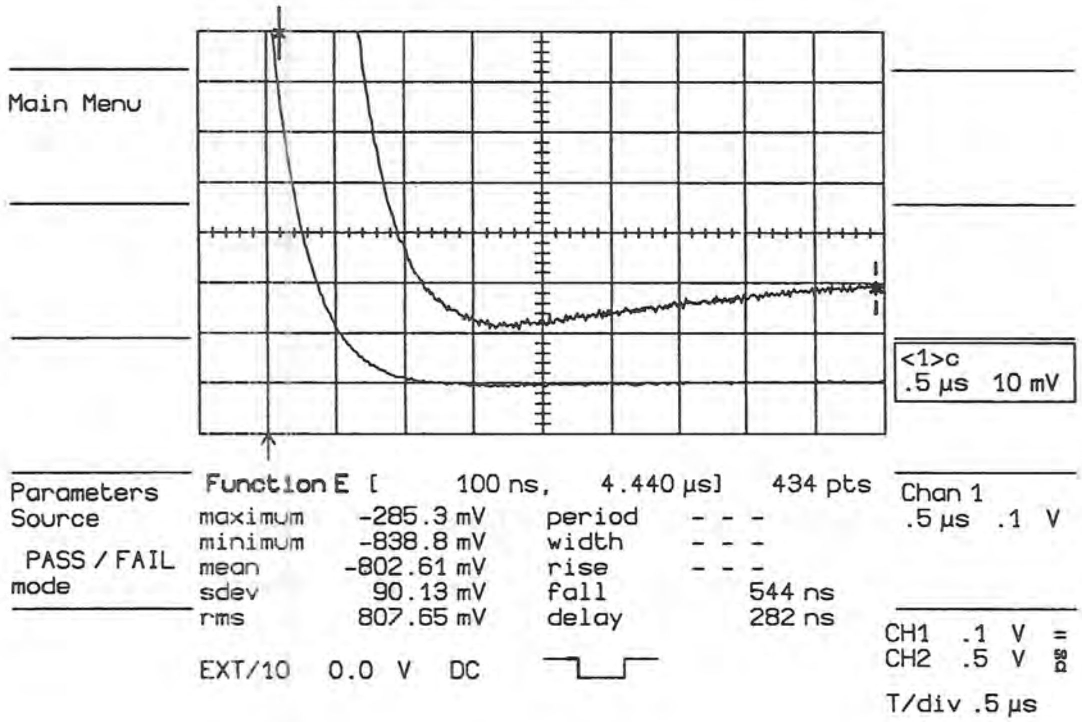


Figure 20 : External/10 Fall Time

- Select External Trigger, 0.5 us/div. Add a 20 db attenuator. Check that the fall time is at +/- 35 ns the same than in EXT/10

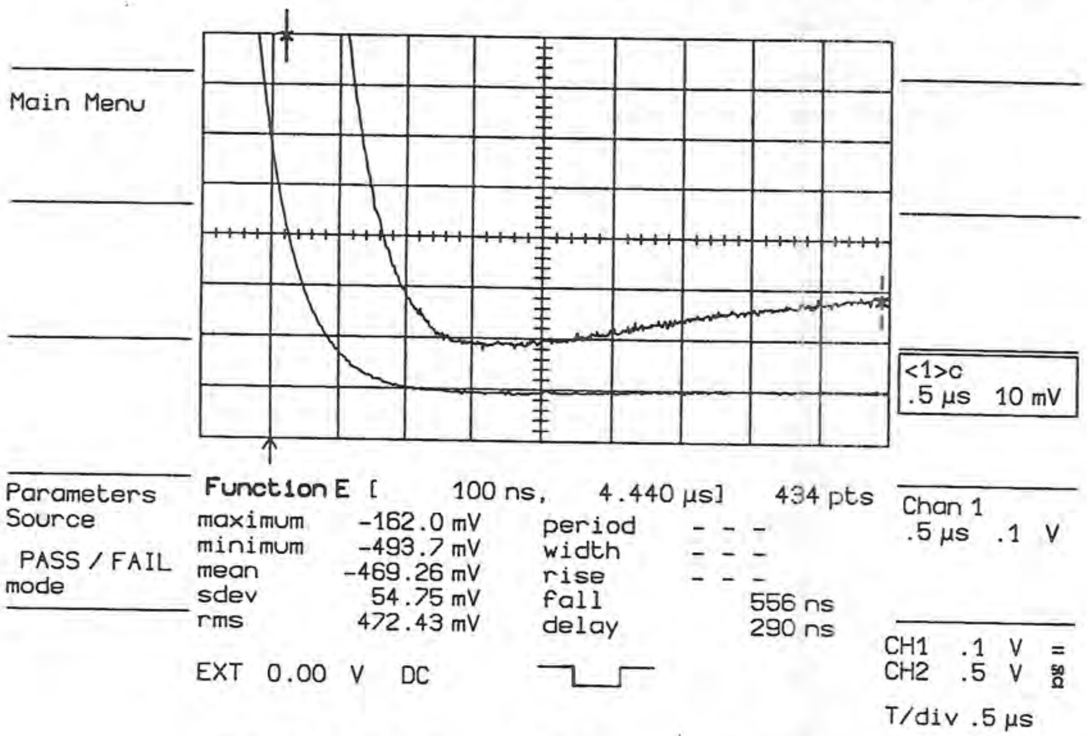


Figure 21 : External Trigger Fall Time

- Set time base to 5 us/div, verify that the flatness is within 5 % limit.

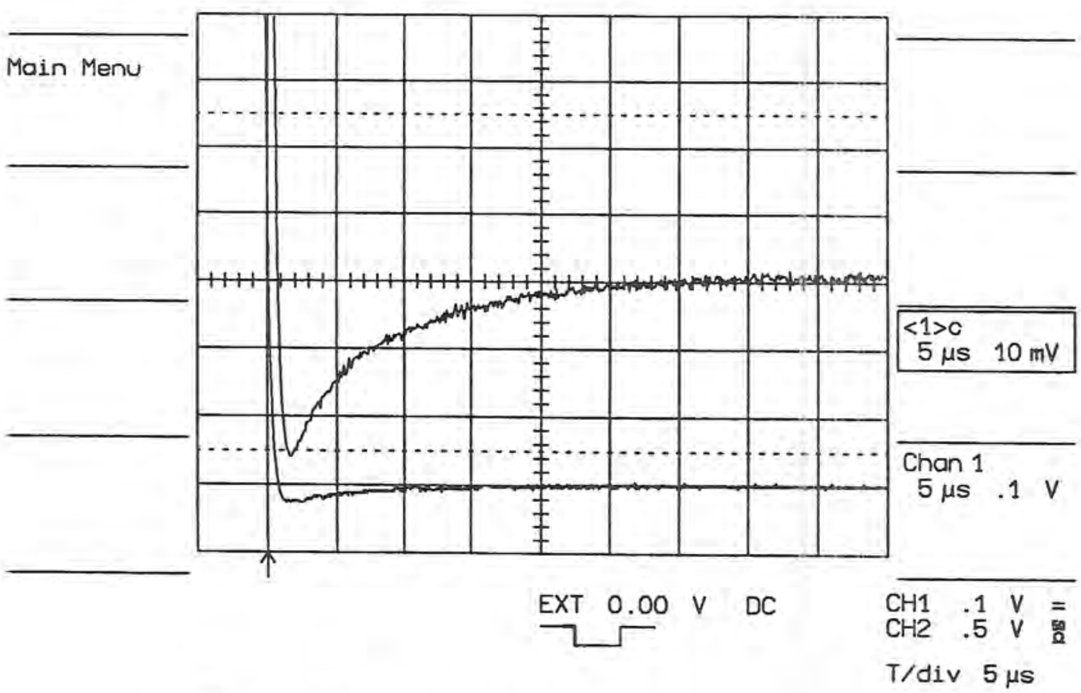


Figure 22 : External Trigger Flatness

4.6.12 50 Ohm Overshoot Compensation

- Apply the pulse generator LeCroy 4969, set to 61.05 us period, to the 50 Ohm input of the scope set at 100 mV/div.

- Set the time base to INTERLEAVED on 5 ns/div.

- Turn on the pulse parameters.

- Press Pass/Fail mode, Press Setup Pass/Fail

- Set Channel 1 and Channel 2 parameters on Show, over +, and rise

- Verify on both channel : overshoot < 8 %, and rise < 2.2 ns.

- If the overshoot is larger, it can be reduced by the following procedure:

* for range < 100mV/div increase the resistor value R101 for CH1 and R201 for CH2.

  From 30 to 39 Ohm. Typical 33 Ohm

* for range > 100mV/div increase the resistor R109 for CH1 and R209 for CH2.

  From 120 to 220 Ohm. Typical 150 Ohm

- Verify with CALSOFT2 that the bandwidth on both channel is at least 150 Mhz at 5 mV/div.

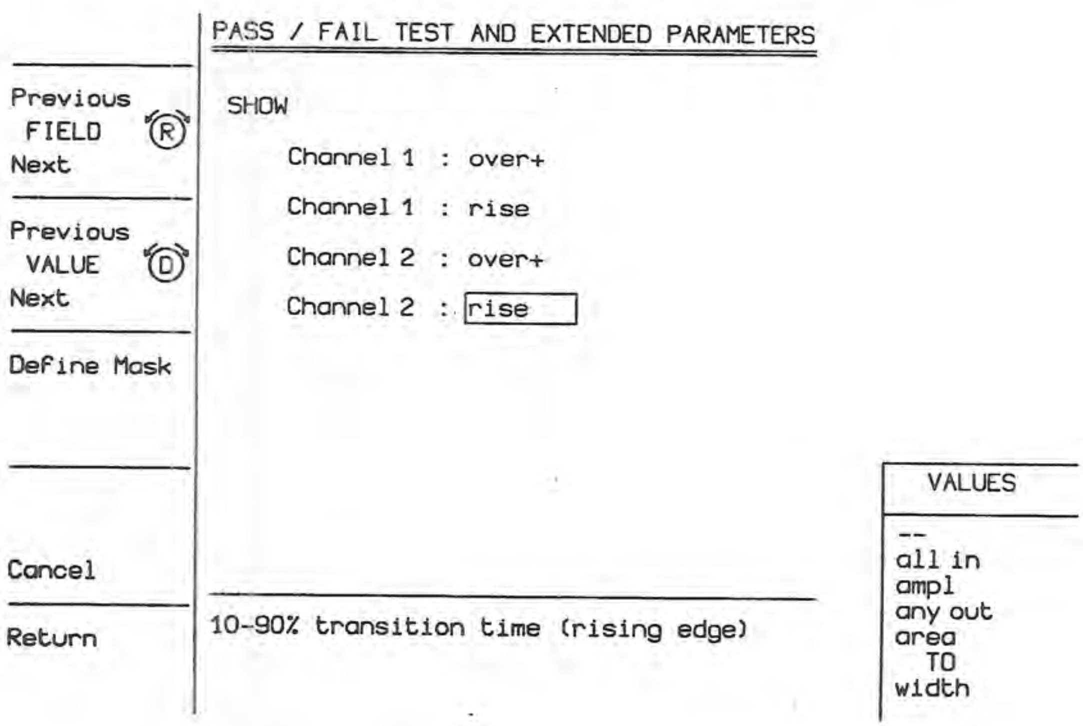


Figure 23 : Pass/Fail Parameters

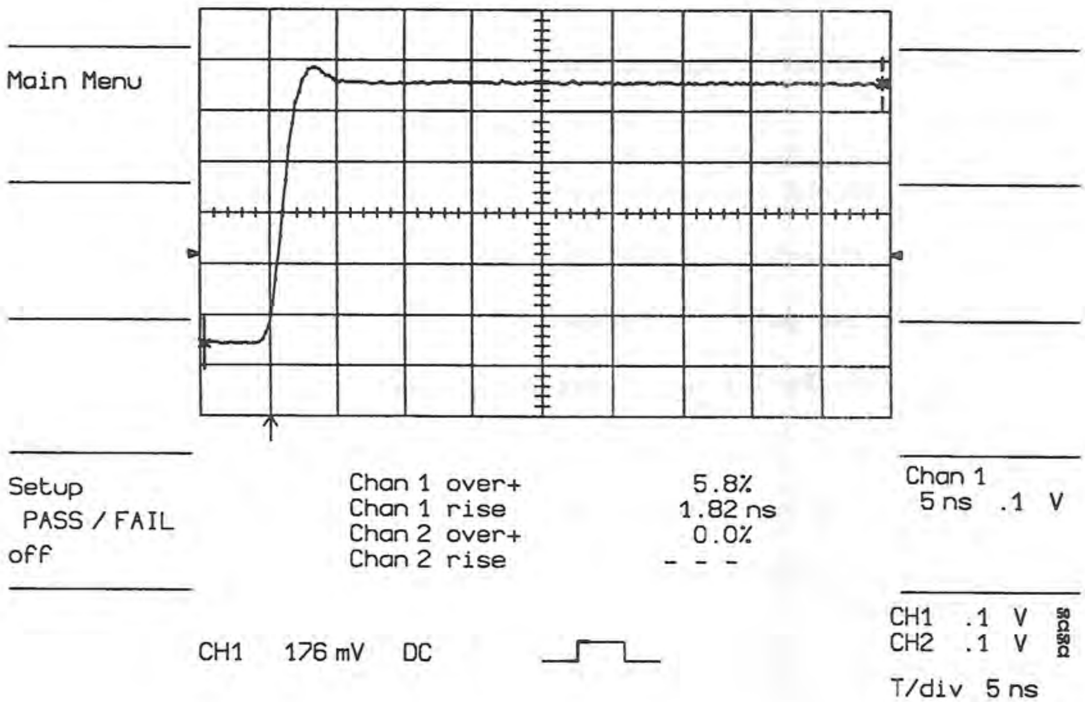


Figure 24 : Overshoot Compensation at 100 mV/div

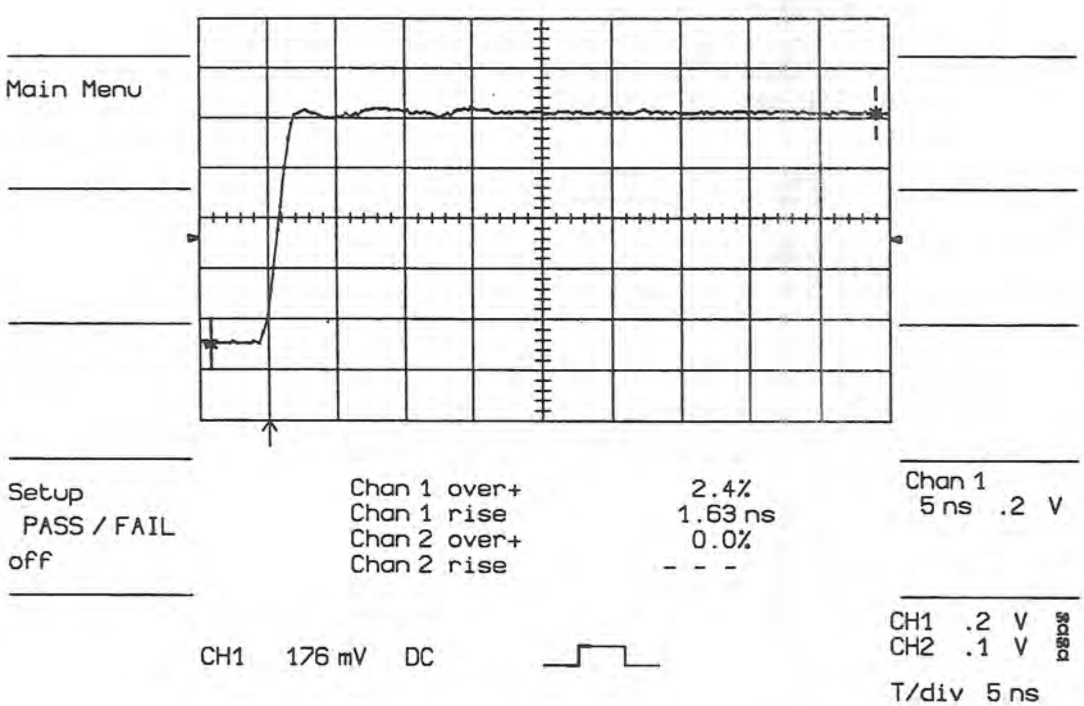


Figure 25 : Overshoot Compensation at 200 mV/div

4.6.13 50 Ohm CH1 and CH2 Overload Protection Adjustment

- The front-end has to be in the scope with the aluminum covers mounted and the upper DSO cover closed.
- Warm up the unit for 20 minutes.
- Set scope to 50 Ohm, 2s/div, norm, pos
- Apply 7.07 V (1 watt) to the channel to be adjusted.
- Adjust the overload detection ,potentiometer R35 for CH1 and R48 for CH2, through the opening aluminum cover, such that the overload trips within 10 to 20 seconds.
- Turn the potentiometer clockwise if it's too slow or counterclockwise if it's too fast.
- Apply 5 v (0.5 watt) to the channel to be tested, and check that the overload doesn't trip after 40 seconds.

4.7 F9450-2 Display Board Calibration Procedure

It is advisable to perform this adjustment when the scope is in a stable condition, after few minutes of warm up.

Also it is important to check the power supplies, and to readjust them to the nominal values.

The reference for the measurements are the pins on connector J7 on the base board F9424-1.

- 15.00 V	: +/- 1%	on pin 10
+ 15.04 V	: +/- 1%	on pin 9
- 5.07 V	: +/- 1%	on pin 8
+ 5.16 V	: +/- 1%	on pin 5
GND	:	on pin 6

4.7.1 Image Position adjustment

If the X,Y Gain amplifiers or X,Y Offset amplifiers are not correctly adjusted, or the image is poorly centered or distorted on the screen, it may be desirable to readjust the four potentiometers on the F9450-2 display board, or the two magnetic rings on the yoke, or the mechanical yoke position.

4.7.1.1 Vertical, Horizontal, Gain and Offset Amplifiers adjustment

By pressing the "Main Menu" button while keeping the lowest menu button depressed, enter into the secret menu, then press the "Software Tests" key, and select "Characters". See figure 1.

With the help of the border lines of the Character set Display, adjust the potentiometers GAIN X, OFFS X, GAIN Y, OFFS Y (see POT LAYOUT) to center the image on the screen.

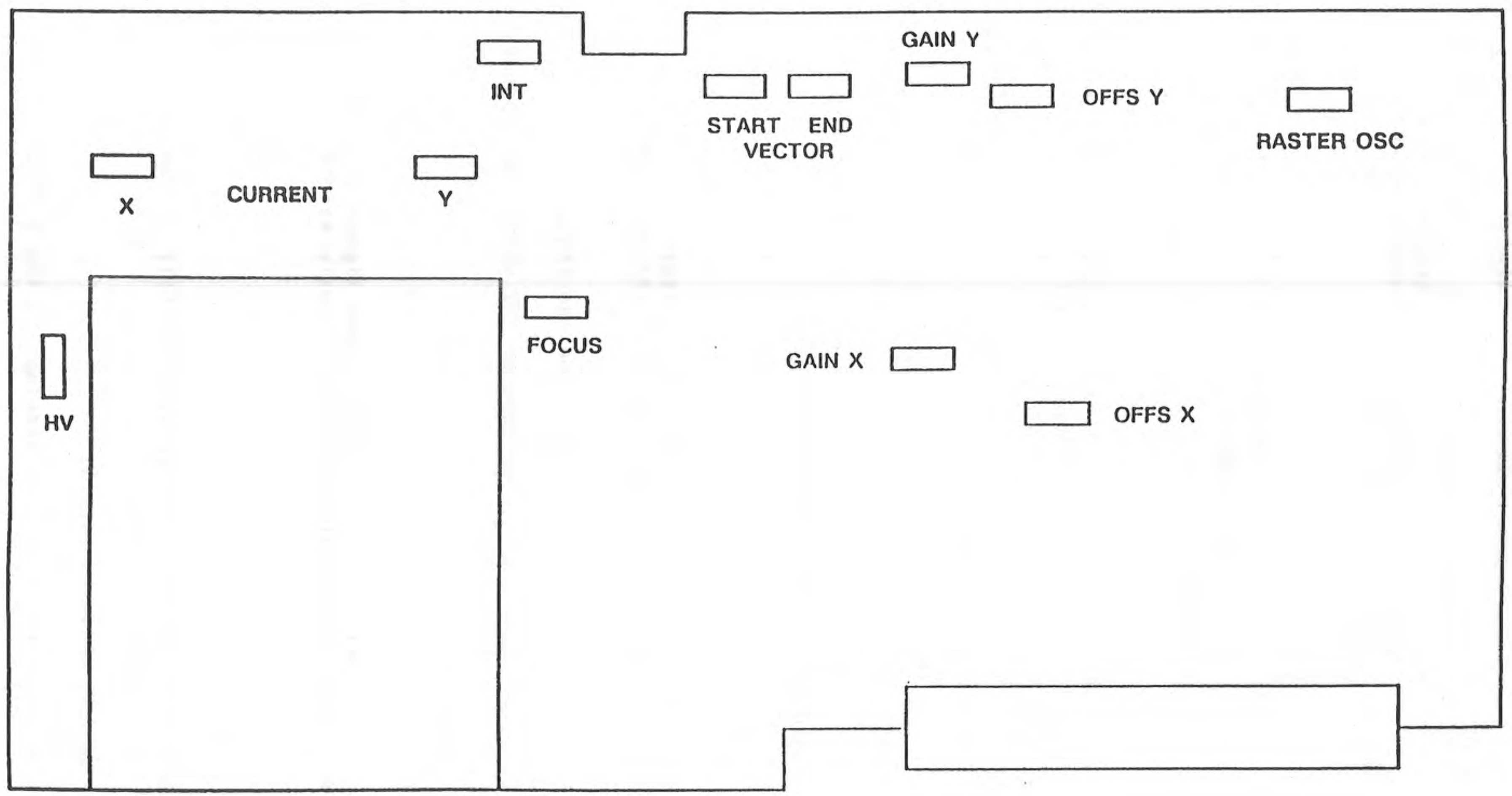
Adjust the size of the display, in order to get 5mm gap between the middle of the image lines (top, bottom, left, right) and the CRT lines.

4.7.1.2 Centralizing adjustment and Yoke Rotation

This should be done unless all other sources of offset have been eliminated.

By adjusting the two rings on the Yoke, center the image on the screen.

Loosen the screw on the Yoke ring holder, and rotate the image by turning the mechanical Yoke position.



9450-2 POT LAYOUT

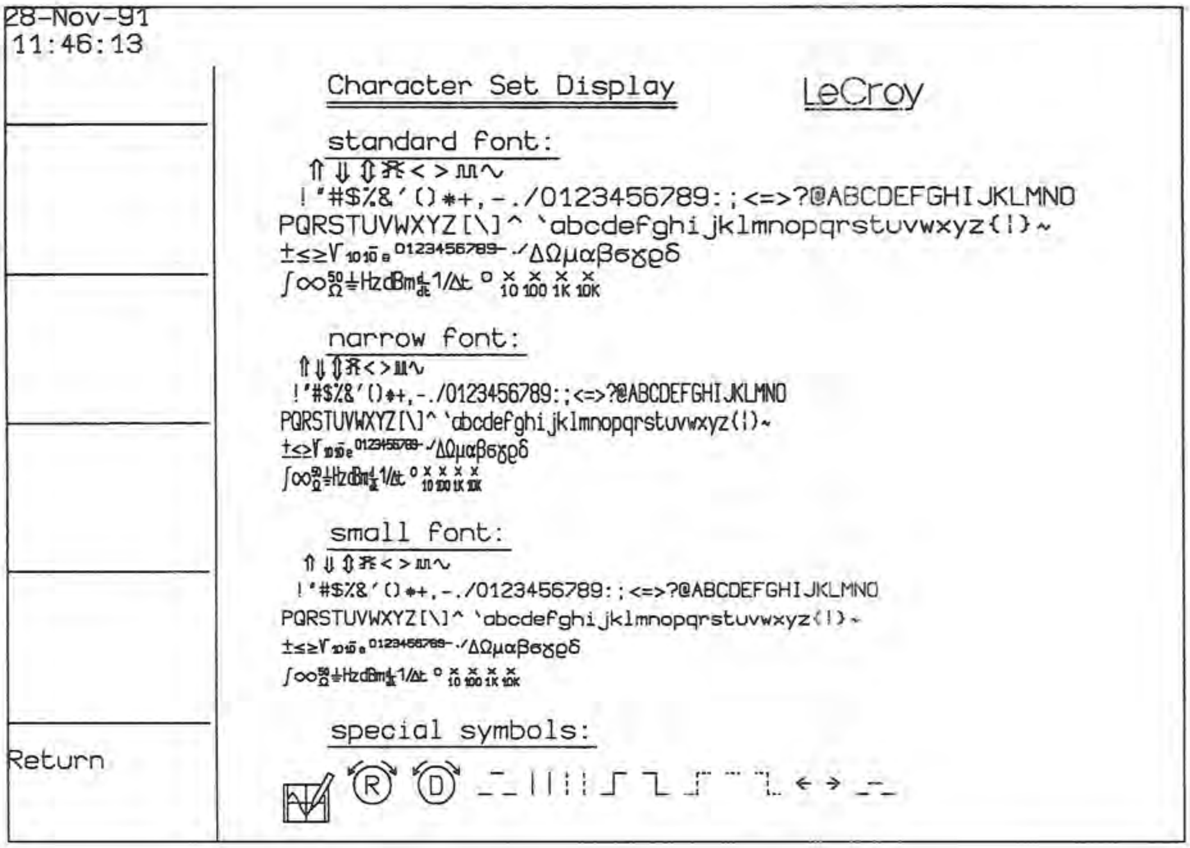


Figure 1 : Character Set Display

4.7.2 Intensity

Set DSO to 1 MOhm, 5mV/div, .2ms/div, CH1 auto trigger.
Turn on Expand A (X Chan 1), and make an expand of only few horizontal divisions of the trace.

On the Front Panel turn the Grid Intensity and the Intensity to minimum.

On the display board, adjust the potentiometer INT until the expanded trace just appears on the screen.

4.7.3 Focus

With the help of the characters set Display (see figure 1), adjust the Focus potentiometer on the display board to optimize the characters and the image.

4.7.4 Vector Joining

On the display board adjust the vectors with the help of the START and END vector potentiometers

The characters should be neatly drawn.

Check that there are neither gaps nor overlaps in the letters.

4.7.5 Raster

Set the DSO to 1 MOhm, DC, .2V/div, .2ms/div, auto trigger on CH1

Send a 1 kHz sine wave or square wave to channel 1, adjust the signal amplitude to 6 V peak to peak.

Turn on the persistence mode, set 1 sweep, and make a single trigger.

With the RASTER OSC potentiometer on the display board, adjust the vertical alignment of the dots. See figure 2.

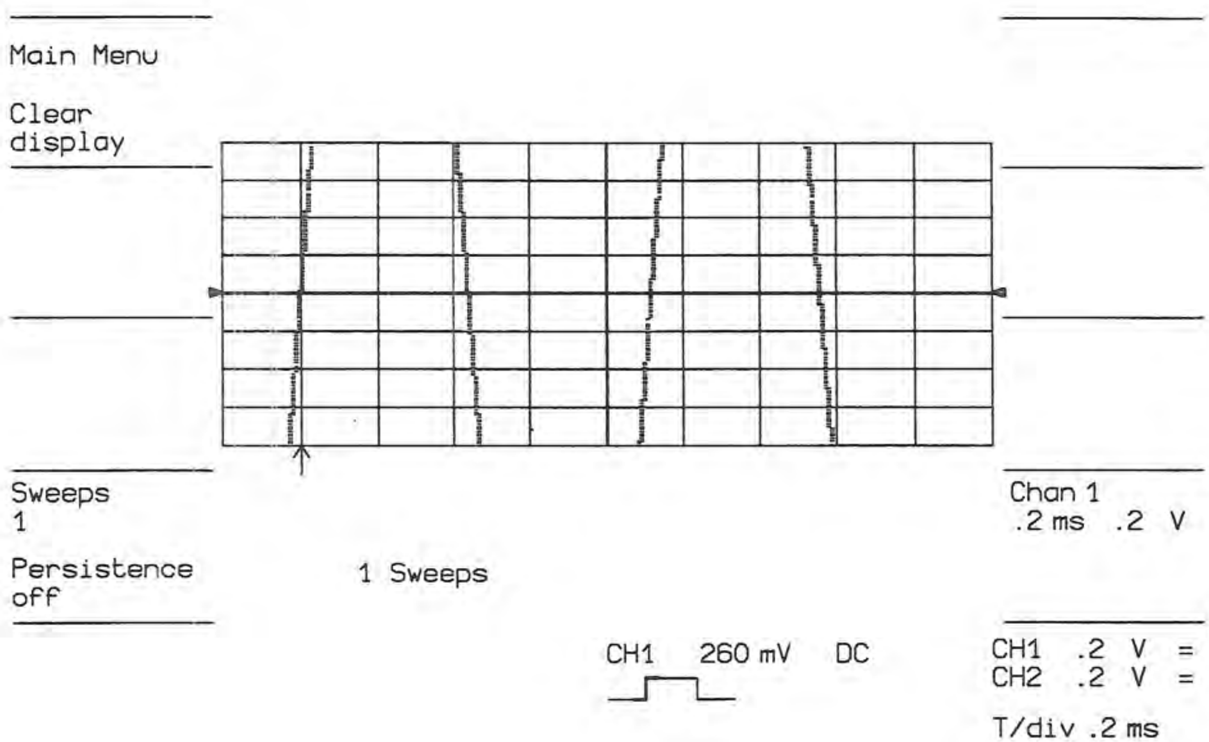


Figure 2 : Raster Oscillator

Chapter 5

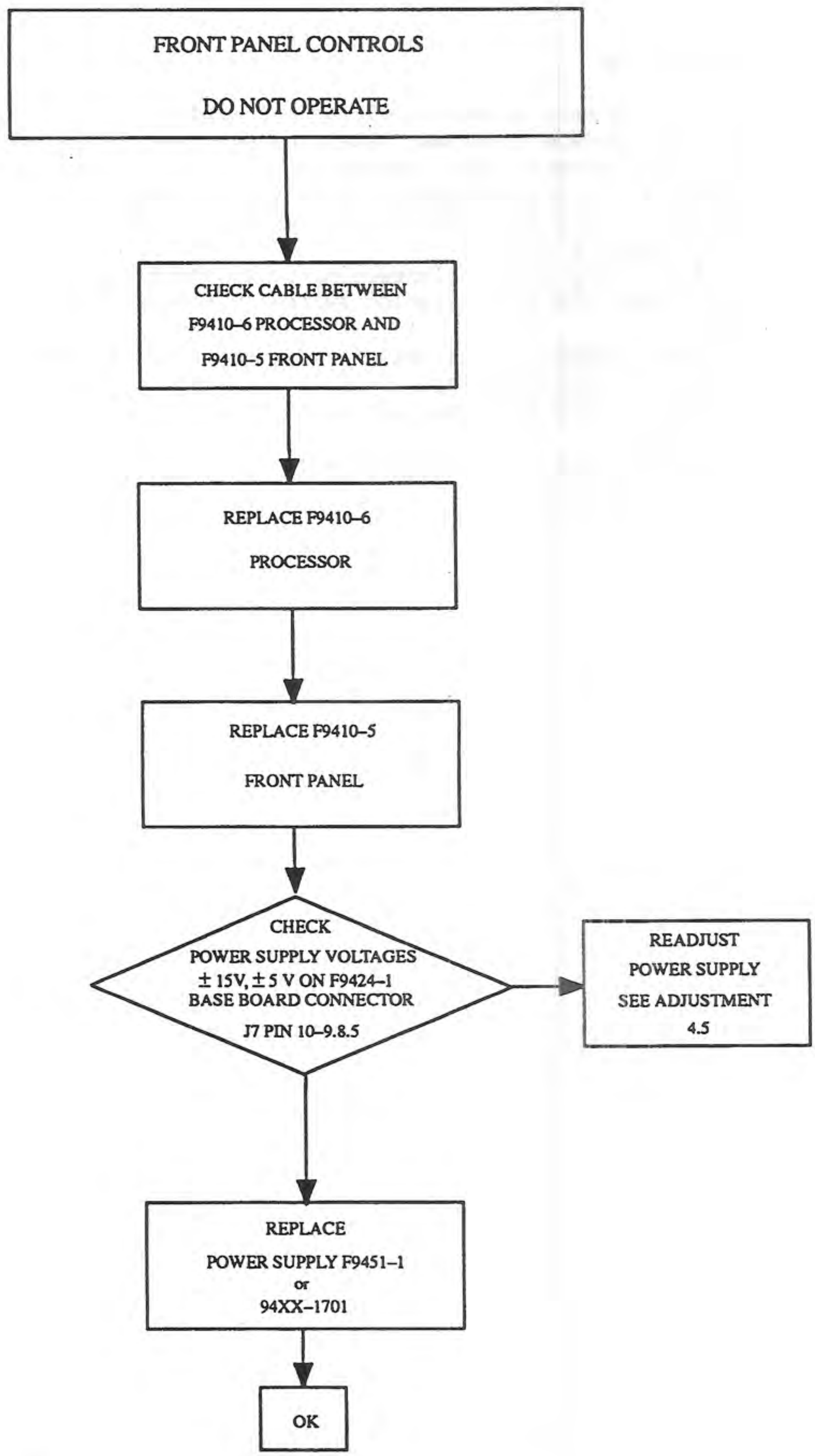
TROUBLESHOOTING and FLOW CHARTS

Table of contents:

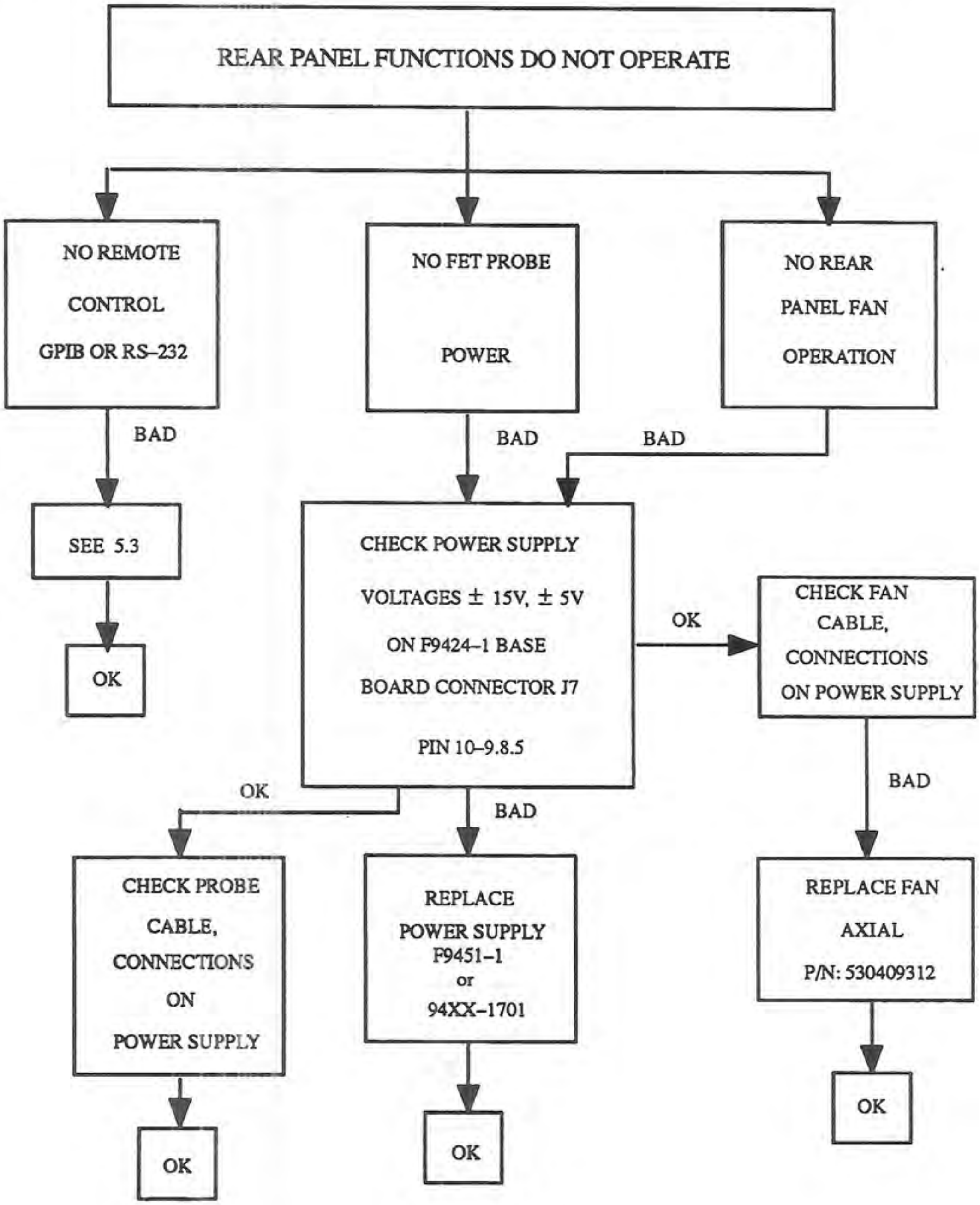
5.1 Introduction

In order to help simply servicing and minimize downtime, the following list of possible symptoms, likely causes, and troubleshooting steps have been prepared. Most procedures in this section will allow a technician to troubleshooting down to the board level.
Defective circuit boards will be repaired or exchanged by our regional LeCroy service office .
The first step in troubleshooting is to check for obvious items like blown fuses, voltage selector switch in correct position and loose line cord.
The power supply is the next item to check before proceeding to more detailed troubleshooting.
Noisy or low power supply can cause a variety of problems, both digital and analog.
A complete list of recommanded service equipment and spare parts is given in section 5.8.

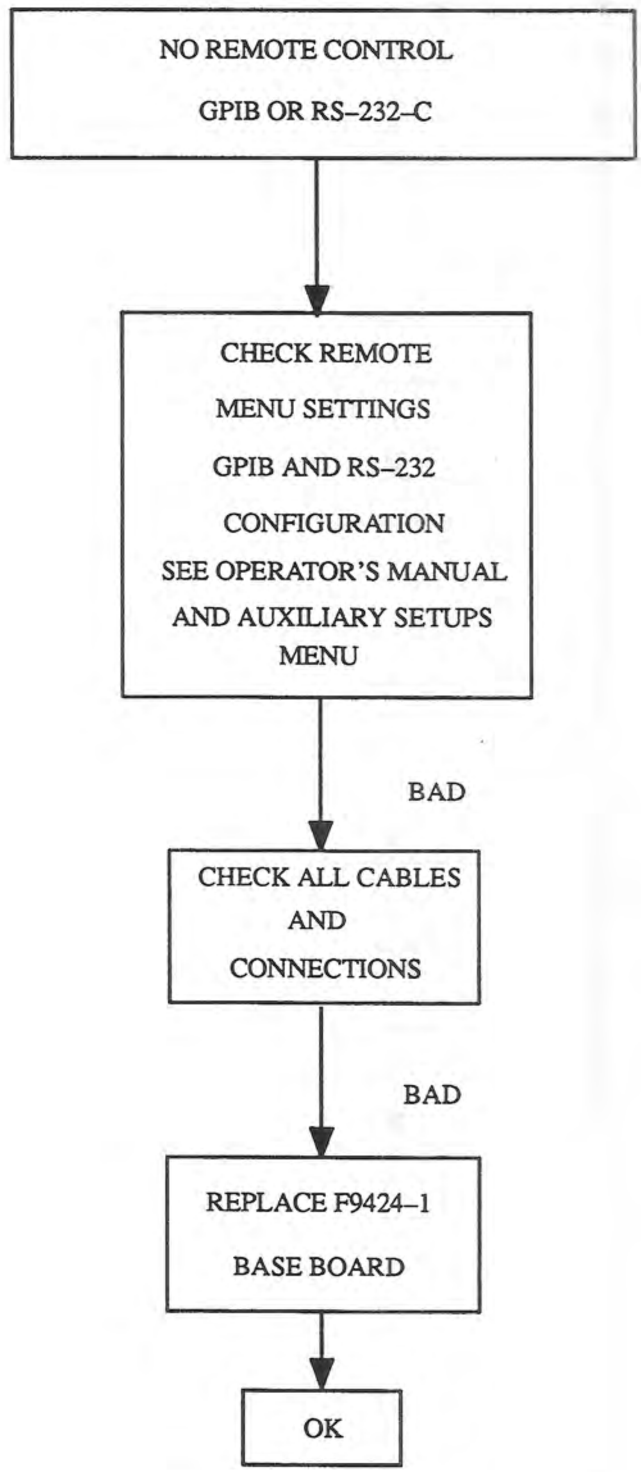
5.2


FRONT PANEL CONTROLS
DO NOT OPERATE
CHECK CABLE BETWEEN
F9410–6 PROCESSOR AND
F9410–5 FRONT PANEL
REPLACE F9410–6
PROCESSOR
REPLACE F9410–5
FRONT PANEL
CHECK
POWER SUPPLY VOLTAGES
± 15V, ± 5 V ON F9424–1
BASE BOARD CONNECTOR
J7 PIN 10–9.8.5
READJUST
POWER SUPPLY
SEE ADJUSTMENT
4.5
REPLACE
POWER SUPPLY F9451–1
or
94XX–1701
OK

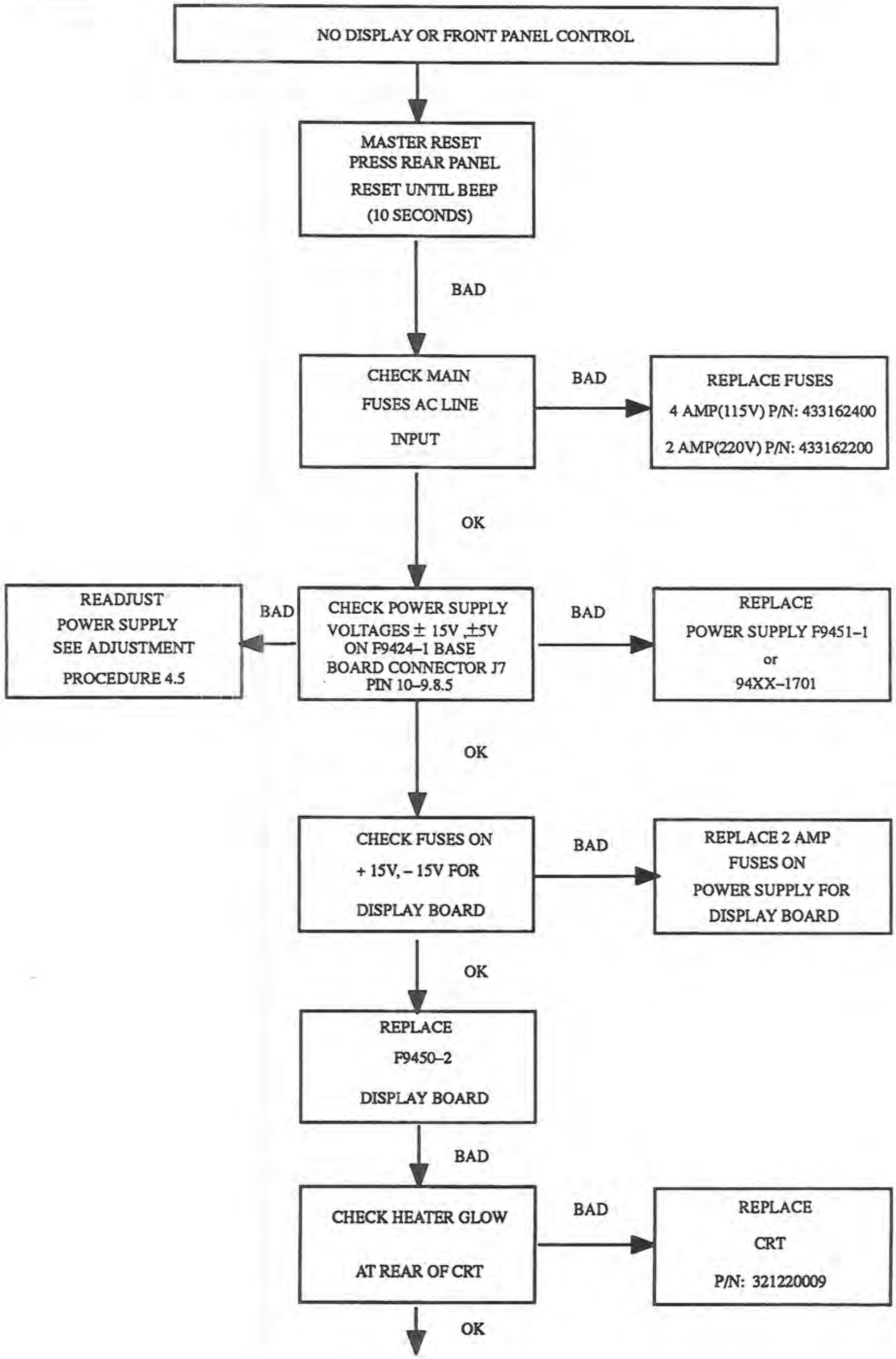
5.3


REAR PANEL FUNCTIONS DO NOT OPERATE
NO REMOTE CONTROL GPIB OR RS-232
NO FET PROBE POWER
NO REAR PANEL FAN OPERATION
BAD
BAD
BAD
SEE 5.3
OK
CHECK POWER SUPPLY VOLTAGES ± 15V, ± 5V ON F9424-1 BASE BOARD CONNECTOR J7 PIN 10-9.8.5
OK
CHECK FAN CABLE, CONNECTIONS ON POWER SUPPLY
OK
BAD
BAD
CHECK PROBE CABLE, CONNECTIONS ON POWER SUPPLY
REPLACE POWER SUPPLY F9451-1 or 94XX-1701
REPLACE FAN AXIAL P/N: 530409312
OK
OK
OK

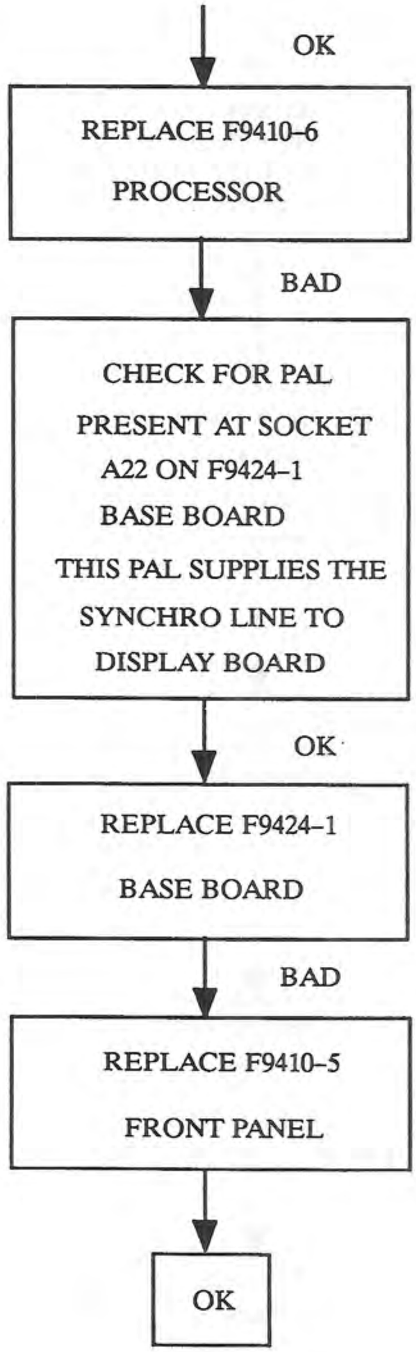
5.4


NO REMOTE CONTROL
GPIB OR RS–232–C
CHECK REMOTE
MENU SETTINGS
GPIB AND RS–232
CONFIGURATION
SEE OPERATOR'S MANUAL
AND AUXILIARY SETUPS
MENU
BAD
CHECK ALL CABLES
AND
CONNECTIONS
BAD
REPLACE F9424–1
BASE BOARD
OK

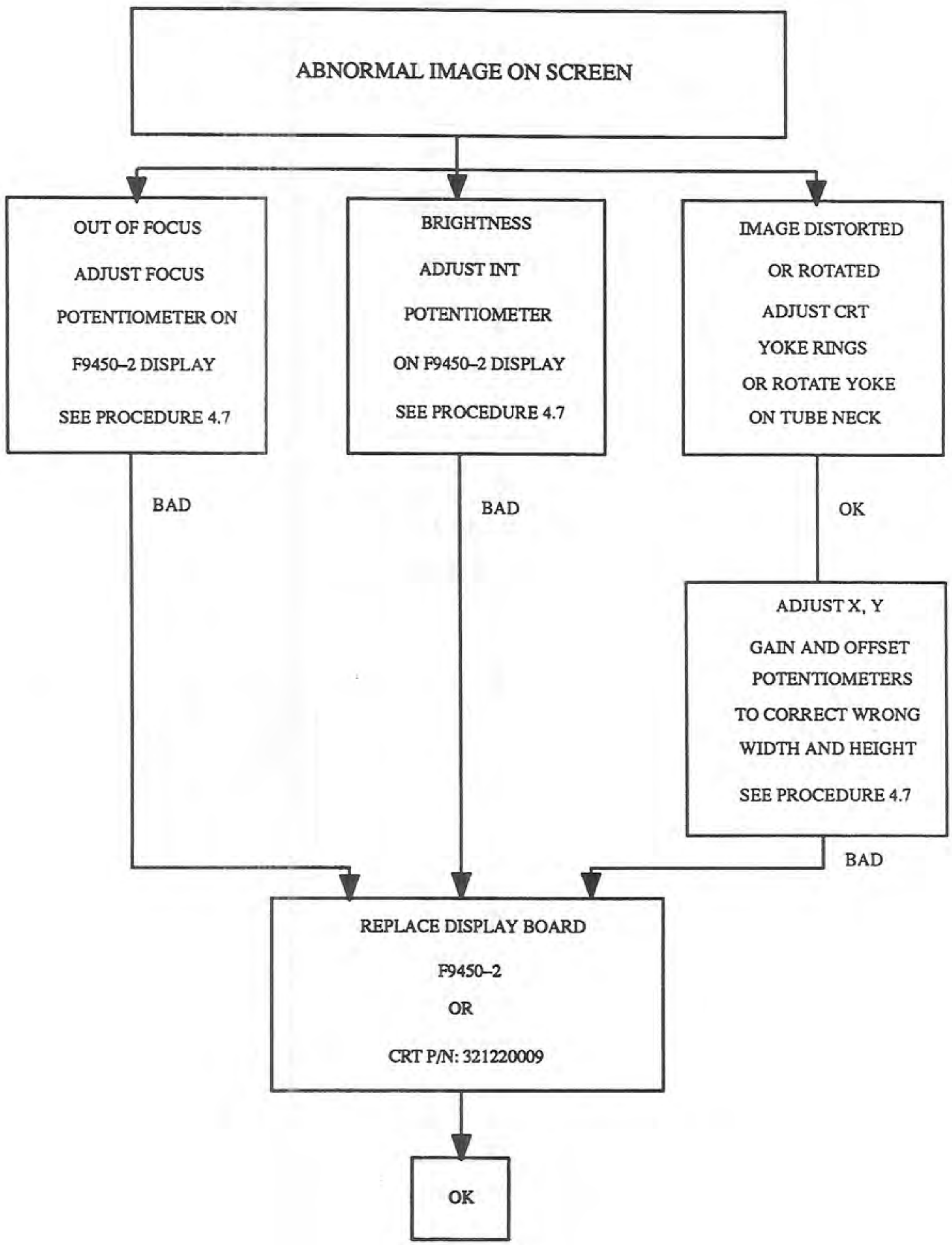
5.5.1


NO DISPLAY OR FRONT PANEL CONTROL
MASTER RESET
PRESS REAR PANEL
RESET UNTIL BEEP
(10 SECONDS)
BAD
CHECK MAIN
FUSES AC LINE
INPUT
BAD
REPLACE FUSES
4 AMP(115V) P/N: 433162400
2 AMP(220V) P/N: 433162200
OK
READJUST
POWER SUPPLY
SEE ADJUSTMENT
PROCEDURE 4.5
BAD
CHECK POWER SUPPLY
VOLTAGES ± 15V ,±5V
ON F9424–1 BASE
BOARD CONNECTOR J7
PIN 10–9.8.5
BAD
REPLACE
POWER SUPPLY F9451–1
or
94XX–1701
OK
CHECK FUSES ON
+ 15V, – 15V FOR
DISPLAY BOARD
BAD
REPLACE 2 AMP
FUSES ON
POWER SUPPLY FOR
DISPLAY BOARD
OK
REPLACE
F9450–2
DISPLAY BOARD
BAD
CHECK HEATER GLOW
AT REAR OF CRT
BAD
REPLACE
CRT
P/N: 321220009
OK

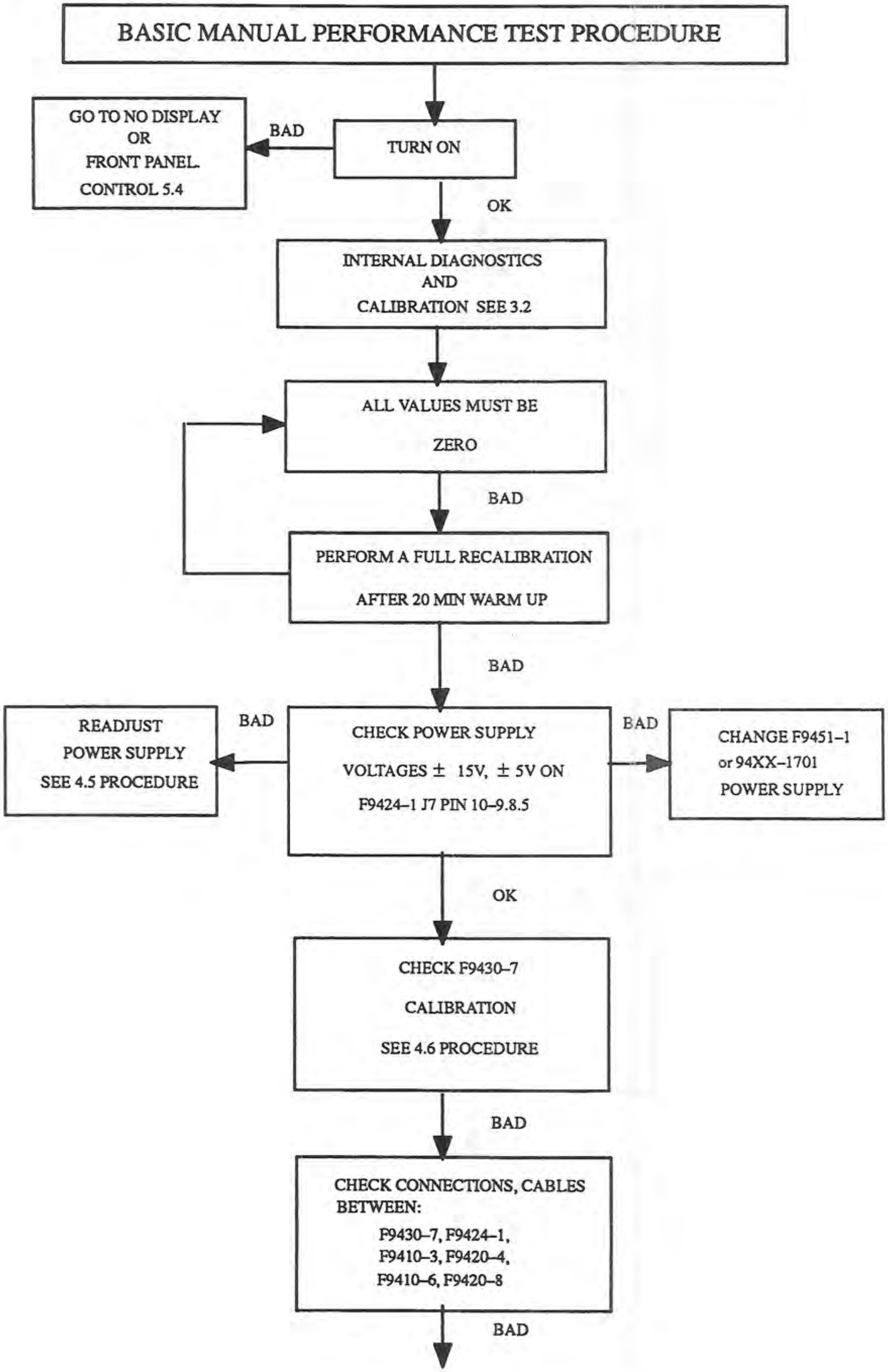
5.5.2


OK
REPLACE F9410-6
PROCESSOR
BAD
CHECK FOR PAL
PRESENT AT SOCKET
A22 ON F9424-1
BASE BOARD
THIS PAL SUPPLIES THE
SYNCHRO LINE TO
DISPLAY BOARD
OK
REPLACE F9424-1
BASE BOARD
BAD
REPLACE F9410-5
FRONT PANEL
OK

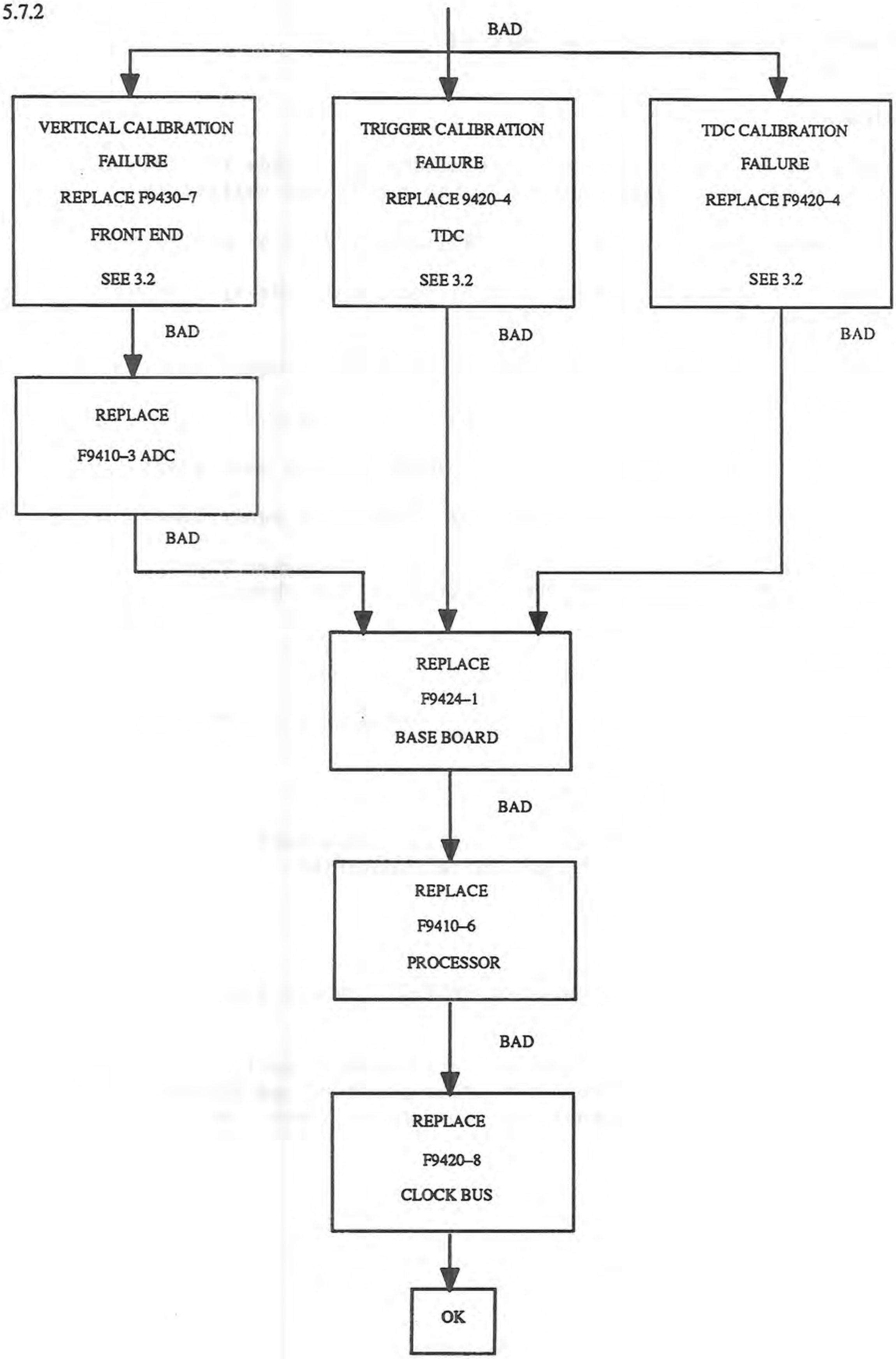
5.6


ABNORMAL IMAGE ON SCREEN
OUT OF FOCUS
ADJUST FOCUS
POTENTIOMETER ON
F9450–2 DISPLAY
SEE PROCEDURE 4.7
BRIGHTNESS
ADJUST INT
POTENTIOMETER
ON F9450–2 DISPLAY
SEE PROCEDURE 4.7
IMAGE DISTORTED
OR ROTATED
ADJUST CRT
YOKE RINGS
OR ROTATE YOKE
ON TUBE NECK
BAD
BAD
OK
ADJUST X, Y
GAIN AND OFFSET
POTENTIOMETERS
TO CORRECT WRONG
WIDTH AND HEIGHT
SEE PROCEDURE 4.7
BAD
REPLACE DISPLAY BOARD
F9450–2
OR
CRT P/N: 321220009
OK

5.7.1


BASIC MANUAL PERFORMANCE TEST PROCEDURE
GO TO NO DISPLAY OR FRONT PANEL. CONTROL 5.4
BAD
TURN ON
OK
INTERNAL DIAGNOSTICS AND CALIBRATION SEE 3.2
ALL VALUES MUST BE ZERO
BAD
PERFORM A FULL RECALIBRATION AFTER 20 MIN WARM UP
BAD
READJUST POWER SUPPLY SEE 4.5 PROCEDURE
BAD
CHECK POWER SUPPLY VOLTAGES ± 15V, ± 5V ON F9424–1 J7 PIN 10–9.8.5
BAD
CHANGE F9451–1 or 94XX–1701 POWER SUPPLY
OK
CHECK F9430–7 CALIBRATION SEE 4.6 PROCEDURE
BAD
CHECK CONNECTIONS, CABLES BETWEEN: F9430–7, F9424–1, F9410–3, F9420–4, F9410–6, F9420–8
BAD

5.7.2


BAD
VERTICAL CALIBRATION
FAILURE
REPLACE F9430–7
FRONT END
SEE 3.2
TRIGGER CALIBRATION
FAILURE
REPLACE 9420–4
TDC
SEE 3.2
TDC CALIBRATION
FAILURE
REPLACE F9420–4
SEE 3.2
BAD
BAD
BAD
REPLACE
F9410–3 ADC
BAD
REPLACE
F9424–1
BASE BOARD
BAD
REPLACE
F9410–6
PROCESSOR
BAD
REPLACE
F9420–8
CLOCK BUS
OK

5.8 Equipment and spare parts recommended for service

5.8.1 Equipment

The following list of equipment are needed to provide the technician access to the 9410 subassemblies during repair and calibration.

1- Sine wave generator: Marconi 2019A, 2022C, 2030 or equivalent.

2- Sine wave generator: 5volt peak to peak amplitude type SG503 or equivalent.

3- DC precision power supply: Tektronix PS5004 or equivalent.

4- Digital Multimeter: Philips PM2525 or equivalent.

5- Digital scope 350 MHz bandwidth: LeCroy 9450 or equivalent.

6- Fast rise time pulser: LeCroy 4969 (<700PS) or equivalent.

7- BNC coaxial cables (5nsec, 2nsec, 1 nsec), adapter T BNC, Adapter BNC - banana, 50Ω BNC terminator feed through.

5.8.2 Spare parts

In order to make the repair of 9410 at board level, a minimum stock of boards is at least one each:

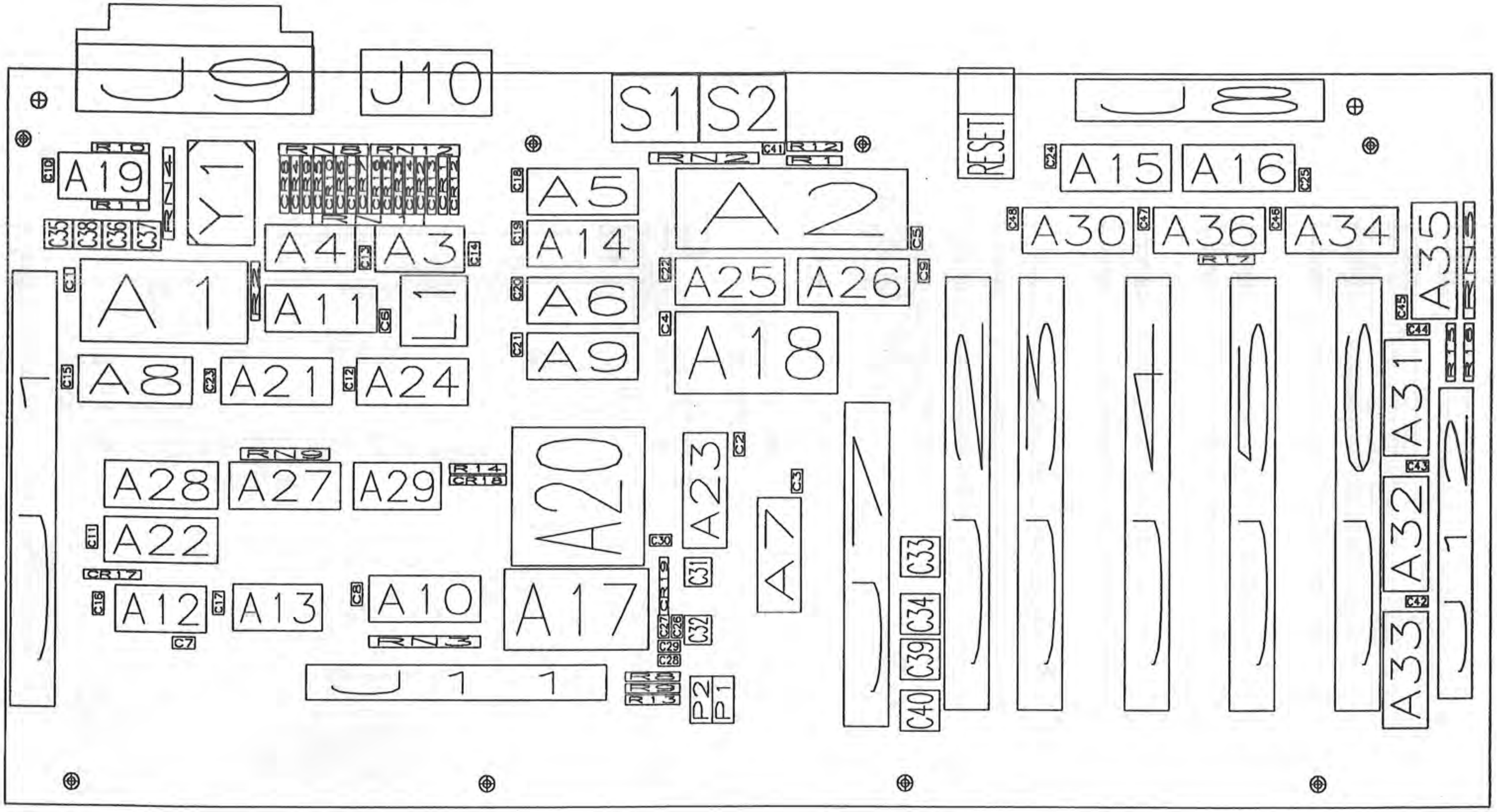
- F9424-1	Base board
- F9450-2	Display board
- F9410-3	ADC (Analog to Digital Converter)
- F9420-4	TDC (Time to Digital Converter)
- F9410-5	Front panel
- F9410-6	Processor
- F9430-7	Front End
- F9420-8	Clock bus
- F9451-1	Power supply or 94XX-1701 power supply

The display tube, yoke and FAN are very reliable parts. Their failure rate is extremely low. Also a few other parts (scope handle, metal enclosure case and back panel) are not on the above list.

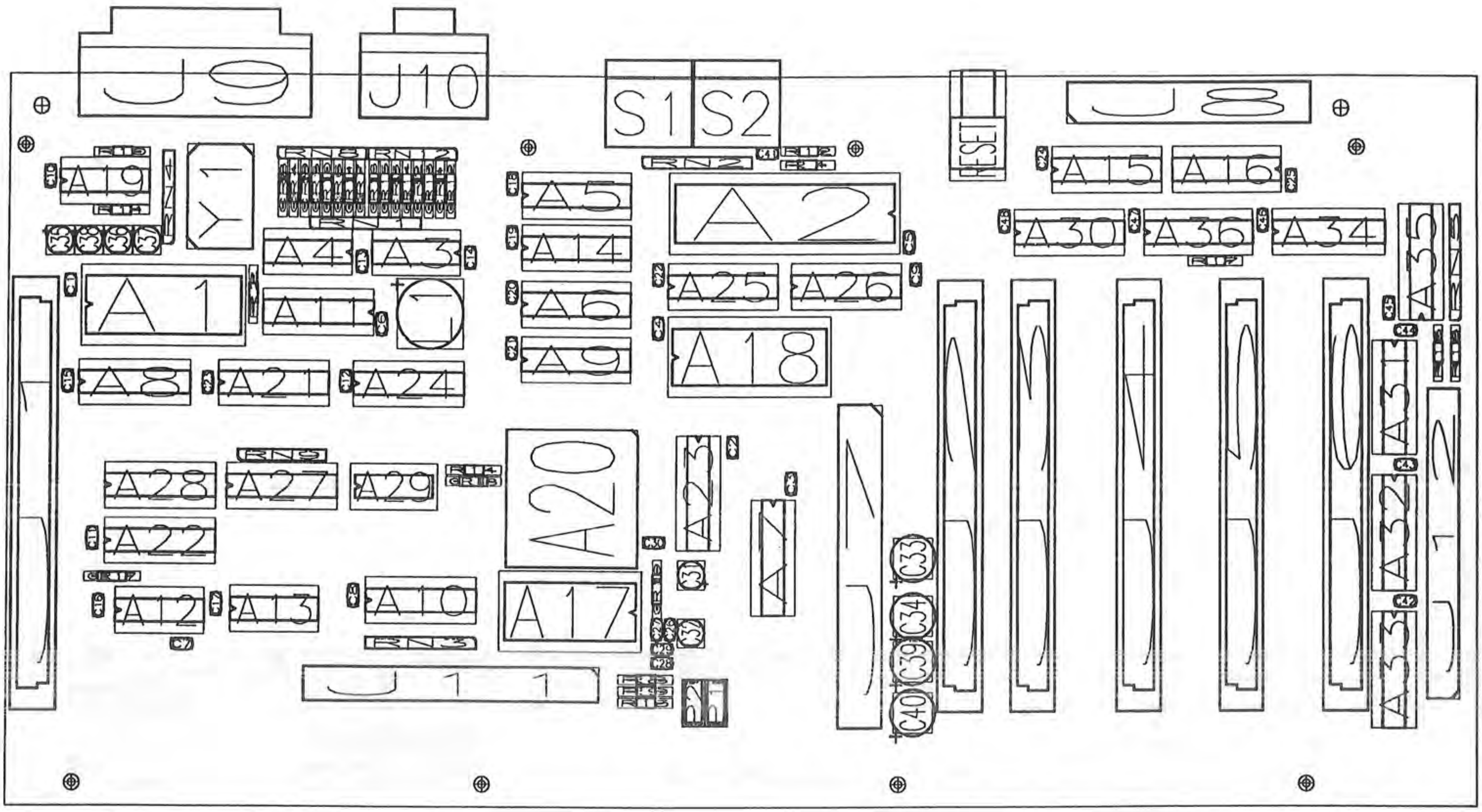
Chapter 6

CIRCUIT DIAGRAMS

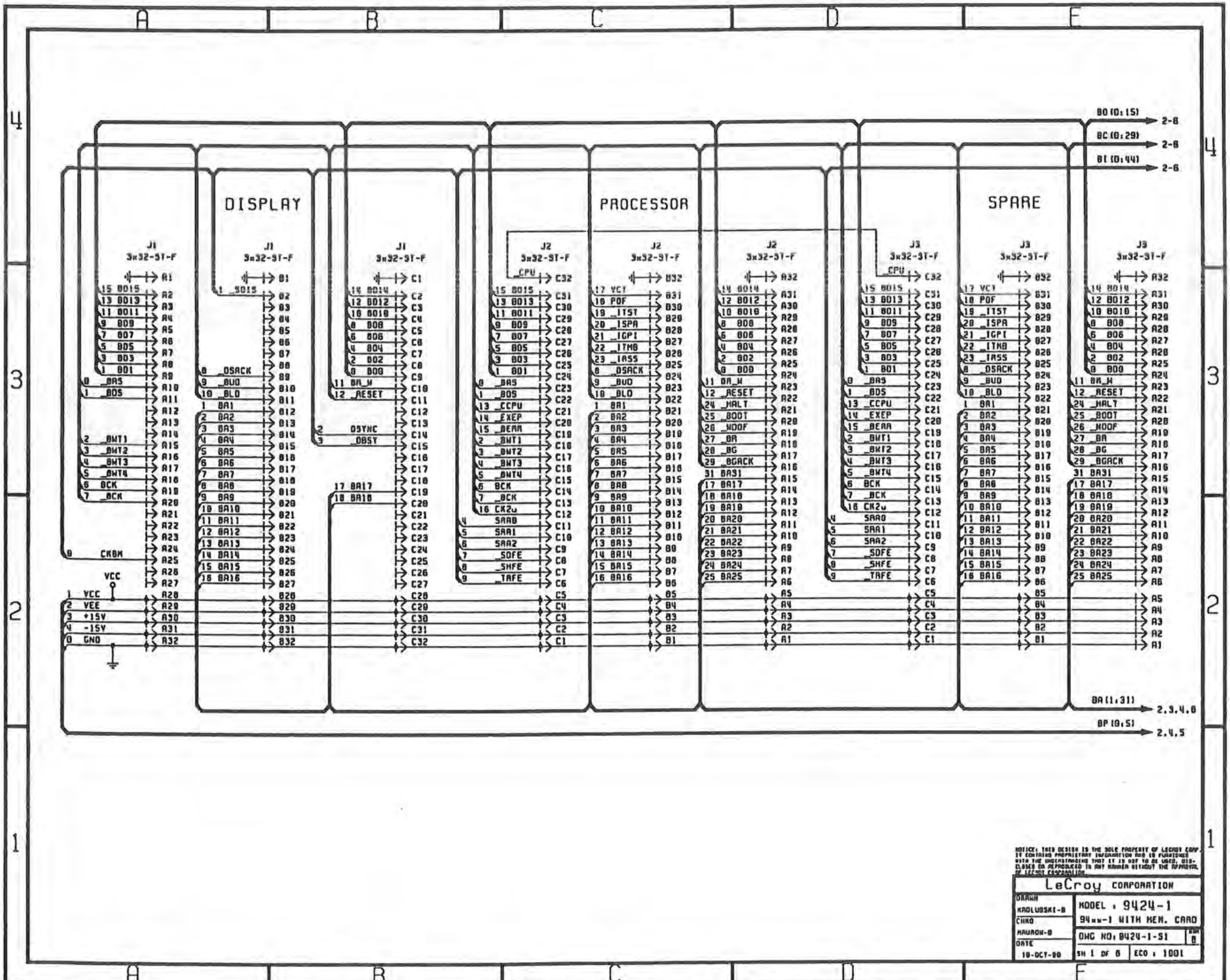
Table of Contents:



9424_1 PCB Rev: B



9424_1 PCB Rev:B



DISPLAY
PROCESSOR
SPARE
J1 3x32-9T-F
J2 3x32-9T-F
J3 3x32-9T-F
BD(0:15) 2-8
BC(0:29) 2-8
BI(0:44) 2-8
BA(1:31) 2,3,4,8
BP(0:5) 2,4,5
VCC
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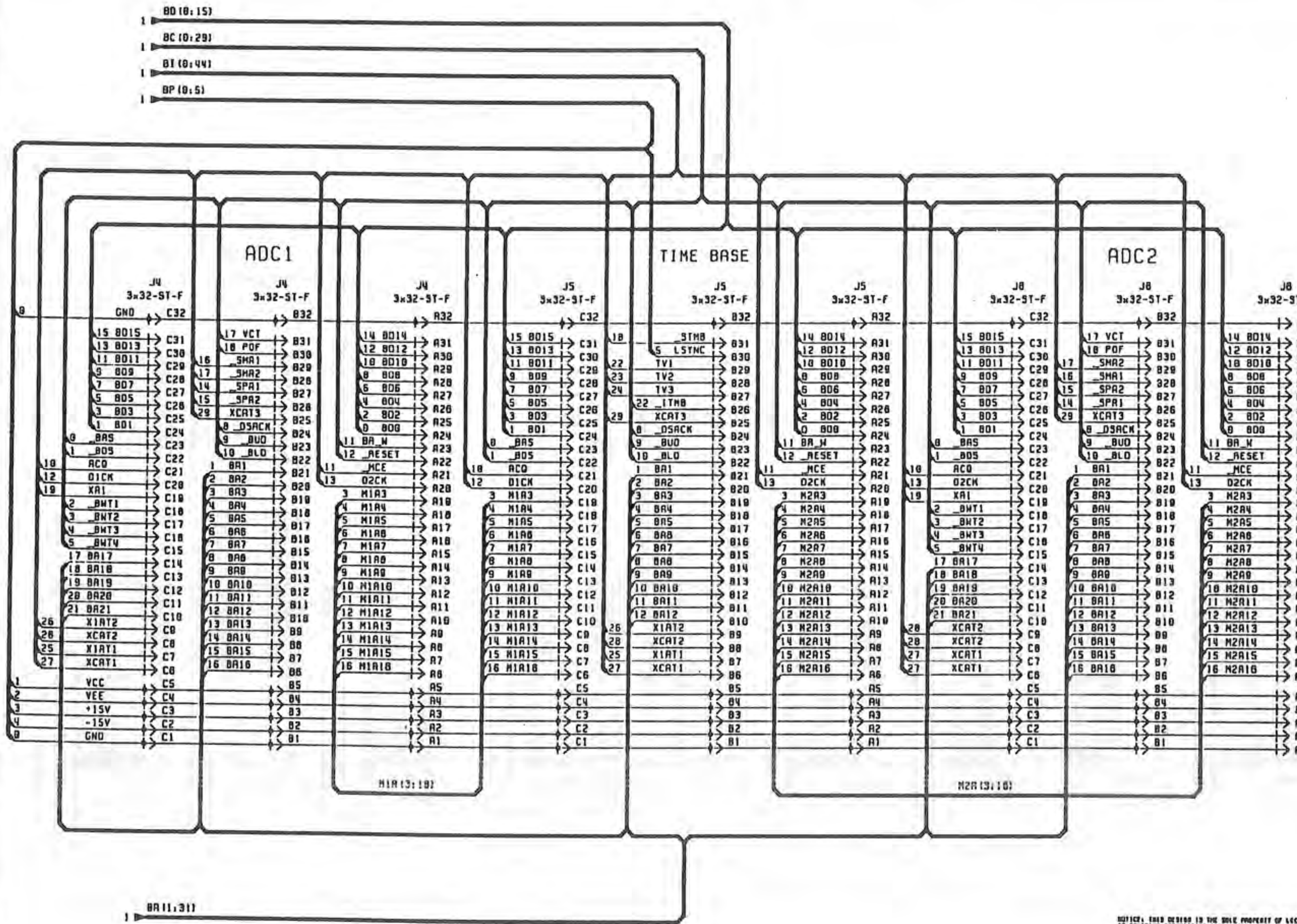
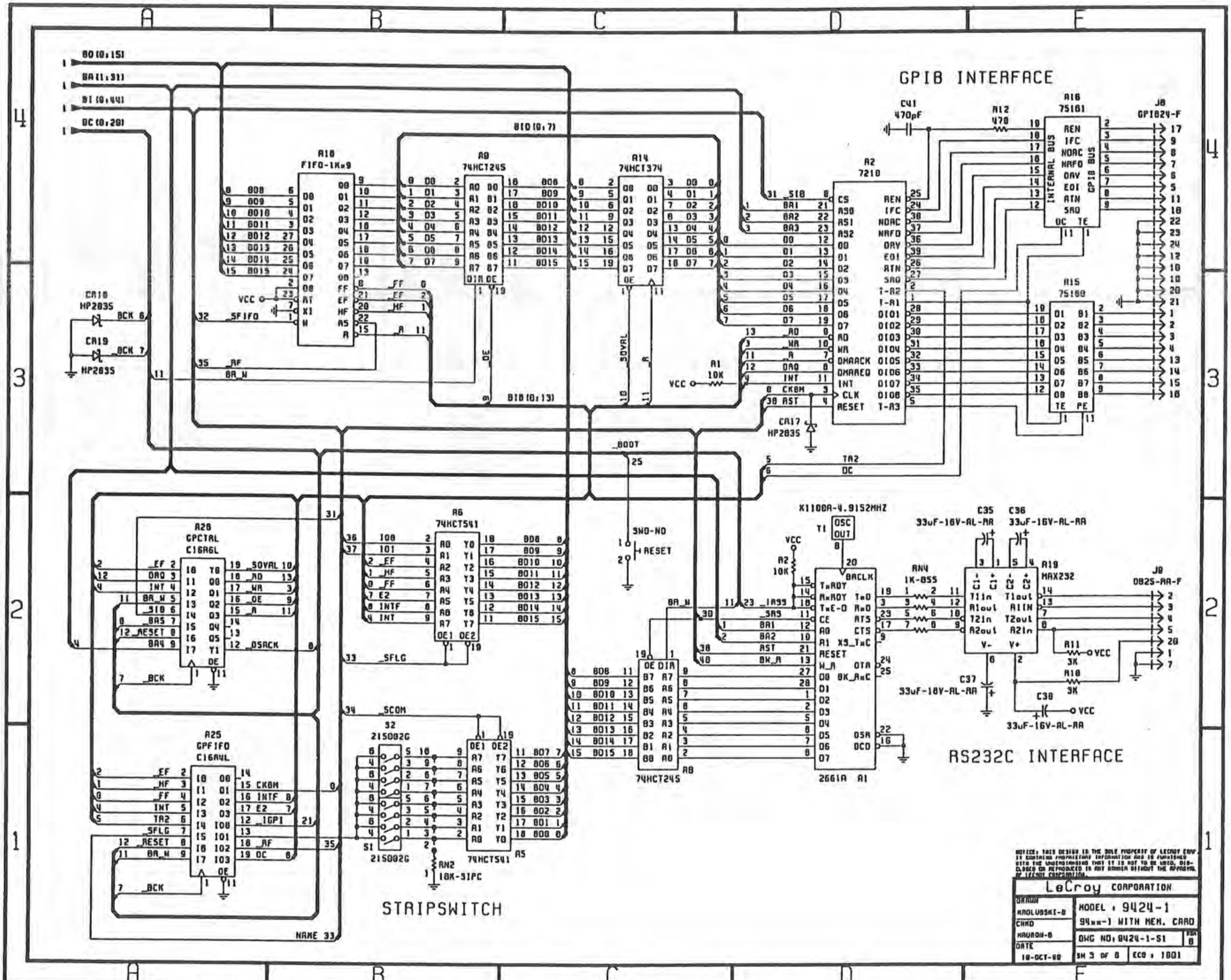
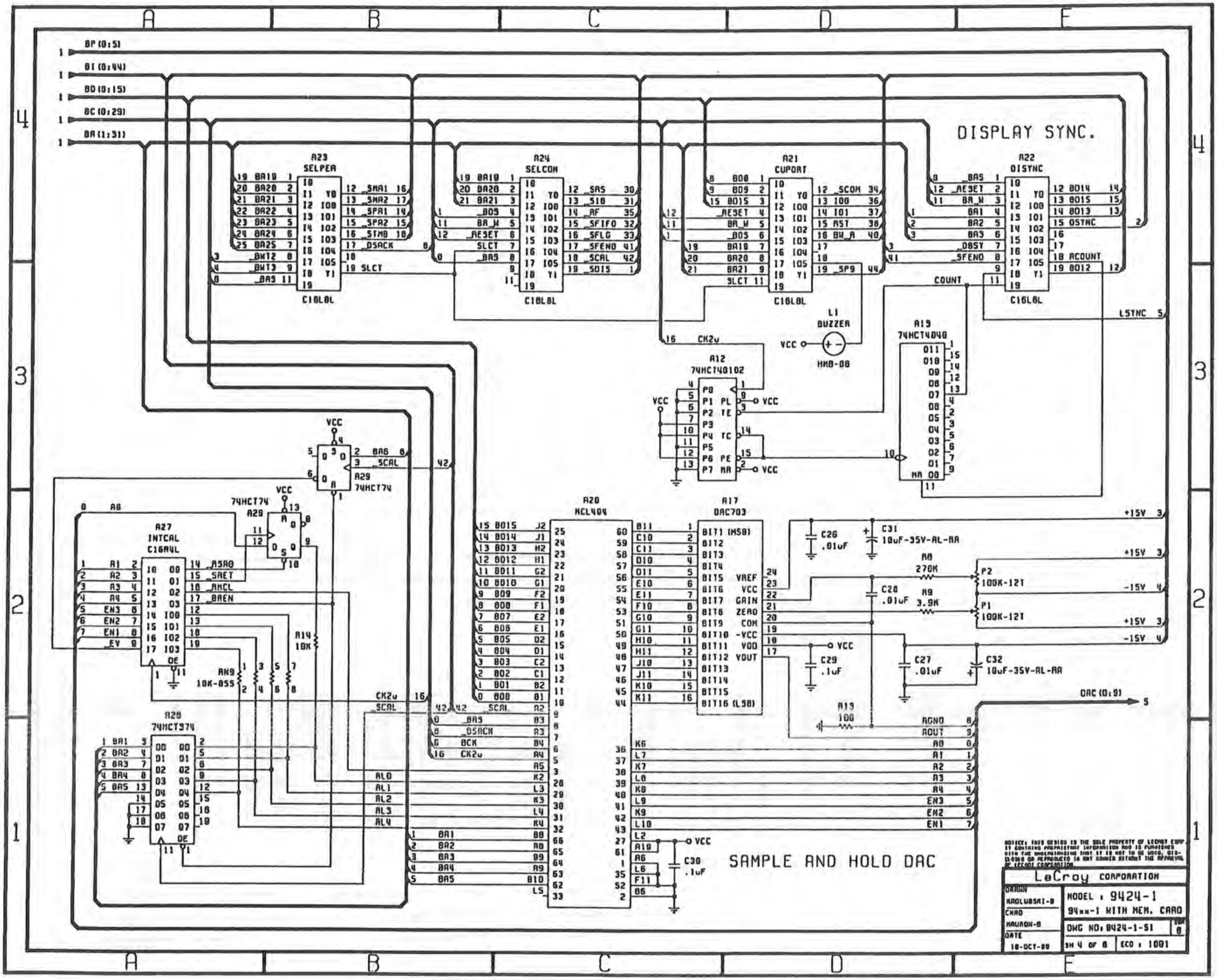
LeCroy CORPORATION
DRAWN KADLUBSKI-B
CHKD MAURON-D
DATE 18-OCT-90
MODEL : 9424-1
94xx-1 WITH MEM. CARD
DWG NO: 9424-1-S1
SH 1 OF 8
ECO : 1001

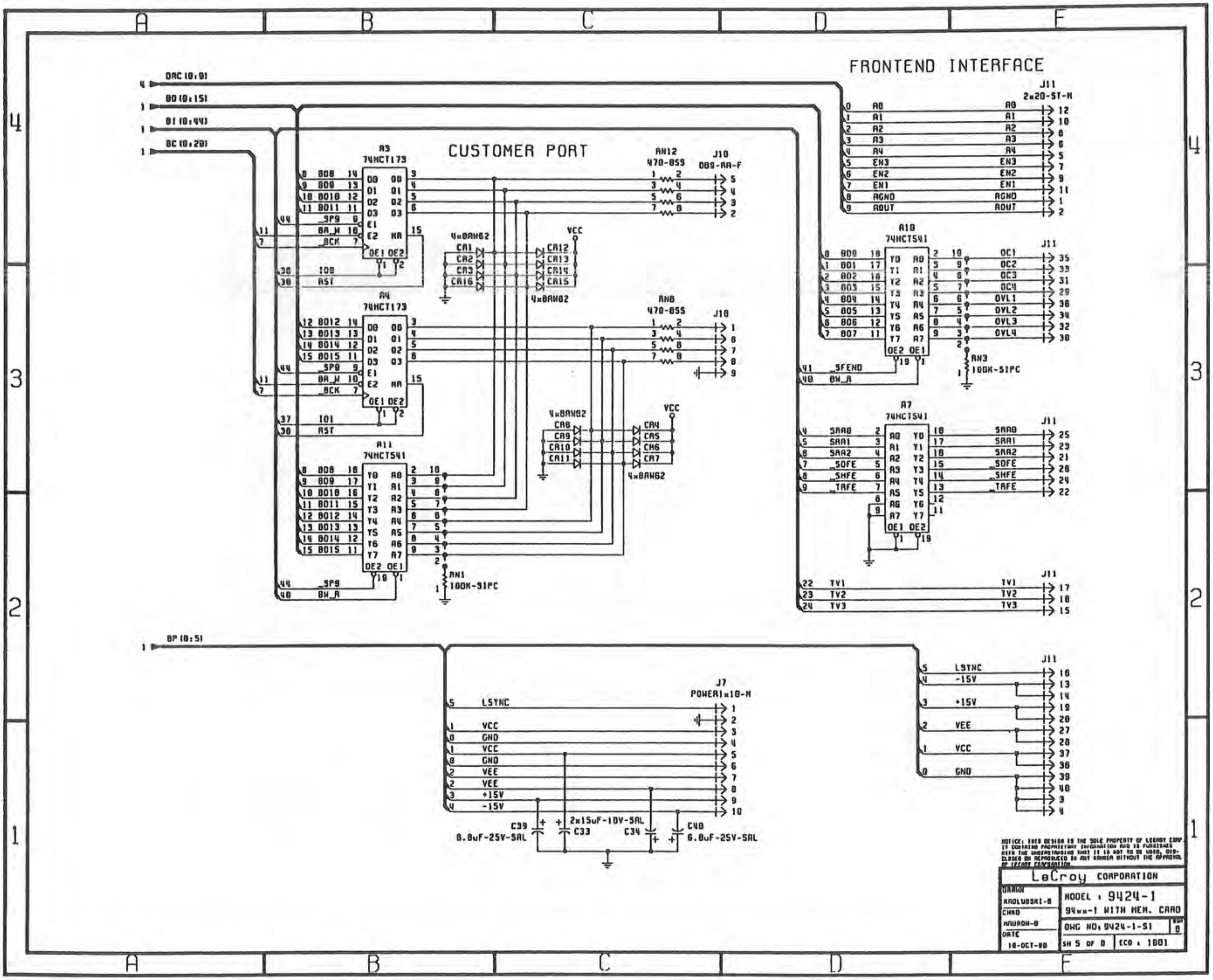


LeCroy CORPORATION	
DRAWN KAOLUBSKI-B	MODEL : 9424-1
CHKD MAURON-B	94xx-1 WITH MEM. CARD
DATE 18-OCT-88	DWG NO: 9424-1-51 REV B
	SH 2 OF 8 ECO : 1001


GPIB INTERFACE
RS232C INTERFACE
STRIPSWITCH
NOTICE: THIS DESIGN IS THE SOLE PROPERTY OF LECROY CORP. IT CONTAINS PROPRIETARY INFORMATION AND IS FURNISHED WITH THE UNDERSTANDING THAT IT IS NOT TO BE USED, DISCLOSED OR REPRODUCED IN ANY MANNER WITHOUT THE APPROVAL OF LECROY CORPORATION.
LeCroy CORPORATION
MODEL : 9424-1
94xx-1 WITH MEM. CARD
DWG NO: 9424-1-S1
DRAWN KROLUWSKI-B
CHKD KAURON-B
DATE 18-OCT-88
SH 3 OF 8
ECO : 1801



DISPLAY SYNC.
SAMPLE AND HOLD DAC
BP(0:5)
BI(0:44)
BD(0:15)
BC(0:29)
BA(1:31)
A23 SELPER C16L8L
A24 SELCON C16L8L
A21 CUPORT C16L8L
A22 DISYNC C16L8L
L1 BUZZER HMB-08
A12 74HCT40102
A19 74HCT4040
A29 74HCT74
A27 INTCAL C16R4L
A28 74HCT374
A20 MCL404
A17 DAC703
COUNT
LSYNC
CK2u
DAC(0:9)
LeCroy CORPORATION
MODEL : 9424-1
94xx-1 WITH MEM. CARD
DWG NO: 9424-1-S1
DRAWN KADLUBSKI-B
CHKD MAURON-B
DATE 10-OCT-89
SH 4 OF 8
ECO : 1091



FRONTEND INTERFACE
CUSTOMER PORT
DAC(0:9)
BD(0:15)
BI(0:44)
BC(0:20)
BP(0:5)
A3 74HCT173
A4 74HCT173
A11 74HCT541
A10 74HCT541
A7 74HCT541
RN12 470-8SS
RN8 470-8SS
RN1 100K-SIPC
RN3 100K-SIPC
J10 DB9-RA-F
J11 2x20-ST-M
J7 POWER1x10-M
4xBAN62
VCC
LSYNC
GND
VEE
+15V
-15V
C39 6.8uF-25V-SAL
2x15uF-10V-SAL C33
C34
C40 6.8uF-25V-SAL
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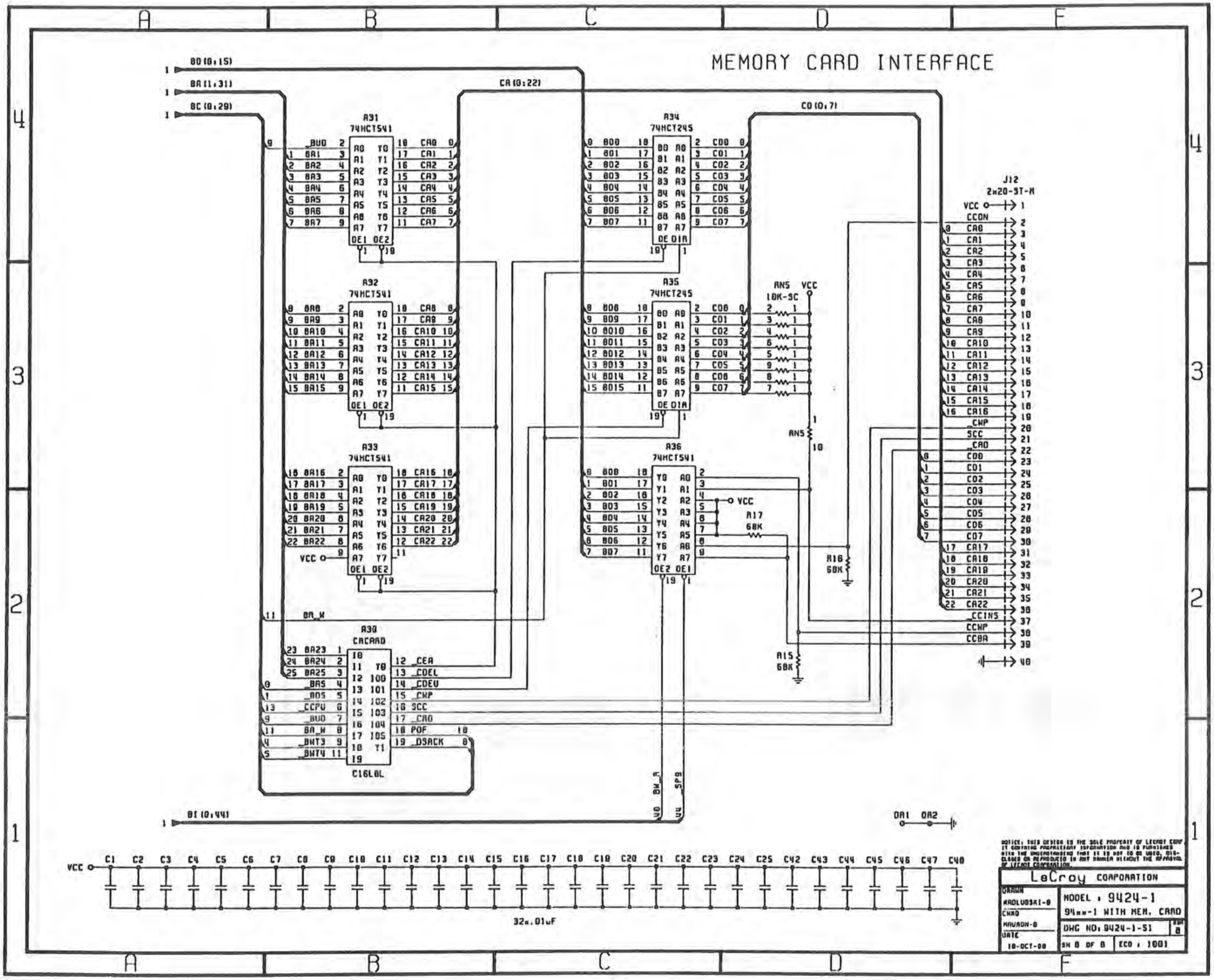
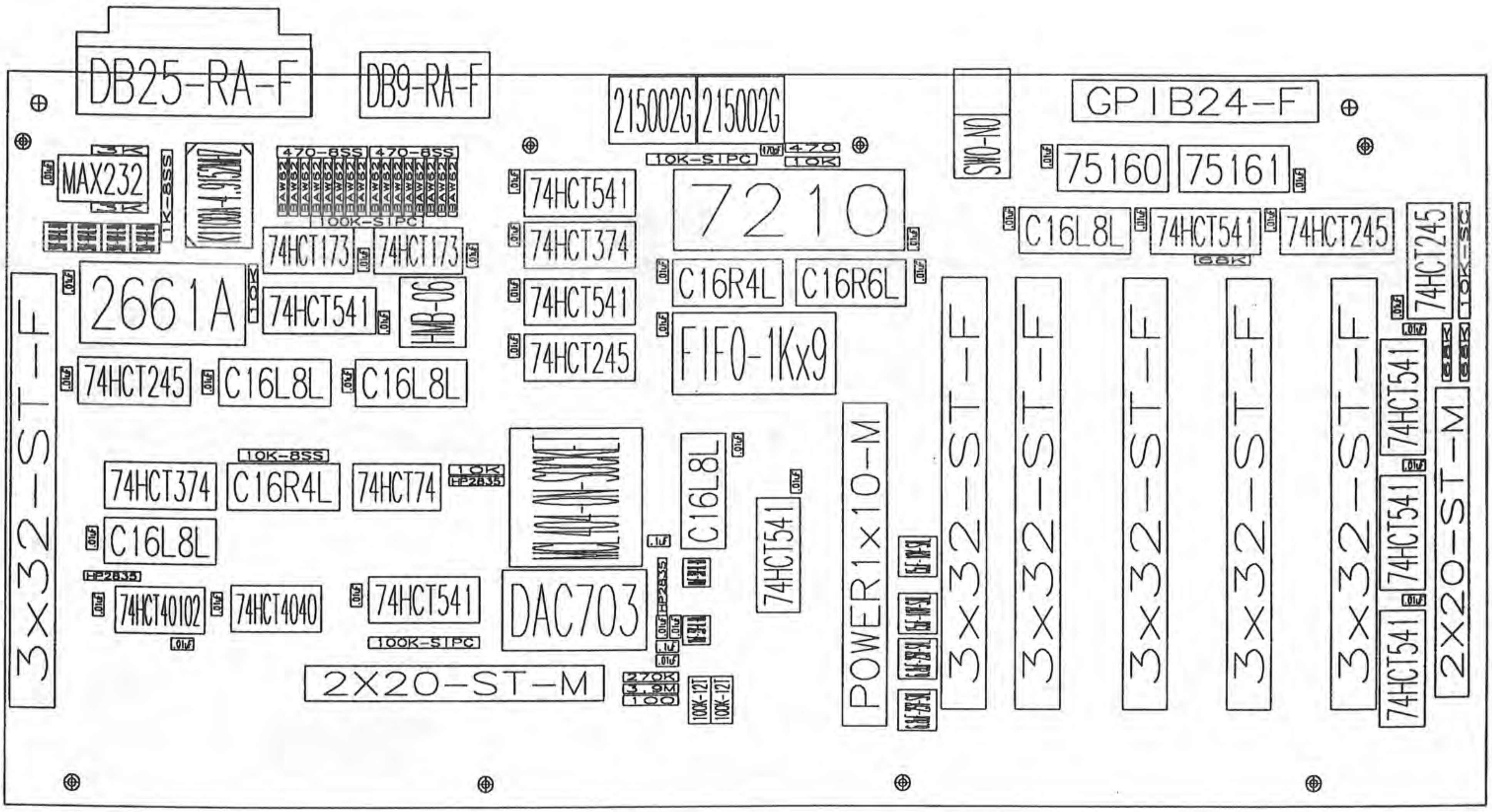
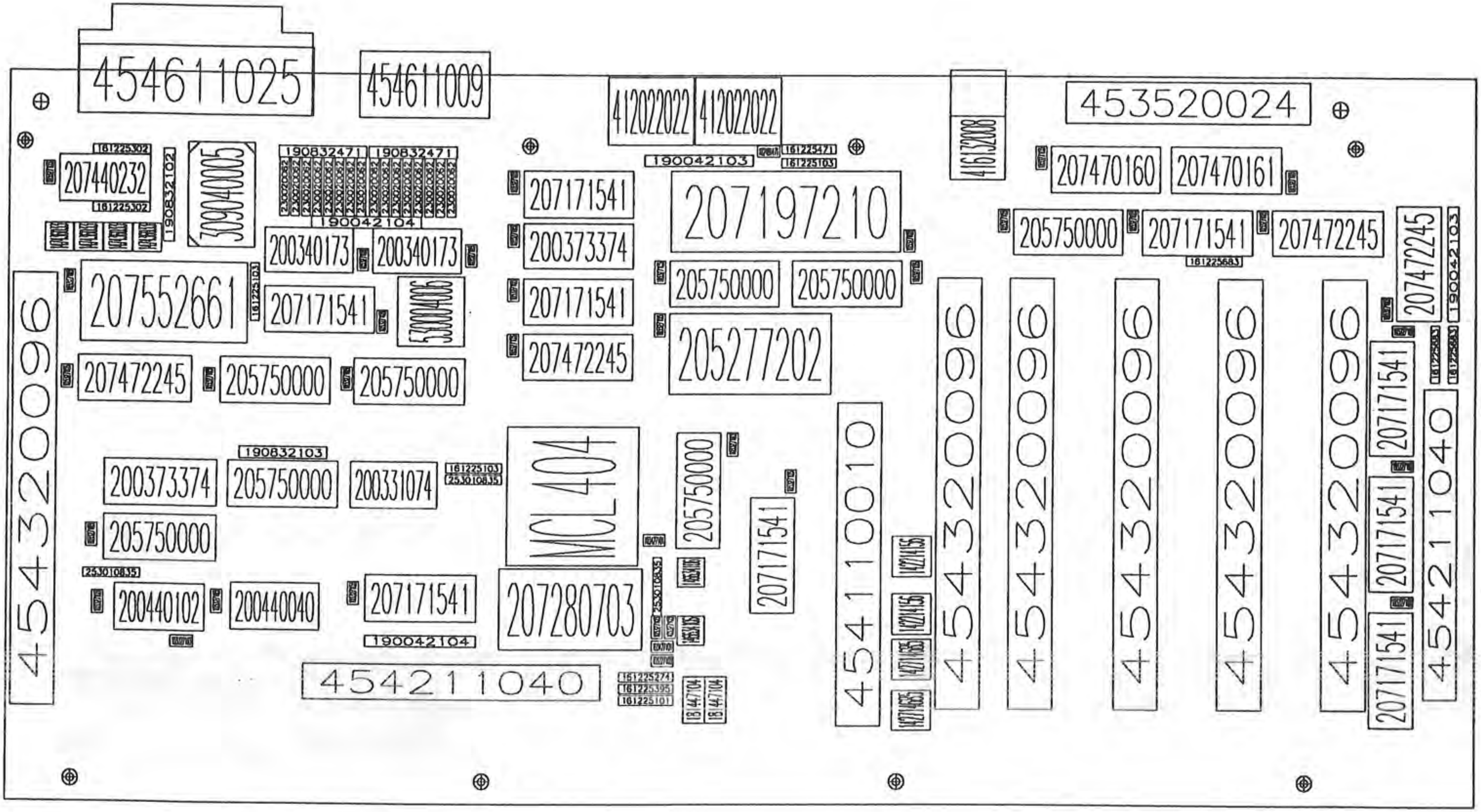
LeCroy CORPORATION
DRAWN KROLUSKI-B
CHKD MAURON-B
DATE 18-OCT-88
MODEL : 9424-1
94xx-1 WITH MEM. CARD
DWG NO: 9424-1-S1
SH 5 OF 8
ECO : 1001



MEMORY CARD INTERFACE
LeCroy CORPORATION
MODEL : 9424-1
94xx-1 WITH MEM. CARD
DWG NO: 9424-1-S1
SH 8 OF 8
ECO : 1001
DRAWN KROLUDSKI-B
CHKD MAURON-B
DATE 18-OCT-88
32x.01uF

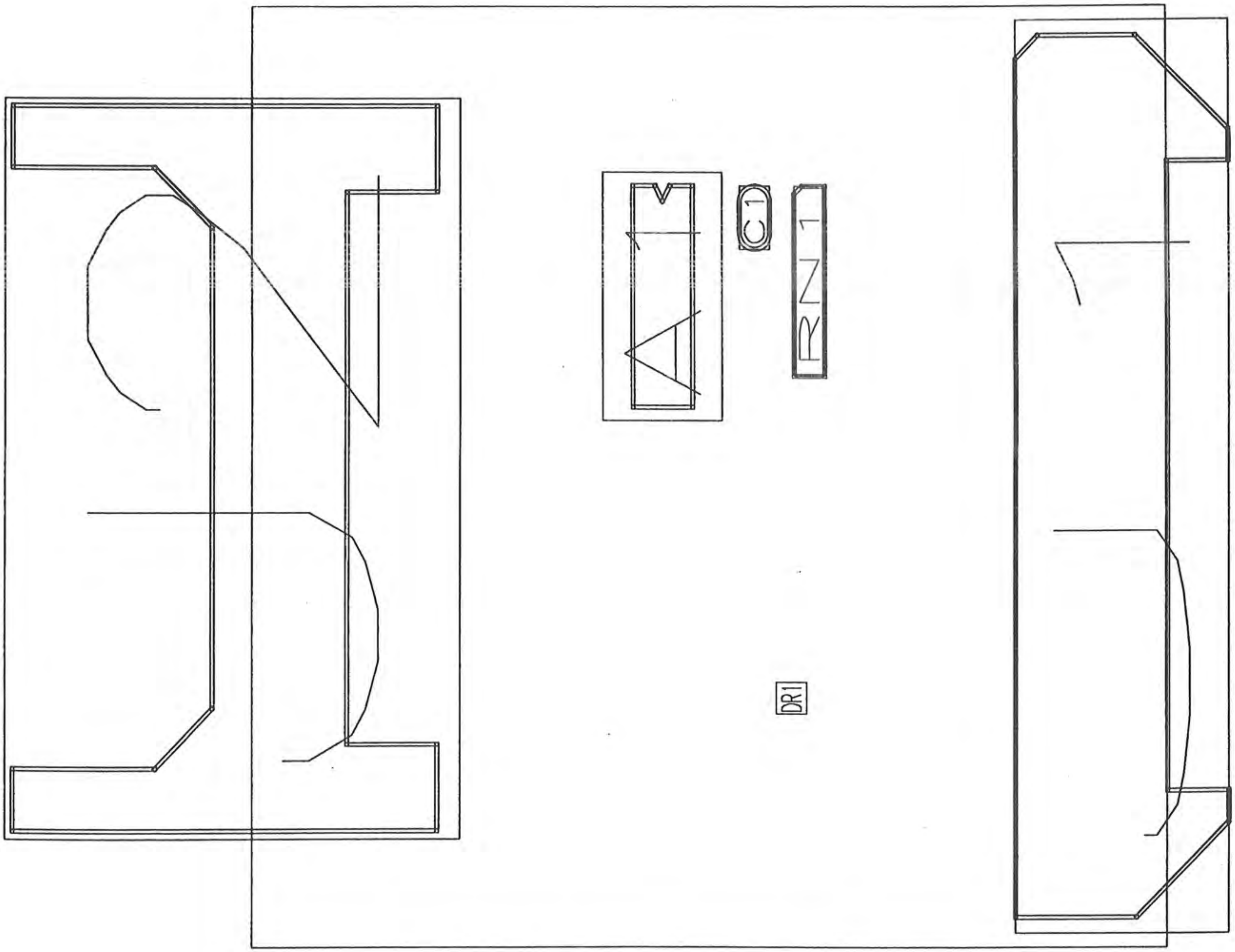


9424_1 PCB Rev:B

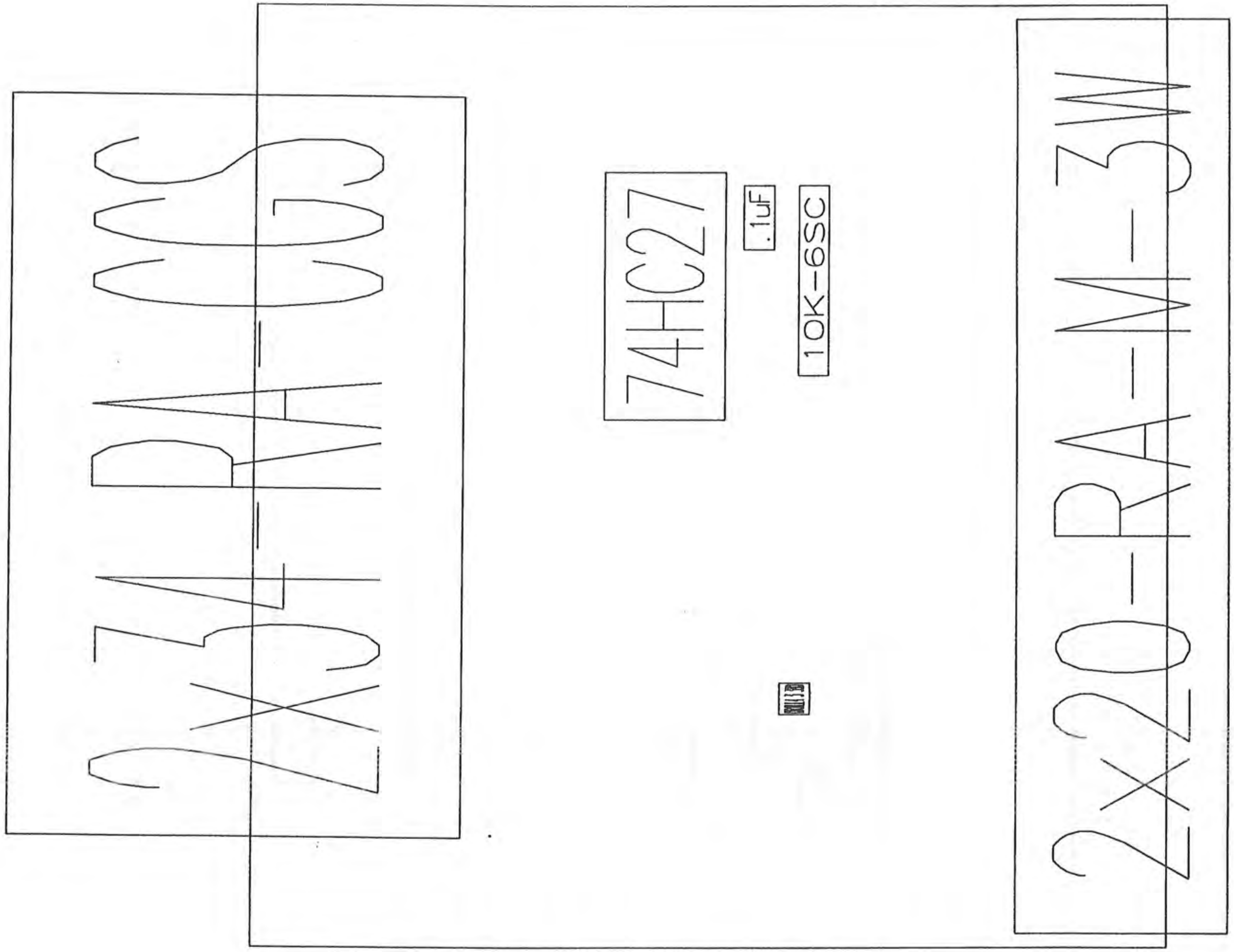


9424_1 PCB Rev:B

CR19	253010835	HP2835	DO35	-762000	-2540000	1	90
RESET	416132008	SW0-NO	SW0_NO	6598920	6959600	1	270
RN1	190042104	100K-SIPC	SIP10RES	-8686800	5994400	1	90
RN2	190042103	10K-SIPC	SIP10RES	-1016000	7366000	1	90
RN3	190042104	100K-SIPC	SIP10RES	-5080000	-3251200	1	270
RN4	190832102	1K-8SS	SIP8RES	-12090400	5638800	1	180
RN5	190042103	10K-SC	SIP10RES	17576800	4013200	1	180
RN8	190832471	470-8SS	SIP8RES	-9448800	7518400	1	90
RN9	190832103	10K-8SS	SIP8RES	-10312400	863600	1	90
RN12	190832471	470-8SS	SIP8RES	-5588000	7518400	1	270



9424-2 REV:E



9424-2 REV:E

4045000068

74HC27

103427104

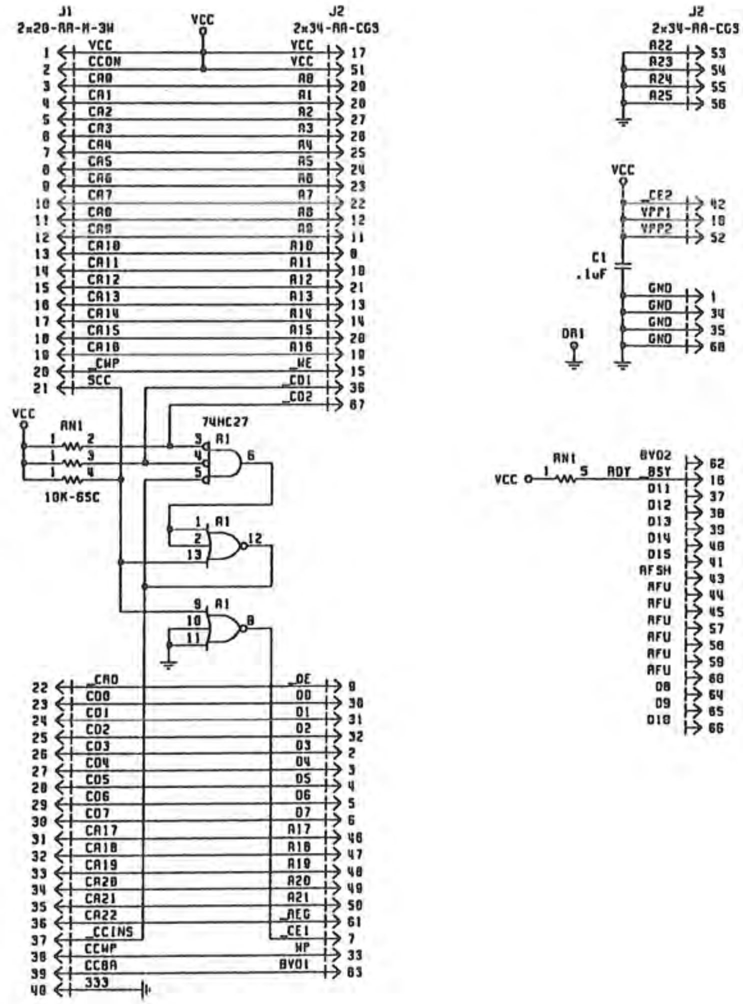
190642103

\$NULL

454611040

9424-2 REV:E

A1	74HC27	74HC27	DIP14	1524000	50800	1	0
C1	103427104	.1uF	SMONOBP	2692400	50800	1	270
J1	454611040	2x20-RA-M-3W	CONN2X20_RA_M_3W	5130800	254000	1	270
J2	404500068	2x34-RA-CGS	CONN4X17_RA_CGS	0	0	1	90
RN1	190642103	10K-6SC	SIP6RES	3149600	50800	1	0



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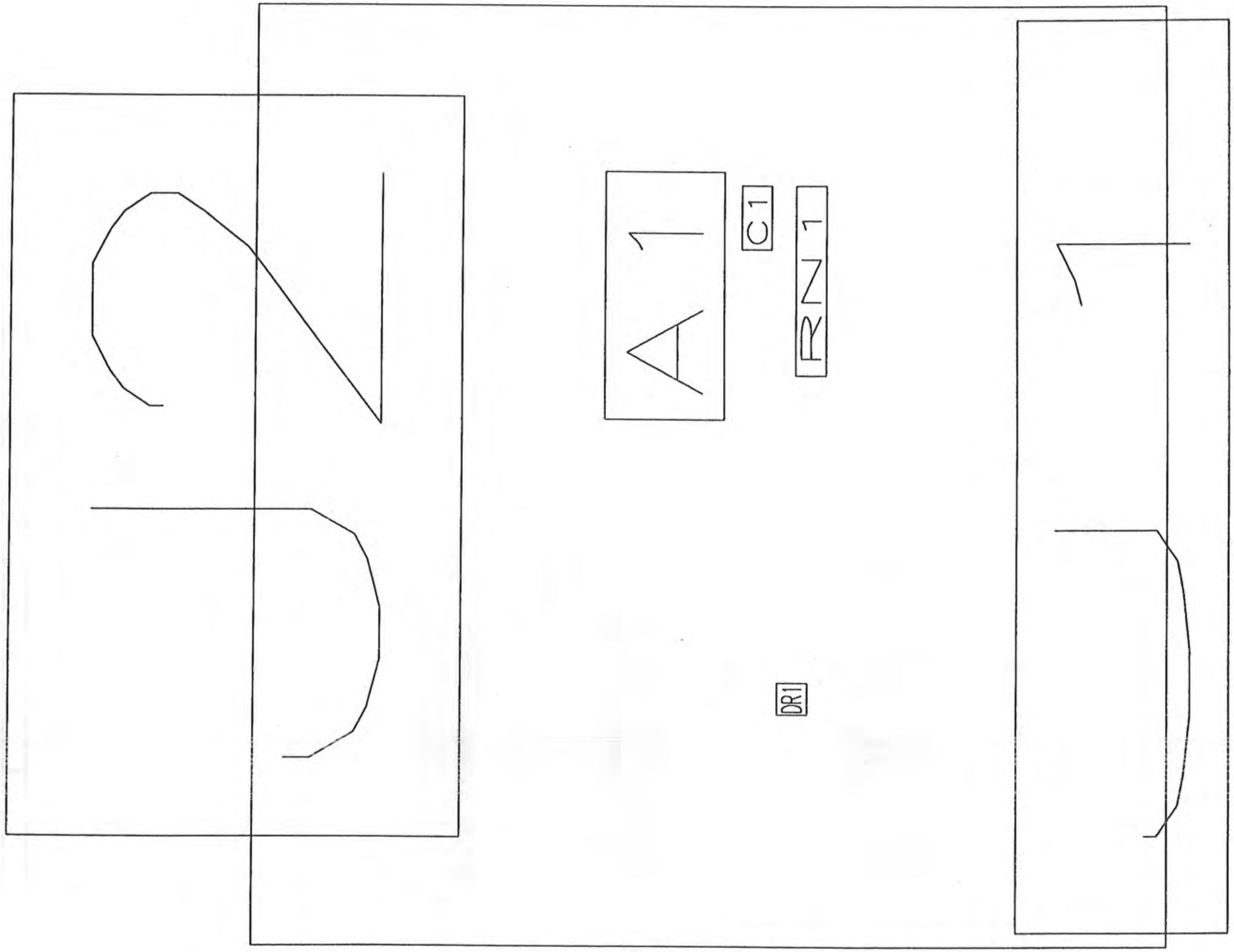
LeCroy CORPORATION	
DRAWN KADLUBSKI-B	MODEL : 9424-2 SUPPORT FOR MEM. CARD
CHKD NAVRON-B	DWG NO: 9424-2-S1 — REV A
DATE 20-JAN-91	SH 1 OF 1 — ECO : 1000



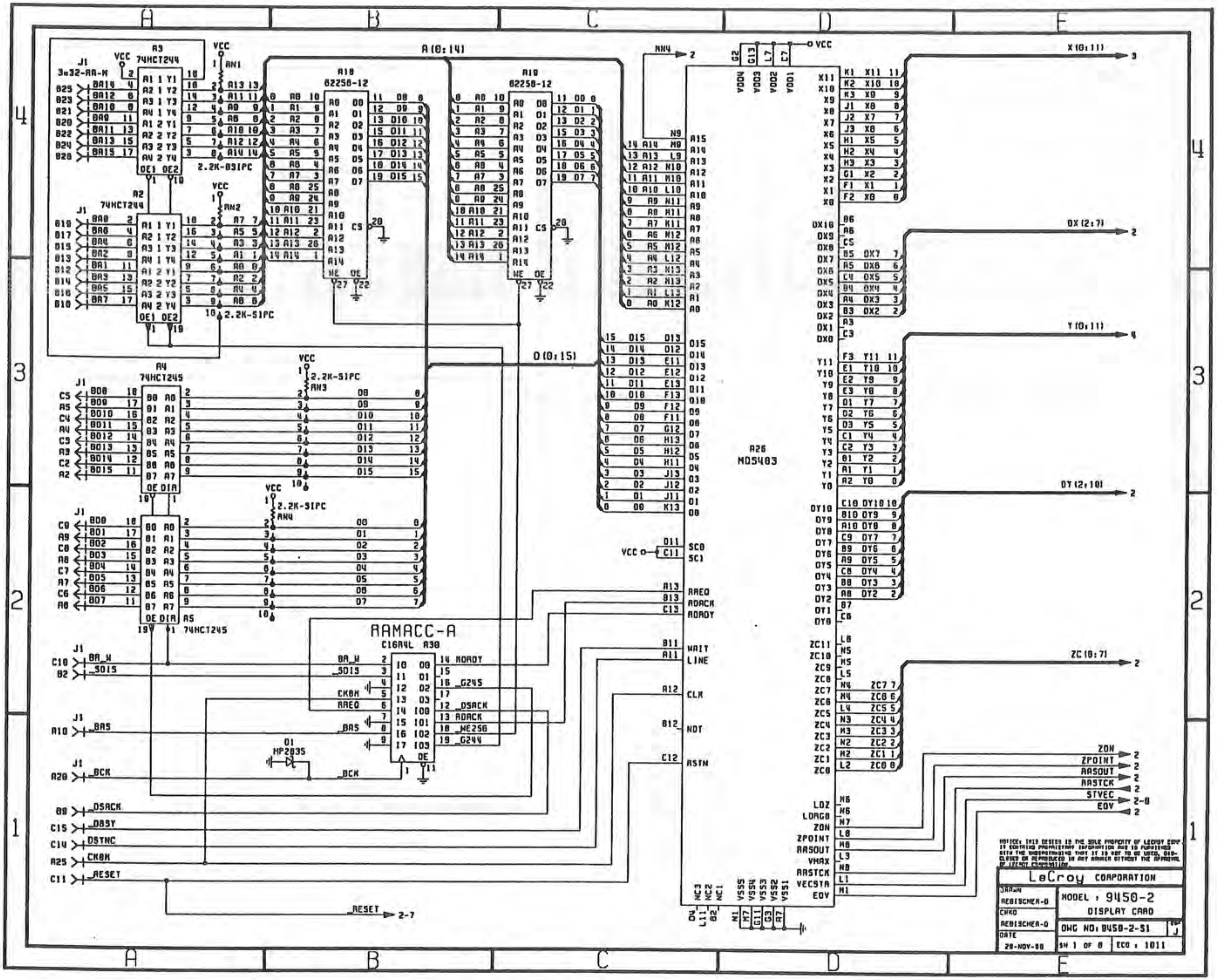
9424-2 REV:E

A1	207552661	2661A	DIP28	-13817600	3403600	1	90
A2	207197210	7210	DIP40	4572000	7010400	1	270
A3	200340173	74HCT173	DIP16	-5486400	5740400	1	270
A4	200340173	74HCT173	DIP16	-7975600	5740400	1	270
A5	207171541	74HCT541	DIP20	-3810000	6248400	1	90
A6	207171541	74HCT541	DIP20	-3810000	3860800	1	90
A7	207171541	74HCT541	DIP20	1524000	-203200	1	0
A8	207472245	74HCT245	DIP20	-13970000	2082800	1	90
A9	207472245	74HCT245	DIP20	-3810000	2641600	1	90
A10	207171541	74HCT541	DIP20	-7366000	-2692400	1	90
A11	207171541	74HCT541	DIP20	-7467600	4419600	1	270
A12	200440102	74HCT40102	DIP16	-13106400	-2946400	1	90
A13	200440040	74HCT4040	DIP16	-10464800	-2895600	1	90
A14	200373374	74HCT374	DIP20	-3810000	5105400	1	90
A15	207470160	75160	DIP20	8432800	6807200	1	90
A16	207470161	75161	DIP20	13512800	7569200	1	270
A17	207280703	DAC703	DIP24	-1371600	-1778000	1	270
A18	205277202	FIFO-1Kx9	DIP28	-304800	2336800	1	90
A19	207440232	MAX232	DIP16	-14427200	6502400	1	90
A20	MCL404	MCL404-ON-SOCKET	QILE68EX	-1473200	-50800	1	270
A21	205750000	C16L8L	DIP20	-10769600	2082800	1	90
A22	205750000	C16L8L	DIP20	-13360400	-1422400	1	90
A23	205750000	C16L8L	DIP20	-203200	1219200	1	0
A24	205750000	C16L8L	DIP20	-7670800	2082800	1	90
A25	205750000	C16R4L	DIP20	-406400	4267200	1	90
A26	205750000	C16R6L	DIP20	2438400	4267200	1	90
A27	205750000	C16R4L	DIP20	-10566400	-203200	1	90
A28	200373374	74HCT374	DIP20	-13360400	-203200	1	90
A29	200331074	74HCT74	DIP14	-7620000	-203200	1	90
A30	205750000	C16L8L	DIP20	7569200	5435600	1	90
A31	207171541	74HCT541	DIP20	15798800	3302000	1	0
A32	207171541	74HCT541	DIP20	15798800	304800	1	0
A33	207171541	74HCT541	DIP20	15798800	-2692400	1	0
A34	207472245	74HCT245	DIP20	13563600	5435600	1	90
A35	207472245	74HCT245	DIP20	17170400	4013200	1	180
A36	207171541	74HCT541	DIP20	10566400	5435600	1	90
C1	103327103	.01uF	SMONOBP	-14300200	4724400	1	270
C2	103327103	.01uF	SMONOBP	965200	1219200	1	270
C3	103327103	.01uF	SMONOBP	2311400	152400	1	90
C4	103327103	.01uF	SMONOBP	-762000	3606800	1	90
C5	103327103	.01uF	SMONOBP	5029200	5486400	1	90
C6	103327103	.01uF	SMONOBP	-7162800	3657600	1	90
C7	103327103	.01uF	SMONOBP	-11582400	-3302000	1	180
C8	103327103	.01uF	SMONOBP	-7772400	-2082800	1	270
C9	103327103	.01uF	SMONOBP	5181600	5029200	1	270
C10	103327103	.01uF	SMONOBP	-14782800	7112000	1	270
C11	103327103	.01uF	SMONOBP	-13766800	-863600	1	270
C12	103327103	.01uF	SMONOBP	-7975600	2641600	1	270
C13	103327103	.01uF	SMONOBP	-7620000	5029200	1	90
C14	103327103	.01uF	SMONOBP	-5130800	5130800	1	90
C15	103327103	.01uF	SMONOBP	-14351000	2616200	1	270
C16	103327103	.01uF	SMONOBP	-13614400	-2590800	1	90
C17	103327103	.01uF	SMONOBP	-10922000	-2540000	1	90
C18	103327103	.01uF	SMONOBP	-4165600	7010400	1	270
C19	103327103	.01uF	SMONOBP	-4165600	5842000	1	270
C20	103327103	.01uF	SMONOBP	-4165600	4622800	1	270
C21	103327103	.01uF	SMONOBP	-4165600	3403600	1	270
C22	103327103	.01uF	SMONOBP	-762000	5029200	1	270
C23	103327103	.01uF	SMONOBP	-11150600	2590800	1	270
C24	103327103	.01uF	SMONOBP	8077200	7569200	1	270
C25	103327103	.01uF	SMONOBP	13868400	6807200	1	90
C26	103327103	.01uF	SMONOBP	-457200	-3048000	1	90
C27	103327103	.01uF	SMONOBP	-762000	-3048000	1	90
C28	103327103	.01uF	SMONOBP	-762000	-3657600	1	0
C29	103427104	.1uF	SMONOBP	-762000	-3352800	1	0
C30	103427104	.1uF	SMONOBP	-711200	-1016000	1	180

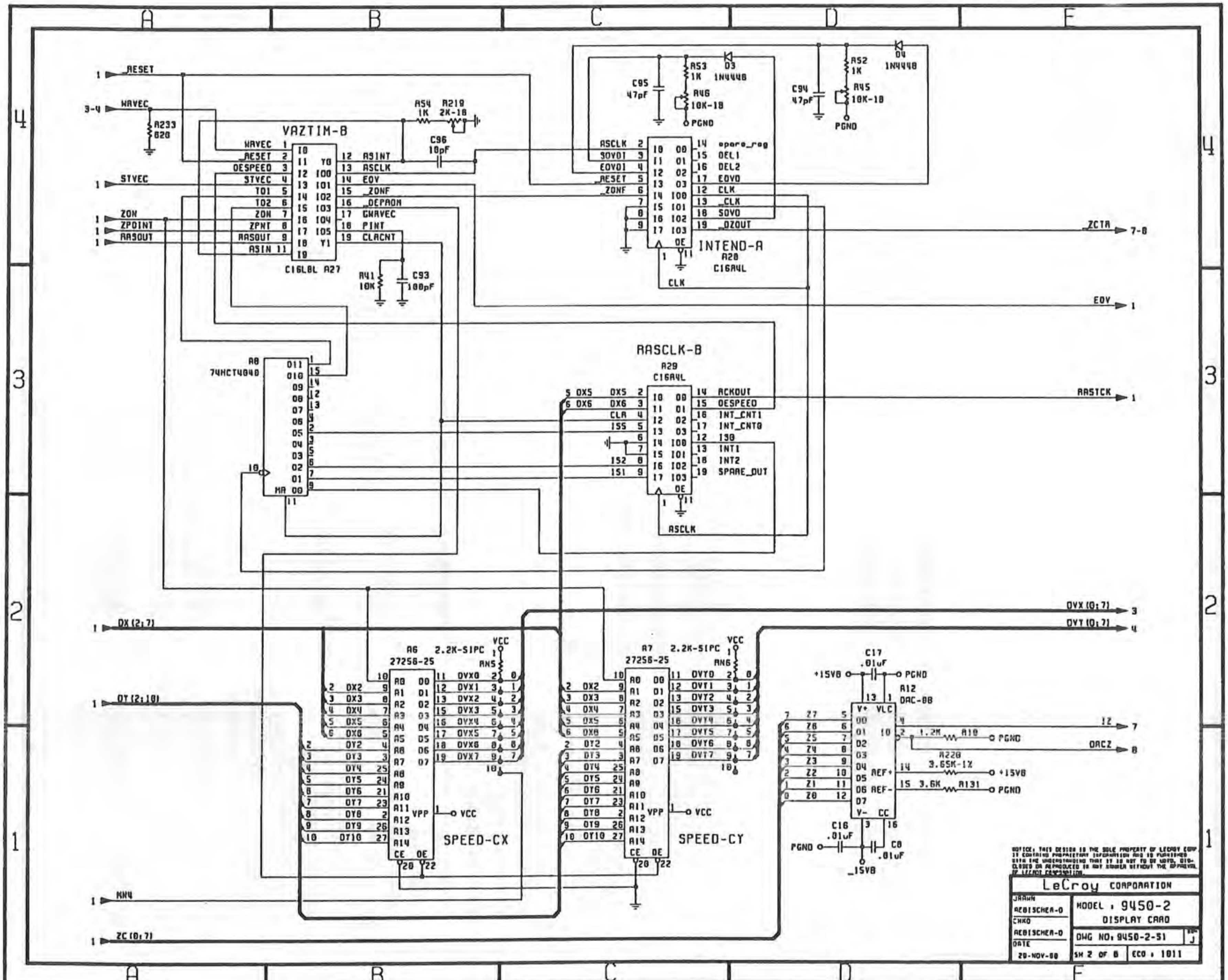
C31	146634106	10uF-35V-AL-RA	TCAP	152400	-1727200	1	180
C32	146634106	10uF-35V-AL-RA	TCAP	-101600	-2997200	1	0
C33	142214156	15uF-10V-SAL	LTCAP	5130800	-1625600	1	90
C34	142214156	15uF-10V-SAL	LTCAP	5130800	-2895600	1	90
C35	147436033	33uF-16V-AL-RA	TCAP	-14681200	5588000	1	0
C36	147436033	33uF-16V-AL-RA	TCAP	-13360400	5588000	1	0
C37	147436033	33uF-16V-AL-RA	TCAP	-12700000	5588000	1	0
C38	147436033	33uF-16V-AL-RA	TCAP	-14020800	5588000	1	0
C39	142714685	6.8uF-25V-SAL	LTCAP	5130800	-3886200	1	90
C40	142714685	6.8uF-25V-SAL	LTCAP	5130800	-5003800	1	90
C41	102484471	470pF	SMONO	1879600	7569200	1	180
C42	103327103	.01uF	SMONOBP	16560800	-2336800	1	180
C43	103327103	.01uF	SMONOBP	16560800	660400	1	180
C44	103327103	.01uF	SMONOBP	16560800	3657600	1	180
C45	103327103	.01uF	SMONOBP	16052800	4013200	1	90
C46	103327103	.01uF	SMONOBP	13208000	6197600	1	270
C47	103327103	.01uF	SMONOBP	10210800	6197600	1	270
C48	103327103	.01uF	SMONOBP	7213600	6197600	1	270
J1	454320096	3x32-ST-F	CONN3X32_ST_F	-15341600	3962400	1	270
J2	454320096	3x32-ST-F	CONN3X32_ST_F	6451600	-3911600	1	90
J3	454320096	3x32-ST-F	CONN3X32_ST_F	8128000	-3911600	1	90
J4	454320096	3x32-ST-F	CONN3X32_ST_F	10566400	-3911600	1	90
J5	454320096	3x32-ST-F	CONN3X32_ST_F	12954000	-3911600	1	90
J6	454320096	3x32-ST-F	CONN3X32_ST_F	15341600	-3911600	1	90
J7	454110010	POWER1x10-M	POWER1X10_M	3911600	1320800	1	270
J8	453520024	GPIB24-F	GPIB24_F	10210800	8534400	1	0
J9	454611025	DB25-RA-F	DB25_RA_F	-13174980	8407400	1	180
J10	454611009	DB9-RA-F	DB9_RA_F	-6705600	8407400	1	180
J11	454211040	2X20-ST-M	CONN2X20_ST_M	-3098800	-4013200	1	180
J12	454211040	2X20-ST-M	CONN2X20_ST_M	17424400	-3454400	1	90
L1	530004006	HMB-06	HBM_06	-6045200	4013200	1	0
P1	181447104	100K-12T	POT66WR	609600	-4775200	1	90
P2	181447104	100K-12T	POT66WR	101600	-4267200	1	270
R1	161225103	10K	RES05	3200400	7315200	1	180
R2	161225103	10K	RES05	-10109200	3911600	1	90
R8	161225274	270K	RES05	-1524000	-4013200	1	0
R9	161225395	3.9M	RES05	-1524000	-4267200	1	0
R10	161225302	3K	RES05	-13665200	7518400	1	0
R11	161225302	3K	RES05	-12649200	6248400	1	180
R12	161225471	470	RES05	2184400	7620000	1	0
R13	161225101	100	RES05	-1524000	-4521200	1	0
R14	161225103	10K	RES05	-5537200	558800	1	0
R15	161225683	68K	RES05	17170400	2641600	1	90
R16	161225683	68K	RES05	17576800	2641600	1	90
R17	161225683	68K	RES05	11582400	5181600	1	0
S1	412022022	215002G	STRIPSWITCH	-1717040	7993380	1	180
S2	412022022	215002G	STRIPSWITCH	320040	7993380	1	180
Y1	309040005	K1100A-4.9152MHZ	$1100_QUARTZ	-12801600	5791200	1	90
CR1	230020062	BAW62	DO35	-5842000	6248400	1	90
CR2	230020062	BAW62	DO35	-6350000	6248400	1	90
CR3	230020062	BAW62	DO35	-6858000	6248400	1	90
CR4	230020062	BAW62	DO35	-9194800	7264400	1	270
CR5	230020062	BAW62	DO35	-8686800	7264400	1	270
CR6	230020062	BAW62	DO35	-8178800	7264400	1	270
CR7	230020062	BAW62	DO35	-7670800	7264400	1	270
CR8	230020062	BAW62	DO35	-9448800	6248400	1	90
CR9	230020062	BAW62	DO35	-8940800	6248400	1	90
CR10	230020062	BAW62	DO35	-8432800	6248400	1	90
CR11	230020062	BAW62	DO35	-7924800	6248400	1	90
CR12	230020062	BAW62	DO35	-5588000	7264400	1	270
CR13	230020062	BAW62	DO35	-6096000	7264400	1	270
CR14	230020062	BAW62	DO35	-6604000	7264400	1	270
CR15	230020062	BAW62	DO35	-7112000	7264400	1	270
CR16	230020062	BAW62	DO35	-7366000	6248400	1	90
CR17	253010835	HP2835	DO35	-12801600	-1828800	1	180
CR18	253010835	HP2835	DO35	-5537200	304800	1	0

R112	161225241	240	RES05	-4876800	11531600	1	0
R113	161225241	240	RES05	-4876800	11277600	1	0
R114	161225202	2K	RES05	-1219200	8712200	1	90
R115	161225202	2K	RES05	-2438400	7721600	1	0
R116	161225202	2K	RES05	-2438400	12446000	1	0
R117	161225202	2K	RES05	-1219200	13436600	1	90
R118	161225202	2K	RES05	-12242800	3352800	1	0
R119	180487205	2M-1B	pot3386x	-13766800	9194800	1	0
R120	180487205	2M-1B	pot3386x	-13309600	15189200	1	0
R121	161225332	3.3K	RES05	-26670000	7518400	1	180
R122	161225332	3.3K	RES05	-11226800	12649200	1	180
R123	161225621	620	RES05	-12700000	4978400	1	180
R124	161225271	270	RES05	-12700000	4724400	1	180
R125	161225332	3.3K	RES05	-10058400	2895600	1	270
R126	161225332	3.3K	RES05	-9804400	2895600	1	270
R127	161225332	3.3K	RES05	-11226800	4622800	1	180
R128	168531541	'34.8K-1%'	RES07	-27635200	3302000	1	90
R129	168531445	'3.48K-1%'	RES07	-11125200	609600	1	0
R130	161225362	3.6K	RES05	203200	7772400	1	270
R131	161225362	3.6K	RES05	406400	6045200	1	180
R132	161225272	2.7K	RES05	-11125200	355600	1	0
R133	161225362	3.6K	RES05	203200	12496800	1	270
R134	161225333	33K	RES05	-24028400	3606800	1	270
R135	161225333	33K	RES05	-26670000	152400	1	180
R136	161225394	390K	RES05	-9499600	9093200	1	270
R137	161225394	390K	RES05	-9753600	8077200	1	90
R138	161225394	390K	RES05	-9753600	11684000	1	270
R139	161225394	390K	RES05	-9499600	10668000	1	90
R140	161225302	3K	RES05	-7874000	8585200	1	0
R141	161225302	3K	RES05	-7569200	12242800	1	0
R142	161225302	3K	RES05	-12700000	2235200	1	180
R143	161225302	3K	RES05	-13716000	1981200	1	0
R144	161225302	3K	RES05	-13716000	2743200	1	0
R145	161225302	3K	RES05	-12700000	2997200	1	180
R146	161225472	4.7K	RES05	-12700000	-406400	1	180
R147	161225472	4.7K	RES05	-12700000	-660400	1	180
R148	161225471	470	RES05	-8178800	6299200	1	90
R149	161225471	470	RES05	-27736800	12700000	1	270
R150	161225471	470	RES05	-21285200	13411200	1	180
R151	161225471	470	RES05	-13208000	12750800	1	270
R152	161225471	470	RES05	-20370800	13411200	1	0
R153	161225471	470	RES05	-27686000	8026400	1	0
R154	161225471	470	RES05	-22809200	13157200	1	90
R155	161225471	470	RES05	-27736800	13157200	1	90
R156	161225471	470	RES05	-13868400	13411200	1	90
R157	161225471	470	RES05	-18846800	13157200	1	90
R158	161335241	240-1/4W	RES07	-23622000	12395200	1	180
R159	161335241	240-1/4W	RES07	-25298400	12395200	1	180
R160	161335241	240-1/4W	RES07	-16357600	12395200	1	0
R161	161335241	240-1/4W	RES07	-18034000	12395200	1	0
R162	161335471	470-1/4W	RES07	-23063200	14427200	1	270
R163	161335471	470-1/4W	RES07	-27482800	13157200	1	90
R164	161335471	470-1/4W	RES07	-14122400	13157200	1	90
R165	161335471	470-1/4W	RES07	-18592800	14427200	1	270
R166	161225512	5.1K	RES05	-22758400	8382000	1	90
R167	161225332	3.3K	RES05	-26670000	7772400	1	180
R168	161225512	5.1K	RES05	-13716000	-152400	1	0
R169	161225512	5.1K	RES05	-10109200	1117600	1	180
R170	161225512	5.1K	RES05	-13716000	1371600	1	0
R171	161225512	5.1K	RES05	-13716000	3860800	1	0
R172	180487502	5K-1B	pot3386x	-15900400	12700000	1	0
R173	180487502	5K-1B	pot3386x	-26060400	6756400	1	90
R174	180487502	5K-1B	pot3386x	-26263600	12700000	1	0
R175	161335565	5.6M-1/4W	RES07	-9245600	9093200	1	270
R176	161335565	5.6M-1/4W	RES07	-9245600	10668000	1	90
R177	168531495	'11.5K-1%'	RES07	-50800	7772400	1	270

R178	168531495	'11.5K-1%'	RES07	-50800	12496800	1	270
R179	161225622	6.2K	RES05	-965200	8432800	1	270
R180	161225752	7.5K	RES05	-24638000	11887200	1	0
R181	161225752	7.5K	RES05	-25044400	11887200	1	180
R182	161225752	7.5K	RES05	-16611600	11887200	1	0
R183	161225752	7.5K	RES05	-17018000	12141200	1	180
R184	161225622	6.2K	RES05	-965200	13157200	1	270
R185	168531471	'6.49K-1%'	RES07	304800	10718800	1	0
R186	168531471	'6.49K-1%'	RES07	304800	15443200	1	0
R187	161225682	6.8K	RES05	-939800	9728200	1	270
R188	161225682	6.8K	RES05	-939800	14452600	1	270
R189	161225821	820	RES05	-6553200	10718800	1	180
R190	161225821	820	RES05	-27686000	7010400	1	0
R191	180487502	5K-1B	pot3386x	-7772400	9398000	1	0
R192	180487501	500-1B	pot3386x	-6451600	7721600	1	0
R193	180487501	500-1B	pot3386x	-5994400	12242800	1	0
R194	180487502	5K-1B	pot3386x	-7569200	13004800	1	0
R195	161225510	51	RES05	-27432000	11226800	1	0
R196	161225510	51	RES05	-22453600	12801600	1	270
R197	161225510	51	RES05	-14579600	11887200	1	0
R198	161225510	51	RES05	-19202400	12801600	1	270
R199	168531365	'511-1%'	RES07	-990600	10579100	1	180
R200	168531365	'511-1%'	RES07	-1854200	10833100	1	180
R201	168531365	'511-1%'	RES07	-1879600	15557500	1	180
R202	168531365	'511-1%'	RES07	-990600	15303500	1	180
R203	168531385	'825-1%'	RES07	-1752600	8712200	1	90
R204	168531385	'825-1%'	RES07	-1752600	13436600	1	90
R205	161335752	7.5K-1/4W	RES07	-13563600	6604000	1	90
R206	161335752	7.5K-1/4W	RES07	-13055600	6604000	1	90
R207	172137022	.22-1W	RES32	-21844000	8483600	1	270
R208	168035125	1.2M-700V	A_P500_L300X100	-23418800	6248400	1	270
R209	168531453	'4.22K-1%'	RES07	-9855200	863600	1	180
R210	161225512	5.1K	RES05	-6858000	9093200	1	180
R211	161225161	160	RES05	-6858000	7061200	1	180
R212	161445102	1K-1/2W	RES20	-12344400	11176000	1	270
R213	161225272	2.7K	RES05	-11226800	4876800	1	180
R214	161225204	200K	RES05	-13716000	4114800	1	0
R215	161225221	220	RES05	-26670000	1168400	1	180
R216	161225223	22K	RES05	-26670000	2946400	1	180
R217	168531495	'11.5K-1%'	RES07	-11125200	-152400	1	0
R218	161225271	270	RES05	-6553200	10464800	1	180
R219	180487202	2K-1B	pot3386x	1981200	10363200	1	0
R220	168531447	'3.65K-1%'	RES07	762000	6045200	1	0
R221	161225273	27K	RES05	-11125200	-406400	1	0
R222	161225331	330	RES05	-6858000	6807200	1	180
R223	168045336	33M-3KV	A_P600_L400X150	-21336000	4064000	1	180
R224	161225473	47K	RES05	-11226800	12395200	1	180
R225	161225912	9.1K	RES05	-26670000	6756400	1	180
R226	165375824	820K-700V	A_P500_L300X100	-21945600	5486400	1	0
R227	161225753	75K	RES05	-12242800	12141200	1	0
R228	161225511	510	RES05	-9753600	5080000	1	180
R229	161225681	680	RES05	-27686000	660400	1	0
R230	161445560	56-1/2W	RES20	-16510000	12801600	1	180
R231	161225103	10K	RES05	-12700000	1727200	1	180
R232	161225103	10K	RES05	-12700000	2489200	1	180
R233	161225621	620	RES05	-2844800	6324600	1	180
R234	161225623	62K	RES05	-12039600	6146800	1	90
R235	161225560	56	RES05	-2006600	13436600	1	90
R236	161225560	56	RES05	-1473200	14452600	1	270
R237	161225560	56	RES05	-2006600	8712200	1	90
R238	161225560	56	RES05	-1473200	9728200	1	270
R239	161225101	100	RES05	-17627600	11582400	1	180
RN1	190842222	2.2K-8SIPC	SIP8RES	-3251200	2794000	1	90
RN2	190042222	2.2K-SIPC	SIP10RES	-762000	2794000	1	90
RN3	190042222	2.2K-SIPC	SIP10RES	5232400	2794000	1	90
RN4	190042222	2.2K-SIPC	SIP10RES	2235200	2794000	1	90



A (0:14)
D (0:15)
X (0:11)
DX (2:7)
Y (0:11)
DY (2:10)
ZC (0:7)
A3 74HCT244
A2 74HCT244
A4 74HCT245
A5 74HCT245
A18 82258-12
A19 82258-12
A26 MD5403
RAMACC-A
C16R4L A30
D1 HP2835
2.2K-S1PC
2.2K-S1PC
2.2K-S1PC
2.2K-031PC
J1 3x32-RA-M
_RESET 2-7
ZON
ZPOINT
RASOUT
RASTCK
STVEC
EOV
LeCroy CORPORATION
MODEL : 9450-2
DISPLAY CARD
DRAWN REBISCHER-D
CHKD REBISCHER-D
DATE 28-NOV-88
DWG NO: 9450-2-S1
REV J
SH 1 OF 8
ECO : 1011


VAZTIM-B
C16L8L A27
INTEND-A
A20
C16A4L
RASCLK-B
A29
C16A4L
A8
74HCT4040
A6
27256-25
SPEED-CX
A7
27256-25
SPEED-CY
A12
DAC-08
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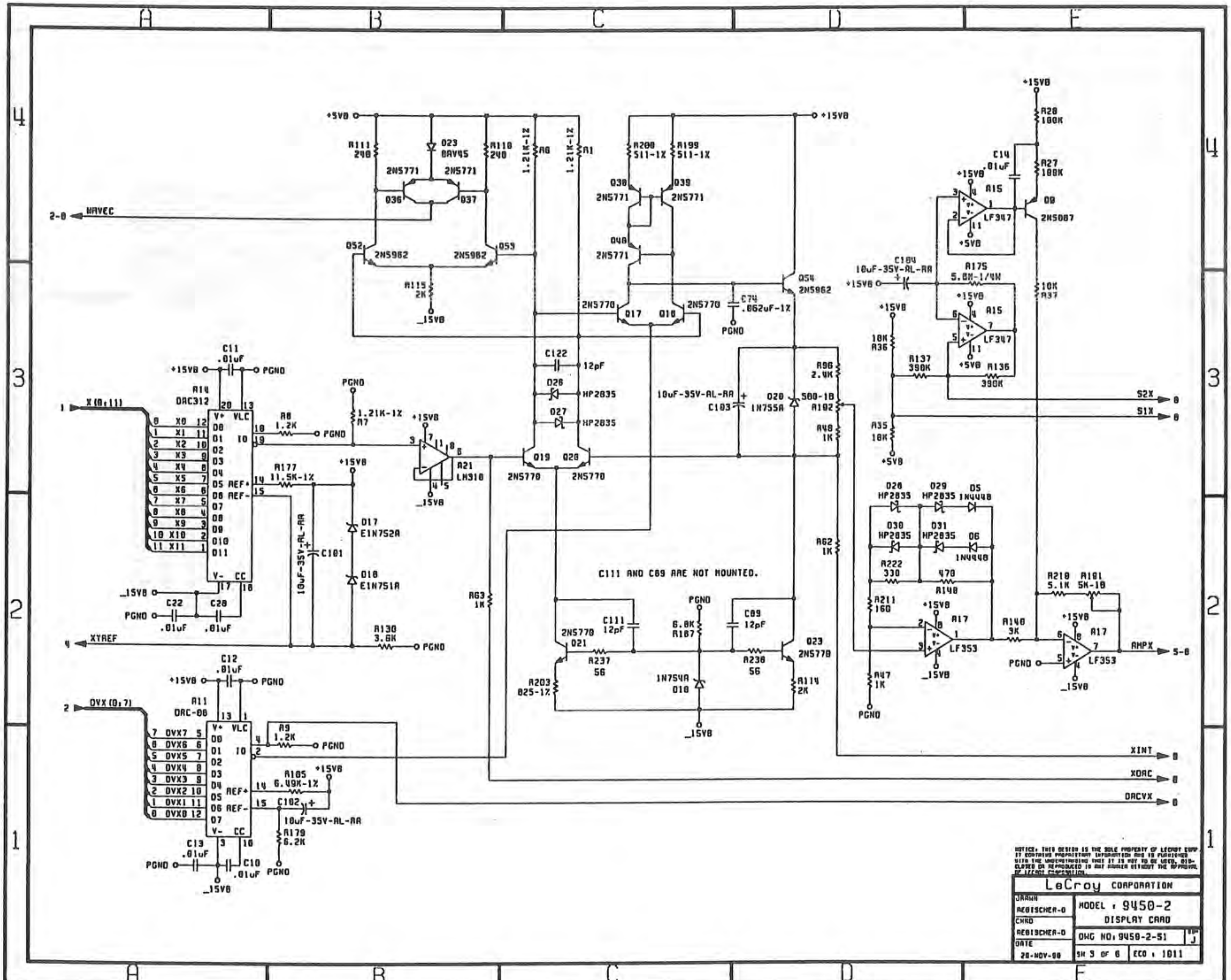
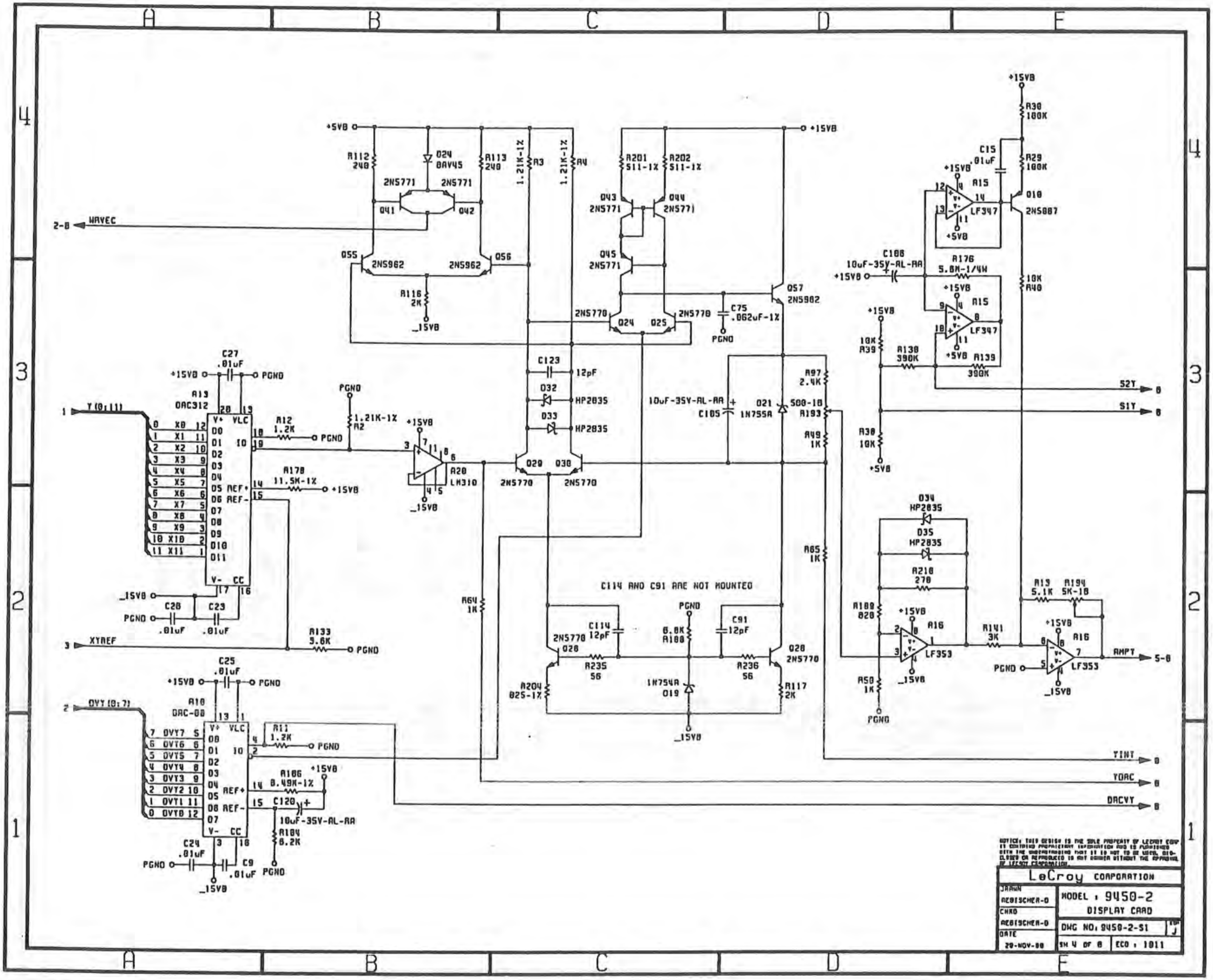
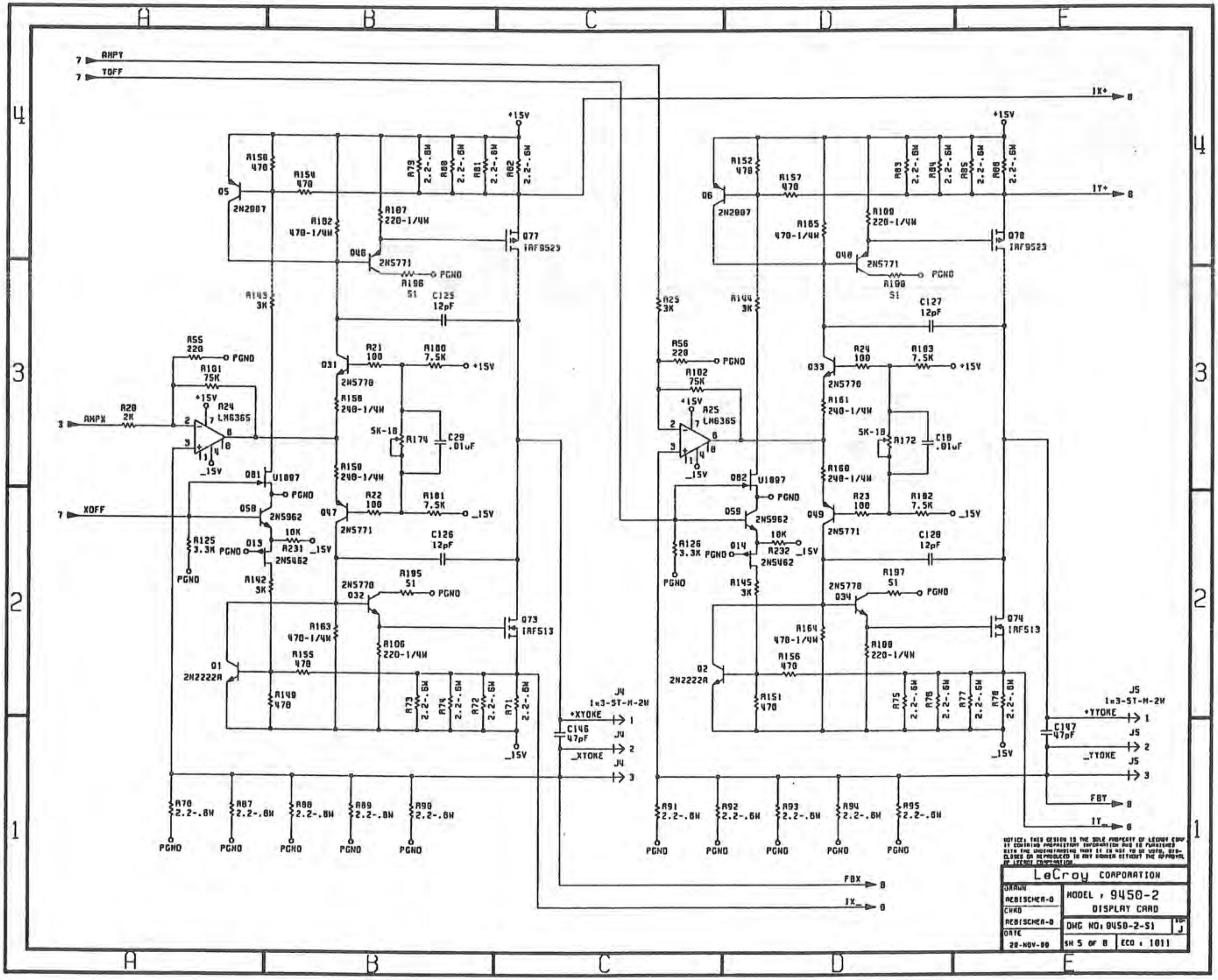
LeCroy CORPORATION
DRAWN AEBISCHER-O
CHKD AEBISCHER-O
DATE 29-NOV-88
MODEL : 9450-2
DISPLAY CARD
DWG NO: 9450-2-S1
J
SH 2 OF 8
ECO : 1011

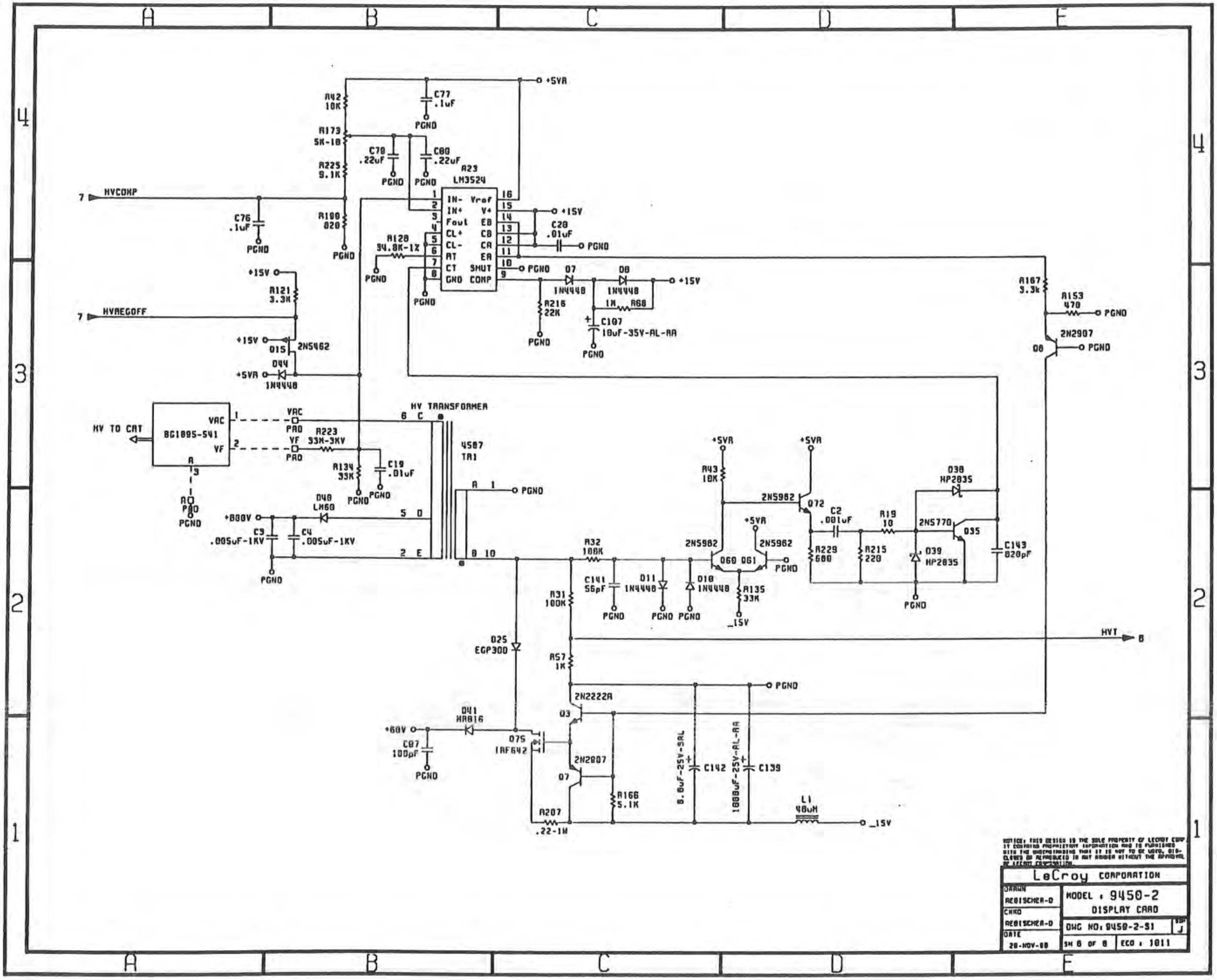


C111 AND C89 ARE NOT MOUNTED.
WAVEC
X(0:11)
DVX(0:7)
XYREF
XINT
XDAC
DACVX
S2X
S1X
AMPX
LeCroy CORPORATION
MODEL : 9450-2
DISPLAY CARD
DWG NO: 9450-2-S1
SH 3 OF 6
ECO : 1011
DRAWN REBISCHER-D
CHKD REBISCHER-D
DATE 28-NOV-88

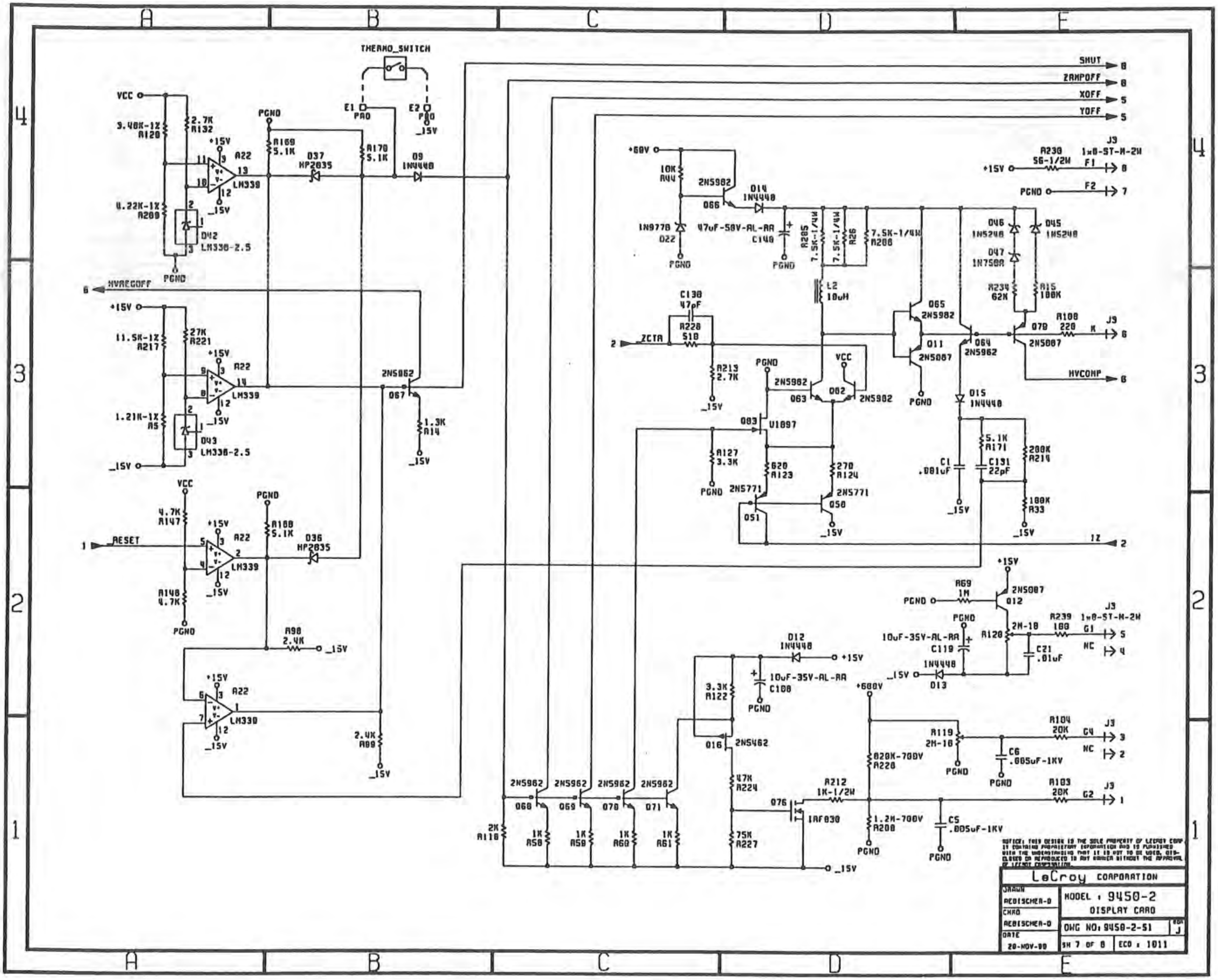


Y (0:11)
DVY (0:7)
XYREF
WAVEC
S2Y
S1Y
AMPY
YINT
YDAC
DACVY
DAC312
DAC-08
LM310
LF347
LF353
C114 AND C91 ARE NOT MOUNTED
LeCroy CORPORATION
DRAWN
AEBISCHER-D
CHKD
AEBISCHER-D
DATE
29-NOV-88
MODEL : 9450-2
DISPLAY CARD
DWG NO: 9450-2-S1
J
SH 4 OF 8
ECO : 1011

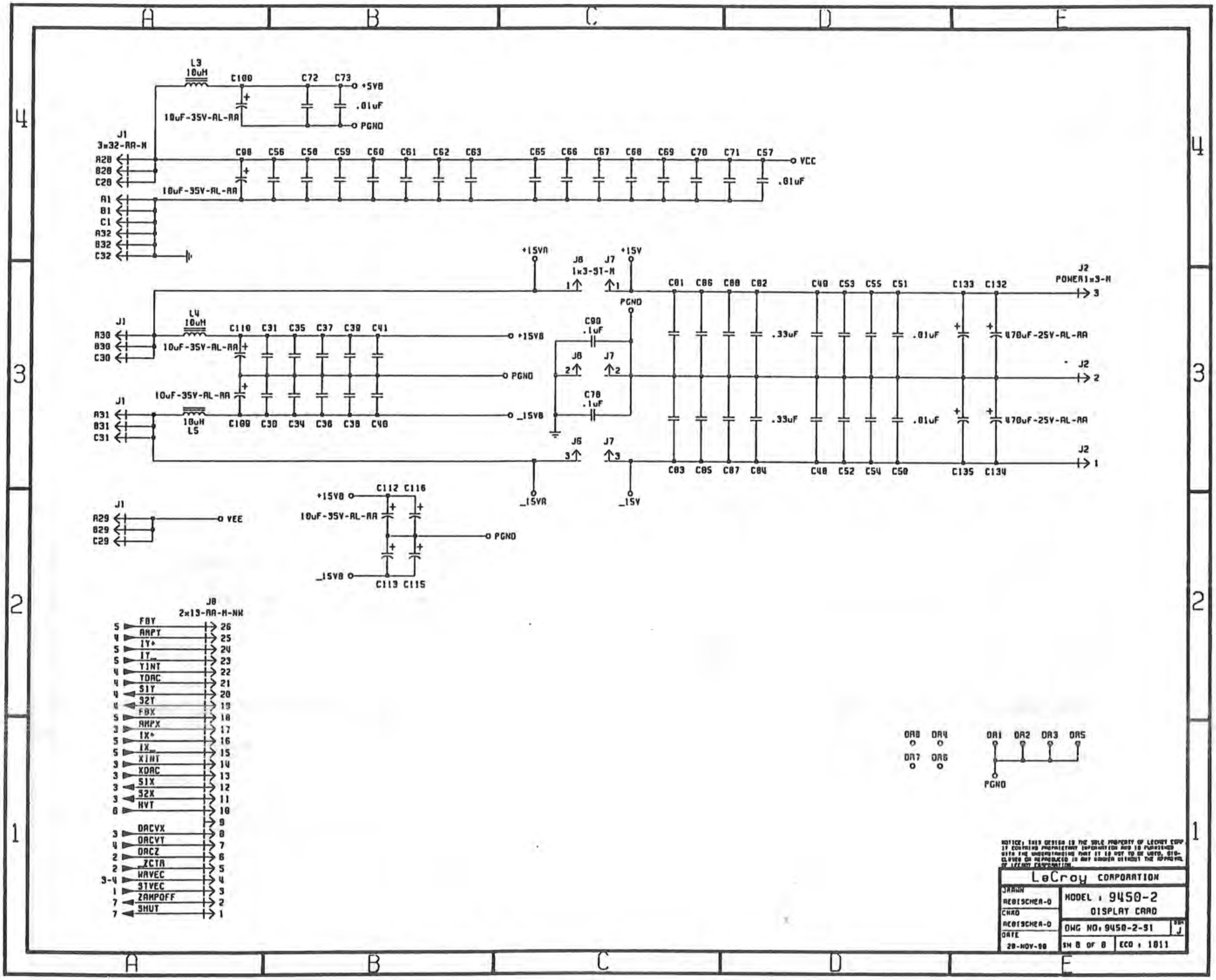

LeCroy CORPORATION
MODEL : 9450-2
DISPLAY CARD
DRAWN AEBISCHER-D
CHKD AEBISCHER-D
DATE 28-NOV-90
DWG NO: 9450-2-S1
J
SH 5 OF 8
ECO : 1011



HVCOMP
HVREGOFF
HV TO CRT
BG1895-541
VAC
VF
PAD
R42 10K
R173 5K-10
R225 9.1K
R190 820
C76 .1uF
C77 .1uF
C79 .22uF
C80 .22uF
A23 LM3524
IN- IN+ Fout CL+ CL- RT CT GND Vref V+ EB CB CA EA SHUT COMP
R128 34.8K-1%
C28 .01uF
D7 1N4448
D8 1N4448
R216 22K
1K R68
C107 10uF-35V-AL-RA
R121 3.3K
Q15 2N5462
D44 1N4448
HV TRANSFORMER
4587 TR1
R223 33M-3KV
R134 33K
C19 .01uF
D40 LM60
+880V
C3 .005uF-1KV
C4 .005uF-1KV
R32 100K
C141 56pF
D11 1N4448
D10 1N4448
R31 100K
D25 EGP300
R57 1K
2N2222A
Q3
+60V
DU1 MR816
C87 100pF
Q75 IRF642
2N2907
Q7
R207 .22-1W
R166 5.1K
8.0uF-25V-SAL C142
1000uF-25V-AL-RA C139
L1 40uH
-15V
+5VA
R43 10K
2N5982
Q60 Q61
R135 33K
Q72
C2 .001uF
R229 680
R215 220
R19 10
2N5770
Q35
D38 HP2835
D39 HP2835
C143 820pF
R167 3.3k
R153 470
Q8
HVT
PGND
+15V
LeCroy CORPORATION
DRAWN REDISCHER-D
CHKD REDISCHER-D
DATE 28-NOV-88
MODEL : 9450-2
DISPLAY CARD
DWG NO: 9450-2-S1
J
SH 8 OF 8
ECO : 1011



LeCroy CORPORATION
MODEL : 9450-2
DISPLAY CARD
DWG NO: 9450-2-S1
REV J
SH 7 OF 8
ECO : 1011
DRAWN REDISCHER-D
CHKD REDISCHER-D
DATE 20-NOV-90
THERMO_SWITCH
SHUT
ZRMPOFF
XOFF
YOFF
HVREGOFF
HVCOMP
_RESET
ZCTR


LeCroy CORPORATION
MODEL : 9450-2
DISPLAY CARD
DRAWN REDISCHER-D
CHKD REDISCHER-D
DATE 28-NOV-90
DWG NO: 9450-2-51
REV J
SH 8 OF 8
ECO : 1011
J1 3x32-RA-M
J2 POWER1x3-M
J6 1x3-ST-M
J8 2x13-RA-M-NK
VCC
VEE
PGND
+5VB
+15VB
_15VB
+15VA
_15VA
+15V
_15V
10uF-35V-AL-RA
470uF-25V-AL-RA
.01uF
.33uF
.1uF
L3 10uH
L4 10uH
L5 10uH
FBY
AMPY
IY+
IY_
YINT
YDAC
S1Y
S2Y
FBX
AMPX
IX+
IX_
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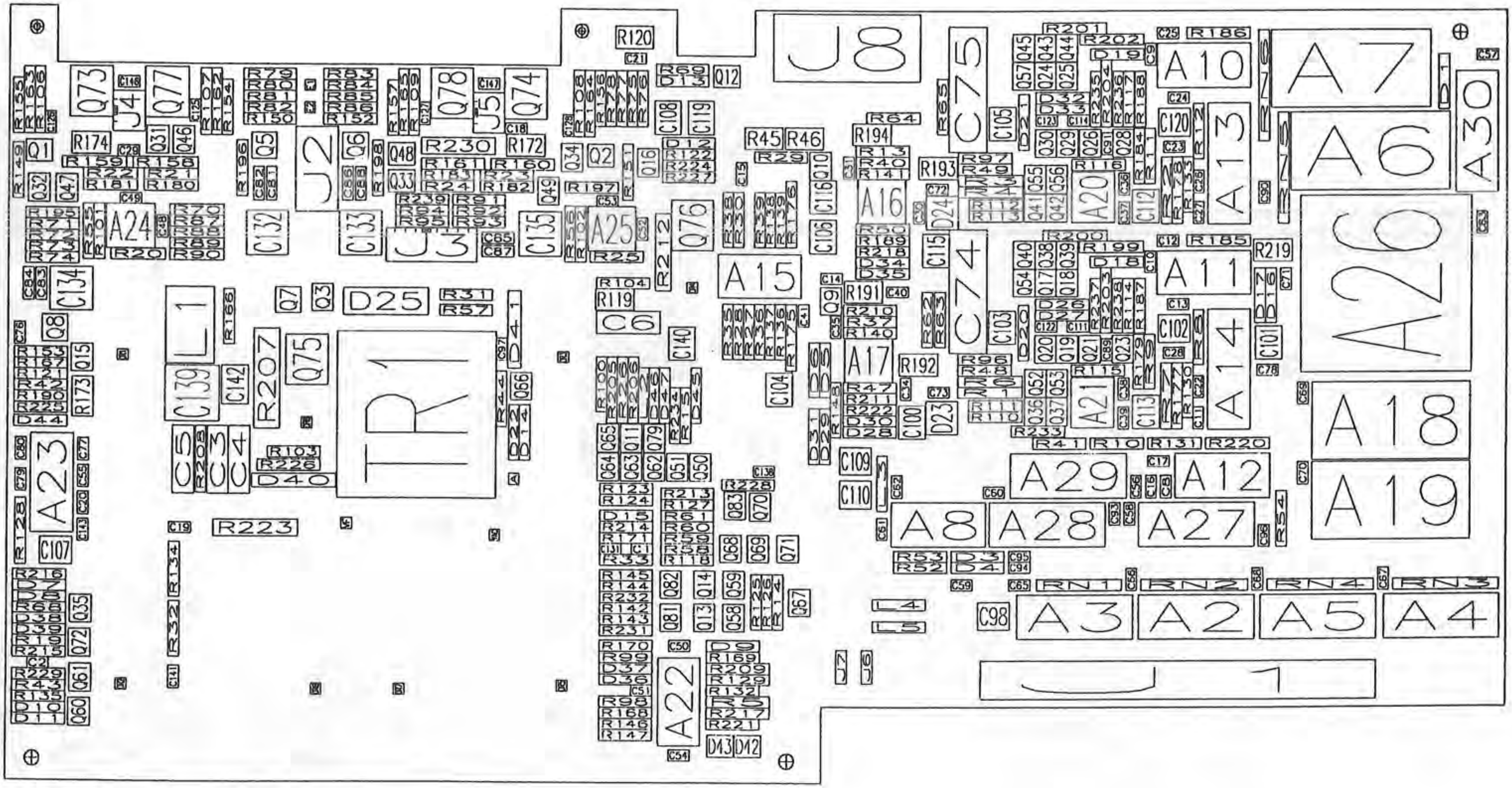
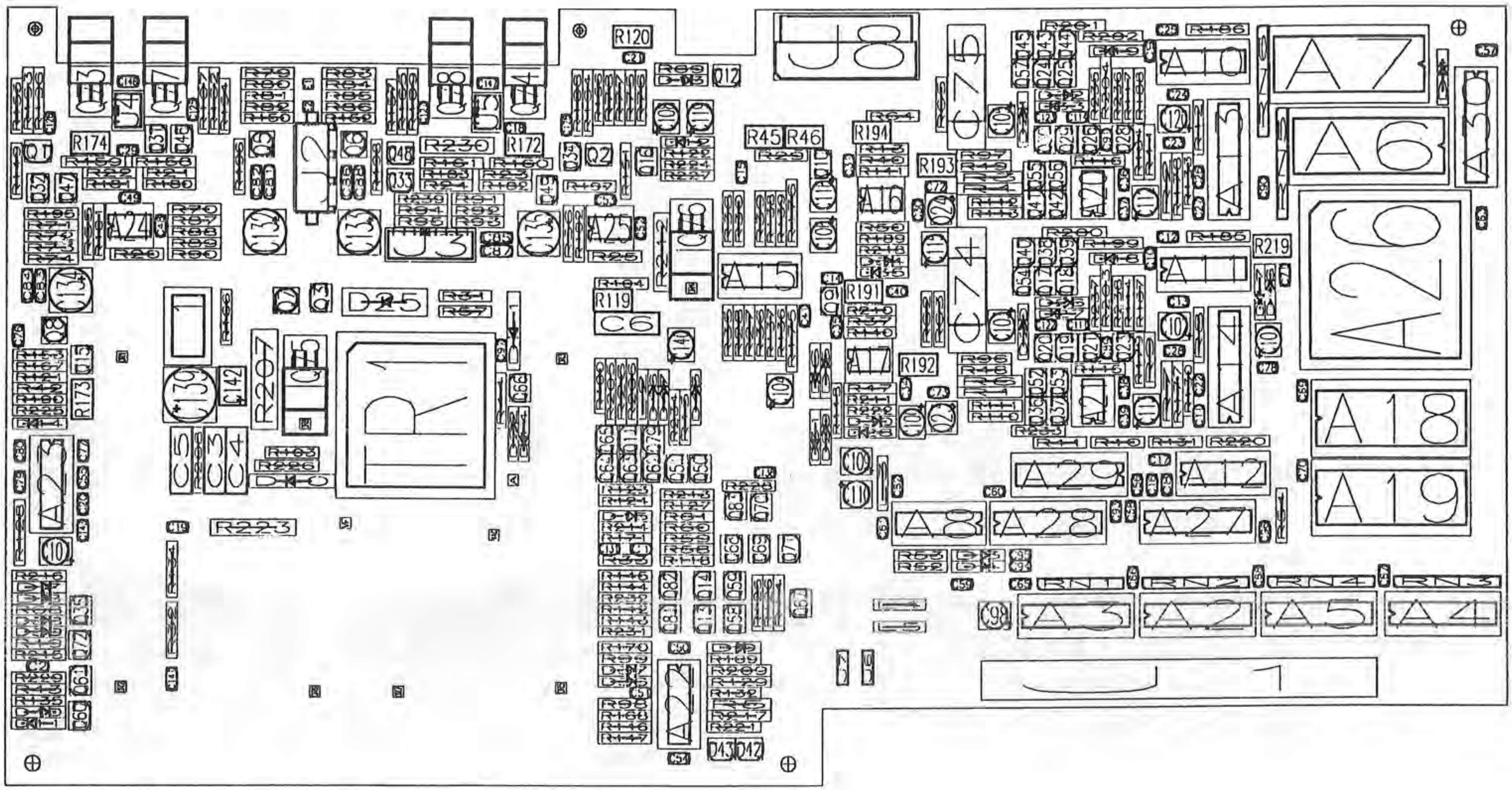


9450-2 Rev: J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A7
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A2
A5
A4
RN1
RN2
RN4
RN3
J1
A15
A16
A17
A24
A25
A23
A22
J2
J3
C6
C5
C3
C4
R120
R174
R173
R230
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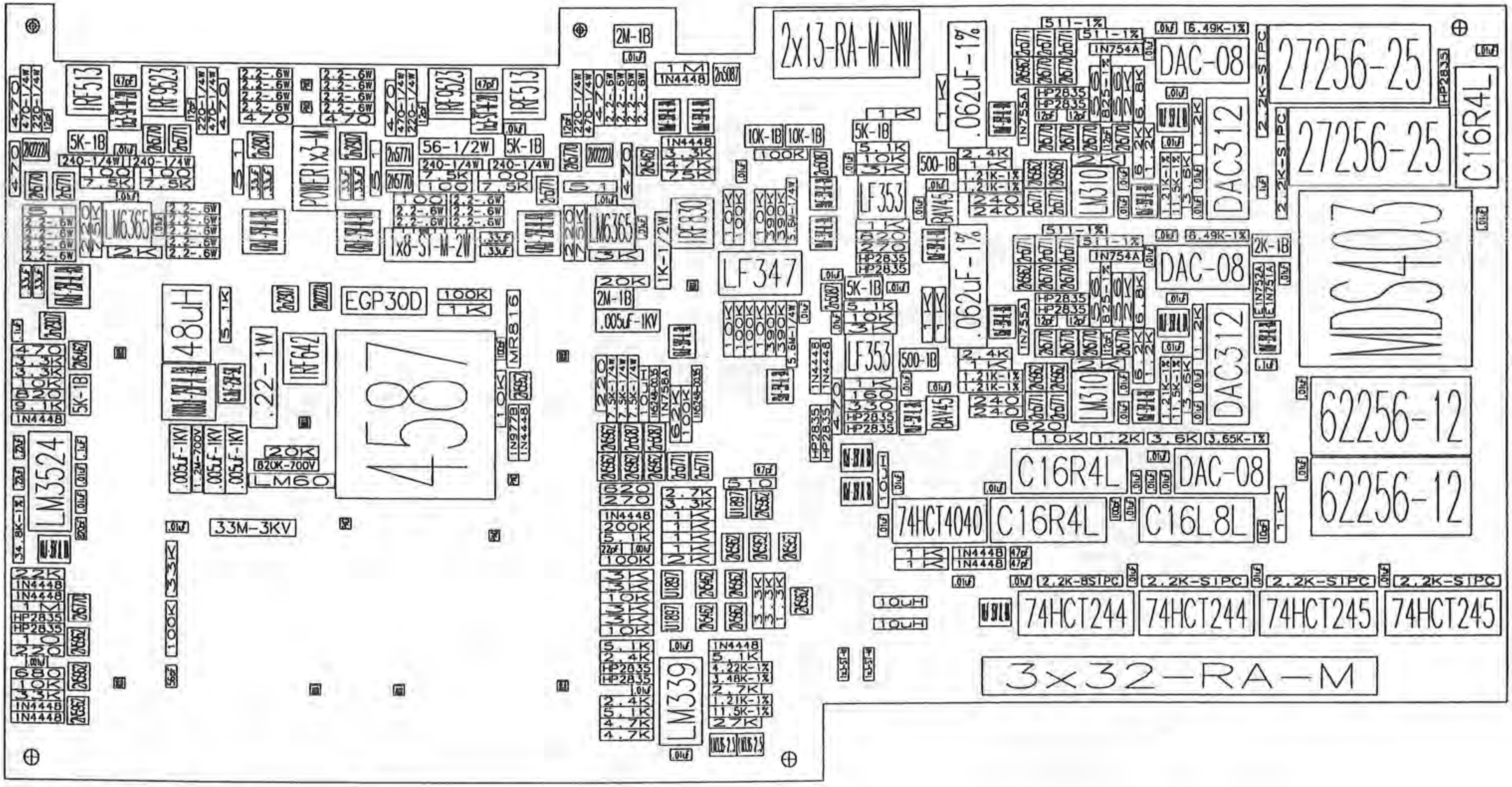
R207
R223
C142
D25

9450-2 Rev: J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62256-12
62256-12
DAC-08
DAC312
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LF353
LF347
IRF830
LM6365
IRF513
IRF9523
POWER1x3-M
1x8-ST-M-2W
EGP30D
4587
48uH
IRF642
LM3524
LM339
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C16L8L
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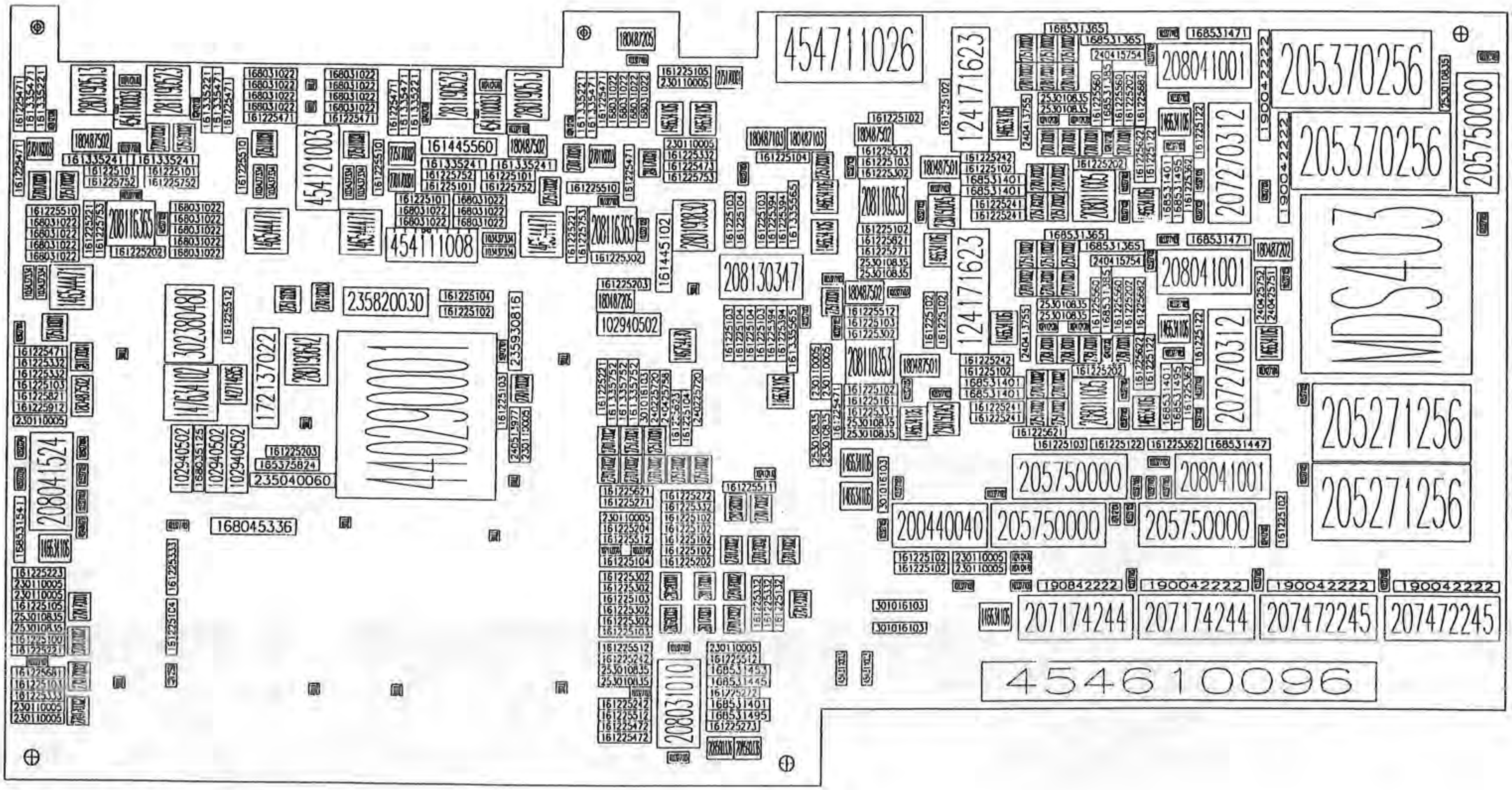
74HCT245
3x32-RA-M

9450-2 Rev: J



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9450-2 Rev: J

A2	207174244	74HCT244	DIP20	-711200	1676400	1	90
A3	207174244	74HCT244	DIP20	-3606800	1676400	1	90
A4	207472245	74HCT245	DIP20	5130800	1676400	1	90
A5	207472245	74HCT245	DIP20	2184400	1676400	1	90
A6	205370256	27256-25	DIP28	6197600	13512800	1	270
A7	205370256	27256-25	DIP28	5740400	15392400	1	270
A8	200440040	74HCT4040	DIP16	-4826000	4572000	1	270
A10	208041001	DAC-08	DIP16	-304800	14325600	1	90
A11	208041001	DAC-08	DIP16	-304800	9601200	1	90
A12	208041001	DAC-08	DIP16	152400	4927600	1	90
A13	207270312	DAC312	DIP20	1574800	11328400	1	180
A14	207270312	DAC312	DIP20	1574800	6604000	1	180
A15	208130347	LF347	DIP14	-10769600	9499600	1	90
A16	208110353	LF353	DIP8	-7467600	11226800	1	90
A17	208110353	LF353	DIP8	-7772400	7569200	1	90
A18	205271256	62256-12	DIP28	3403600	5791200	1	90
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A20	208011005	LM310	DIP8	-1676400	11328400	1	180
A21	208011005	LM310	DIP8	-1676400	6604000	1	180
A22	208031010	LM339	DIP14	-12293600	863600	1	0
A23	208041524	LM3524	DIP16	-27279600	5943600	1	0
A24	208116365	LM6365	DIP8	-25450800	10566400	1	90
A25	208116365	LM6365	DIP8	-13970000	10566400	1	90
A26	MDS403	MDS403	GRID121	3403600	11226800	1	0
A27	205750000	C16L8L	DIP20	-711200	3810000	1	90
A28	205750000	C16R4L	DIP20	-4267200	3810000	1	90
A29	205750000	C16R4L	DIP20	-1473200	5689600	1	270
A30	205750000	C16R4L	DIP20	6705600	14325600	1	0
C1	103327102	.001uF	SMONO	-12700000	3606800	1	180
C2	103327102	.001uF	SMONO	-27330400	914400	1	0
C3	102940502	.005uF-1KV	R_P375_L500X200	-23012400	5130800	1	90
C4	102940502	.005uF-1KV	R_P375_L500X200	-22504400	5130800	1	90
C5	102940502	.005uF-1KV	R_P375_L500X200	-23825200	5130800	1	90
C6	102940502	.005uF-1KV	R_P375_L500X200	-12700000	8788400	1	180
C8	103327103	.01uF	SMONOBP	-304800	4927600	1	90
C9	103327103	.01uF	SMONOBP	-698500	14833600	1	90
C10	103327103	.01uF	SMONOBP	-698500	10109200	1	90
C11	103327103	.01uF	SMONOBP	457200	6502400	1	90
C12	103327103	.01uF	SMONOBP	-152400	10718800	1	180
C13	103327103	.01uF	SMONOBP	-152400	9245600	1	0
C14	103327103	.01uF	SMONOBP	-8153400	9829800	1	180
C15	103327103	.01uF	SMONOBP	-10452100	12090400	1	90
C16	103327103	.01uF	SMONOBP	-660400	5181600	1	270
C17	103327103	.01uF	SMONOBP	-355600	5638800	1	180
C18	103327103	.01uF	SMONOBP	-15748000	13208000	1	180
C19	103327103	.01uF	SMONOBP	-23774400	4064000	1	180
C20	103327103	.01uF	SMONOBP	-26162000	4724400	1	270
C21	103327103	.01uF	SMONOBP	-12903200	14833600	1	180
C22	103327103	.01uF	SMONOBP	457200	7213600	1	90
C23	103327103	.01uF	SMONOBP	-254000	12852400	1	0
C24	103327103	.01uF	SMONOBP	-152400	13970000	1	0
C25	103327103	.01uF	SMONOBP	-152400	15443200	1	180
C26	103327103	.01uF	SMONOBP	457200	11938000	1	90
C27	103327103	.01uF	SMONOBP	457200	11226800	1	90
C28	103327103	.01uF	SMONOBP	-254000	8128000	1	0
C29	103327103	.01uF	SMONOBP	-24993600	12649200	1	180
C30	103327103	.01uF	SMONOBP	-6197600	11226800	1	90
C31	103327103	.01uF	SMONOBP	-7874000	12242800	1	90
C34	103327103	.01uF	SMONOBP	-6502400	7416800	1	270
C35	103327103	.01uF	SMONOBP	-8178800	8585200	1	90
C36	103327103	.01uF	SMONOBP	-1320800	12141200	1	270
C37	103327103	.01uF	SMONOBP	-1320800	11226800	1	90
C38	103327103	.01uF	SMONOBP	-1320800	7416800	1	270
C39	103327103	.01uF	SMONOBP	-1320800	6502400	1	90
C40	103327103	.01uF	SMONOBP	-6578600	9525000	1	180
C41	103327103	.01uF	SMONOBP	-8940800	9093200	1	270

C48	103327103	.01uF	SMONOBP	-24333200	10820400	1 90
C49	103327103	.01uF	SMONOBP	-25196800	11582400	1 0
C50	103327103	.01uF	SMONOBP	-11785600	1371600	1 180
C51	103327103	.01uF	SMONOBP	-12700000	355600	1 180
C52	103327103	.01uF	SMONOBP	-12852400	10820400	1 90
C53	103327103	.01uF	SMONOBP	-13817600	11582400	1 0
C54	103327103	.01uF	SMONOBP	-11785600	-1117600	1 180
C55	103327103	.01uF	SMONOBP	-26162000	5334000	1 270
C56	103327103	.01uF	SMONOBP	-1016000	4927600	1 90
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C58	103327103	.01uF	SMONOBP	-1168400	4572000	1 270
C59	103327103	.01uF	SMONOBP	-5029200	2794000	1 180
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C61	103327103	.01uF	SMONOBP	-7061200	4216400	1 270
C62	103327103	.01uF	SMONOBP	-6705600	4927600	1 90
C63	103327103	.01uF	SMONOBP	7213600	10972800	1 90
C65	103327103	.01uF	SMONOBP	-3657600	2794000	1 180
C66	103327103	.01uF	SMONOBP	-1117600	2794000	1 90
C67	103327103	.01uF	SMONOBP	4876800	2794000	1 90
C68	103327103	.01uF	SMONOBP	1879600	2794000	1 90
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C70	103327103	.01uF	SMONOBP	2946400	5486400	1 270
C71	103327103	.01uF	SMONOBP	2540000	9702800	1 90
C72	103327103	.01uF	SMONOBP	-5638800	11887200	1 180
C73	103327103	.01uF	SMONOBP	-5588000	7213600	1 180
C74	124171623	'.062uF-1%'	A_P900_L600X350	-5029200	10718800	1 270
C75	124171623	'.062uF-1%'	A_P900_L600X350	-5041900	15341600	1 270
C76	103427104	.1uF	SMONOBP	-27686000	8585200	1 270
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C78	103427104	.1uF	SMONOBP	2235200	7721600	1 180
C79	103327224	.22uF	SMONO	-27635200	5232400	1 270
C80	103327224	.22uF	SMONO	-27635200	5689600	1 90
C81	103437334	.33uF	LMONO	-21742400	12192000	1 270
C82	103437334	.33uF	LMONO	-22047200	12192000	1 270
C83	103437334	.33uF	LMONO	-27178000	9347200	1 90
C84	103437334	.33uF	LMONO	-27482800	9347200	1 90
C85	103437334	.33uF	LMONO	-16052800	10718800	1 180
C86	103437334	.33uF	LMONO	-19913600	12192000	1 270
C87	103437334	.33uF	LMONO	-16052800	10414000	1 180
C88	103437334	.33uF	LMONO	-19608800	12192000	1 270
C89	102412120	12pF	SMONO	-1727200	8077200	1 90
C90	103427104	.1uF	SMONOBP	2032000	11684000	1 90
C91	102412120	12pF	SMONO	-1727200	12801600	1 90
C93	102412101	100pF	SMONO	-1524000	4572000	1 270
C94	102412470	47pF	SMONO	-3911600	3200400	1 0
C95	102412470	47pF	SMONO	-3911600	3454400	1 0
C96	102412100	10pF	SMONO	2032000	4064000	1 270
C97	102412101	100pF	SMONO	-16205200	8026400	1 90
C98	146634106	10uF-35V-AL-RA	TCAP	-4267200	2082800	1 180
C100	146634106	10uF-35V-AL-RA	TCAP	-6350000	6654800	1 270
C101	146634106	10uF-35V-AL-RA	TCAP	2133600	8229600	1 90
C102	146634106	10uF-35V-AL-RA	TCAP	0	8686800	1 180
C103	146634106	10uF-35V-AL-RA	TCAP	-4216400	8839200	1 270
C104	146634106	10uF-35V-AL-RA	TCAP	-9525000	7137400	1 90
C105	146634106	10uF-35V-AL-RA	TCAP	-4216400	13512800	1 270
C106	146634106	10uF-35V-AL-RA	TCAP	-8483600	10922000	1 270
C107	146634106	10uF-35V-AL-RA	TCAP	-26670000	3505200	1 180
C108	146634106	10uF-35V-AL-RA	TCAP	-12242800	13360400	1 90
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C113	146634106	10uF-35V-AL-RA	TCAP	-787400	6642100	1 90
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C115	146634106	10uF-35V-AL-RA	TCAP	-5791200	10363200	1 90
C116	146634106	10uF-35V-AL-RA	TCAP	-8483600	11836400	1 270

C119	146634106	10uF-35V-AL-RA	TCAP	-11430000	13360400	1	90
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C122	102412120	12pF	SMONO	-3048000	8737600	1	180
C123	102412120	12pF	SMONO	-3048000	13462000	1	180
C125	102412120	12pF	SMONO	-23571200	13716000	1	270
C126	102412120	12pF	SMONO	-26974800	13157200	1	90
C127	102412120	12pF	SMONO	-18084800	13411200	1	90
C128	102412120	12pF	SMONO	-14630400	13157200	1	90
C131	102412220	22pF	SMONO	-13716000	3606800	1	0
C132	146544471	470uF-25V-AL-RA	R_P200_D400	-21844000	11074400	1	270
C133	146544471	470uF-25V-AL-RA	R_P200_D400	-19608800	11074400	1	270
C134	146544471	470uF-25V-AL-RA	R_P200_D400	-26466800	9753600	1	270
C135	146544471	470uF-25V-AL-RA	R_P200_D400	-15290800	11074400	1	270
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C139	147634102	1000uF-25V-AL-RA	R_P200_D500	-23622000	6858000	1	90
C140	146754470	47uF-50V-AL-RA	TCAP	-11887200	8178800	1	90
C141	102412560	56pF	SMONO	-24028400	762000	1	270
C142	142714685	6.8uF-25V-SAL	LTCAP	-22606000	7061200	1	90
C143	102484821	820pF	SMONO	-26162000	3860800	1	90
C146	102412470	47pF	SMONO	-25247600	14224000	1	0
C147	102412470	47pF	SMONO	-16662400	14224000	1	0
D1	253010835	HP2835	DO35	6299200	13817600	1	90
D3	230110005	1N4448	DO35	-5283200	3454400	1	0
D4	230110005	1N4448	DO35	-5283200	3200400	1	0
D5	230110005	1N4448	DO35	-8432800	7213600	1	90
D6	230110005	1N4448	DO35	-8686800	8229600	1	270
D7	230110005	1N4448	DO35	-27686000	2692400	1	0
D8	230110005	1N4448	DO35	-27686000	2438400	1	0
D9	230110005	1N4448	DO35	-11125200	1371600	1	0
D10	230110005	1N4448	DO35	-27686000	-101600	1	0
D11	230110005	1N4448	DO35	-26670000	-355600	1	180
D12	230110005	1N4448	DO35	-11226800	12903200	1	180
D13	230110005	1N4448	DO35	-12395200	14325600	1	0
D14	230110005	1N4448	DO35	-15646400	6756400	1	270
D15	230110005	1N4448	DO35	-13716000	4368800	1	0
D16	240425751	E1N751A	DO35	2184400	8940800	1	90
D17	240425752	E1N752A	DO35	1930400	9956800	1	270
D18	240415754	1N754A	DO35	-990600	10236200	1	180
D19	240415754	1N754A	DO35	-990600	14960600	1	180
D20	240413755	1N755A	DO35	-3708400	8077200	1	90
D21	240413755	1N755A	DO35	-3708400	12903200	1	90
D22	240513977	1N977B	DO35	-15900400	5740400	1	90
D23	230150045	BAV45	to18_2L	-5638800	4724400	1	0
D24	230150045	BAV45	to18_2L	-5638800	9448800	1	0
D25	235820030	EGP30D	A_P600_L400X250	-18237200	9245600	1	180
D26	253010835	HP2835	DO35	-3302000	9245600	1	0
D27	253010835	HP2835	DO35	-2286000	8991600	1	180
D28	253010835	HP2835	DO35	-6858000	6299200	1	180
D29	253010835	HP2835	DO35	-8432800	5689600	1	90
D30	253010835	HP2835	DO35	-7874000	6553200	1	0
D31	253010835	HP2835	DO35	-8686800	6705600	1	270
D32	253010835	HP2835	DO35	-3302000	13970000	1	0
D33	253010835	HP2835	DO35	-2286000	13716000	1	180
D34	253010835	HP2835	DO35	-7569200	10210800	1	0
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D36	253010835	HP2835	DO35	-13716000	609600	1	0
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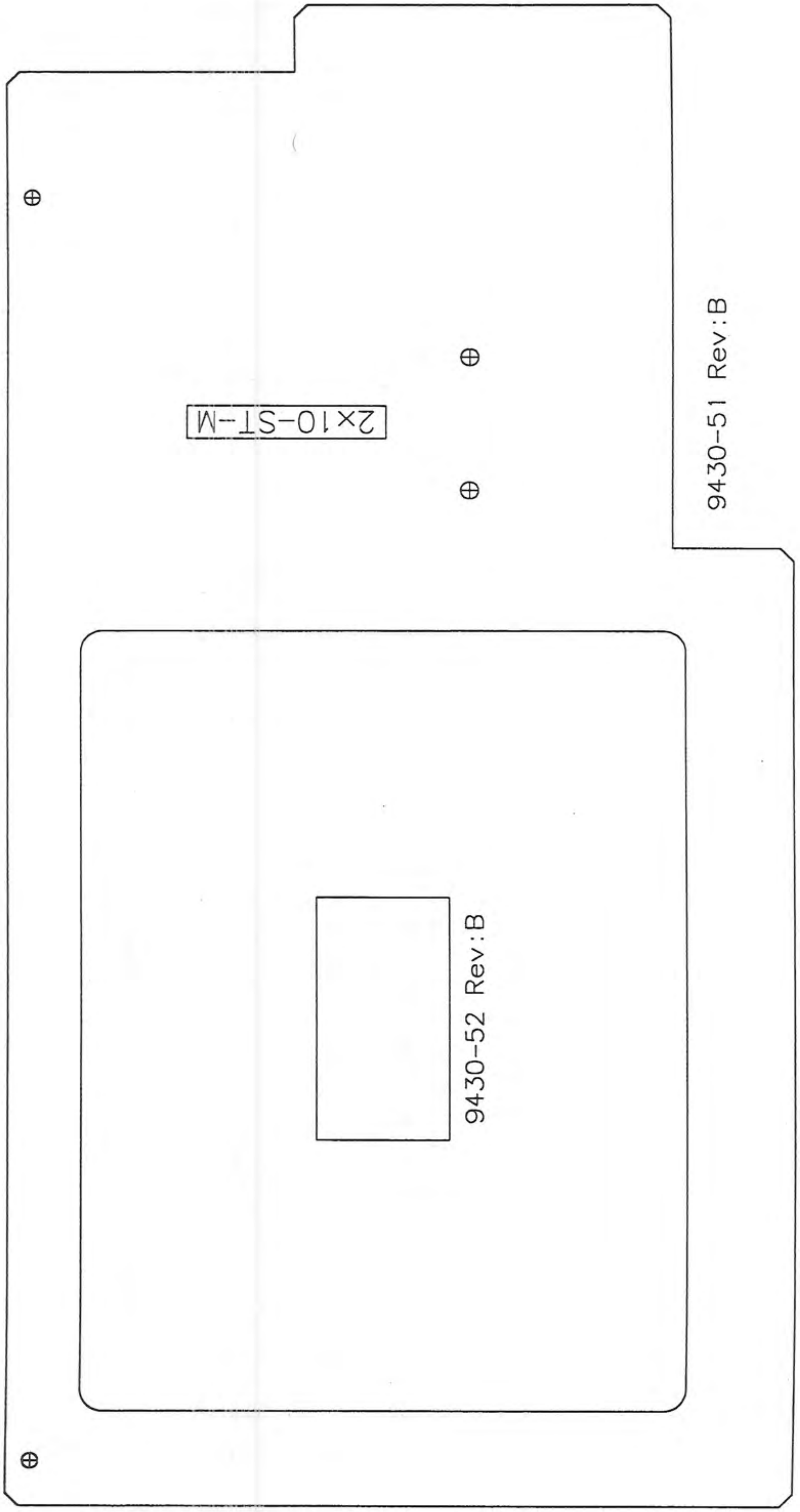
D38	253010835	HP2835	DO35	-27686000	1930400	1	0
D39	253010835	HP2835	DO35	-27686000	1676400	1	0
D40	235040060	LM60	A_P600_L400X125	-20421600	5130800	1	180
D41	235930816	MR816	A_P500_L300X120	-15900400	9245600	1	270
D42	208590336	LM336-2.5	TO92	-10058400	-965200	1	180
D43	208590336	LM336-2.5	TO92	-10718800	-965200	1	180
D44	230110005	1N4448	DO35	-26670000	6451600	1	180
D45	240225720	1N5248-DO35	DO35	-11531600	6604000	1	90
D46	240225720	1N5248-DO35	DO35	-12547600	6604000	1	90

D47	240425758	1N758A	DO7	-12293600	6604000	1	90
E1	$NULL	PAD	TESTPAD	-20828000	14173200	1	0
E2	$NULL	PAD	TESTPAD	-20828000	13665200	1	0
J1	454610096	3x32-RA-M	CONN3X32_RA_M	-3937000	1061720	1	0
J2	454121003	POWER1x3-M	POWER1X3_M	-20726400	11633200	1	180
J3	454111008	1x8-ST-M-2W	CONN1X8_ST_M_2W	-17018000	10515600	1	270
J4	454110003	1x3-ST-M-2W	CONN1X3_ST_M_2W	-25095200	13817600	1	0
J5	454110003	1x3-ST-M-2W	CONN1X3_ST_M_2W	-16510000	13817600	1	0
J6	454311003	1x3-ST-M	CONN1X3_ST_M	-7416800	1168400	1	270
J7	454311003	1x3-ST-M	CONN1X3_ST_M	-8026400	1168400	1	270
J8	454711026	2x13-RA-M-NW	CONN2X13_RA_M_NW	-9448800	14528800	1	0
L1	302380480	48uH	E106	-23418800	8686800	1	270
L2	301016103	10uH	IND07	-12801600	6604000	1	90
L3	301016103	10uH	IND07	-7061200	4622800	1	90
L4	301016103	10uH	IND07	-6146800	2336800	1	180
L5	301016103	10uH	IND07	-6146800	1828800	1	180
Q1	270110003	2N2222A	TO92	-27051000	12573000	1	180
Q2	270110003	2N2222A	TO92	-13665200	12547600	1	180
Q3	270110003	2N2222A	TO92	-20574000	9144000	1	90
Q5	275110001	2n2907	TO18	-21793200	12801600	1	180
Q6	275110001	2n2907	TO18	-19862800	12801600	1	0
Q7	275110001	2n2907	TO18	-21336000	9144000	1	90
Q8	275110001	2n2907	TO18	-26974800	8585200	1	0
Q9	275170001	2n5087	TO92	-8356600	9118600	1	90
Q10	275170001	2n5087	TO92	-8483600	12598400	1	270
Q11	275170001	2n5087	TO92	-13157200	5943600	1	90
Q12	275170001	2n5087	TO92	-10617200	14376400	1	180
Q13	281170001	2N5462	TO92	-11379200	1828800	1	90
Q14	281170001	2N5462	TO92	-11379200	2590800	1	90
Q15	281170001	2N5462	TO92	-26136600	8102600	1	270
Q16	281170001	2N5462	TO92	-12776200	12268200	1	90
Q17	270170001	2N5770	TO92	-3251200	9550400	1	90
Q18	270170001	2N5770	TO92	-2743200	9550400	1	90
Q19	270170001	2N5770	TO92	-2743200	8026400	1	90
Q20	270170001	2N5770	TO92	-3251200	8026400	1	90
Q21	270170001	2N5770	TO92	-2070100	8407400	1	270
Q23	270170001	2N5770	TO92	-1282700	8407400	1	270
Q24	270170001	2N5770	TO92	-3276600	14274800	1	90
Q25	270170001	2N5770	TO92	-2768600	14274800	1	90
Q26	270170001	2N5770	TO92	-2070100	13131800	1	270
Q28	270170001	2N5770	TO92	-1282700	13131800	1	270
Q29	270170001	2N5770	TO92	-2743200	12750800	1	90
Q30	270170001	2N5770	TO92	-3251200	12750800	1	90
Q31	270170001	2N5770	TO92	-24384000	13106400	1	270
Q32	270170001	2N5770	TO92	-27178000	11988800	1	270
Q33	270170001	2N5770	TO92	-18440400	11938000	1	180
Q34	270170001	2N5770	TO92	-14478000	12750800	1	270
Q35	270170001	2N5770	TO92	-26263600	1981200	1	90
Q36	275170002	2n5771	TO92	-3352800	6959600	1	270
Q37	275170002	2n5771	TO92	-2844800	6959600	1	270
Q38	275170002	2n5771	TO92	-3124200	10579100	1	270
Q39	275170002	2n5771	TO92	-2616200	10579100	1	270
Q40	275170002	2n5771	TO92	-3632200	10579100	1	270
Q41	275170002	2n5771	TO92	-3378200	11658600	1	270
Q42	275170002	2n5771	TO92	-2870200	11658600	1	270
Q43	275170002	2n5771	TO92	-3149600	15303500	1	270
Q44	275170002	2n5771	TO92	-2641600	15303500	1	270
Q45	275170002	2n5771	TO92	-3657600	15303500	1	270
Q46	275170002	2n5771	TO92	-23774400	13106400	1	270
Q47	275170002	2n5771	TO92	-26517600	11988800	1	270
Q48	275170002	2n5771	TO92	-18440400	12547600	1	180
Q49	275170002	2n5771	TO92	-15036800	11988800	1	270
Q50	275170002	2n5771	TO92	-11480800	5283200	1	90
Q51	275170002	2n5771	TO92	-12039600	5283200	1	90
Q52	270170002	2N5962	TO92	-3352800	7620000	1	270
Q53	270170002	2N5962	TO92	-2844800	7620000	1	270

Q54	270170002	2N5962	TO92	-3759200	9550400	1 90
Q55	270170002	2N5962	TO92	-3378200	12319000	1 270
Q56	270170002	2N5962	TO92	-2870200	12319000	1 270
Q57	270170002	2N5962	TO92	-3784600	14274800	1 90
Q58	270170002	2N5962	TO92	-10668000	1828800	1 90
Q59	270170002	2N5962	TO92	-10668000	2590800	1 90
Q60	270170002	2N5962	TO92	-26162000	0	1 270
Q61	270170002	2N5962	TO92	-26263600	406400	1 90
Q62	270170002	2N5962	TO92	-12598400	5283200	1 90
Q63	270170002	2N5962	TO92	-13157200	5283200	1 90
Q64	270170002	2N5962	TO92	-13716000	5283200	1 90
Q65	270170002	2N5962	TO92	-13716000	5943600	1 90
Q66	270170002	2N5962	TO92	-15798800	7112000	1 90
Q67	270170002	2N5962	TO92	-9093200	2184400	1 90
Q68	270170002	2N5962	TO92	-10617200	3810000	1 270
Q69	270170002	2N5962	TO92	-9956800	3810000	1 270
Q70	270170002	2N5962	TO92	-10033000	4394200	1 90
Q71	270170002	2N5962	TO92	-9245600	3810000	1 270
Q72	270170002	2N5962	TO92	-26162000	1574800	1 270
Q73	280190513	IRF513	TO220	-26263600	13614400	1 90
Q74	280190513	IRF513	TO220	-15900400	13614400	1 90
Q75	280190642	IRF642	TO220	-20624800	8280400	1 270
Q76	280190830	IRF830	TO220	-11379200	11430000	1 270
Q77	281190523	IRF9523	TO220	-24485600	13614400	1 90
Q78	281190523	IRF9523	TO220	-17678400	13614400	1 90
Q79	275170001	2n5087	TO92	-12598400	5943600	1 90
Q81	280180001	U1897	TO92	-12192000	1828800	1 90
Q82	280180001	U1897	TO92	-12192000	2590800	1 90
Q83	280180001	U1897	TO92	-10642600	4419600	1 90
R1	168531401	'1.21K-1%'	RES07	-5130800	7213600	1 0
R2	168531401	'1.21K-1%'	RES07	-304800	11226800	1 90
R3	168531401	'1.21K-1%'	RES07	-5130800	12090400	1 0
R4	168531401	'1.21K-1%'	RES07	-5130800	11836400	1 0
R5	168531401	'1.21K-1%'	RES07	-9855200	101600	1 180
R6	168531401	'1.21K-1%'	RES07	-5130800	7467600	1 0
R7	168531401	'1.21K-1%'	RES07	-304800	6502400	1 90
R8	161225122	1.2K	RES05	457200	7975600	1 90
R9	161225122	1.2K	RES05	-711200	8432800	1 270
R10	161225122	1.2K	RES05	-965200	6045200	1 180
R11	161225122	1.2K	RES05	-711200	13157200	1 270
R12	161225122	1.2K	RES05	457200	12700000	1 90
R13	161225512	5.1K	RES05	-6553200	12750800	1 180
R14	161225132	1.3K	RES05	-9550400	1879600	1 90
R15	161225104	100K	RES05	-11785600	6146800	1 90
R19	161225100	10	RES05	-27686000	1422400	1 0
R20	161225202	2K	RES05	-24384000	10312400	1 180
R21	161225101	100	RES05	-23622000	12141200	1 180
R22	161225101	100	RES05	-26060400	12141200	1 0
R23	161225101	100	RES05	-15595600	12141200	1 180
R24	161225101	100	RES05	-18034000	11887200	1 0
R25	161225302	3K	RES05	-12954000	10312400	1 180
R26	161335752	7.5K-1/4W	RES07	-13309600	7874000	1 270
R27	161225104	100K	RES05	-10261600	9093200	1 270
R28	161225104	100K	RES05	-10515600	8077200	1 90
R29	161225104	100K	RES05	-10007600	12598400	1 0
R30	161225104	100K	RES05	-10515600	10668000	1 90
R31	161225104	100K	RES05	-17576800	9398000	1 0
R32	161225104	100K	RES05	-24028400	2235200	1 270
R33	161225104	100K	RES05	-12700000	3352800	1 180
R35	161225103	10K	RES05	-10769600	8077200	1 90
R36	161225103	10K	RES05	-10007600	8077200	1 90
R37	161225103	10K	RES05	-6858000	8839200	1 180
R38	161225103	10K	RES05	-10769600	11684000	1 270
R39	161225103	10K	RES05	-10007600	11684000	1 270
R40	161225103	10K	RES05	-6553200	12496800	1 180
R41	161225103	10K	RES05	-2336800	6045200	1 180

R42	161225103	10K	RES05	-27686000	7264400	1	0
R43	161225103	10K	RES05	-27686000	406400	1	0
R44	161225103	10K	RES05	-16205200	6502400	1	90
R45	180487103	10K-1B	pot3386x	-10160000	12903200	1	0
R46	180487103	10K-1B	pot3386x	-9194800	12903200	1	0
R47	161225102	1K	RES05	-7874000	7315200	1	0
R48	161225102	1K	RES05	-5130800	7721600	1	0
R49	161225102	1K	RES05	-5130800	12344400	1	0
R50	161225102	1K	RES05	-7569200	10972800	1	0
R52	161225102	1K	RES05	-5638800	3200400	1	180
R53	161225102	1K	RES05	-5638800	3454400	1	180
R54	161225102	1K	RES05	2438400	3810000	1	90
R55	161225221	220	RES05	-26060400	10312400	1	90
R56	161225221	220	RES05	-14579600	10312400	1	90
R57	161225102	1K	RES05	-17576800	9042400	1	0
R58	161225102	1K	RES05	-12242800	3606800	1	0
R59	161225102	1K	RES05	-12242800	3860800	1	0
R60	161225102	1K	RES05	-12242800	4114800	1	0
R61	161225102	1K	RES05	-12242800	4368800	1	0
R62	161225102	1K	RES05	-5994400	8382000	1	90
R63	161225102	1K	RES05	-5689600	8382000	1	90
R64	161225102	1K	RES05	-6299200	13512800	1	180
R65	161225102	1K	RES05	-5638800	13258800	1	90
R68	161225105	1M	RES05	-27686000	2184400	1	0
R69	161225105	1M	RES05	-12395200	14579600	1	0
R70	168031022	2.2-.6W	A_P400_L300X100	-24028400	11328400	1	0
R71	168031022	2.2-.6W	A_P400_L300X100	-26416000	10972800	1	180
R72	168031022	2.2-.6W	A_P400_L300X100	-26416000	10718800	1	180
R73	168031022	2.2-.6W	A_P400_L300X100	-26416000	10464800	1	180
R74	168031022	2.2-.6W	A_P400_L300X100	-26416000	10210800	1	180
R75	168031022	2.2-.6W	A_P400_L300X100	-13106400	14427200	1	270
R76	168031022	2.2-.6W	A_P400_L300X100	-12852400	14427200	1	270
R77	168031022	2.2-.6W	A_P400_L300X100	-13360400	14427200	1	270
R78	168031022	2.2-.6W	A_P400_L300X100	-13614400	14427200	1	270
R79	168031022	2.2-.6W	A_P400_L300X100	-21285200	14427200	1	180
R80	168031022	2.2-.6W	A_P400_L300X100	-21285200	14173200	1	180
R81	168031022	2.2-.6W	A_P400_L300X100	-21285200	13919200	1	180
R82	168031022	2.2-.6W	A_P400_L300X100	-21285200	13665200	1	180
R83	168031022	2.2-.6W	A_P400_L300X100	-20370800	14427200	1	0
R84	168031022	2.2-.6W	A_P400_L300X100	-20370800	14173200	1	0
R85	168031022	2.2-.6W	A_P400_L300X100	-20370800	13919200	1	0
R86	168031022	2.2-.6W	A_P400_L300X100	-20370800	13665200	1	0
R87	168031022	2.2-.6W	A_P400_L300X100	-24028400	11074400	1	0
R88	168031022	2.2-.6W	A_P400_L300X100	-24028400	10820400	1	0
R89	168031022	2.2-.6W	A_P400_L300X100	-24028400	10566400	1	0
R90	168031022	2.2-.6W	A_P400_L300X100	-24028400	10312400	1	0
R91	168031022	2.2-.6W	A_P400_L300X100	-17272000	11582400	1	0
R92	168031022	2.2-.6W	A_P400_L300X100	-17272000	11328400	1	0
R93	168031022	2.2-.6W	A_P400_L300X100	-17272000	11074400	1	0
R94	168031022	2.2-.6W	A_P400_L300X100	-17627600	11328400	1	180
R95	168031022	2.2-.6W	A_P400_L300X100	-17627600	11074400	1	180
R96	161225242	2.4K	RES05	-4114800	7975600	1	180
R97	161225242	2.4K	RES05	-4114800	12598400	1	180
R98	161225242	2.4K	RES05	-12700000	101600	1	180
R99	161225242	2.4K	RES05	-12700000	1117600	1	180
R100	161225221	220	RES05	-13817600	6858000	1	90
R101	161225753	75K	RES05	-25806400	10312400	1	90
R102	161225753	75K	RES05	-14325600	10312400	1	90
R103	161225203	20K	RES05	-20675600	5791200	1	180
R104	161225203	20K	RES05	-12801600	9702800	1	180
R106	161335221	220-1/4W	RES07	-27228800	13157200	1	90
R107	161335221	220-1/4W	RES07	-23317200	14427200	1	270
R108	161335221	220-1/4W	RES07	-14376400	13157200	1	90
R109	161335221	220-1/4W	RES07	-18338800	14427200	1	270
R110	161225241	240	RES05	-4876800	6654800	1	0
R111	161225241	240	RES05	-4876800	6908800	1	0

RN5	190042222	2.2K-SIPC	SIP10RES	2489200	13512800	1 0
RN6	190042222	2.2K-SIPC	SIP10RES	2032000	15392400	1 0
TR1	440290001	4587	TRANSFO_HT	-19507200	7670800	1 0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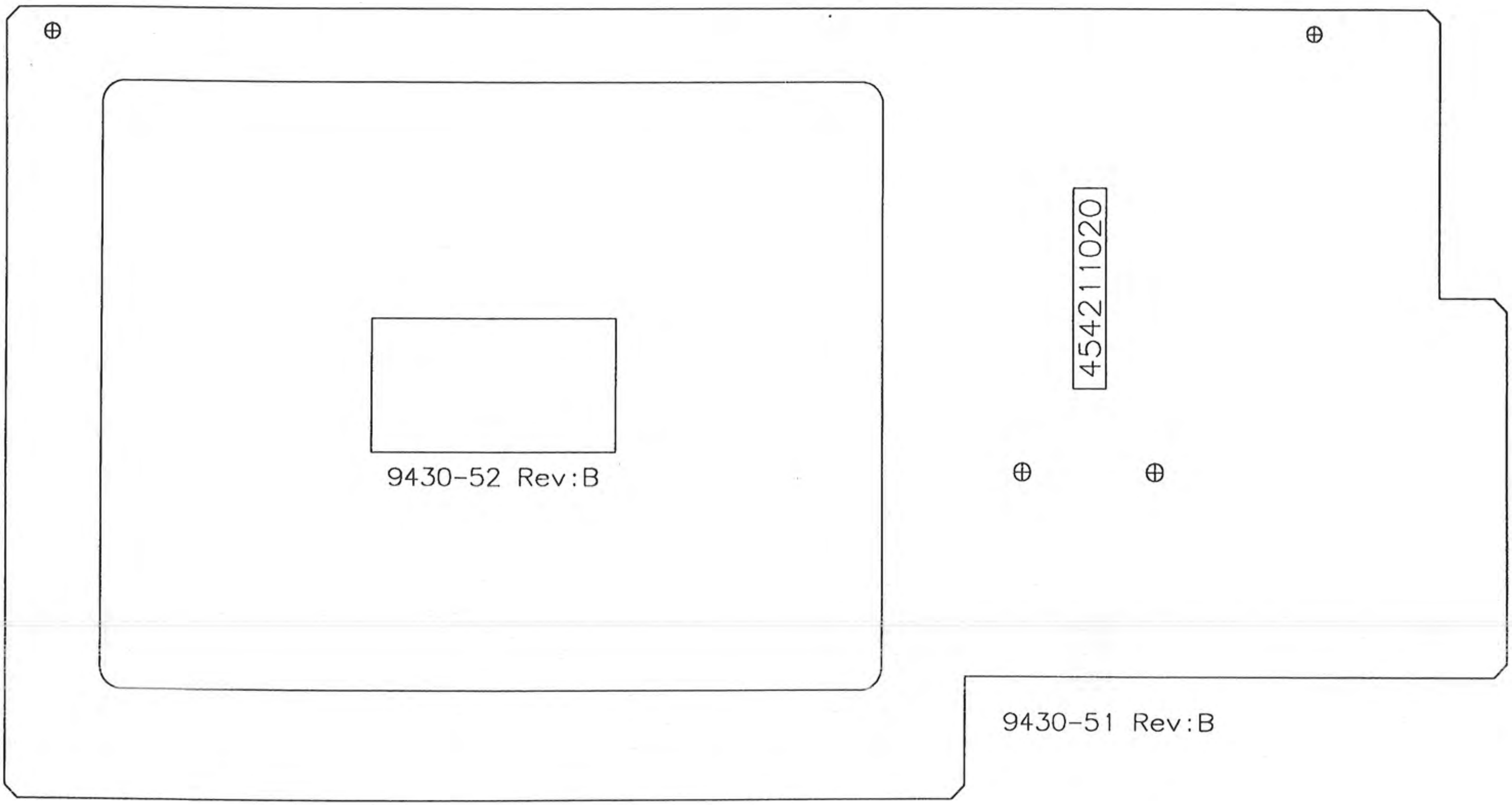
9430-51 Rev:B
9430-52 Rev:B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9430-52 Rev:B
9430-51 Rev:B

A1	HPC411AIH	HPC411A	HPC411	2166620	-7754620	1	0
A2	207345051	74HCT4051-PS	DIP16	6629400	6134100	1	270
A3	205644094	74HCT4094-PS	DIP16	8191500	-2921000	1	180
A4	205644094	74HCT4094-PS	DIP16	8420100	-5346700	1	180
A5	207345051	74HCT4051-PS	DIP16	10515600	2971800	1	270
A6	205750000	C16L8L	DIP20	11036300	6045200	1	270
A8	207345051	74HCT4051-PS	DIP16	13157200	2971800	1	270
A9	200344138	74HCT138	DIP16	13411200	6045200	1	270
A10	205644094	74HCT4094-PS	DIP16	14630400	-50800	1	270
A11	205644094	74HCT4094-PS	DIP16	15646400	2844800	1	270
A12	207345051	74HCT4051-PS	DIP16	15748000	6045200	1	270
A13	205644094	74HCT4094-PS	DIP16	17208500	-50800	1	270
C1	103427104	.1uF	SMONOBP	-368300	-7404100	1	90
C2	103327103	.01uF	SMONOBP	5107940	6703060	1	180
C3	103327103	.01uF	SMONOBP	5105400	6433820	1	180
C4	103427104	.1uF	SMONOBP	7010400	1384300	1	90
C5	103427104	.1uF	SMONOBP	10363200	927100	1	270
C6	103427104	.1uF	SMONOBP	11468100	8229600	1	0
C7	103427104	.1uF	SMONOBP	12750800	-2006600	1	90
C8	103427104	.1uF	SMONOBP	13411200	4953000	1	180
C9	103427104	.1uF	SMONOBP	15024100	-304800	1	90
C10	103427104	.1uF	SMONOBP	15303500	901700	1	90
C11	103327103	.01uF	SMONOBP	-6700520	383540	1	270
C12	103327103	.01uF	SMONOBP	-3589020	414020	1	270
J1	709450511	CAL-TERM	CAL_TERMINAL	2745740	-8298180	1	0
J2	709450511	CAL-TERM	CAL_TERMINAL	3845560	-8298180	1	0
J3	454211020	2x10-ST-M	CONN2X10_ST_M	7950200	3746500	2	270
P1	184437502	5K-1T-PC-MTG	POT_9400_5_M5	-14244320	-7137400	1	0
P2	184437502	5K-1T-PC-MTG	POT_9400_5_M5	-11645900	-7137400	1	0
P3	184427502	5K-1T-LONG-SHAFT-PS	POT_9400_5_M4	-6987540	144780	1	270
P4	184417502	5K-DUAL-INF-TURN	POT_9400_5_M3	6253480	7711440	1	0
P5	184417502	5K-DUAL-INF-TURN	POT_9400_5_M3	9354820	7711440	1	0
P6	184417502	5K-DUAL-INF-TURN	POT_9400_5_M3	10111740	3746500	1	270
P7	184417502	5K-DUAL-INF-TURN	POT_9400_5_M3	6761480	645160	1	270
P8	184417502	5K-DUAL-INF-TURN	POT_9400_5_M3	11752580	7711440	1	0
P9	184417502	5K-DUAL-INF-TURN	POT_9400_5_M3	12260580	645160	1	270
P10	184417502	5K-DUAL-INF-TURN	POT_9400_5_M3	12260580	-1554480	1	270
P11	184417502	5K-DUAL-INF-TURN	POT_9400_5_M3	14952980	7711440	1	0
P12	184417502	5K-DUAL-INF-TURN	POT_9400_5_M3	15938500	1153160	1	90
P13	184417502	5K-DUAL-INF-TURN	POT_9400_5_M3	9860280	645160	1	270
P14	184427502	5K-1T-LONG-SHAFT-PS	POT_9400_5_M4	-3886200	144780	1	270
R1	161225121	120	RES05	-1953260	-8270240	1	180
R2	168531381	750-1%	RES07	406400	-6908800	1	0
R3	161225121	120	RES05	-314960	-8280400	1	0
R4	168531365	511-1%	RES07	1676400	-7162800	1	180
R5	168531365	511-1%	RES07	1676400	-6654800	1	180
R6	161225121	120	RES05	5113020	-4414520	1	90
R7	161225121	120	RES05	4762500	-5778500	1	0
R8	161225121	120	RES05	10706100	-3124200	1	180
R9	161225121	120	RES05	7907020	-5778500	1	0
R10	169416473	NTC-DISC-47K	NTC_DISC	7467600	6273800	1	180
R13	168531521	21.5K-1%	RES07	8140700	6515100	1	270
R14	161225103	10K	RES05	8356600	4013200	1	270
R15	161225103	10K	RES05	8356600	1701800	1	90
R18	161225121	120	RES05	9715500	-5811520	1	0
R20	161225121	120	RES05	12357100	4737100	1	180
R21	161225121	120	RES05	14071600	1435100	1	180
R22	161225121	120	RES05	14058900	355600	1	180
R23	161225121	120	RES05	14071600	-2933700	1	180
R24	161225121	120	RES05	13766800	-5791200	1	180
R25	161225121	120	RES05	14757400	-3403600	1	0
R26	161225121	120	RES05	16395700	-1066800	1	180
R27	161225121	120	RES05	16395700	-1739900	1	180
R28	161225121	120	RES05	16395700	-3136900	1	180
S1	416161002	SW-P-SPST	SW_P_SPST	-16880840	6118860	1	0
S2	416161002	SW-P-SPST	SW_P_SPST	-16880840	3995420	1	0

S3	416161002	SW-P-SPST	SW_P_SPST	-16880840	2895600	1 0
S4	416161002	SW-P-SPST	SW_P_SPST	-16880840	1795780	1 0
S5	416161002	SW-P-SPST	SW_P_SPST	-16880840	695960	1 0
S6	416161002	SW-P-SPST	SW_P_SPST	-16880840	-403860	1 0
S7	416161002	SW-P-SPST	SW_P_SPST	-16880840	-1503680	1 0
S8	416161002	SW-P-SPST	SW_P_SPST	-16880840	-2603500	1 0
S9	416161002	SW-P-SPST	SW_P_SPST	-16880840	-3703320	1 0
S10	416161002	SW-P-SPST	SW_P_SPST	-16880840	-4803140	1 0
S11	416161002	SW-P-SPST	SW_P_SPST	-16880840	-8153400	1 0
S12	416161002	SW-P-SPST	SW_P_SPST	-10279380	-8153400	1 0
S13	416161002	SW-P-SPST	SW_P_SPST	-8679180	-8153400	1 0
S14	416161002	SW-P-SPST	SW_P_SPST	-7279640	-8153400	1 0
S15	416161002	SW-P-SPST	SW_P_SPST	-5880100	-8153400	1 0
S16	416161002	SW-P-SPST	SW_P_SPST	-4480560	-8153400	1 0
S17	416161002	SW-P-SPST	SW_P_SPST	-1678940	-8153400	1 0
S18	416161002	SW-P-SPST	SW_P_SPST	967740	-8153400	1 0
S19	416161002	SW-P-SPST	SW_P_SPST	3718560	6695440	1 0
S20	412001012	SW-ROT-12	SW_ROT_12	9347200	-899160	1 0
S21	416161002	SW-P-SPST	SW_P_SPST	3718560	3995420	1 0
S22	416161002	SW-P-SPST	SW_P_SPST	3718560	2895600	1 0
S23	416161002	SW-P-SPST	SW_P_SPST	3718560	1795780	1 0
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S28	416161002	SW-P-SPST	SW_P_SPST	3718560	-3703320	1 0
S30	416161002	SW-P-SPST	SW_P_SPST	3718560	-6202680	1 0
S31	416161002	SW-P-SPST	SW_P_SPST	9768840	-5453380	1 0
S32	412001012	SW-ROT-12	SW_ROT_12	6248400	4650740	1 0
S33	412001012	SW-ROT-12	SW_ROT_12	6248400	-899160	1 0
S34	416161002	SW-P-SPST	SW_P_SPST	9768840	-4254500	1 0
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S40	416161002	SW-P-SPST	SW_P_SPST	6466840	-5453380	1 0
S41	416161002	SW-P-SPST	SW_P_SPST	11518900	3345180	1 0
S42	416161002	SW-P-SPST	SW_P_SPST	12019280	-2854960	1 0
S43	416161002	SW-P-SPST	SW_P_SPST	12019280	-4254500	1 0
S44	416161002	SW-P-SPST	SW_P_SPST	12019280	-5453380	1 0
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S46	412001012	SW-ROT-12	SW_ROT_12	14450060	4650740	1 0
S47	416161002	SW-P-SPST	SW_P_SPST	14317980	645160	1 0
S48	416161002	SW-P-SPST	SW_P_SPST	14317980	-1653540	1 0
S49	416161002	SW-P-SPST	SW_P_SPST	14317980	-2854960	1 0
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CR1	230020062	BAW62	DO35	-17145000	7137400	1 270
CR2	230020062	BAW62	DO35	-17145000	4864100	1 0
CR3	230020062	BAW62	DO35	-17106900	3911600	1 270
CR4	230020062	BAW62	DO35	-17195800	1714500	1 270
CR5	230020062	BAW62	DO35	-17195800	-292100	1 270
CR6	230020062	BAW62	DO35	-17119600	-2692400	1 270
CR7	230020062	BAW62	DO35	-15760700	2819400	1 270
CR8	230020062	BAW62	DO35	-15824200	609600	1 270
CR9	230020062	BAW62	DO35	-15811500	-1574800	1 270
CR10	230020062	BAW62	DO35	-15811500	-3797300	1 270
CR11	230020062	BAW62	DO35	-15849600	-7137400	1 270
CR12	230020062	BAW62	DO35	-10566400	-7137400	1 270
CR13	230020062	BAW62	DO35	-8991600	-7137400	1 270
CR14	230020062	BAW62	DO35	-7569200	-7137400	1 270
CR15	230020062	BAW62	DO35	-6197600	-7137400	1 270
CR16	230020062	BAW62	DO35	-4775200	-7137400	1 270

CR17	256443401	LED-HLMP-0401	LED_RECT	-2527300	-7899400	1	0
CR18	230020062	BAW62	DO35	-640080	-7137400	1	270
CR19	208590385	LM385-1.2	TO92	76200	-6718300	1	270
CR20	256443401	LED-HLMP-0401	LED_RECT	121920	-7899400	1	0
CR21	230020062	BAW62	DO35	703580	-8564880	1	0
CR22	230020062	BAW62	DO35	3467100	7708900	1	270
CR23	230020062	BAW62	DO35	8648700	-406400	1	0
CR24	230020062	BAW62	DO35	3505200	5003800	1	270
CR25	230020062	BAW62	DO35	3505200	2806700	1	270
CR26	230020062	BAW62	DO35	3505200	609600	1	270
CR27	230020062	BAW62	DO35	3505200	-1587500	1	270
CR28	230020062	BAW62	DO35	3505200	-2857500	1	270
CR29	230020062	BAW62	DO35	3505200	-5194300	1	270
CR30	230020062	BAW62	DO35	4711700	3911600	1	270
CR31	230020062	BAW62	DO35	5118100	1714500	1	270
CR32	230020062	BAW62	DO35	9690100	-3378200	1	0
CR33	230020062	BAW62	DO35	4711700	-1041400	1	270
CR35	230020062	BAW62	DO35	9685020	-4605020	1	0
CR36	230020062	BAW62	DO35	5727700	5118100	1	0
CR38	256243300	LED-HLMP-0300	LED_RECT	5621020	-3403600	1	0
CR39	256443401	LED-HLMP-0401	LED_RECT	5621020	-3802380	1	0
CR40	256443401	LED-HLMP-0401	LED_RECT	5621020	-4201160	1	0
CR41	256443401	LED-HLMP-0401	LED_RECT	5621020	-4599940	1	0
CR42	256443401	LED-HLMP-0401	LED_RECT	5621020	-4998720	1	0
CR43	256443401	LED-HLMP-0401	LED_RECT	5621020	-5397500	1	0
CR44	230020062	BAW62	DO35	6273800	2832100	1	0
CR45	230020062	BAW62	DO35	6959600	7708900	1	270
CR47	256243300	LED-HLMP-0300	LED_RECT	8920480	-3403600	1	0
CR48	256443401	LED-HLMP-0401	LED_RECT	8920480	-3802380	1	0
CR49	256443401	LED-HLMP-0401	LED_RECT	8920480	-4201160	1	0
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CR51	256443401	LED-HLMP-0401	LED_RECT	8920480	-4998720	1	0
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CR62	230020062	BAW62	DO35	8623300	1701800	1	0
CR72	230020062	BAW62	DO35	6350000	-4605020	1	0
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CR74	230020062	BAW62	DO35	6350000	-5811520	1	0
CR75	256443401	LED-HLMP-0401	LED_RECT	11173460	-3802380	1	0
CR76	256443401	LED-HLMP-0401	LED_RECT	11173460	-4201160	1	0
CR77	256443401	LED-HLMP-0401	LED_RECT	11173460	-4599940	1	0
CR78	256443401	LED-HLMP-0401	LED_RECT	11173460	-4998720	1	0
CR79	256443401	LED-HLMP-0401	LED_RECT	11772900	4399280	1	0
CR80	230020062	BAW62	DO35	11976100	-4610100	1	0
CR81	230020062	BAW62	DO35	12458700	7543800	1	0
CR82	230020062	BAW62	DO35	12204700	-3340100	1	0
CR83	230020062	BAW62	DO35	13004800	-1625600	1	270
CR84	256443401	LED-HLMP-0401	LED_RECT	13472160	1097280	1	0
CR85	256443401	LED-HLMP-0401	LED_RECT	13472160	698500	1	0
CR86	256443401	LED-HLMP-0401	LED_RECT	13472160	-1402080	1	0
CR87	256443401	LED-HLMP-0401	LED_RECT	13472160	-1800860	1	0
CR88	256443401	LED-HLMP-0401	LED_RECT	13472160	-2199640	1	0
CR89	256443401	LED-HLMP-0401	LED_RECT	13472160	-2598420	1	0
CR90	230020062	BAW62	DO35	13474700	-3187700	1	0
CR91	256443401	LED-HLMP-0401	LED_RECT	13472160	-3802380	1	0
CR92	256443401	LED-HLMP-0401	LED_RECT	13472160	-4201160	1	0
CR93	256443401	LED-HLMP-0401	LED_RECT	13472160	-4599940	1	0
CR94	256443401	LED-HLMP-0401	LED_RECT	13472160	-4998720	1	0
CR95	256443401	LED-HLMP-0401	LED_RECT	13472160	-5397500	1	0
CR96	230020062	BAW62	DO35	14211300	-4597400	1	0
CR97	230020062	BAW62	DO35	14020800	-5791200	1	0
CR98	230020062	BAW62	DO35	14351000	304800	1	0
CR99	230020062	BAW62	DO35	14312900	-1993900	1	0
CR100	230020062	BAW62	DO35	14884400	1498600	1	0
CR101	230020062	BAW62	DO35	15646400	4991100	1	270

CR102	256443401	LED-HLMP-0401	LED_RECT	15773400	-1399540	1	0
CR103	256443401	LED-HLMP-0401	LED_RECT	15773400	-2400300	1	0
CR104	256443401	LED-HLMP-0401	LED_RECT	15773400	-2799080	1	0
CR105	256443401	LED-HLMP-0401	LED_RECT	15773400	-3802380	1	0
CR106	256443401	LED-HLMP-0401	LED_RECT	15773400	-4201160	1	0
CR107	256443401	LED-HLMP-0401	LED_RECT	15773400	-4599940	1	0
CR108	256443401	LED-HLMP-0401	LED_RECT	15773400	-4998720	1	0
CR109	230020062	BAW62	DO35	16012160	-5798820	1	0
CR110	230020062	BAW62	DO35	16319500	-2006600	1	0
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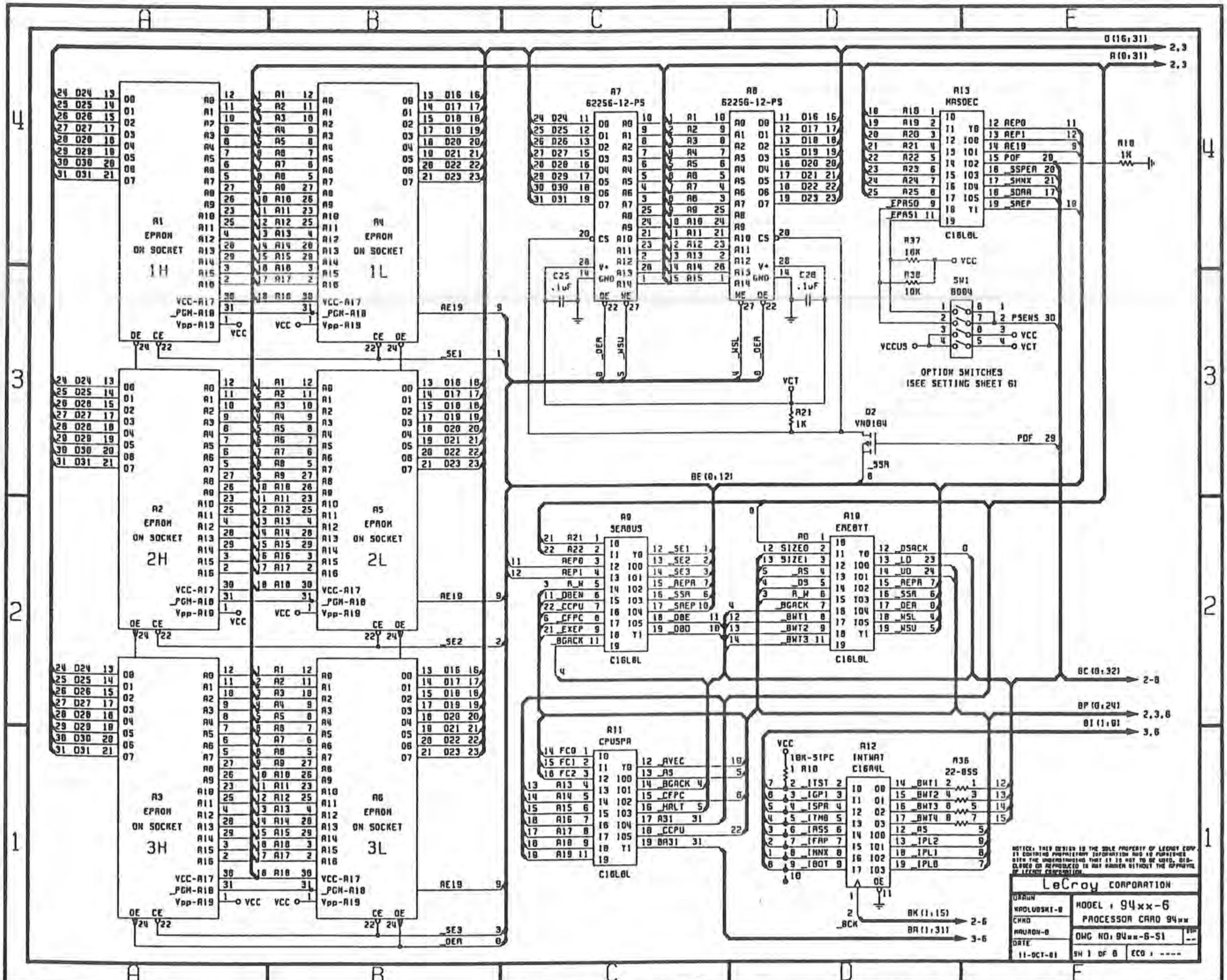
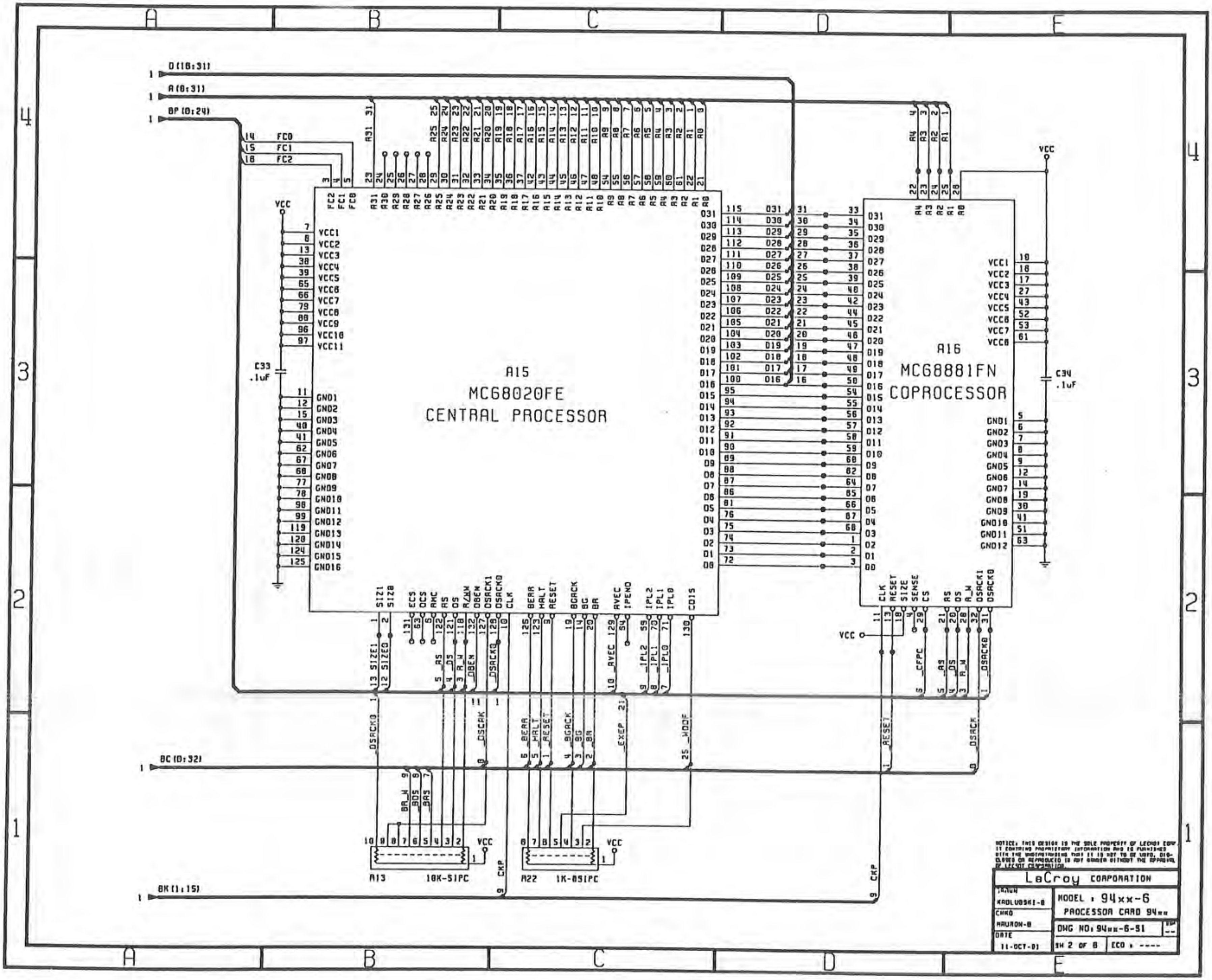
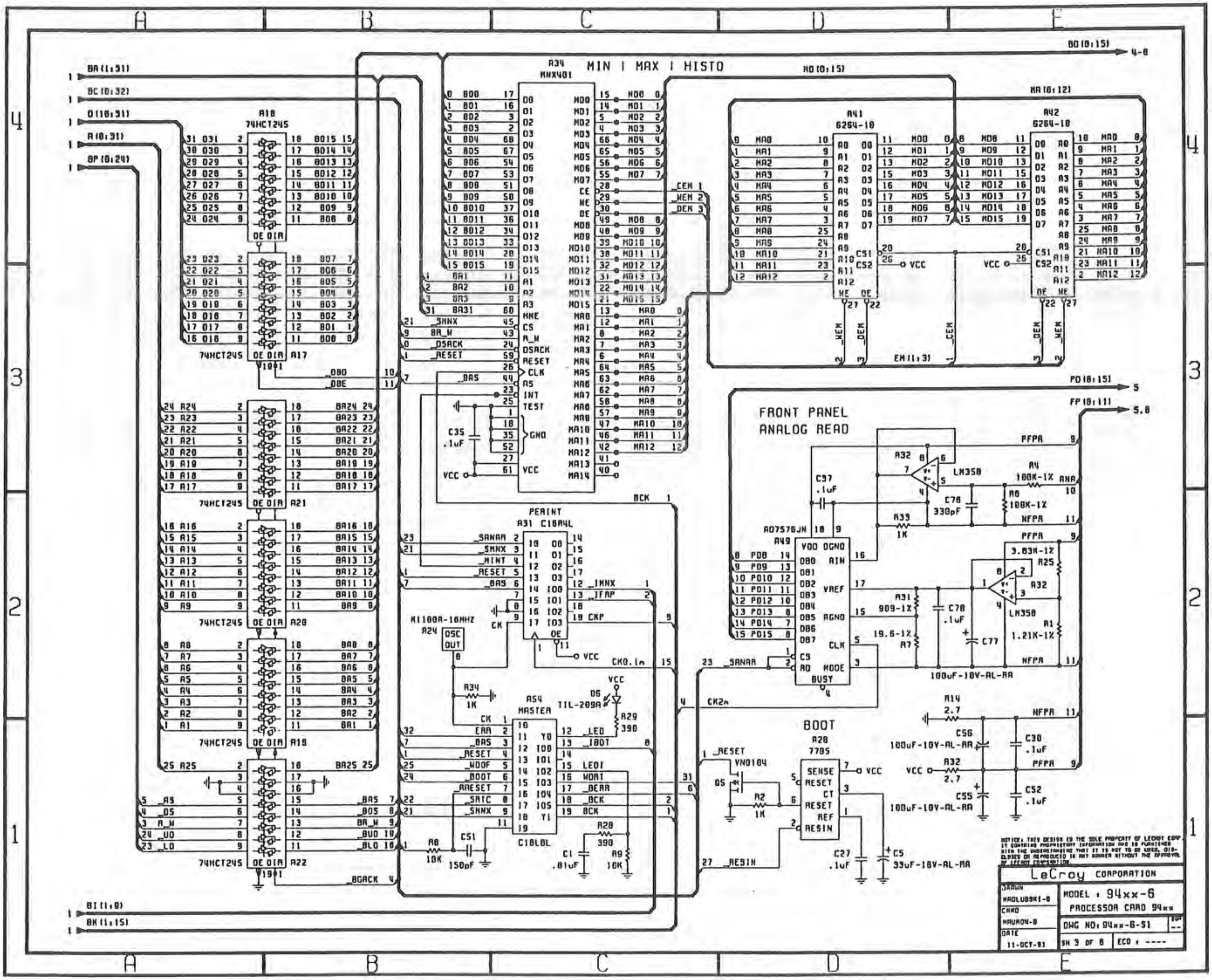
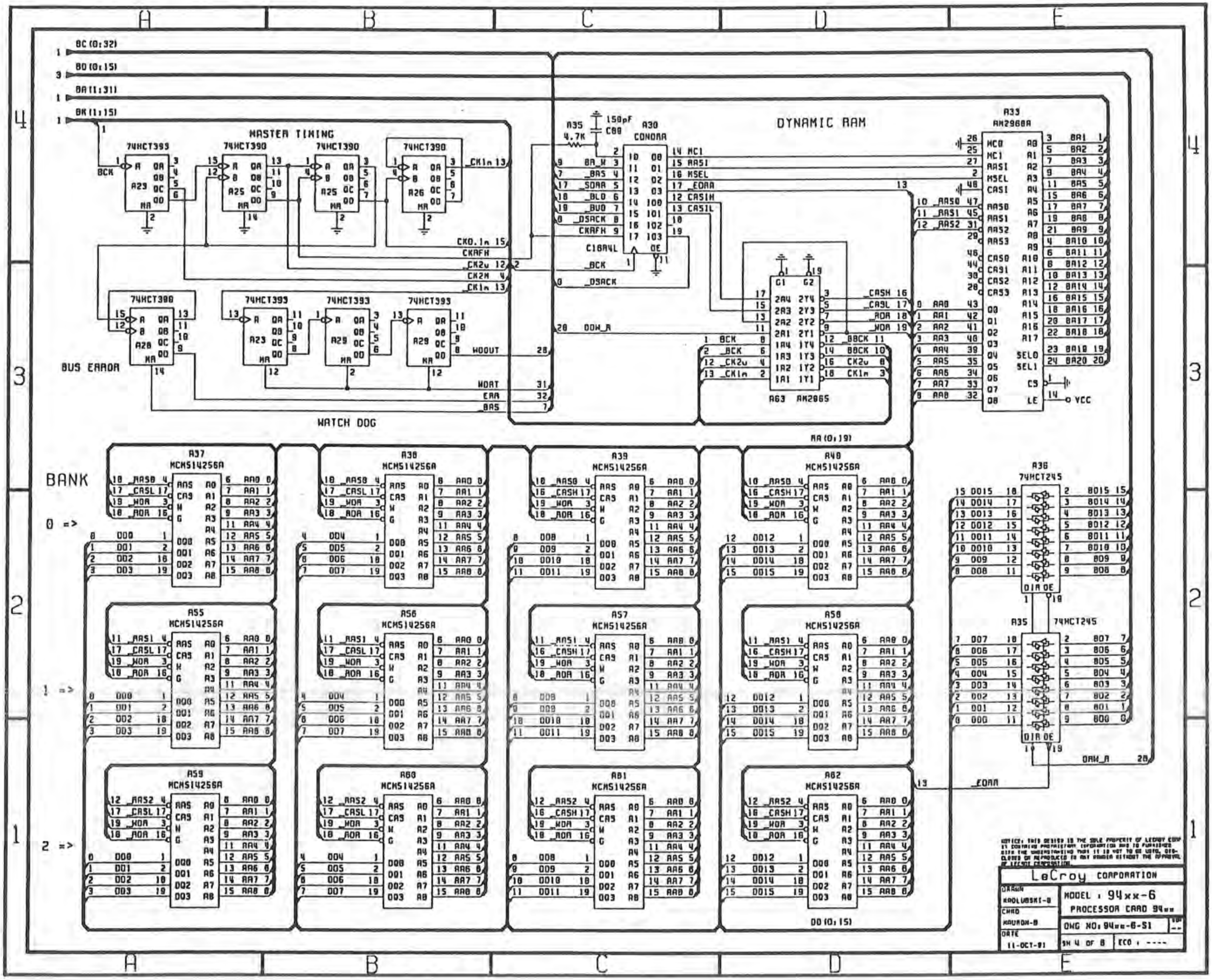
RN1	190001001	SIP13RES	SIP13RES	1320800	8039100	1	90


LeCroy CORPORATION
MODEL : 94xx-6
PROCESSOR CARD 94xx
DWG NO: 94xx-6-S1
SH 1 OF 8
ECO : ----
DRAWN KROLUBSKI-B
CHKD HAVRON-B
DATE 11-OCT-81
OPTION SWITCHES
(SEE SETTING SHEET 6)

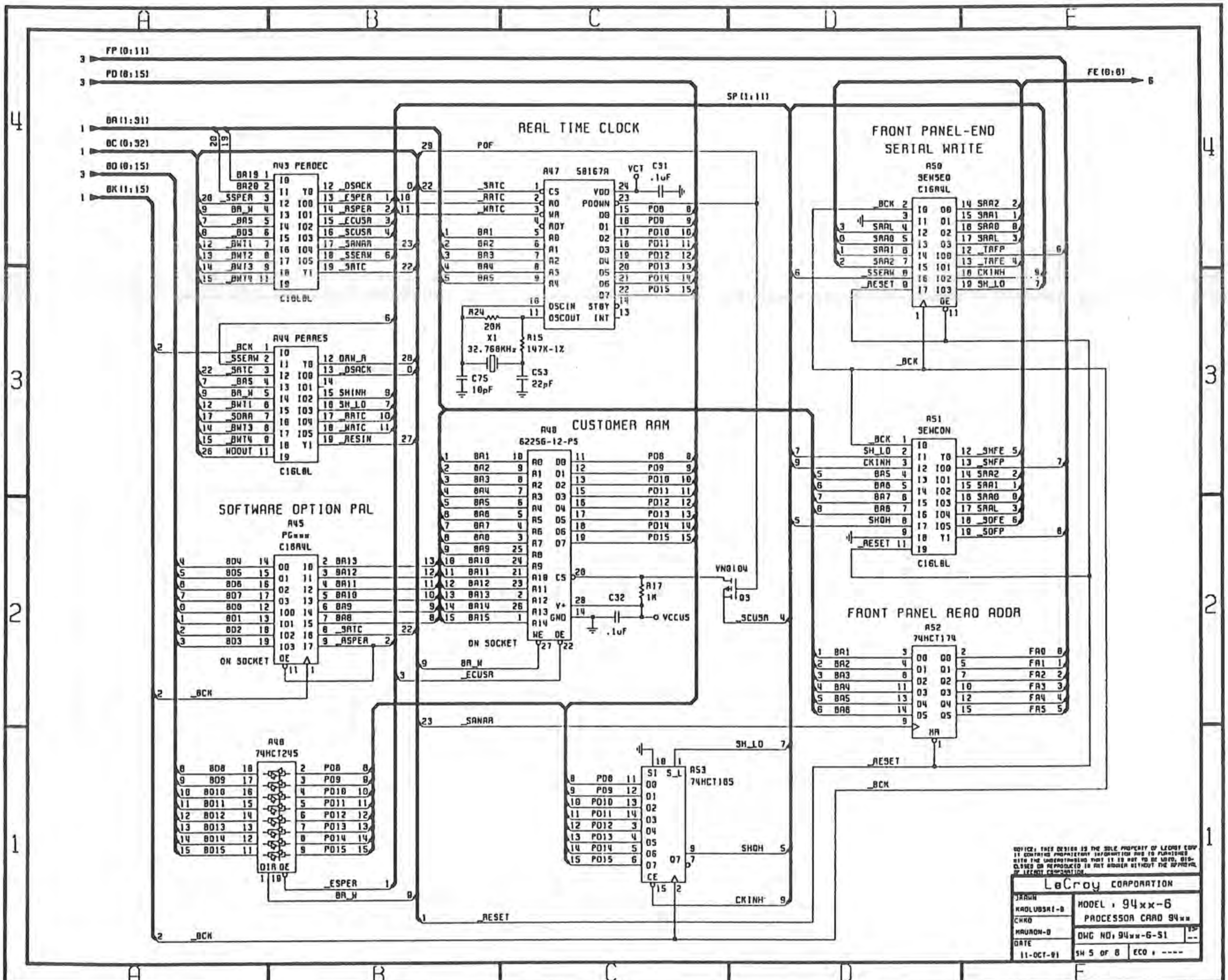

A15
MC68020FE
CENTRAL PROCESSOR
A16
MC68881FN
COPROCESSOR
D(0:31)
A(0:31)
BP(0:24)
BC(0:32)
BK(1:15)
C33 .1uF
C34 .1uF
VCC
A13 10K-SIPC
A22 1K-8SIPC
CKP
LeCroy CORPORATION
MODEL : 94xx-6
PROCESSOR CARD 94xx
DWG NO: 94xx-6-S1
SH 2 OF 8
11-OCT-91



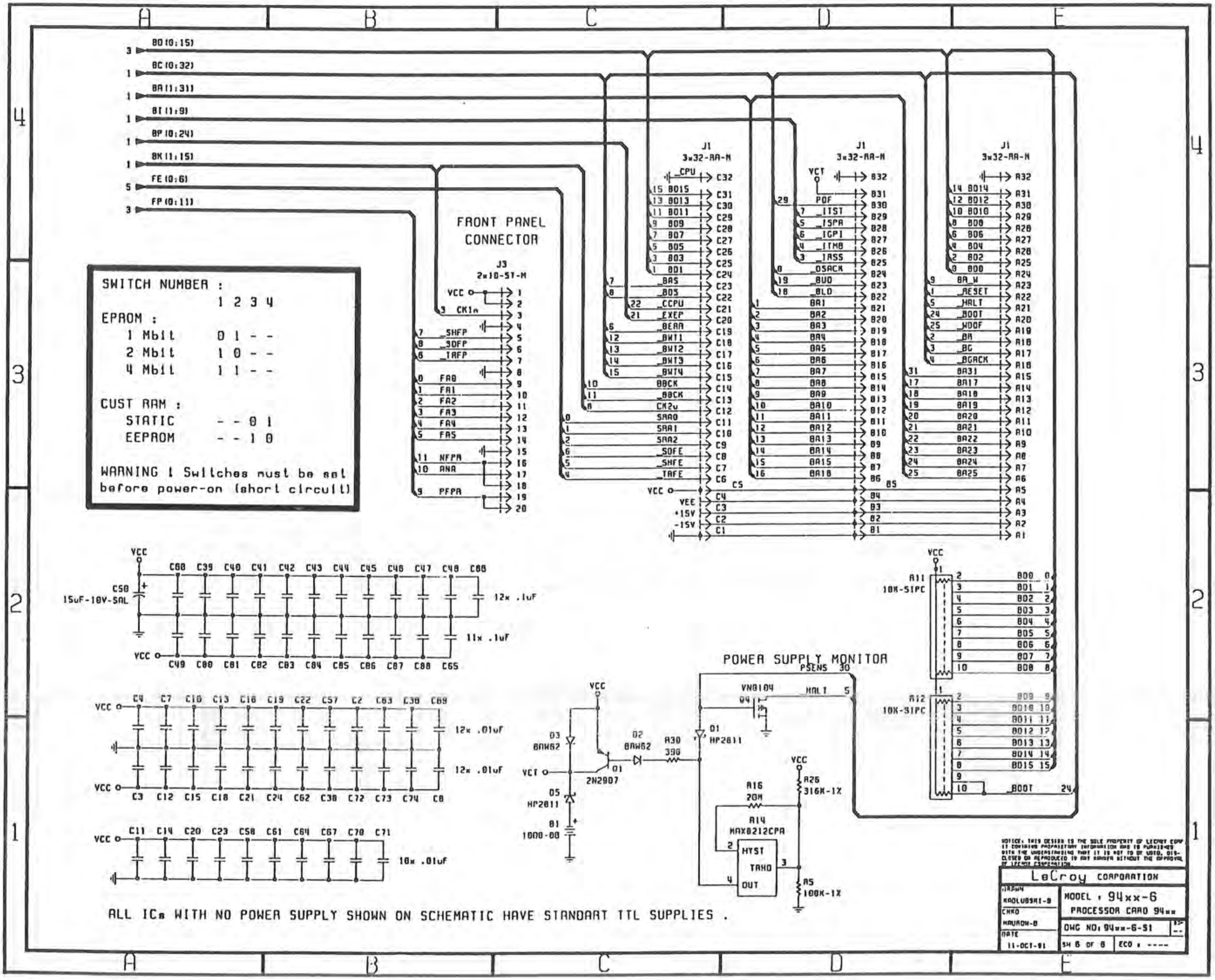
MIN | MAX | HISTO
FRONT PANEL
ANALOG READ
BOOT
LeCroy CORPORATION
MODEL : 94xx-6
PROCESSOR CARD 94xx
DWG NO: 94xx-6-S1
SH 3 OF 8
ECO : ----
11-OCT-91



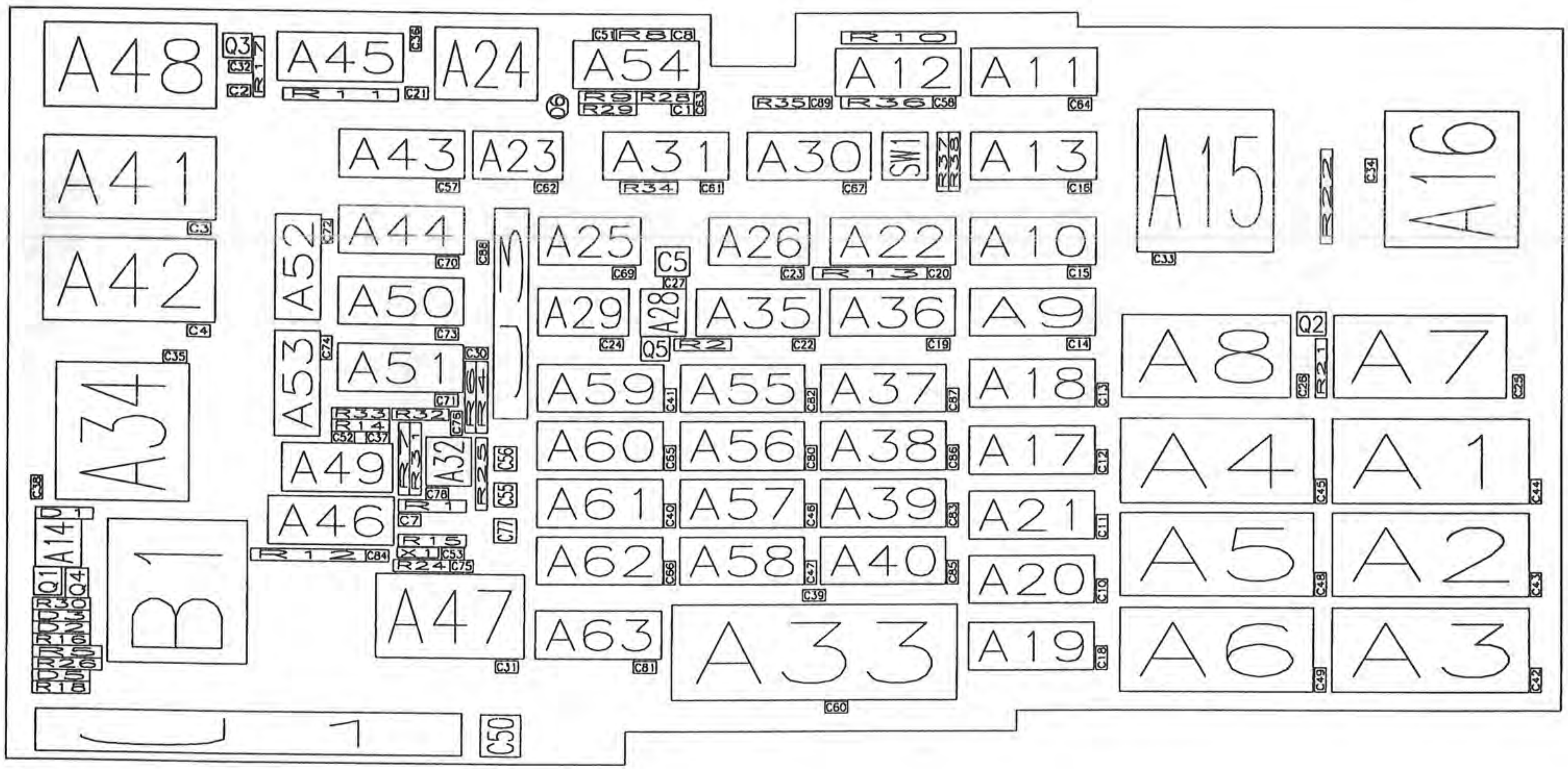
MASTER TIMING
DYNAMIC RAM
BUS ERROR
WATCH DOG
BANK
0 =>
1 =>
2 =>
BC(0:32)
BD(0:15)
BA(1:31)
BK(1:15)
RA(0:19)
DD(0:15)
LeCroy CORPORATION
MODEL : 94xx-6
PROCESSOR CARD 94xx
DWG NO: 94xx-6-S1
SH 4 OF 8
ECO : ----
DRAWN KAOLUBSKI-B
CHKD HAURON-B
DATE 11-OCT-91



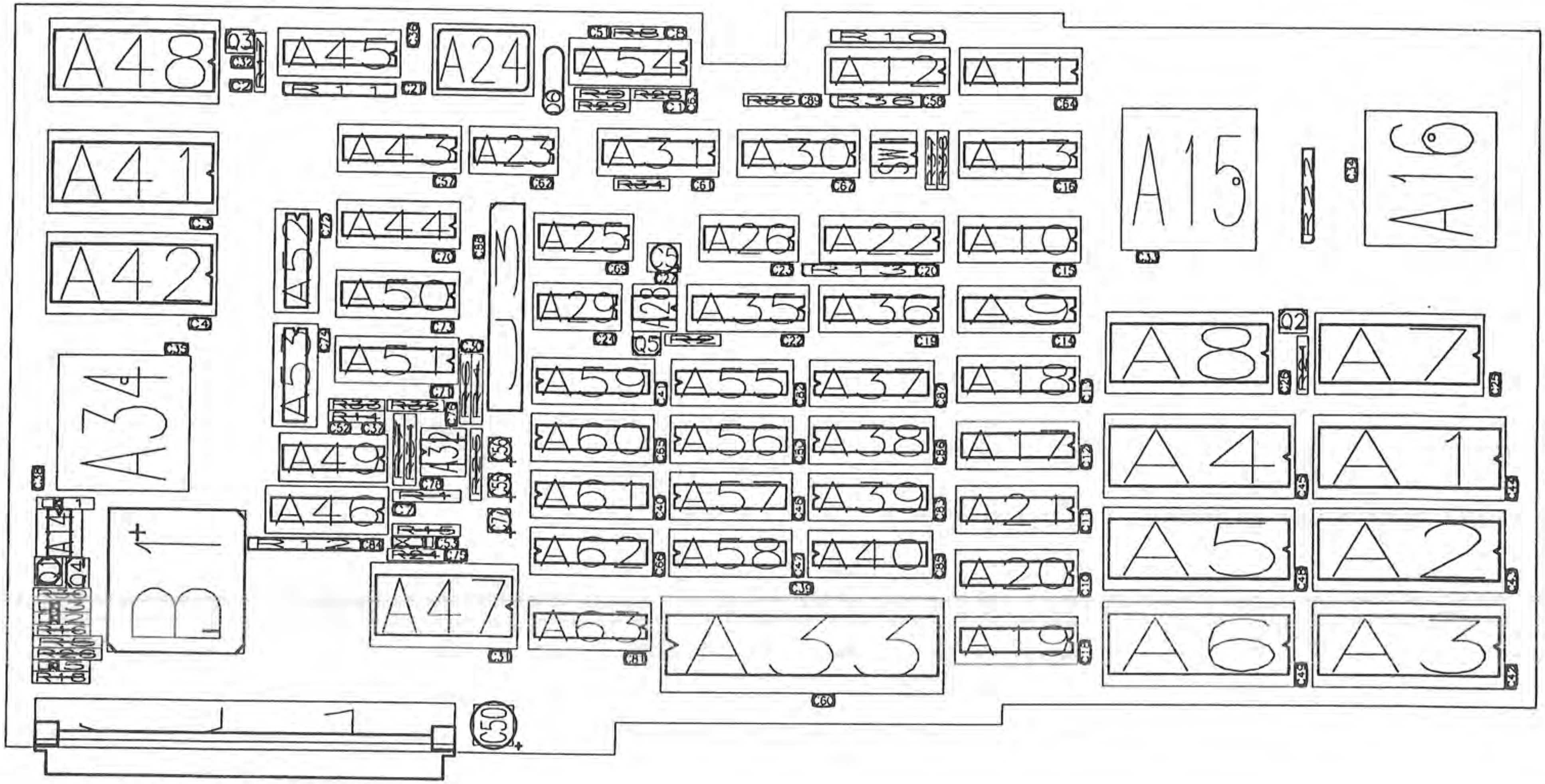
REAL TIME CLOCK
CUSTOMER RAM
SOFTWARE OPTION PAL
FRONT PANEL-END SERIAL WRITE
FRONT PANEL READ ADDR
A43 PEADEC
A44 PEARES
A45 PC***
C18A4L
A46 74HCT245
A47 58167A
A48 62256-12-PS
A50 SENSEO C16A4L
A51 SENCON C16L8L
A52 74HCT174
A53 74HCT165
VN0104
X1 32.768KHz
FP(0:11)
PD(0:15)
BA(1:31)
BC(0:32)
BD(0:15)
BK(1:15)
SP(1:11)
FE(0:6)
ON SOCKET
NOTICE: THIS DESIGN IS THE SOLE PROPERTY OF LECROY CORP. IT CONTAINS PROPRIETARY INFORMATION AND IS FURNISHED WITH THE UNDERSTANDING THAT IT IS NOT TO BE USED, DISCLOSED OR REPRODUCED IN ANY MANNER WITHOUT THE APPROVAL OF LECROY CORPORATION.
LeCroy CORPORATION
DRAWN KAOLUBSKI-B
CHKD MAURON-D
DATE 11-OCT-91
MODEL : 94xx-6
PROCESSOR CARD 94**
DWG NO: 94**-6-S1
SH 5 OF 8
ECO : ----



BD(0:15)
BC(0:32)
BA(1:31)
BI(1:9)
BP(0:24)
BK(1:15)
FE(0:6)
FP(0:11)
FRONT PANEL CONNECTOR
J3 2x10-ST-M
J1 3x32-RA-M
SWITCH NUMBER : 1 2 3 4
EPROM :
1 Mbit 0 1 - -
2 Mbit 1 0 - -
4 Mbit 1 1 - -
CUST RAM :
STATIC - - 0 1
EEPROM - - 1 0
WARNING ! Switches must be set before power-on (short circuit)
C50 15uF-10V-SAL
12x .1uF
11x .1uF
12x .01uF
12x .01uF
10x .01uF
POWER SUPPLY MONITOR
VN0104
HALT
PSENS 30
D1 HP2811
D2 BAW62
D3 BAW62
D5 HP2811
Q1 2N2907
R30 390
B1 1000-80
R16 20M
R14 MAX8212CPA
HYST
THRO
OUT
R26 316K-1%
R5 100K-1%
R11 10K-SIPC
R12 10K-SIPC
BOOT
ALL ICs WITH NO POWER SUPPLY SHOWN ON SCHEMATIC HAVE STANDART TTL SUPPLIES .
LeCroy CORPORATION
MODEL : 94xx-6
PROCESSOR CARD 94xx
DWG NO: 94xx-6-S1
SH 8 OF 8
ECO : ----
DRAWN KAOLUBSKI-B
CHKD MAURON-B
DATE 11-OCT-91



94XX_6 Rev:A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A55
A37
A18
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A60
A56
A38
A17
A4
A1
A46
A61
A57
A39
A21
A62
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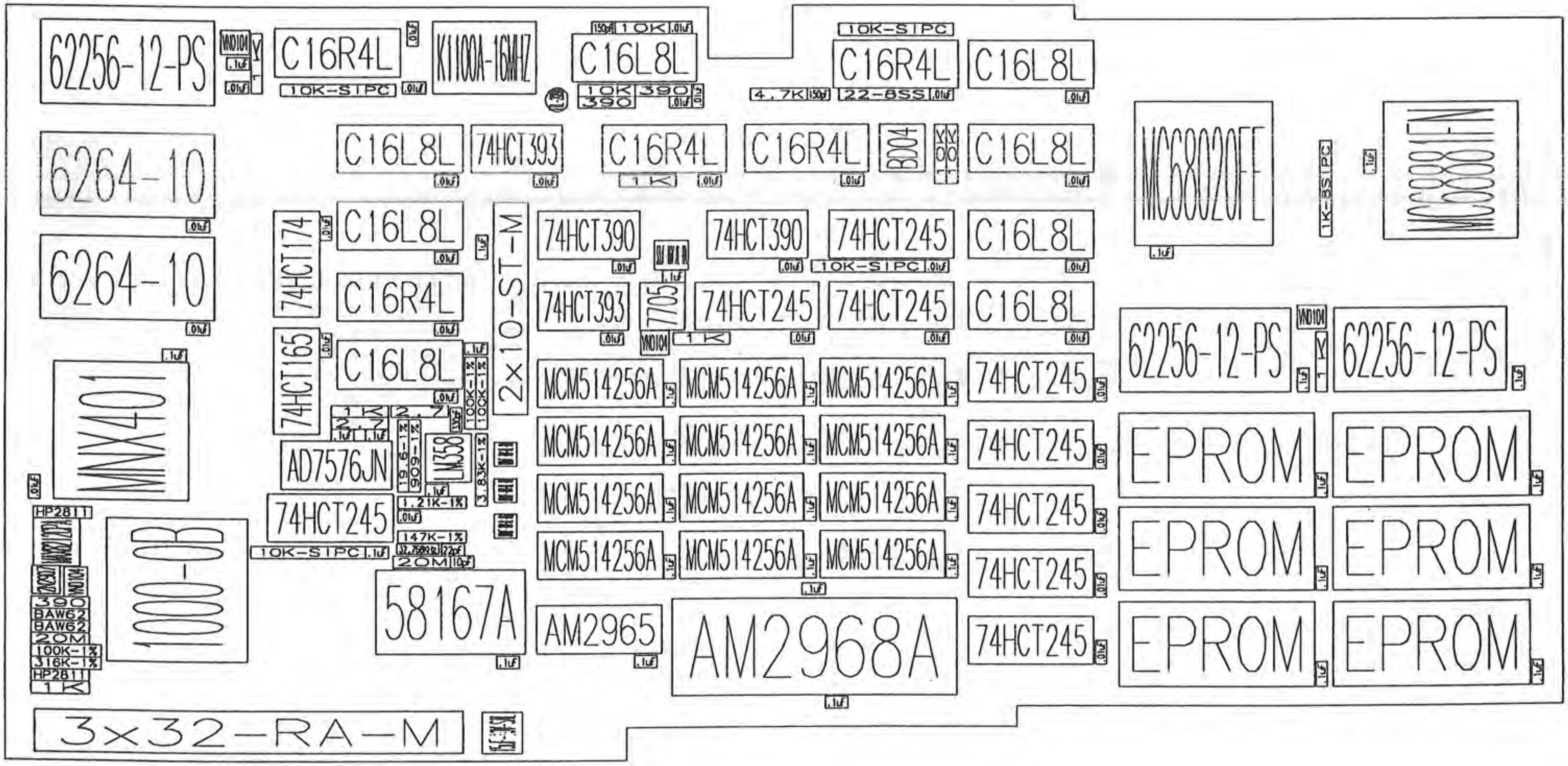
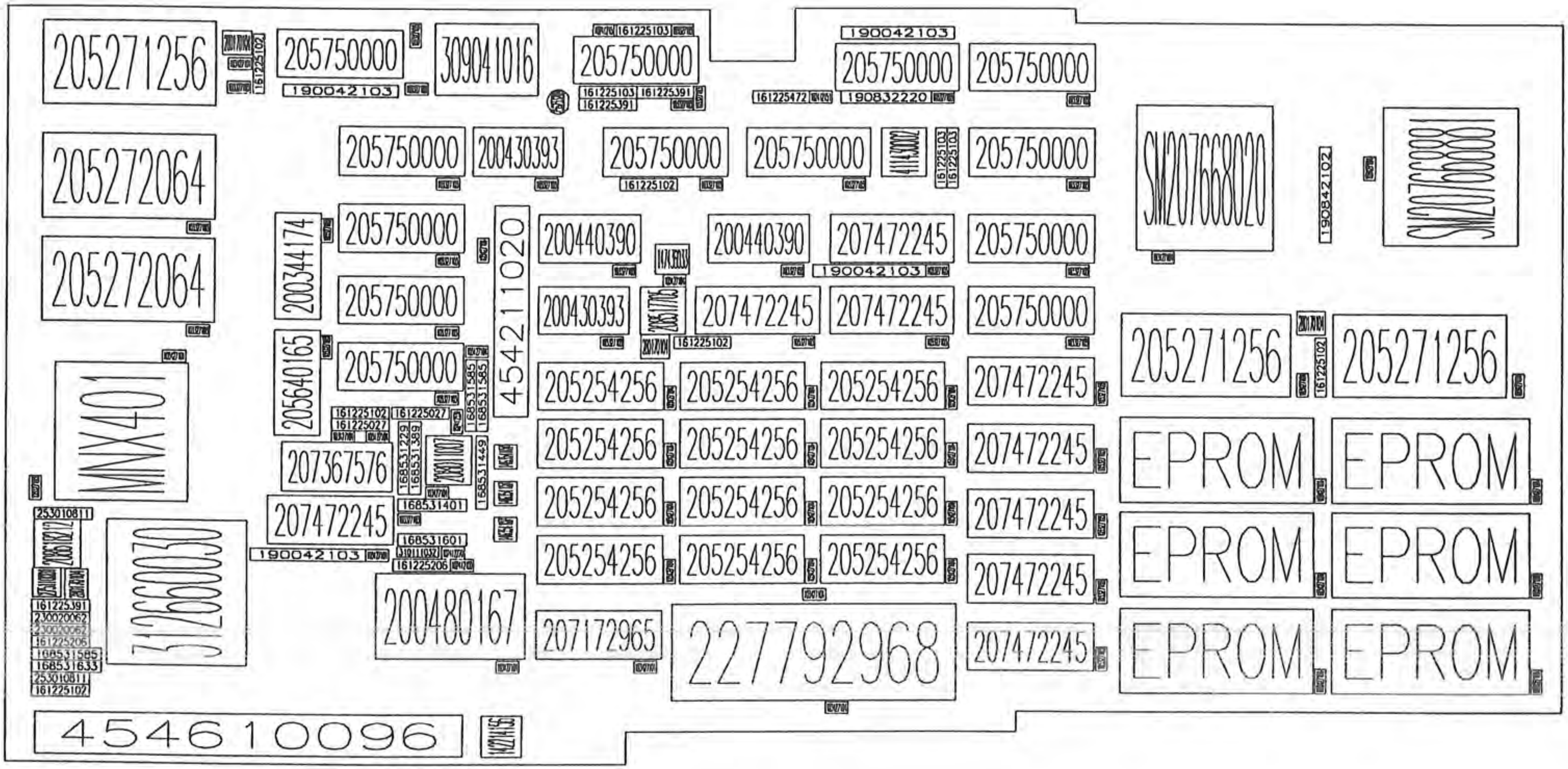
A47
A63
A33
A19
A6
A3
C50

94XX_6 Rev:A



62256-12-PS
6264-10
6264-10
MNX401
1000-0B
3x32-RA-M
C16R4L
10K-SIPC
K1100A-16MHZ
C16L8L
10K
390
C16L8L
74HCT393
74HCT174
74HCT165
C16R4L
AD7576JN
74HCT245
58167A
2x10-ST-M
74HCT390
74HCT393
7705
C16R4L
C16R4L
BD04
74HCT390
74HCT245
4.7K
22-8SS
MCM514256A
AM2965
AM2968A
74HCT245
MC68020FE
MC68881FN
1K-8SIPC
EPROM
LM358
HP2811
BAW62
20M
100K-1%
316K-1%
1K

94XX_6 Rev:A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205750000
SM207668020
190842102
SM207668881
205272064
200344174
205750000
454211020
200440390
200440390
207472245
205750000
205750000
200430393
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207472245
205750000
205271256
205271256
205640165
205750000
205254256
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205254256
207472245
MNX401
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EPROM
EPROM
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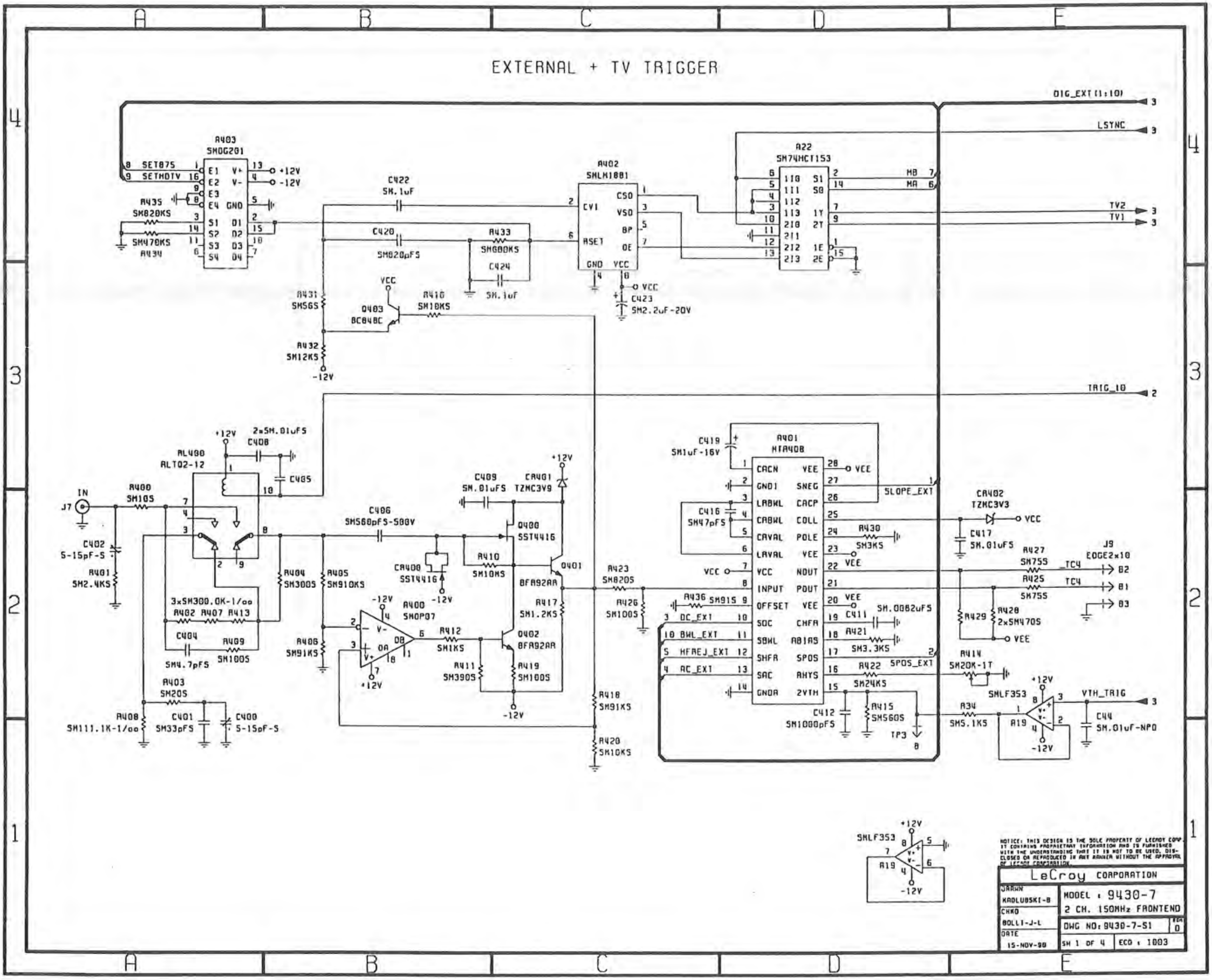
205254256
207472245
200480167
207172965
227792968
207472245
EPROM
EPROM
454610096

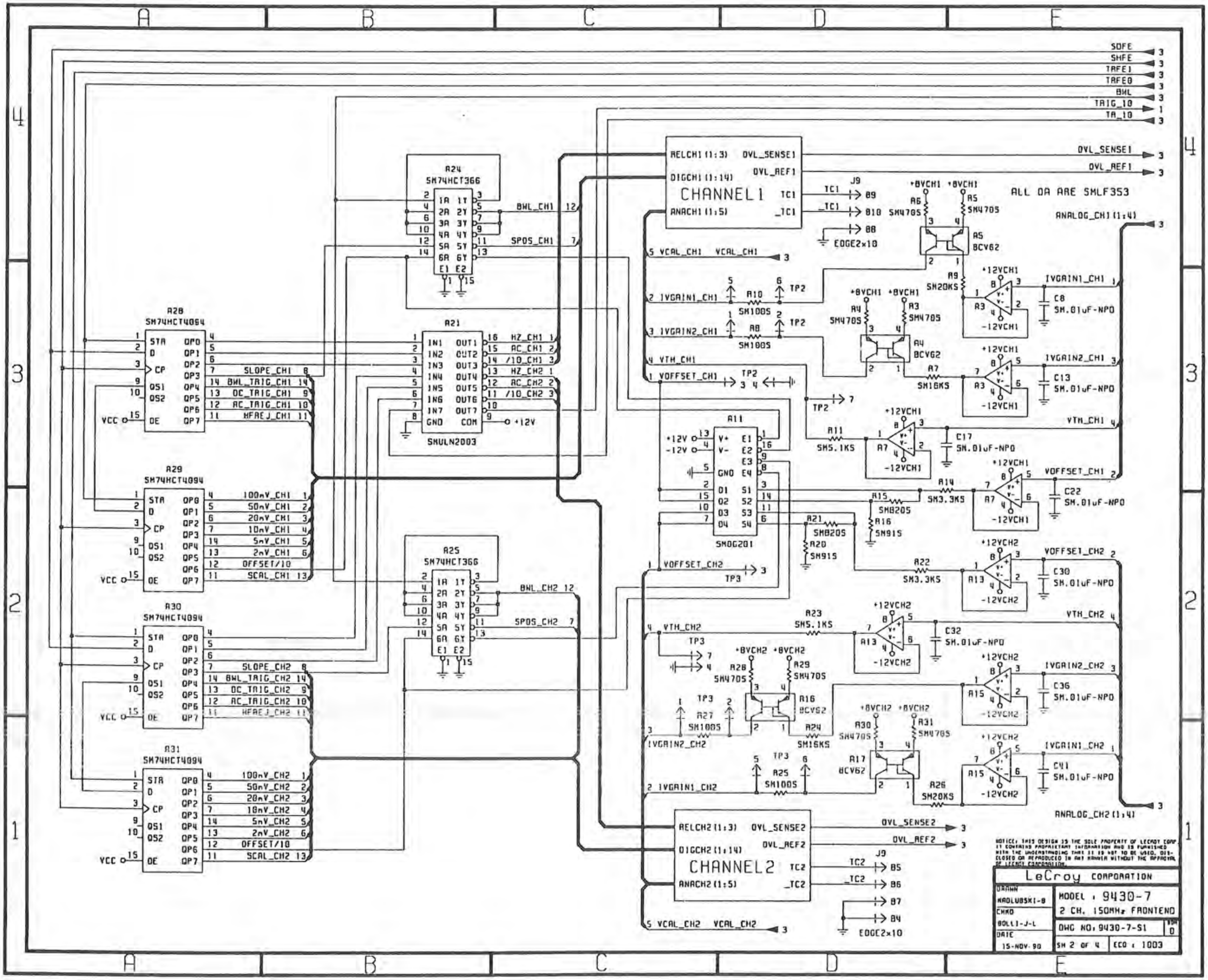
94XX_6 Rev:A

A1	EPROM	EPROM	DIP32	33426400	7162800	1	270
A2	EPROM	EPROM	DIP32	33426400	5181600	1	270
A3	EPROM	EPROM	DIP32	33426400	3149600	1	270
A4	EPROM	EPROM	DIP32	28702000	7162800	1	270
A5	EPROM	EPROM	DIP32	28702000	5181600	1	270
A6	EPROM	EPROM	DIP32	28702000	3149600	1	270
A7	205271256	62256-12-PS	DIP28	32918400	9398000	1	270
A8	205271256	62256-12-PS	DIP28	28194000	9398000	1	270
A9	205750000	C16L8L	DIP20	23825200	9956800	1	270
A10	205750000	C16L8L	DIP20	23825200	11480800	1	270
A11	205750000	C16L8L	DIP20	23825200	15087600	1	270
A12	205750000	C16R4L	DIP20	20828000	15087600	1	270
A13	205750000	C16L8L	DIP20	23825200	13309600	1	270
A14	208618212	MAX8212CPA	DIP8	762000	4927600	1	0
A15	SM207668020	MC68020FE	QUAD_FP_132P	27838400	12395200	1	270
A16	SM207668881	MC68881FN	PLCC_68	31940500	13652500	1	0
A17	207472245	74HCT245	DIP20	23825200	7010400	1	270
A18	207472245	74HCT245	DIP20	23825200	8432800	1	270
A19	207472245	74HCT245	DIP20	23825200	2844800	1	270
A20	207472245	74HCT245	DIP20	23825200	4267200	1	270
A21	207472245	74HCT245	DIP20	23825200	5638800	1	270
A22	207472245	74HCT245	DIP20	20726400	11480800	1	270
A23	200430393	74HCT393	DIP14	11988800	13309600	1	270
A24	309041016	K1100A-16MHZ	$1100_QUARTZ	9753600	16764000	1	0
A25	200440390	74HCT390	DIP16	13716000	11480800	1	270
A26	200440390	74HCT390	DIP16	17475200	11480800	1	270
A28	208517705	7705	DIP8	14833600	9956800	1	270
A29	200430393	74HCT393	DIP14	13462000	9956800	1	270
A30	205750000	C16R4L	DIP20	18846800	13309600	1	270
A31	205750000	C16R4L	DIP20	15646400	13309600	1	270
A32	208011007	LM358	DIP8	9347200	5994400	1	90
A33	227792968	AM2968A	DIP48	14935200	1574800	1	90
A34	MNX401	MNX401	PLCC_68	2540000	8128000	1	0
A35	207472245	74HCT245	DIP20	17729200	9956800	1	270
A36	207472245	74HCT245	DIP20	20726400	9956800	1	270
A37	205254256	MCM514256A	DIP20	18237200	7569200	1	90
A38	205254256	MCM514256A	DIP20	18237200	6350000	1	90
A39	205254256	MCM514256A	DIP20	18237200	5130800	1	90
A40	205254256	MCM514256A	DIP20	18237200	3911600	1	90
A41	205272064	6264-10	DIP28	4318000	13106400	1	270
A42	205272064	6264-10	DIP28	4318000	10922000	1	270
A43	205750000	C16L8L	DIP20	9804400	13309600	1	270
A44	205750000	C16L8L	DIP20	9804400	11684000	1	270
A45	205750000	C16R4L	DIP20	8432800	15341600	1	270
A46	207472245	74HCT245	DIP20	8280400	5486400	1	270
A47	200480167	58167A	$DIP24	11176000	3860800	1	270
A48	205271256	62256-12-PS	DIP28	4318000	15494000	1	270
A49	207367576	AD7576JN	DIP18	8280400	6604000	1	270
A50	205750000	C16R4L	DIP20	9804400	10160000	1	270
A51	205750000	C16L8L	DIP20	9804400	8737600	1	270
A52	200344174	74HCT174	DIP16	5994400	11379200	1	0
A53	205640165	74HCT165	DIP16	5994400	8890000	1	0
A54	205750000	C16L8L	DIP20	14986000	15240000	1	270
A55	205254256	MCM514256A	DIP20	15087600	7569200	1	90
A56	205254256	MCM514256A	DIP20	15087600	6350000	1	90
A57	205254256	MCM514256A	DIP20	15087600	5130800	1	90
A58	205254256	MCM514256A	DIP20	15087600	3911600	1	90
A59	205254256	MCM514256A	DIP20	11938000	7569200	1	90
A60	205254256	MCM514256A	DIP20	11938000	6350000	1	90
A61	205254256	MCM514256A	DIP20	11938000	5130800	1	90
A62	205254256	MCM514256A	DIP20	11938000	3911600	1	90
A63	207172965	AM2965	DIP20	14224000	3098800	1	270
B1	312660030	1000-0B	BAT_1000	2489200	4826000	1	0
C1	103327103	.01uF	SMONOBP	14732000	13919200	1	0
C2	103327103	.01uF	SMONOBP	5181600	14224000	1	180
C3	103327103	.01uF	SMONOBP	4318000	11277600	1	180

C4	103327103	.01uF	SMONOBP	4318000	9093200	1	180
C5	147436033	33uF-16V-AL-RA	TCAP	14782800	10668000	1	180
C7	103327103	.01uF	SMONOBP	8991600	5130800	1	180
C8	103327103	.01uF	SMONOBP	14986000	15494000	1	180
C10	103327103	.01uF	SMONOBP	24231600	3505200	1	90
C11	103327103	.01uF	SMONOBP	24231600	4876800	1	90
C12	103327103	.01uF	SMONOBP	24231600	6248400	1	90
C13	103327103	.01uF	SMONOBP	24231600	7670800	1	90
C14	103327103	.01uF	SMONOBP	23825200	8890000	1	180
C15	103327103	.01uF	SMONOBP	23825200	10414000	1	180
C16	103327103	.01uF	SMONOBP	23825200	12242800	1	180
C18	103327103	.01uF	SMONOBP	24231600	2082800	1	90
C19	103327103	.01uF	SMONOBP	20726400	8890000	1	180
C20	103327103	.01uF	SMONOBP	20726400	10414000	1	180
C21	103327103	.01uF	SMONOBP	8839200	14224000	1	0
C22	103327103	.01uF	SMONOBP	17729200	8890000	1	180
C23	103327103	.01uF	SMONOBP	17475200	10414000	1	180
C24	103327103	.01uF	SMONOBP	13462000	8890000	1	180
C25	103427104	.1uF	SMONOBP	33426400	7874000	1	90
C26	103427104	.1uF	SMONOBP	28702000	7874000	1	90
C27	103427104	.1uF	SMONOBP	14579600	10210800	1	0
C30	103427104	.1uF	SMONOBP	10210800	8686800	1	0
C31	103427104	.1uF	SMONOBP	11176000	2032000	1	180
C32	103427104	.1uF	SMONOBP	4953000	14732000	1	0
C33	103427104	.1uF	SMONOBP	25704800	10718800	1	180
C34	103427104	.1uF	SMONOBP	30175200	12750800	1	270
C35	103427104	.1uF	SMONOBP	3556000	8534400	1	0
C36	103327103	.01uF	SMONOBP	8940800	15240000	1	90
C37	103427104	.1uF	SMONOBP	8026400	6858000	1	0
C38	103327103	.01uF	SMONOBP	660400	5842000	1	270
C39	103427104	.1uF	SMONOBP	17983200	3556000	1	180
C40	103427104	.1uF	SMONOBP	14630400	5130800	1	90
C41	103427104	.1uF	SMONOBP	14630400	7569200	1	90
C42	103427104	.1uF	SMONOBP	33832800	1625600	1	90
C43	103427104	.1uF	SMONOBP	33832800	3657600	1	90
C44	103427104	.1uF	SMONOBP	33832800	5638800	1	90
C45	103427104	.1uF	SMONOBP	29108400	5638800	1	90
C46	103427104	.1uF	SMONOBP	17780000	5130800	1	90
C47	103427104	.1uF	SMONOBP	17780000	3911600	1	90
C48	103427104	.1uF	SMONOBP	29108400	3657600	1	90
C49	103427104	.1uF	SMONOBP	29108400	1625600	1	90
C50	142214156	15uF-10V-SAL	LTCAP	10922000	304800	1	90
C51	102412151	150pF	SMONO	13004800	15494000	1	0
C52	103427104	.1uF	SMONOBP	7264400	6858000	1	0
C53	102412220	22pF	SMONO	9702800	4419600	1	0
C55	146354107	100uF-10V-AL-RA	TDCAP	11125200	5689600	1	180
C56	146354107	100uF-10V-AL-RA	TDCAP	11125200	6451600	1	180
C57	103327103	.01uF	SMONOBP	9804400	12242800	1	180
C58	103327103	.01uF	SMONOBP	20828000	14071600	1	180
C60	103427104	.1uF	SMONOBP	18237200	1168400	1	0
C61	103327103	.01uF	SMONOBP	15646400	12242800	1	180
C62	103327103	.01uF	SMONOBP	11988800	12242800	1	180
C63	103327103	.01uF	SMONOBP	15240000	14173200	1	270
C64	103327103	.01uF	SMONOBP	23825200	14020800	1	180
C65	103427104	.1uF	SMONOBP	14630400	6350000	1	90
C66	103427104	.1uF	SMONOBP	14630400	3911600	1	90
C67	103327103	.01uF	SMONOBP	18846800	12242800	1	180
C69	103327103	.01uF	SMONOBP	13716000	10414000	1	180
C70	103327103	.01uF	SMONOBP	9804400	10617200	1	180
C71	103327103	.01uF	SMONOBP	9804400	7670800	1	180
C72	103327103	.01uF	SMONOBP	7010400	11379200	1	270
C73	103327103	.01uF	SMONOBP	9804400	9093200	1	180
C74	103327103	.01uF	SMONOBP	7010400	8890000	1	270
C75	102412100	10pF	SMONO	9906000	4165600	1	0
C76	102412331	330pF	SMONO	9906000	7061200	1	90
C77	146354107	100uF-10V-AL-RA	TDCAP	11125200	4927600	1	180

C78	103427104	.1uF	SMONOBP	9347200	5689600	1	0
C80	103427104	.1uF	SMONOBP	17780000	6350000	1	90
C81	103427104	.1uF	SMONOBP	14224000	2032000	1	180
C82	103427104	.1uF	SMONOBP	17780000	7569200	1	90
C83	103427104	.1uF	SMONOBP	20929600	5130800	1	90
C84	103427104	.1uF	SMONOBP	8280400	4368800	1	180
C85	103427104	.1uF	SMONOBP	20929600	3911600	1	90
C86	103427104	.1uF	SMONOBP	20929600	6350000	1	90
C87	103427104	.1uF	SMONOBP	20929600	7569200	1	90
C88	103427104	.1uF	SMONOBP	10464800	10718800	1	90
C89	102412151	150pF	SMONO	18084800	14071600	1	180
D1	253010811	HP2811	DO35	1778000	5181600	1	180
D2	230020062	BAW62	DO35	1727200	2743200	1	180
D3	230020062	BAW62	DO35	1727200	2997200	1	180
D5	253010811	HP2811	DO35	1727200	1727200	1	180
D6	256233209	TIL-209A	$LED_1	11988800	13970000	1	90
J1	454610096	3x32-RA-M	CONN3X32_RA_M	9296400	508000	1	180
J3	454211020	2x10-ST-M	CONN2X10_ST_M	10972800	10718800	1	270
Q1	275110001	2N2907	TO18	914400	3606800	1	90
Q2	280170104	VN0104	TO92	28702000	9398000	1	0
Q3	280170104	VN0104	TO92	4826000	15240000	1	0
Q4	280170104	VN0104	TO92	1498600	3505200	1	90
Q5	280170104	VN0104	TO92	14478000	8737600	1	180
R1	168531401	1.21K-1%	RES07	10007600	5435600	1	180
R2	161225102	1K	RES05	14833600	8890000	1	0
R4	168531585	100K-1%	RES07	10464800	8382000	1	270
R5	168531585	100K-1%	RES07	711200	2235200	1	0
R6	168531585	100K-1%	RES07	10210800	8382000	1	270
R7	168531229	19.6-1%	RES07	8737600	7061200	1	270
R8	161225103	10K	RES05	13462000	15494000	1	0
R9	161225103	10K	RES05	13716000	14173200	1	180
R10	190042103	10K-SIPC	SIP10RES	20828000	15443200	1	270
R11	190042103	10K-SIPC	SIP10RES	6146800	14173200	1	90
R12	190042103	10K-SIPC	SIP10RES	7772400	4368800	1	270
R13	190042103	10K-SIPC	SIP10RES	17932400	10414000	1	90
R14	161225027	2.7	RES05	7264400	7112000	1	0
R15	168531601	147K-1%	RES07	8737600	4699000	1	0
R16	161225206	20M	RES05	711200	2489200	1	0
R17	161225102	1K	RES05	5486400	14224000	1	90
R18	161225102	1K	RES05	1727200	1473200	1	180
R21	161225102	1K	RES05	29108400	7874000	1	90
R22	190842102	1K-8SIPC	SIP8RES	29210000	11176000	1	180
R24	161225206	20M	RES05	8636000	4165600	1	0
R25	168531449	3.83K-1%	RES07	10464800	6756400	1	270
R26	168531633	316K-1%	RES07	1981200	1981200	1	180
R28	161225391	390	RES05	14986000	14173200	1	180
R29	161225391	390	RES05	12700000	13919200	1	0
R30	161225391	390	RES05	1727200	3251200	1	180
R31	168531389	909-1%	RES07	8991600	5791200	1	90
R32	161225027	2.7	RES05	9601200	7366000	1	180
R33	161225102	1K	RES05	8280400	7366000	1	180
R34	161225102	1K	RES05	13614400	12242800	1	0
R35	161225472	4.7K	RES05	16560800	14071600	1	0
R36	190832220	22-8SS	SIP8RES	18542000	14071600	1	90
R37	161225103	10K	RES05	20675600	12293600	1	90
R38	161225103	10K	RES05	20929600	13309600	1	270
X1	310111032	32.768KHz	MX_1V	9448800	4521200	1	270
SW1	411430002	BD04	DIP8	20218400	13309600	1	270


EXTERNAL + TV TRIGGER
DIG_EXT(1:10)
LSYNC
TV2
TV1
TRIG_10
VTH_TRIG
A403 SMDG201
A402 SMLM1881
A22 SM74HCT153
A401 MTA408
A400 SMOP07
RL400 ALT02-12
J7 IN
J9 EDGE2x10
LeCroy CORPORATION
MODEL : 9430-7
2 CH. 150MHz FRONTEND
DRAWN KADLUBSKI-B
CHKD BOLLI-J-L
DATE 15-NOV-90
DWG NO: 9430-7-S1
SH 1 OF 4
ECO : 1003


ALL OA ARE SMLF353
CHANNEL1
CHANNEL2
SDFE
SHFE
TRFE1
TRFE0
BWL
TRIG_10
TA_10
OVL_SENSE1
OVL_REF1
ANALOG_CH1(1:4)
ANALOG_CH2(1:4)
OVL_SENSE2
OVL_REF2
R24 SM74HCT366
R25 SM74HCT366
R21 SMULN2003
R11 SMDG201
R28 SM74HCT4094
R29 SM74HCT4094
R30 SM74HCT4094
R31 SM74HCT4094
EDGE2x10
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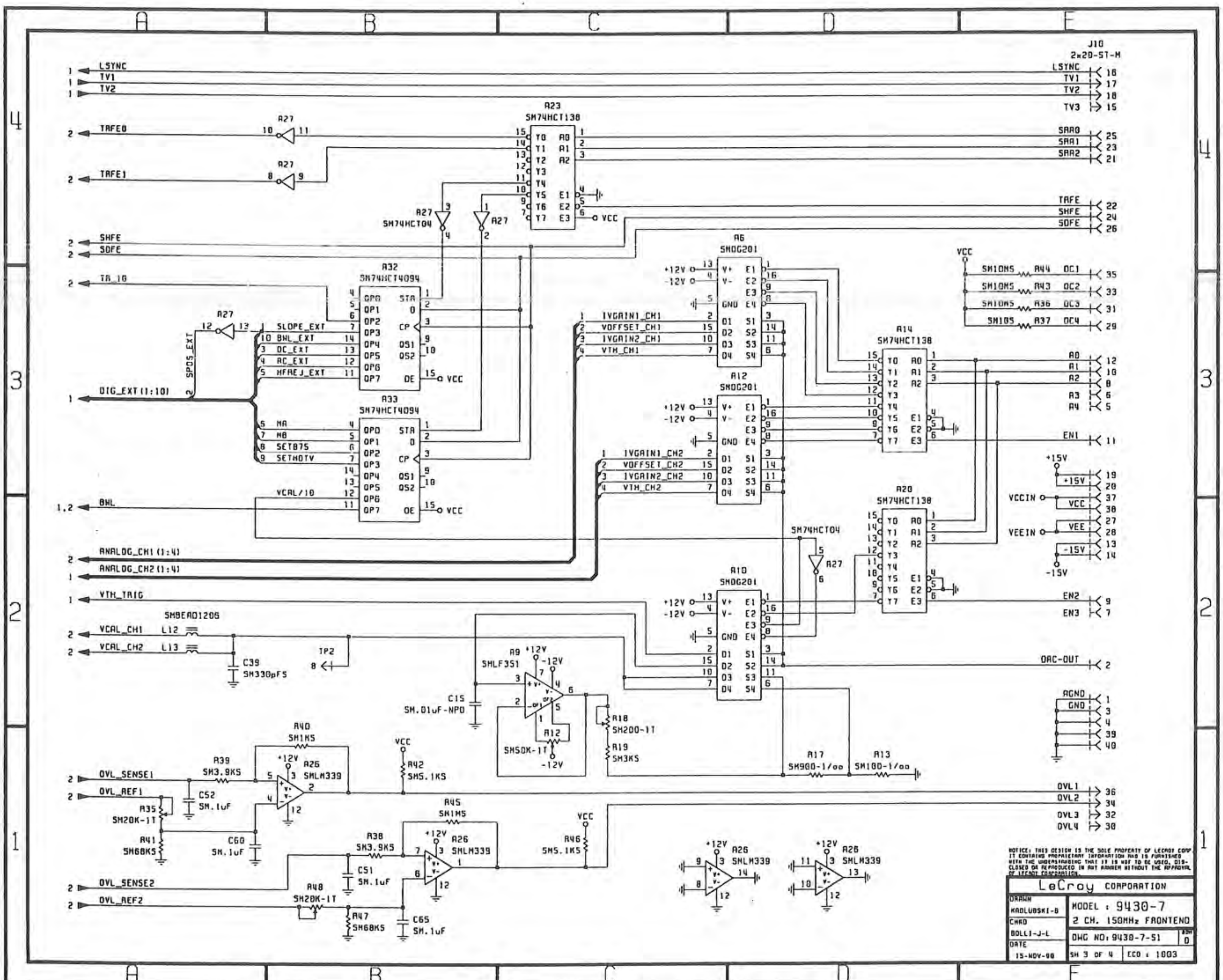
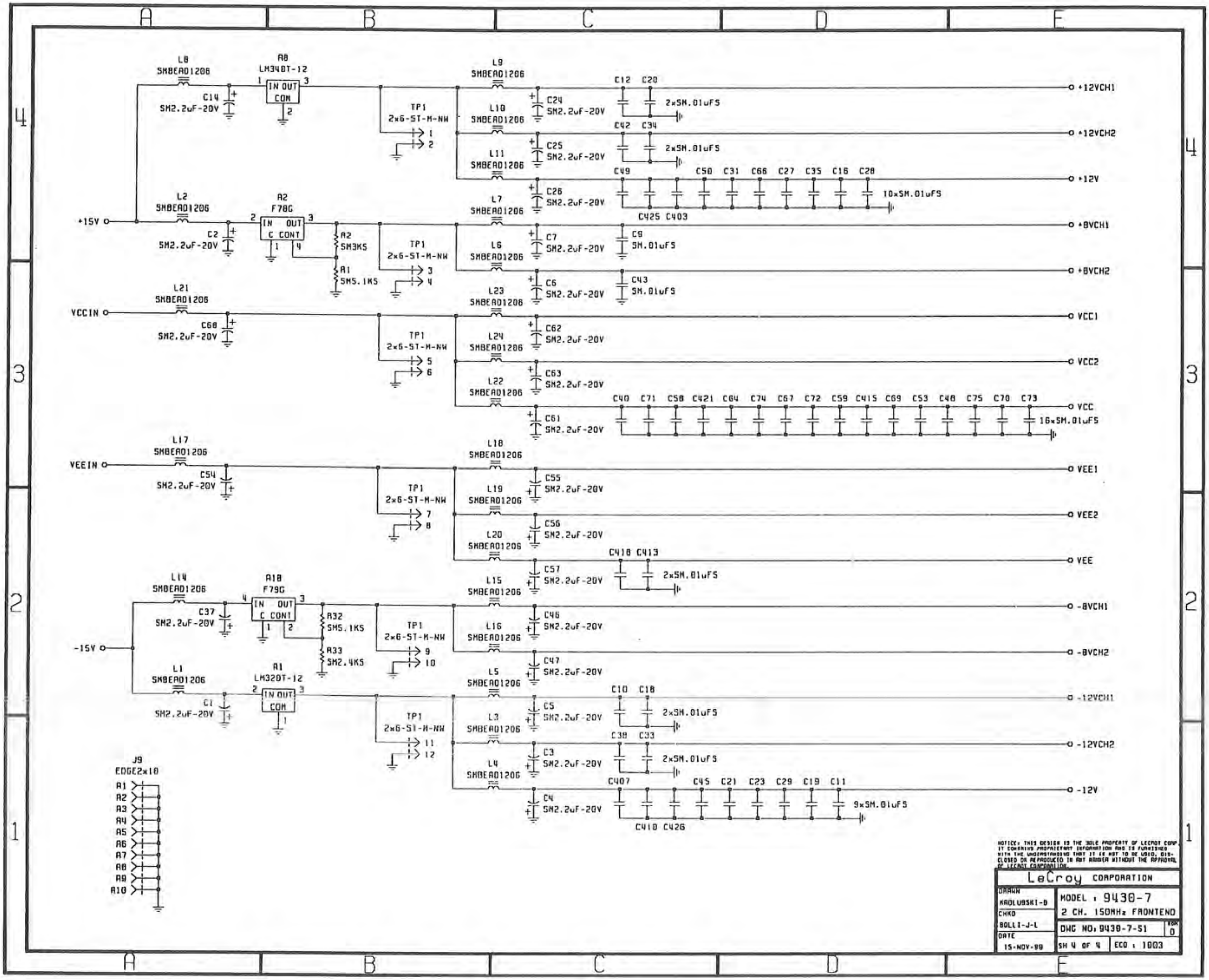
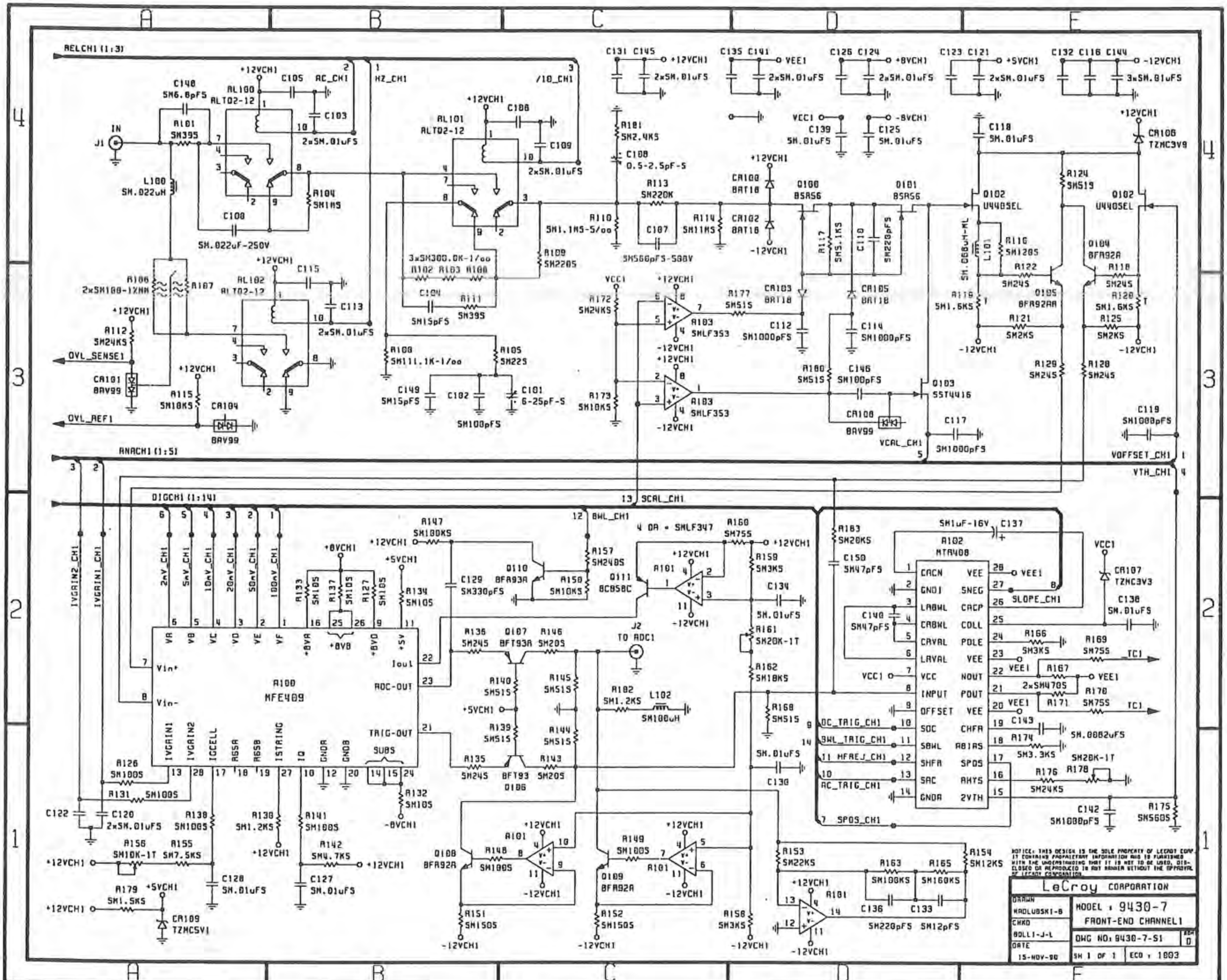
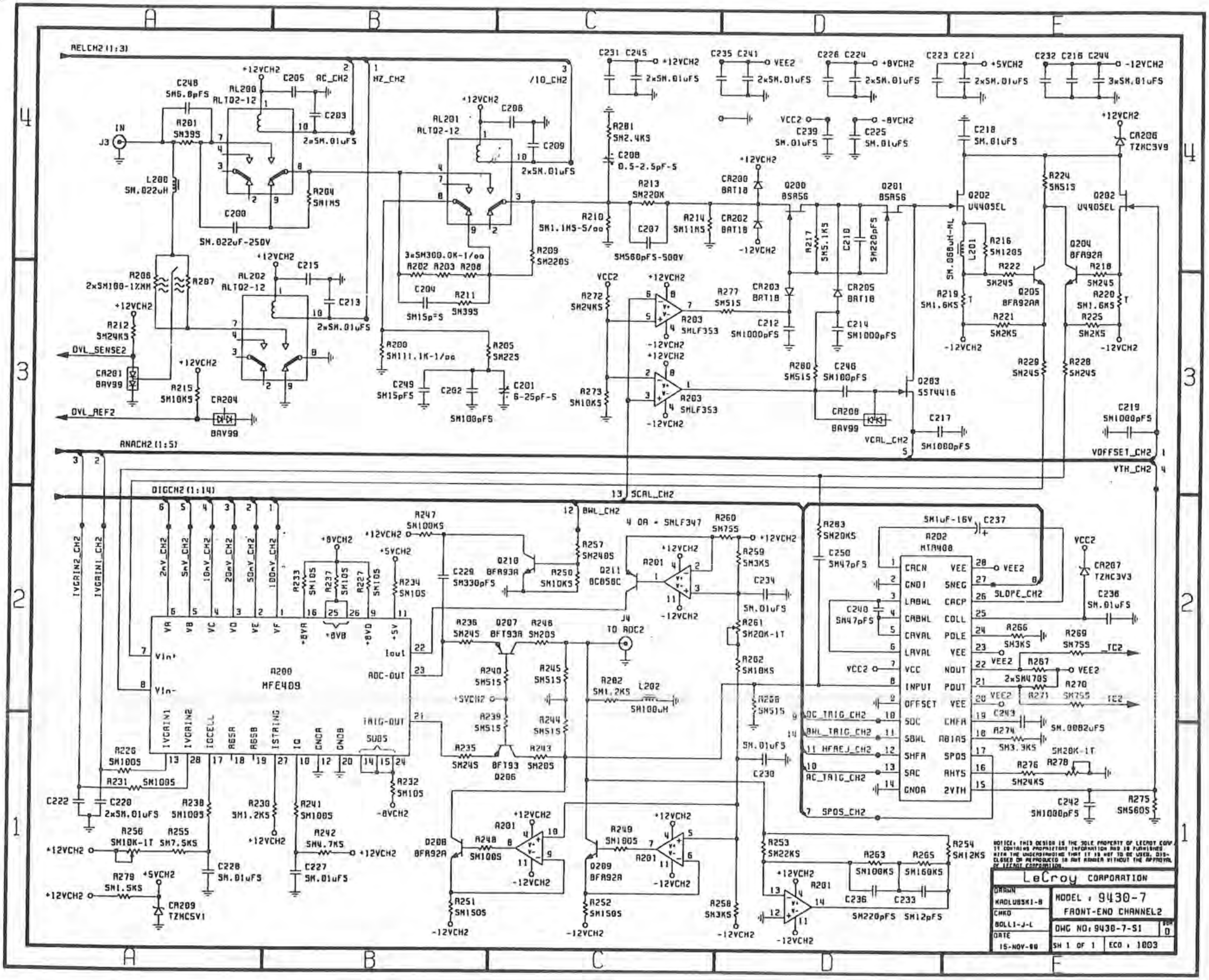
LeCroy CORPORATION
DRAWN MADLUBSKI-B
CHKD BOLLI-J-L
DATE 15-NOV-90
MODEL : 9430-7
2 CH. 150MHz FRONTEND
DWG NO: 9430-7-S1
REV D
SH 2 OF 4
ECO : 1003



NOTICE: THIS DESIGN IS THE SOLE PROPERTY OF LECROY CORP. IT CONTAINS PROPRIETARY INFORMATION AND IS FURNISHED WITH THE UNDERSTANDING THAT IT IS NOT TO BE USED, DISCLOSED OR REPRODUCED IN ANY MANNER WITHOUT THE APPROVAL OF LECROY CORPORATION.
LeCroy CORPORATION
DRAWN KADLUBSKI-B
CHKD BOLLI-J-L
DATE 15-NOV-90
MODEL : 9430-7
2 CH. 150MHz FRONTEND
DWG NO: 9430-7-51
REV D
SH 3 OF 4
ECO : 1003


LeCroy CORPORATION
DRAWN KROLUBSKI-D
CHKD BOLLI-J-L
DATE 15-NOV-99
MODEL : 9430-7
2 CH. 150MHz FRONTEND
DWG NO: 9430-7-51
REV D
SH 4 OF 4
ECO : 1003


LeCroy CORPORATION
MODEL : 9430-7
FRONT-END CHANNEL1
DWG NO: 9430-7-S1
D
DRAWN KADLUBSKI-B
CHKD BOLLI-J-L
DATE 15-NOV-90
SH 1 OF 1
ECO : 1803
J1 IN
J2 TO ADC1
R100 MFE409
R102 MTA408
RELCH1 (1:3)
ANACH1 (1:5)
DIGCH1 (1:14)
OVL_SENSE1
OVL_REF1
VOFFSET_CH1
VTH_CH1
SCAL_CH1
VCAL_CH1
TC1

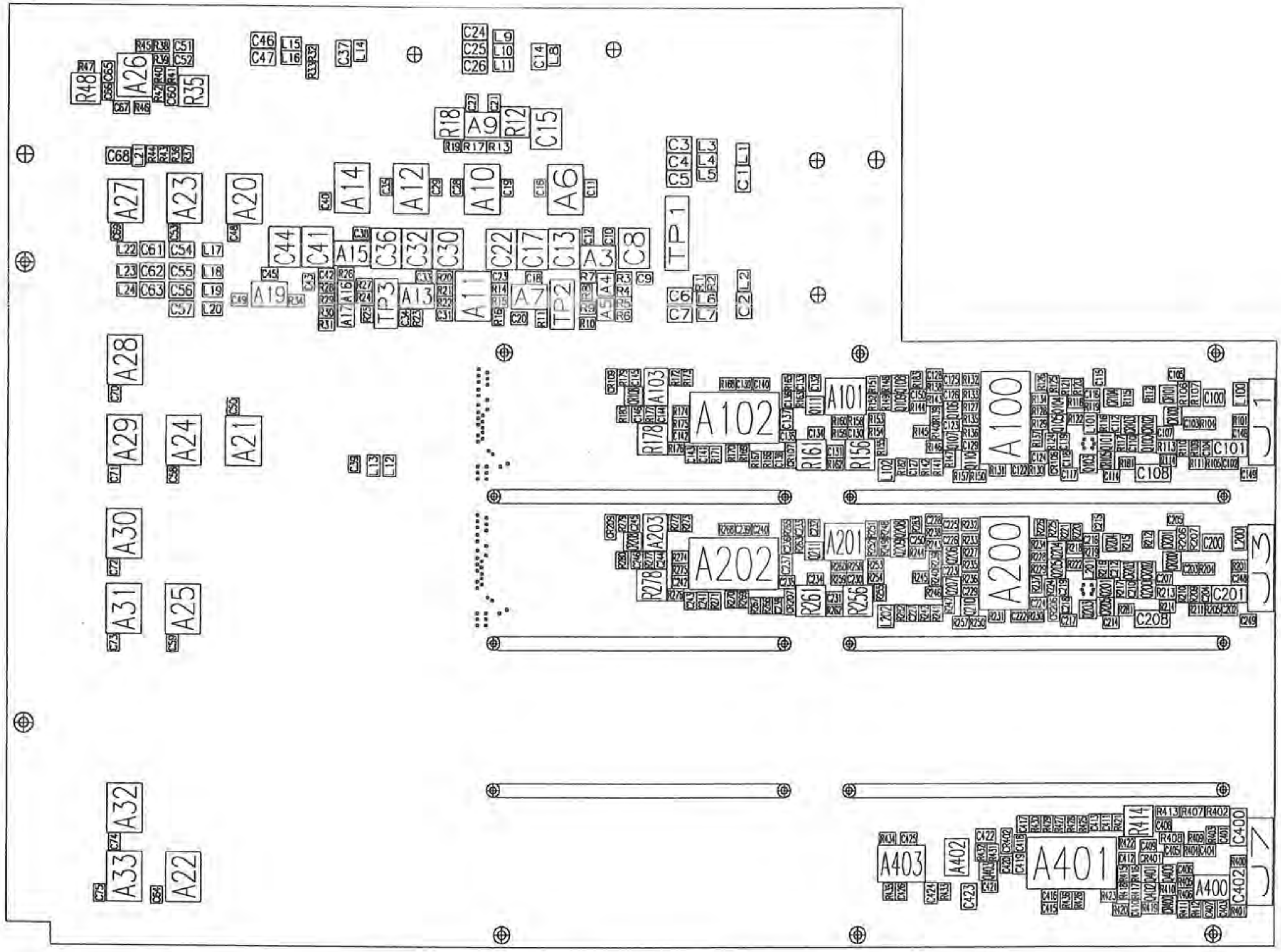

LeCroy CORPORATION
MODEL : 9430-7
FRONT-END CHANNEL2
DRAWN KADLUBSKI-B
CHKD BOLLI-J-L
DATE 15-NOV-88
DWG NO: 9430-7-S1
SH 1 OF 1
ECO : 1003


402110302
402110302
402110302
MFE409
MFE409
MTR408
MTR408
MTR408
454340012
454311008
454311008

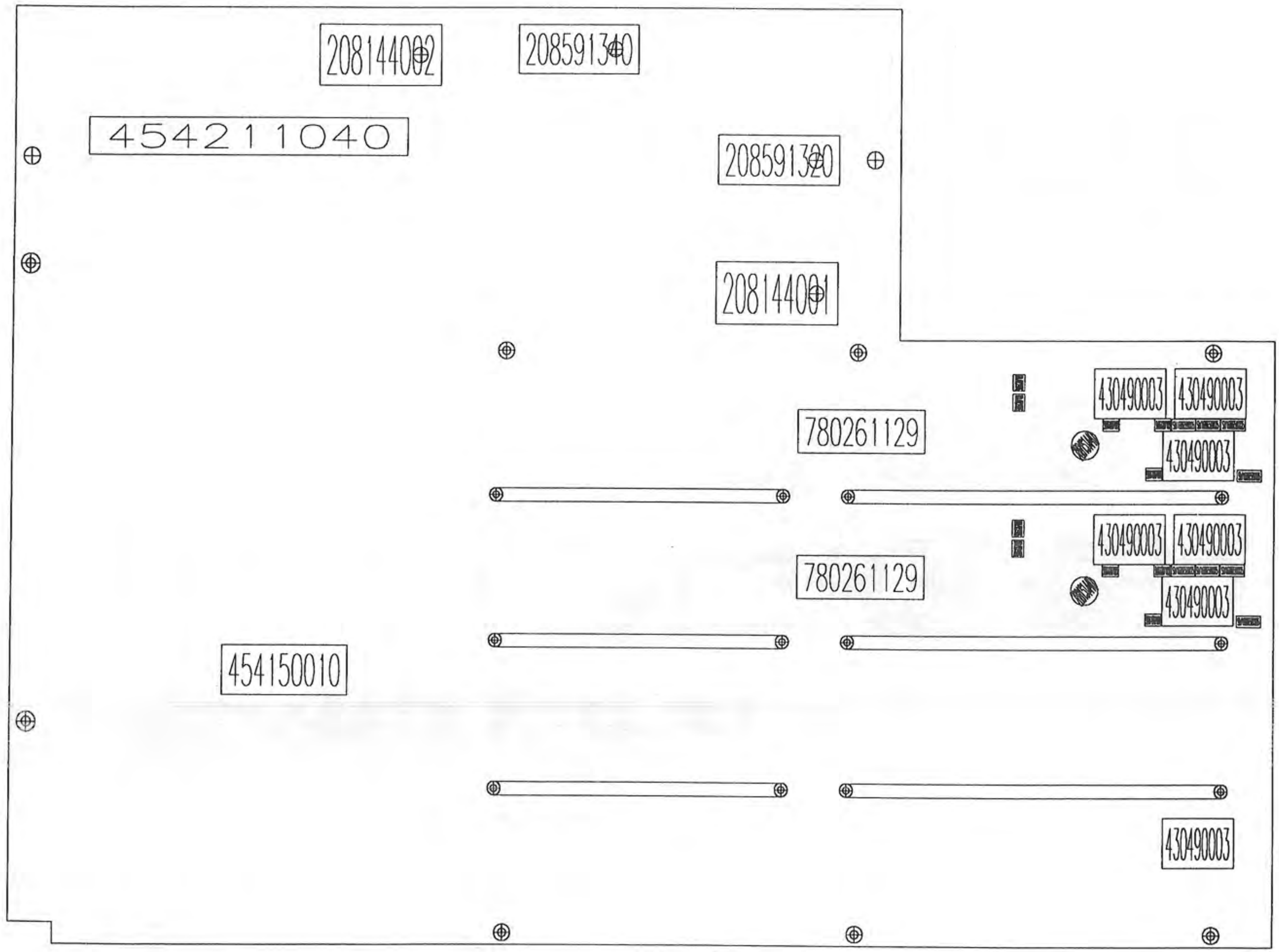
9430-7 Rev:G


BNC-9450
BNC-9450
BNC-9450
MFE409
MFE409
MTR408
MTR408
MTR408
2X6-ST-M-NM

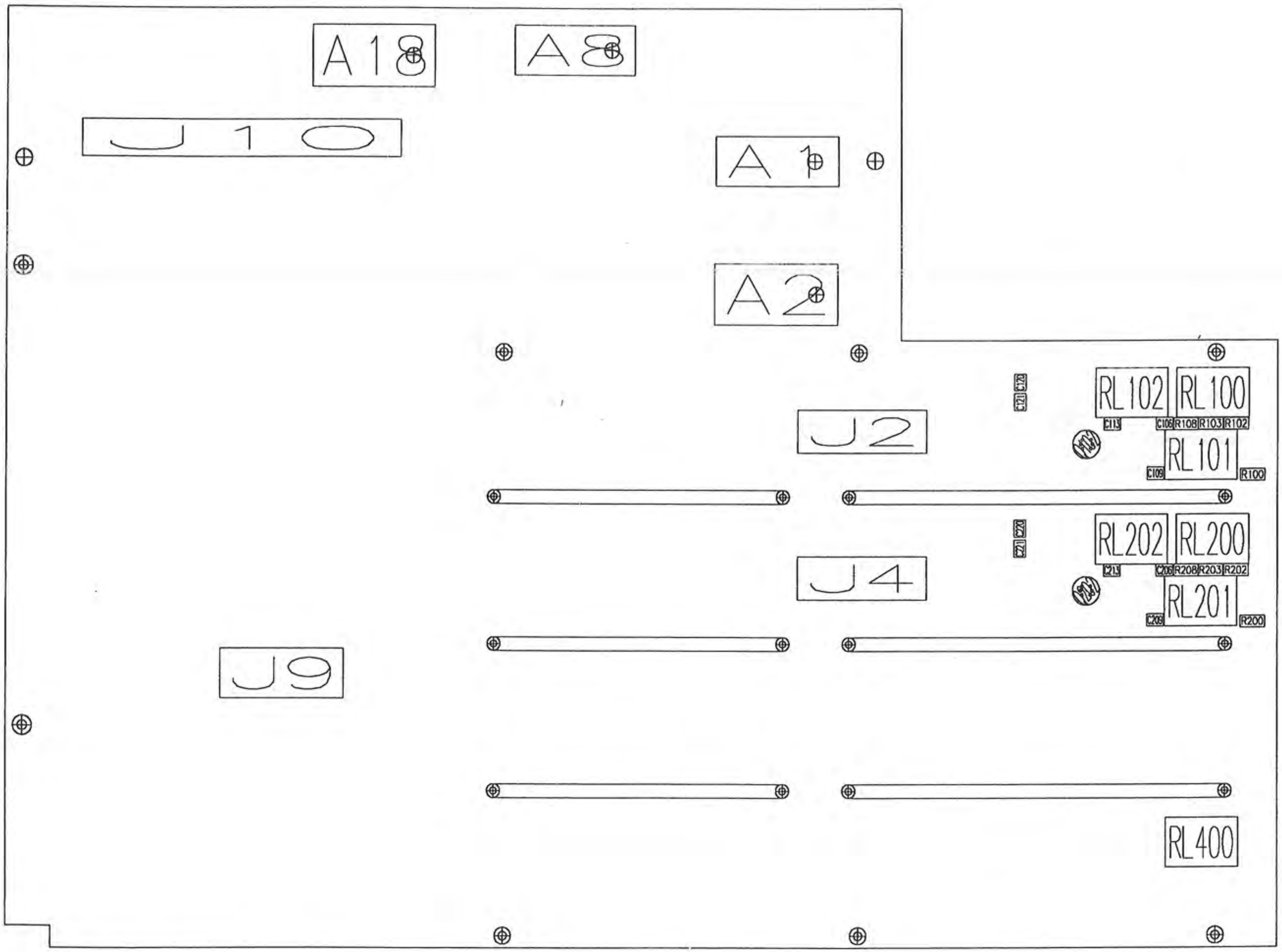
9430-7 Rev:G


J1
J3
J7
A100
A101
A102
A103
A200
A201
A202
A203
A400
A401
A402
A403
A3
A6
A7
A9
A10
A11
A12
A13
A14
A15
A19
A20
A21
A22
A23
A24
A25
A26
A27
A28
A29
A30
A31
A32
A33
TP1
TP2
TP3
C8
C13
C15
C17
C22
C30
C32
C36
C41
C44
C108
C208
C101
C201
R12
R18
R35
R48
R156
R161
R178
R256
R261
R278
R414

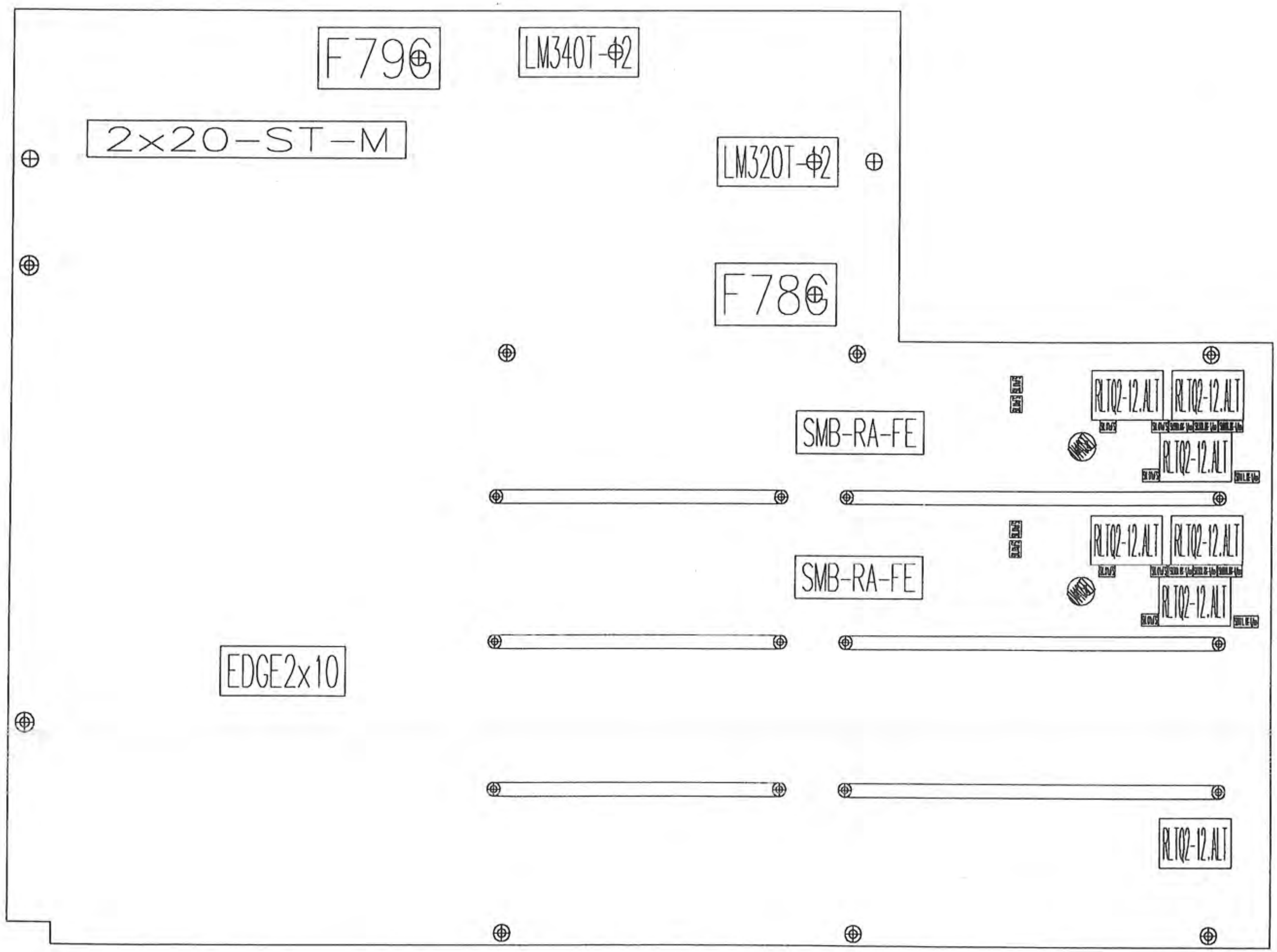
9430-7 Rev:G


208144002
208591340
454211040
208591320
208144001
430490003
430490003
780261129
430490003
430490003
430490003
780261129
430490003
454150010
430490003

9430-7 Rev:G


A18
A8
J10
A1
A2
J2
J4
J9
RL102
RL100
C113
C106
R108
R103
R102
RL101
C109
R100
C121
C120
RL202
RL200
C213
C206
R208
R203
R202
RL201
C209
R200
C221
C220
RL400

9430-7 Rev:G


F796
LM340T-Φ2
2x20-ST-M
LM320T-Φ2
F786
SMB-RA-FE
SMB-RA-FE
RLTQ2-12.ALT
RLTQ2-12.ALT
RLTQ2-12.ALT
RLTQ2-12.ALT
RLTQ2-12.ALT
RLTQ2-12.ALT
RLTQ2-12.ALT
EDGE2x10

9430-7 Rev:G

/10_CH1	$NULL	AREA	AREA
/10_CH2	$NULL	AREA	AREA
10MV_CH1	$NULL	AREA	AREA
10MV_CH2	$NULL	AREA	AREA
100MV_CH1	$NULL	AREA	AREA
100MV_CH2	$NULL	AREA	AREA
2MV_CH1	$NULL	AREA	AREA
2MV_CH2	$NULL	AREA	AREA
20MV_CH1	$NULL	AREA	AREA
20MV_CH2	$NULL	AREA	AREA
5MV_CH1	$NULL	AREA	AREA
5MV_CH2	$NULL	AREA	AREA
50MV_CH1	$NULL	AREA	AREA
50MV_CH2	$NULL	AREA	AREA
A1	208591320	LM320T-12	TO220
A2	208144001	F78G	TO202_8Z
A3	SM208470353	SMLF353	SOIC_8
A4	SM289240062	BCV62	SOT143
A5	SM289240062	BCV62	SOT143
A6	SM207770201	SMDG201-PS	SOIC_16
A7	SM208470353	SMLF353	SOIC_8
A8	208591340	LM340T-12	TO220
A9	SM208470351	SMLF351-OFF	SOIC_8
A10	SM207770201	SMDG201-PS	SOIC_16
A11	SM207770201	SMDG201-PS	SOIC_16
A12	SM207770201	SMDG201-PS	SOIC_16
A13	SM208470353	SMLF353	SOIC_8
A14	SM200178138	SM74HCT138	SOIC_16
A15	SM208470353	SMLF353	SOIC_8
A16	SM289240062	BCV62	SOT143
A17	SM289240062	BCV62	SOT143
A18	208144002	F79G	TO202_8Z
A19	SM208470353	SMLF353	SOIC_8
A20	SM200178138	SM74HCT138	SOIC_16
A21	SM289772003	SMULN2003	SOIC_16
A22	SM207978153	SM74HCT153	SOIC_16
A23	SM200178138	SM74HCT138	SOIC_16
A24	SM207178366	SM74HCT366	SOIC_16
A25	SM207178366	SM74HCT366	SOIC_16
A26	SM208870339	SMLM339	SOIC_14
A27	SM200178004	SM74HCT04	SOIC_14
A28	SM205616094	SM74HCT4094	SOIC_16
A29	SM205616094	SM74HCT4094	SOIC_16
A30	SM205616094	SM74HCT4094	SOIC_16
A31	SM205616094	SM74HCT4094	SOIC_16
A32	SM205616094	SM74HCT4094	SOIC_16
A33	SM205616094	SM74HCT4094	SOIC_16
A100	MFE409	MFE409	SOJ_28
A101	SM208470347	SMLF347	SOIC_14
A102	MTR408	MTR408	SOJ_28
A103	SM208470353	SMLF353	SOIC_8
A200	MFE409	MFE409	SOJ_28
A201	SM208470347	SMLF347	SOIC_14
A202	MTR408	MTR408	SOJ_28
A203	SM208470353	SMLF353	SOIC_8
A400	SM208470007	SMOP07	SOIC_8

A401	MTR408	MTR408	SOJ_28
A402	SM208971881	SMLM1881	SOIC_8
A403	SM207770201	SMDG201-PS	SOIC_16
AC_CH1	$NULL	AREA	AREA
AC_CH2	$NULL	AREA	AREA
AC_TRIG_CH1	$NULL	AREA	AREA
AC_TRIG_CH2	$NULL	AREA	AREA
BWL_CH1	$NULL	AREA	AREA
BWL_CH2	$NULL	AREA	AREA
BWL_TRIG_CH1	$NULL	AREA	AREA
BWL_TRIG_CH2	$NULL	AREA	AREA
C1	SM666327225	SM2.2uF-20V	SMCAPETD2
C2	SM666327225	SM2.2uF-20V	SMCAPETD2
C3	SM666327225	SM2.2uF-20V	SMCAPETD2
C4	SM666327225	SM2.2uF-20V	SMCAPETD2
C5	SM666327225	SM2.2uF-20V	SMCAPETD2
C6	SM666327225	SM2.2uF-20V	SMCAPETD2
C7	SM666327225	SM2.2uF-20V	SMCAPETD2
C8	SM661726103	SM.01uF-NPO	SM2220
C9	SM661207103	SM.01uFS	SM0805
C10	SM661207103	SM.01uFS	SM0805
C11	SM661207103	SM.01uFS	SM0805
C12	SM661207103	SM.01uFS	SM0805
C13	SM661726103	SM.01uF-NPO	SM2220
C14	SM666327225	SM2.2uF-20V	SMCAPETD2
C15	SM661726103	SM.01uF-NPO	SM2220
C16	SM661207103	SM.01uFS	SM0805
C17	SM661726103	SM.01uF-NPO	SM2220
C18	SM661207103	SM.01uFS	SM0805
C19	SM661207103	SM.01uFS	SM0805
C20	SM661207103	SM.01uFS	SM0805
C21	SM661207103	SM.01uFS	SM0805
C22	SM661726103	SM.01uF-NPO	SM2220
C23	SM661207103	SM.01uFS	SM0805
C24	SM666327225	SM2.2uF-20V	SMCAPETD2
C25	SM666327225	SM2.2uF-20V	SMCAPETD2
C26	SM666327225	SM2.2uF-20V	SMCAPETD2
C27	SM661207103	SM.01uFS	SM0805
C28	SM661207103	SM.01uFS	SM0805
C29	SM661207103	SM.01uFS	SM0805
C30	SM661726103	SM.01uF-NPO	SM2220
C31	SM661207103	SM.01uFS	SM0805
C32	SM661726103	SM.01uF-NPO	SM2220
C33	SM661207103	SM.01uFS	SM0805
C34	SM661207103	SM.01uFS	SM0805
C35	SM661207103	SM.01uFS	SM0805
C36	SM661726103	SM.01uF-NPO	SM2220
C37	SM666327225	SM2.2uF-20V	SMCAPETD2
C38	SM661207103	SM.01uFS	SM0805
C39	SM661255331	SM330pFS	SM0805
C40	SM661207103	SM.01uFS	SM0805
C41	SM661726103	SM.01uF-NPO	SM2220
C42	SM661207103	SM.01uFS	SM0805
C43	SM661207103	SM.01uFS	SM0805
C44	SM661726103	SM.01uF-NPO	SM2220
C45	SM661207103	SM.01uFS	SM0805

C46	SM666327225	SM2.2uF-20V	SMCAPETD2
C47	SM666327225	SM2.2uF-20V	SMCAPETD2
C48	SM661207103	SM.01uFS	SM0805
C49	SM661207103	SM.01uFS	SM0805
C50	SM661207103	SM.01uFS	SM0805
C51	SM661127104	SM.1uF	SM1206
C52	SM661127104	SM.1uF	SM1206
C53	SM661207103	SM.01uFS	SM0805
C54	SM666327225	SM2.2uF-20V	SMCAPETD2
C55	SM666327225	SM2.2uF-20V	SMCAPETD2
C56	SM666327225	SM2.2uF-20V	SMCAPETD2
C57	SM666327225	SM2.2uF-20V	SMCAPETD2
C58	SM661207103	SM.01uFS	SM0805
C59	SM661207103	SM.01uFS	SM0805
C60	SM661127104	SM.1uF	SM1206
C61	SM666327225	SM2.2uF-20V	SMCAPETD2
C62	SM666327225	SM2.2uF-20V	SMCAPETD2
C63	SM666327225	SM2.2uF-20V	SMCAPETD2
C64	SM661207103	SM.01uFS	SM0805
C65	SM661127104	SM.1uF	SM1206
C66	SM661207103	SM.01uFS	SM0805
C67	SM661207103	SM.01uFS	SM0805
C68	SM666327225	SM2.2uF-20V	SMCAPETD2
C69	SM661207103	SM.01uFS	SM0805
C70	SM661207103	SM.01uFS	SM0805
C71	SM661207103	SM.01uFS	SM0805
C72	SM661207103	SM.01uFS	SM0805
C73	SM661207103	SM.01uFS	SM0805
C74	SM661207103	SM.01uFS	SM0805
C75	SM661207103	SM.01uFS	SM0805
C100	SM661666223	SM.022uF-250V	SM1210
C101	158849013	6-25pF-S	CAPS_S
C102	SM661255101	SM100pFS	SM0805
C103	SM661207103	SM.01uFS	SM0805
C104	SM661255150	SM15pFS	SM0805
C105	SM661207103	SM.01uFS	SM0805
C106	SM661207103	SM.01uFS	SM0805
C107	SM661495561	SM560pFS-500V	SM0805
C108	158849009	0.5-2.5pF-S	CAPS_S
C109	SM661207103	SM.01uFS	SM0805
C110	SM661255221	SM220pFS	SM0805
C112	SM661255102	SM1000pFS	SM0805
C113	SM661207103	SM.01uFS	SM0805
C114	SM661255102	SM1000pFS	SM0805
C115	SM661207103	SM.01uFS	SM0805
C116	SM661207103	SM.01uFS	SM0805
C117	SM661255102	SM1000pFS	SM0805
C118	SM661207103	SM.01uFS	SM0805
C119	SM661255102	SM1000pFS	SM0805
C120	SM661207103	SM.01uFS	SM0805
C121	SM661207103	SM.01uFS	SM0805
C122	SM661207103	SM.01uFS	SM0805
C123	SM661207103	SM.01uFS	SM0805
C124	SM661207103	SM.01uFS	SM0805
C125	SM661207103	SM.01uFS	SM0805
C126	SM661207103	SM.01uFS	SM0805

C127	SM661207103	SM.01uFS	SM0805
C128	SM661207103	SM.01uFS	SM0805
C129	SM661255331	SM330pFS	SM0805
C130	SM661207103	SM.01uFS	SM0805
C131	SM661207103	SM.01uFS	SM0805
C132	SM661207103	SM.01uFS	SM0805
C133	SM661256120	SM12pFS	SM0805
C134	SM661207103	SM.01uFS	SM0805
C135	SM661207103	SM.01uFS	SM0805
C136	SM661255221	SM220pFS	SM0805
C137	SM666427105	SM1uF-16V	SMCAPTE_Y
C138	SM661207103	SM.01uFS	SM0805
C139	SM661207103	SM.01uFS	SM0805
C140	SM661255470	SM47pFS	SM0805
C141	SM661207103	SM.01uFS	SM0805
C142	SM661255102	SM1000pFS	SM0805
C143	SM661205822	SM.0082uFS	SM0805
C144	SM661207103	SM.01uFS	SM0805
C145	SM661207103	SM.01uFS	SM0805
C146	SM661255101	SM100pFS	SM0805
C148	SM661255068	SM6.8pFS	SM0805
C149	SM661255150	SM15pFS	SM0805
C150	SM661255470	SM47pFS	SM0805
C200	SM661666223	SM.022uF-250V	SM1210
C201	158849013	6-25pF-S	CAPS_S
C202	SM661255101	SM100pFS	SM0805
C203	SM661207103	SM.01uFS	SM0805
C204	SM661255150	SM15pFS	SM0805
C205	SM661207103	SM.01uFS	SM0805
C206	SM661207103	SM.01uFS	SM0805
C207	SM661495561	SM560pFS-500V	SM0805
C208	158849009	0.5-2.5pF-S	CAPS_S
C209	SM661207103	SM.01uFS	SM0805
C210	SM661255221	SM220pFS	SM0805
C212	SM661255102	SM1000pFS	SM0805
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C217	SM661255102	SM1000pFS	SM0805
C218	SM661207103	SM.01uFS	SM0805
C219	SM661255102	SM1000pFS	SM0805
C220	SM661207103	SM.01uFS	SM0805
C221	SM661207103	SM.01uFS	SM0805
C222	SM661207103	SM.01uFS	SM0805
C223	SM661207103	SM.01uFS	SM0805
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C225	SM661207103	SM.01uFS	SM0805
C226	SM661207103	SM.01uFS	SM0805
C227	SM661207103	SM.01uFS	SM0805
C228	SM661207103	SM.01uFS	SM0805
C229	SM661255331	SM330pFS	SM0805
C230	SM661207103	SM.01uFS	SM0805
C231	SM661207103	SM.01uFS	SM0805
C232	SM661207103	SM.01uFS	SM0805
C233	SM661256120	SM12pFS	SM0805

C234	SM661207103	SM.01uFS	SM0805
C235	SM661207103	SM.01uFS	SM0805
C236	SM661255221	SM220pFS	SM0805
C237	SM666427105	SM1uF-16V	SMCAPTE_Y
C238	SM661207103	SM.01uFS	SM0805
C239	SM661207103	SM.01uFS	SM0805
C240	SM661255470	SM47pFS	SM0805
C241	SM661207103	SM.01uFS	SM0805
C242	SM661255102	SM1000pFS	SM0805
C243	SM661205822	SM.0082uFS	SM0805
C244	SM661207103	SM.01uFS	SM0805
C245	SM661207103	SM.01uFS	SM0805
C246	SM661255101	SM100pFS	SM0805
C248	SM661255068	SM6.8pFS	SM0805
C249	SM661255150	SM15pFS	SM0805
C250	SM661255470	SM47pFS	SM0805
C400	158849012	5-15pF-S	CAPS_S
C401	SM661255330	SM33pFS	SM0805
C402	158849012	5-15pF-S	CAPS_S
C403	SM661207103	SM.01uFS	SM0805
C404	SM661250047	SM4.7pFS	SM0805
C405	SM661207103	SM.01uFS	SM0805
C406	SM661495561	SM560pFS-500V	SM0805
C407	SM661207103	SM.01uFS	SM0805
C408	SM661207103	SM.01uFS	SM0805
C409	SM661207103	SM.01uFS	SM0805
C410	SM661207103	SM.01uFS	SM0805
C411	SM661205822	SM.0082uFS	SM0805
C412	SM661255102	SM1000pFS	SM0805
C413	SM661207103	SM.01uFS	SM0805
C415	SM661207103	SM.01uFS	SM0805
C416	SM661255470	SM47pFS	SM0805
C417	SM661207103	SM.01uFS	SM0805
C418	SM661207103	SM.01uFS	SM0805
C419	SM666427105	SM1uF-16V	SMCAPTE_Y
C420	SM661255821	SM820pFS	SM0805
C421	SM661207103	SM.01uFS	SM0805
C422	SM661127104	SM.1uF	SM1206
C423	SM666327225	SM2.2uF-20V	SMCAPETD2
C424	SM661127104	SM.1uF	SM1206
C425	SM661207103	SM.01uFS	SM0805
C426	SM661207103	SM.01uFS	SM0805
CR100	SM252023018	BAT18	SOT23
CR101	SM236030099	BAV99	SOT23
CR102	SM252023018	BAT18	SOT23
CR103	SM252023018	BAT18	SOT23
CR104	SM236030099	BAV99	SOT23
CR105	SM252023018	BAT18	SOT23
CR106	SM240050039	TZMC3V9	SMDIO_MINIMELF
CR107	SM240050033	TZMC3V3	SMDIO_MINIMELF
CR108	SM236030099	BAV99	SOT23
CR109	SM240050051	TZMC5V1	SMDIO_MINIMELF
CR200	SM252023018	BAT18	SOT23
CR201	SM236030099	BAV99	SOT23
CR202	SM252023018	BAT18	SOT23
CR203	SM252023018	BAT18	SOT23

CR204	SM236030099	BAV99	SOT23
CR205	SM252023018	BAT18	SOT23
CR206	SM240050039	TZMC3V9	SMDIO_MINIMELF
CR207	SM240050033	TZMC3V3	SMDIO_MINIMELF
CR208	SM236030099	BAV99	SOT23
CR209	SM240050051	TZMC5V1	SMDIO_MINIMELF
CR400	SM280124416	SST4416	SOT23
CR401	SM240050039	TZMC3V9	SMDIO_MINIMELF
CR402	SM240050033	TZMC3V3	SMDIO_MINIMELF
DC_TRIG_CH1	$NULL	AREA	AREA
DC_TRIG_CH2	$NULL	AREA	AREA
GNDCH1	$NULL	AREA	AREA
GNDCH2	$NULL	AREA	AREA
HZ_CH1	$NULL	AREA	AREA
HZ_CH2	$NULL	AREA	AREA
HFREJ_CH1	$NULL	AREA	AREA
HFREJ_CH2	$NULL	AREA	AREA
IVGAIN1_CH1	$NULL	AREA	AREA
IVGAIN1_CH2	$NULL	AREA	AREA
IVGAIN2_CH1	$NULL	AREA	AREA
IVGAIN2_CH2	$NULL	AREA	AREA
J1	402110302	BNC-9450	BNC_9450
J2	780261129	SMB-RA-FE	SMB_RT_F
J3	402110302	BNC-9450	BNC_9450
J4	780261129	SMB-RA-FE	SMB_RT_F
J7	402110302	BNC-9450	BNC_9450
J9	454150010	EDGE2x10	EDGE2X10
J10	454211040	2x20-ST-M	CONN2X20_ST_M
L1	SM301502001	SMBEAD1206	SM1206
L2	SM301502001	SMBEAD1206	SM1206
L3	SM301502001	SMBEAD1206	SM1206
L4	SM301502001	SMBEAD1206	SM1206
L5	SM301502001	SMBEAD1206	SM1206
L6	SM301502001	SMBEAD1206	SM1206
L7	SM301502001	SMBEAD1206	SM1206
L8	SM301502001	SMBEAD1206	SM1206
L9	SM301502001	SMBEAD1206	SM1206
L10	SM301502001	SMBEAD1206	SM1206
L11	SM301502001	SMBEAD1206	SM1206
L12	SM301502001	SMBEAD1206	SM1206
L13	SM301502001	SMBEAD1206	SM1206
L14	SM301502001	SMBEAD1206	SM1206
L15	SM301502001	SMBEAD1206	SM1206
L16	SM301502001	SMBEAD1206	SM1206
L17	SM301502001	SMBEAD1206	SM1206
L18	SM301502001	SMBEAD1206	SM1206
L19	SM301502001	SMBEAD1206	SM1206
L20	SM301502001	SMBEAD1206	SM1206
L21	SM301502001	SMBEAD1206	SM1206
L22	SM301502001	SMBEAD1206	SM1206
L23	SM301502001	SMBEAD1206	SM1206
L24	SM301502001	SMBEAD1206	SM1206
L100	SM300446220	SM.022uH	SMSELF
L101	SM300367680	SM.068uH-ML	SM1206
L102	SM300486104	SM100uH	SM1210
L200	SM300446220	SM.022uH	SMSELF

L201	SM300367680	SM.068uH-ML	SM1206
L202	SM300486104	SM100uH	SM1210
M8VCH1	$NULL	AREA	AREA
M8VCH2	$NULL	AREA	AREA
M12VCH1	$NULL	AREA	AREA
M12VCH2	$NULL	AREA	AREA
OVL_REF1	$NULL	AREA	AREA
OVL_REF2	$NULL	AREA	AREA
OVL_SENSE1	$NULL	AREA	AREA
OVL_SENSE2	$NULL	AREA	AREA
P8VCH1	$NULL	AREA	AREA
P8VCH2	$NULL	AREA	AREA
P12VCH1	$NULL	AREA	AREA
P12VCH2	$NULL	AREA	AREA
Q100	SM280120056	BSR56	SOT23
Q101	SM280120056	BSR56	SOT23
Q102	280151440	U440SEL	TO71
Q103	SM280124416	SST4416	SOT23
Q104	SM270130092	BFR92A	SOT23
Q105	SM270140092	BFR92AR	SOT23
Q106	SM275030093	BFT93	SOT23
Q107	SM275040093	BFT93R	SOT23
Q108	SM270130092	BFR92A	SOT23
Q109	SM270130092	BFR92A	SOT23
Q110	SM270130093	BFR93A	SOT23
Q111	SM275330858	BC858C	SOT23
Q200	SM280120056	BSR56	SOT23
Q201	SM280120056	BSR56	SOT23
Q202	280151440	U440SEL	TO71
Q203	SM280124416	SST4416	SOT23
Q204	SM270130092	BFR92A	SOT23
Q205	SM270140092	BFR92AR	SOT23
Q206	SM275030093	BFT93	SOT23
Q207	SM275040093	BFT93R	SOT23
Q208	SM270130092	BFR92A	SOT23
Q209	SM270130092	BFR92A	SOT23
Q210	SM270130093	BFR93A	SOT23
Q211	SM275330858	BC858C	SOT23
Q400	SM280124416	SST4416	SOT23
Q401	SM270140092	BFR92AR	SOT23
Q402	SM270140092	BFR92AR	SOT23
Q403	SM270330848	BC848C	SOT23
R1	SM652101512	SM5.1KS	SM0805
R2	SM652101302	SM3KS	SM0805
R3	SM652101471	SM470S	SM0805
R4	SM652101471	SM470S	SM0805
R5	SM652101471	SM470S	SM0805
R6	SM652101471	SM470S	SM0805
R7	SM652101163	SM16KS	SM0805
R8	SM652101101	SM100S	SM0805
R9	SM652101203	SM20KS	SM0805
R10	SM652101101	SM100S	SM0805
R11	SM652101512	SM5.1KS	SM0805
R12	SM185457503	SM50K-1T	SMPOT_ST4
R13	SM168659297	SM100-1/oo	SMRES_MINIMELF
R14	SM652101332	SM3.3KS	SM0805

R15	SM652101821	SM820S	SM0805
R16	SM652101910	SM91S	SM0805
R17	SM168659004	SM900-1/oo	SMRES_MINIMELF
R18	SM185457201	SM200-1T	SMPOT_ST4
R19	SM652101302	SM3KS	SM0805
R20	SM652101910	SM91S	SM0805
R21	SM652101821	SM820S	SM0805
R22	SM652101332	SM3.3KS	SM0805
R23	SM652101512	SM5.1KS	SM0805
R24	SM652101163	SM16KS	SM0805
R25	SM652101101	SM100S	SM0805
R26	SM652101203	SM20KS	SM0805
R27	SM652101101	SM100S	SM0805
R28	SM652101471	SM470S	SM0805
R29	SM652101471	SM470S	SM0805
R30	SM652101471	SM470S	SM0805
R31	SM652101471	SM470S	SM0805
R32	SM652101512	SM5.1KS	SM0805
R33	SM652101242	SM2.4KS	SM0805
R34	SM652101512	SM5.1KS	SM0805
R35	SM185457203	SM20K-1T	SMPOT_ST4
R36	SM652101106	SM10MS	SM0805
R37	SM652101100	SM10S	SM0805
R38	SM652101392	SM3.9KS	SM0805
R39	SM652101392	SM3.9KS	SM0805
R40	SM652101105	SM1MS	SM0805
R41	SM652101683	SM68KS	SM0805
R42	SM652101512	SM5.1KS	SM0805
R43	SM652101106	SM10MS	SM0805
R44	SM652101106	SM10MS	SM0805
R45	SM652101105	SM1MS	SM0805
R46	SM652101512	SM5.1KS	SM0805
R47	SM652101683	SM68KS	SM0805
R48	SM185457203	SM20K-1T	SMPOT_ST4
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R101	SM652101390	SM39S	SM0805
R102	SM168659005	SM300.0K-1/oo	SMRES_MINIMELF
R103	SM168659005	SM300.0K-1/oo	SMRES_MINIMELF
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R105	SM652101220	SM22S	SM0805
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R107	SM168651297	'SM100-1%MM'	SMRES_MINIMELF
R108	SM168659005	SM300.0K-1/oo	SMRES_MINIMELF
R109	SM652101221	SM220S	SM0805
R110	SM652180115	SM1.1MS-5/oo	SM0805
R111	SM652101390	SM39S	SM0805
R112	SM652101243	SM24KS	SM0805
R113	SM653185224	SM220K	SM1206
R114	SM652101116	SM11MS	SM0805
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R125	SM652101202	SM2KS	SM0805
R126	SM652101101	SM100S	SM0805
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R128	SM652101240	SM24S	SM0805
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R178	SM185457203	SM20K-1T	SMPOT_ST4
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R182	SM652101122	SM1.2KS	SM0805
R183	SM652101203	SM20KS	SM0805
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R202	SM168659005	SM300.0K-1/oo	SMRES_MINIMELF
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R205	SM652101220	SM22S	SM0805
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R208	SM168659005	SM300.0K-1/oo	SMRES_MINIMELF
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R210	SM652180115	SM1.1MS-5/oo	SM0805
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R217	SM652101512	SM5.1KS	SM0805
R218	SM652101240	SM24S	SM0805
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R255	SM652101752	SM7.5KS	SM0805
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R259	SM652101302	SM3KS	SM0805
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R261	SM185457203	SM20K-1T	SMPOT_ST4
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R266	SM652101302	SM3KS	SM0805
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R272	SM652101243	SM24KS	SM0805
R273	SM652101103	SM10KS	SM0805
R274	SM652101332	SM3.3KS	SM0805
R275	SM652101561	SM560S	SM0805
R276	SM652101243	SM24KS	SM0805
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R278	SM185457203	SM20K-1T	SMPOT_ST4
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R280	SM652101510	SM51S	SM0805
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R282	SM652101122	SM1.2KS	SM0805
R283	SM652101203	SM20KS	SM0805
R400	SM652101100	SM10S	SM0805
R401	SM652101242	SM2.4KS	SM0805
R402	SM168659005	SM300.0K-1/oo	SMRES_MINIMELF
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R413	SM168659005	SM300.0K-1/oo	SMRES_MINIMELF
R414	SM185457203	SM20K-1T	SMPOT_ST4
R415	SM652101561	SM560S	SM0805
R416	SM652101103	SM10KS	SM0805
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R427	SM652101750	SM75S	SM0805
R428	SM652101471	SM470S	SM0805
R429	SM652101471	SM470S	SM0805
R430	SM652101302	SM3KS	SM0805
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RL101	430490003	RLTQ2-12.ALT	DIP10
RL102	430490003	RLTQ2-12.ALT	DIP10
RL200	430490003	RLTQ2-12.ALT	DIP10
RL201	430490003	RLTQ2-12.ALT	DIP10
RL202	430490003	RLTQ2-12.ALT	DIP10
RL400	430490003	RLTQ2-12.ALT	DIP10
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SCAL_CH2	$NULL	AREA	AREA
SNEG_CH1	$NULL	AREA	AREA
SNEG_CH2	$NULL	AREA	AREA
SPOS_CH1	$NULL	AREA	AREA
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TP1	454340012	2x6-ST-M-NW	CONN2X6_ST_M_NW
TP2	454311008	2x4-ST-M-NW	CONN2X4_ST_M_NW
TP3	454311008	2x4-ST-M-NW	CONN2X4_ST_M_NW
VCC1	$NULL	AREA	AREA
VCC2	$NULL	AREA	AREA
VEE1	$NULL	AREA	AREA
VEE2	$NULL	AREA	AREA
VTH_CH1	$NULL	AREA	AREA
VTH_CH2	$NULL	AREA	AREA
VCAL_CH1	$NULL	AREA	AREA
VCAL_CH2	$NULL	AREA	AREA
VOFFSET_CH1	$NULL	AREA	AREA
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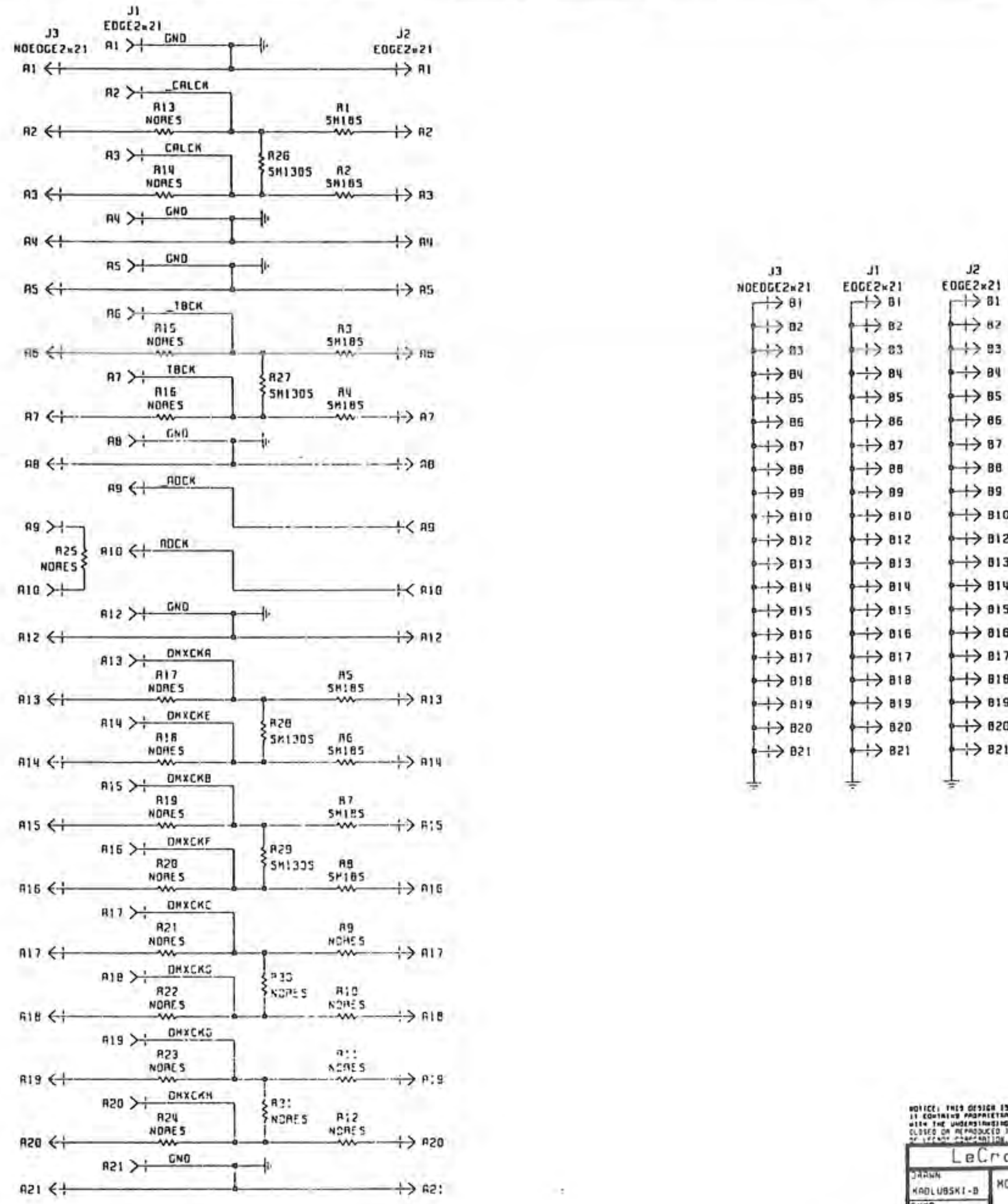

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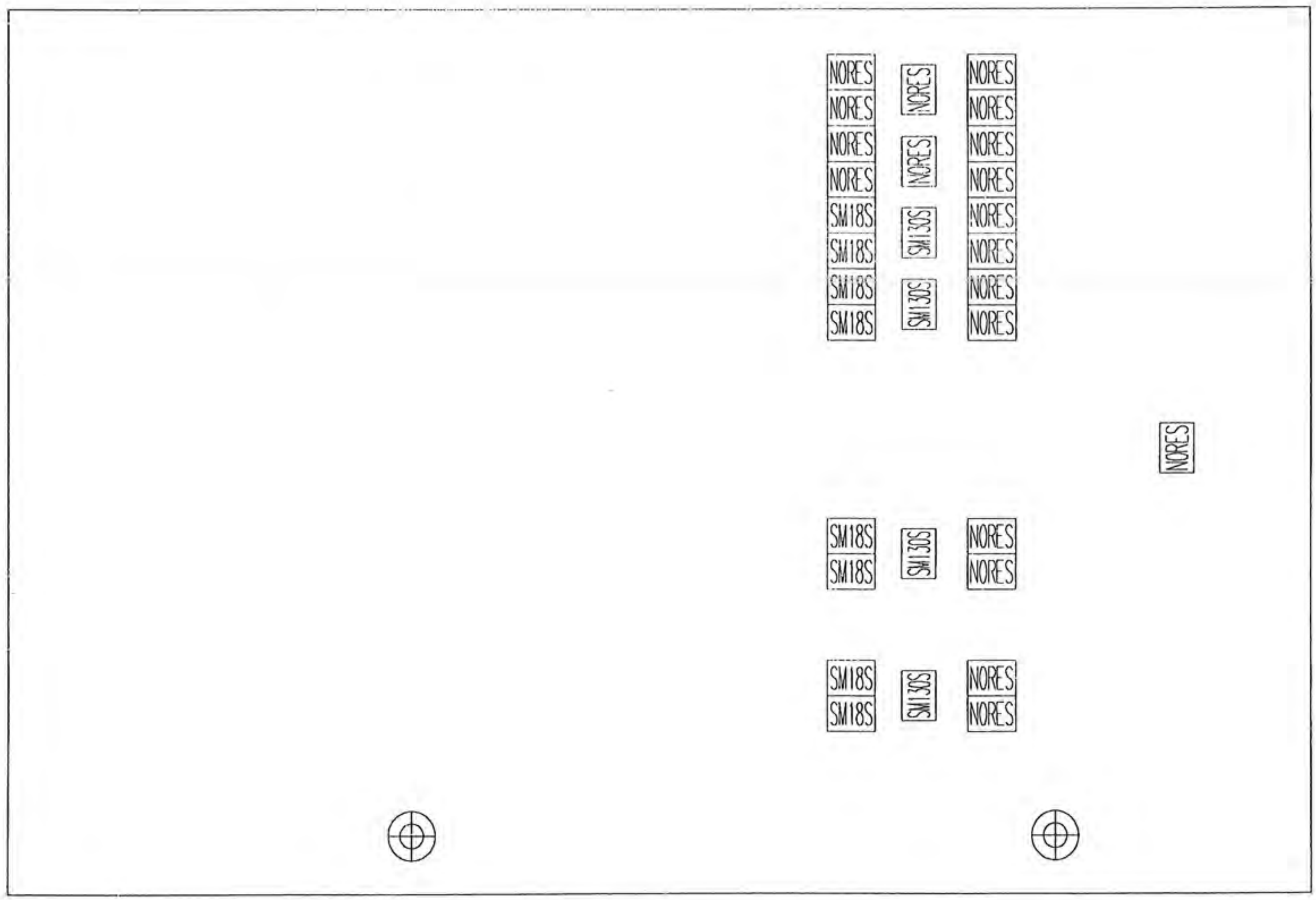
LeCroy CORPORATION

DRAWN KADLUBSKI-B	MODEL : 9420-8 CLOCK_BUS
CHKD VITTET-J-P	DWG NO: 9420-8-S1 / SIZE B
DATE 05-SEP-88	SH 1 OF 1 / ECO : 1001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NORES
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NORES
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SM18S
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SM18S
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NORES
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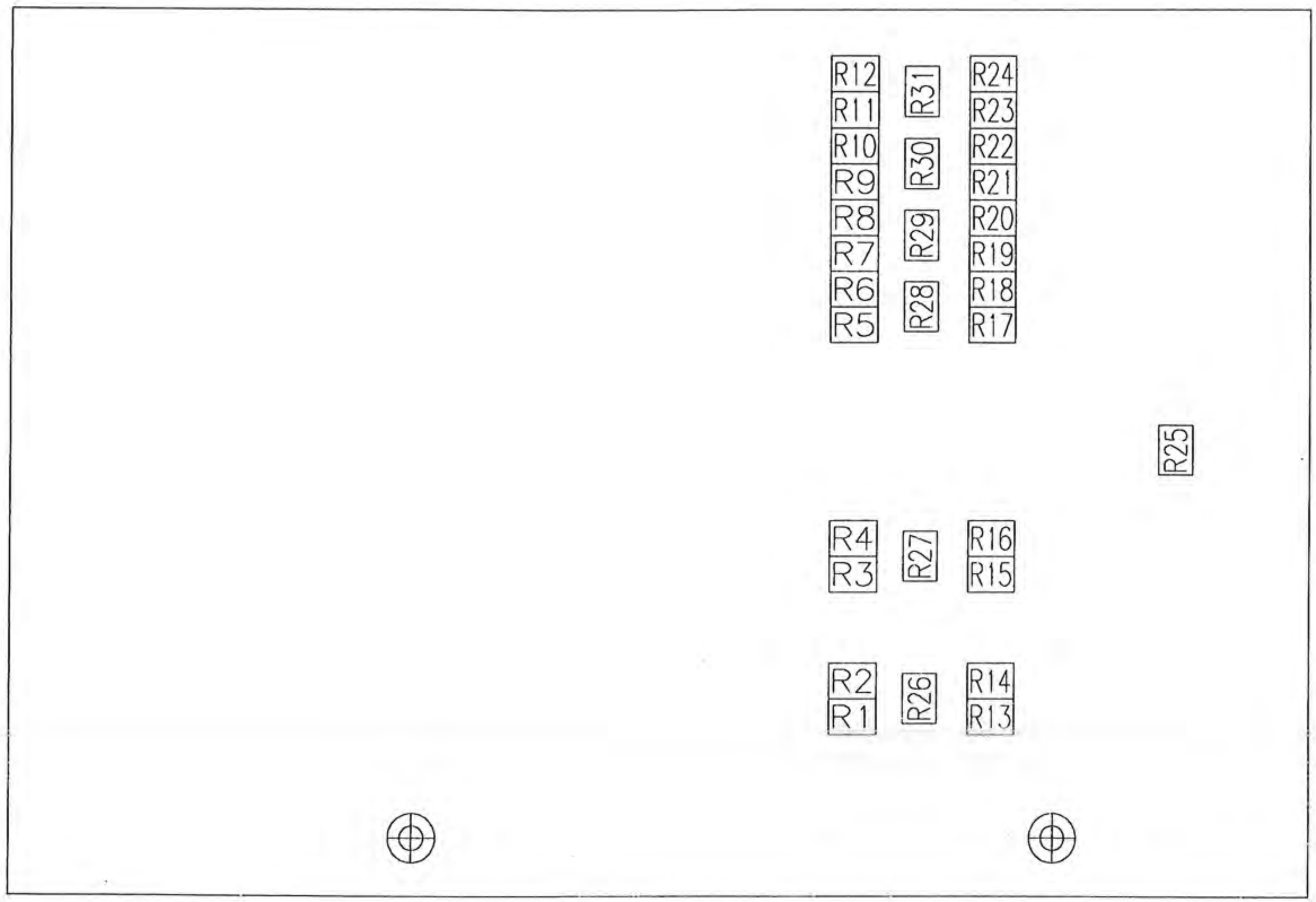
$9420_8 Rev:B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R10
R9
R8
R7
R6
R5
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R30
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R28
R24
R23
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R13

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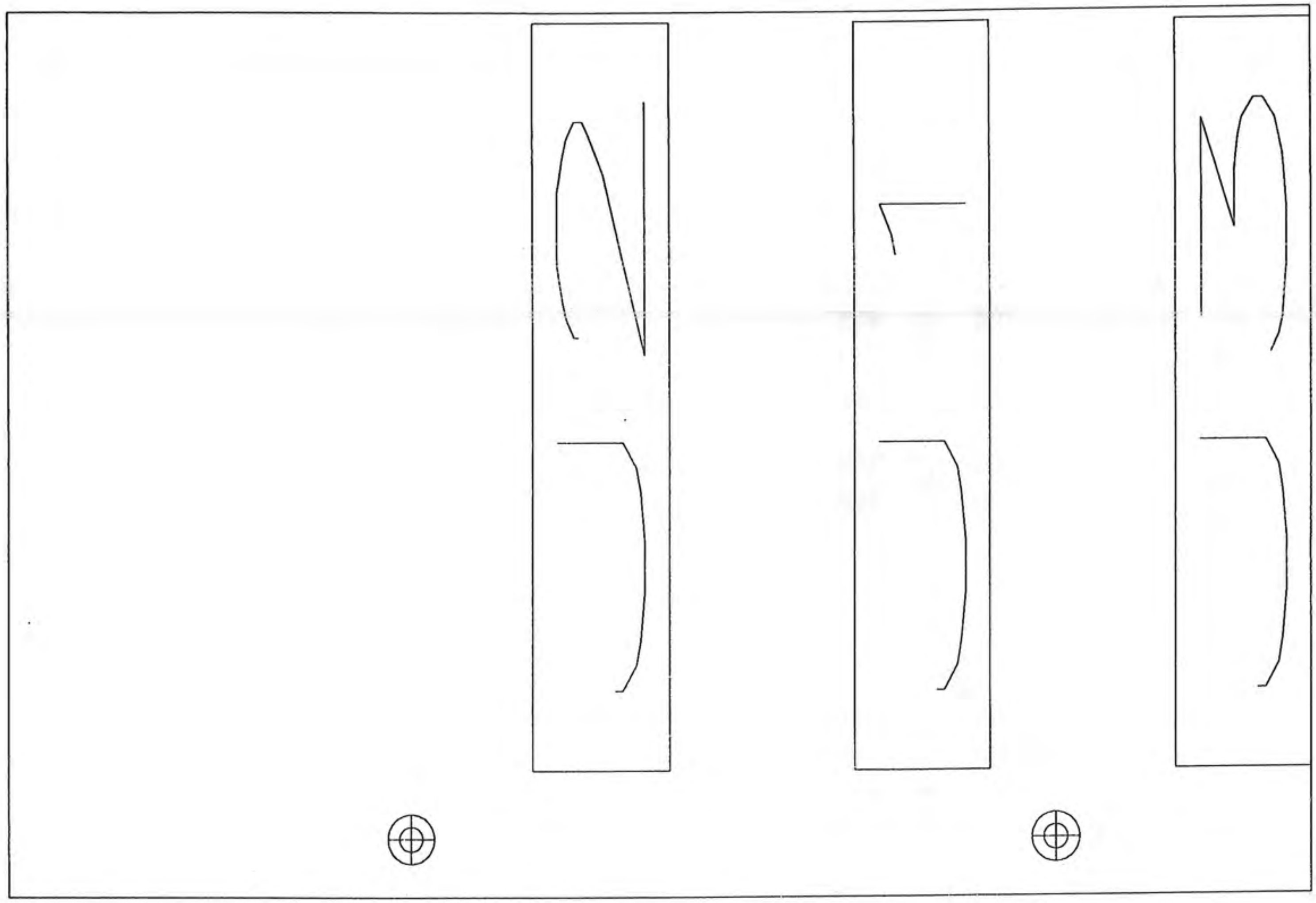

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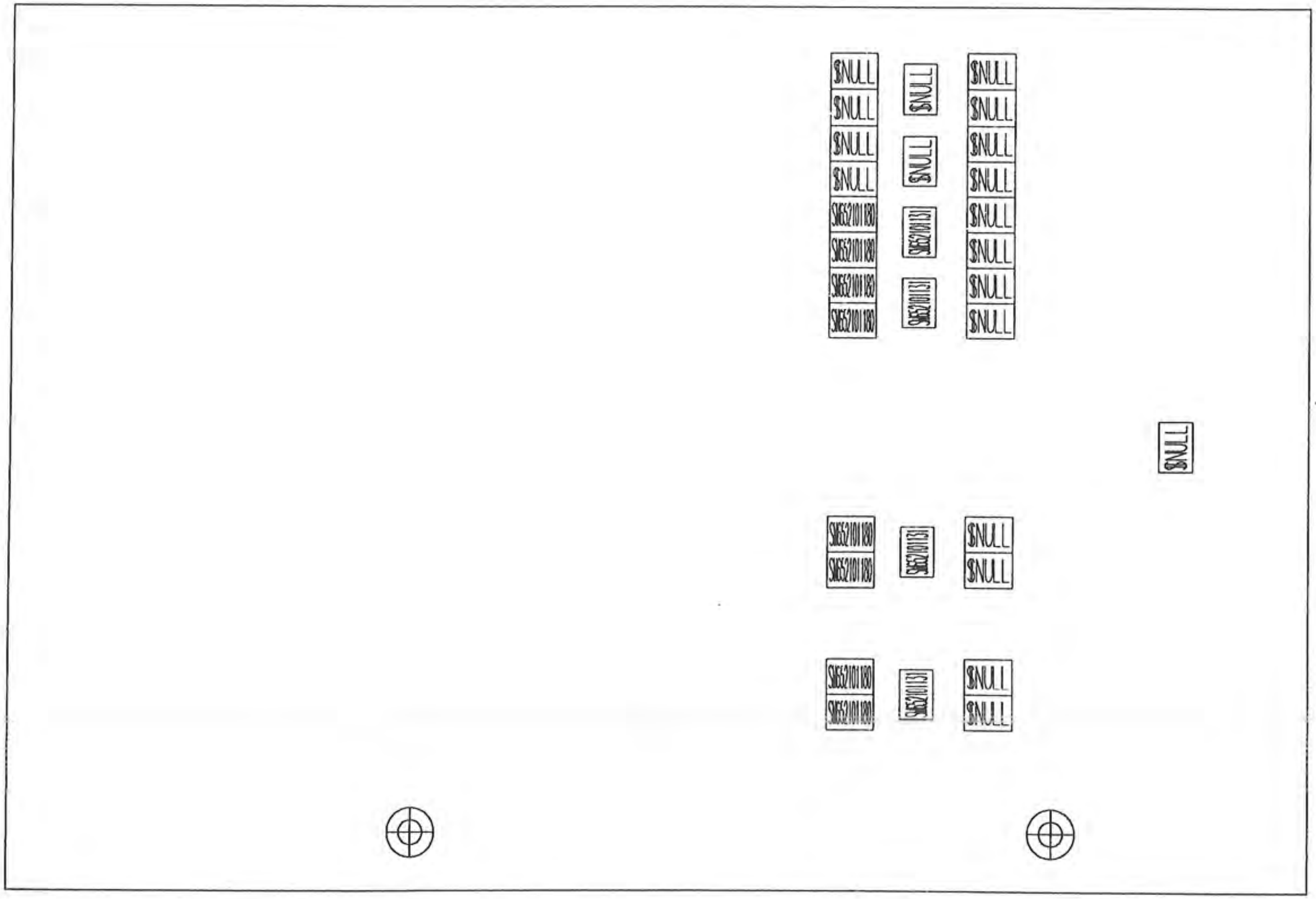

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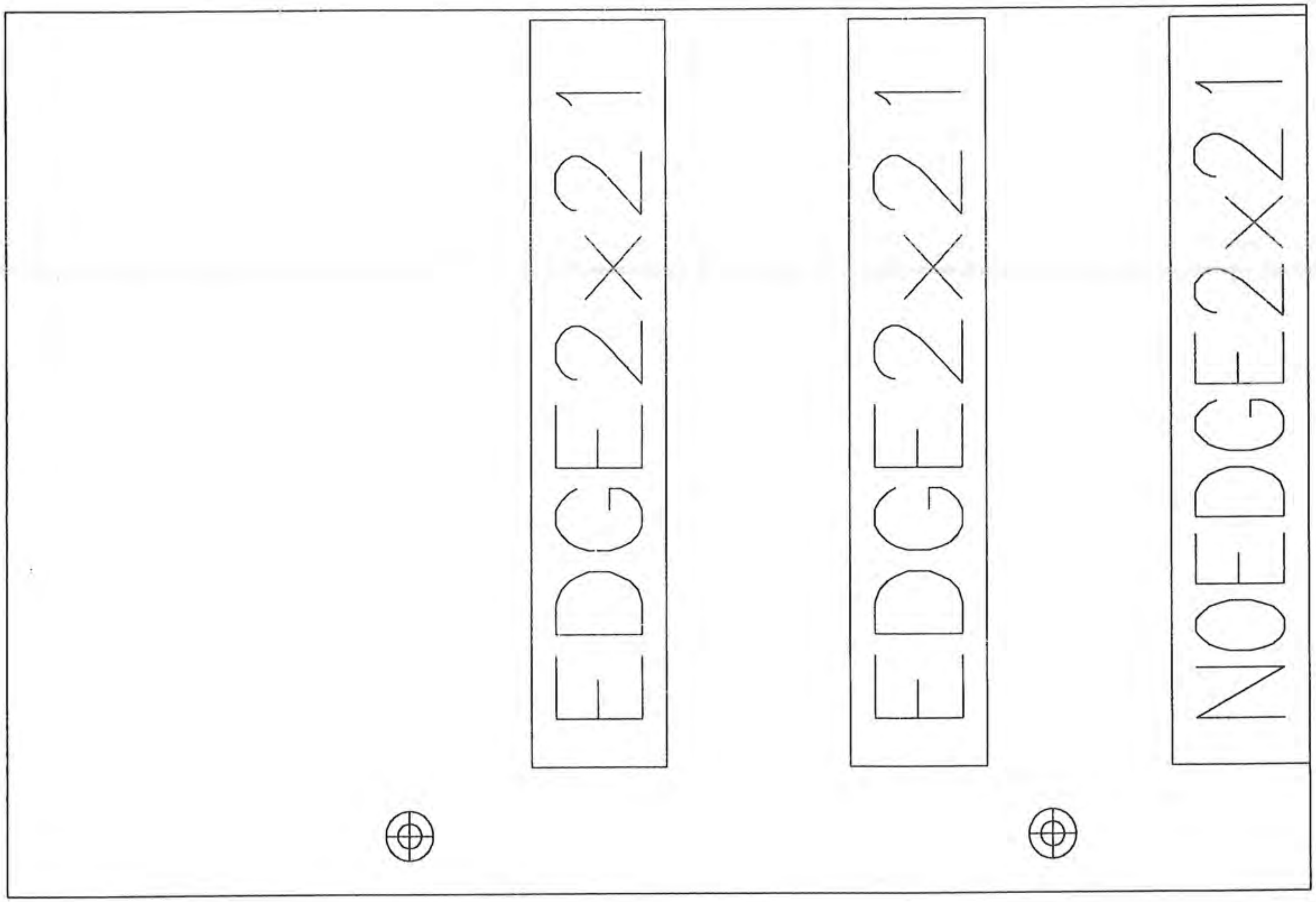

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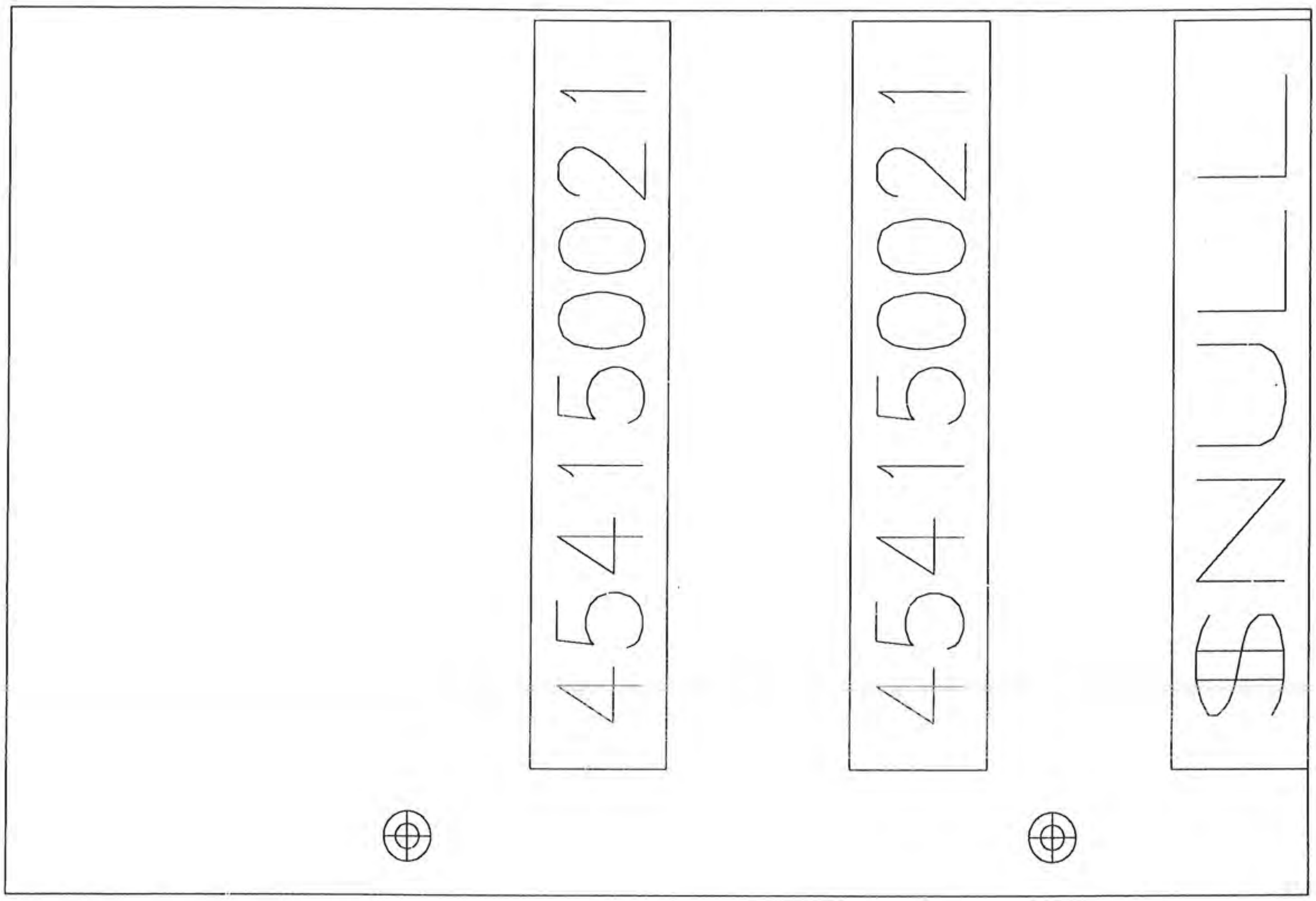

$9420_8 Rev:B

J1	454150021	EDGE2x21	EDGE2X21
J2	454150021	EDGE2x21	EDGE2X21
J3	$NULL	NOEDGE2x21	EDGE2X21
R1	SM652101180	SM18S	SM0805
R2	SM652101180	SM18S	SM0805
R3	SM652101180	SM18S	SM0805
R4	SM652101180	SM18S	SM0805
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R6	SM652101180	SM18S	SM0805
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R8	SM652101180	SM18S	SM0805
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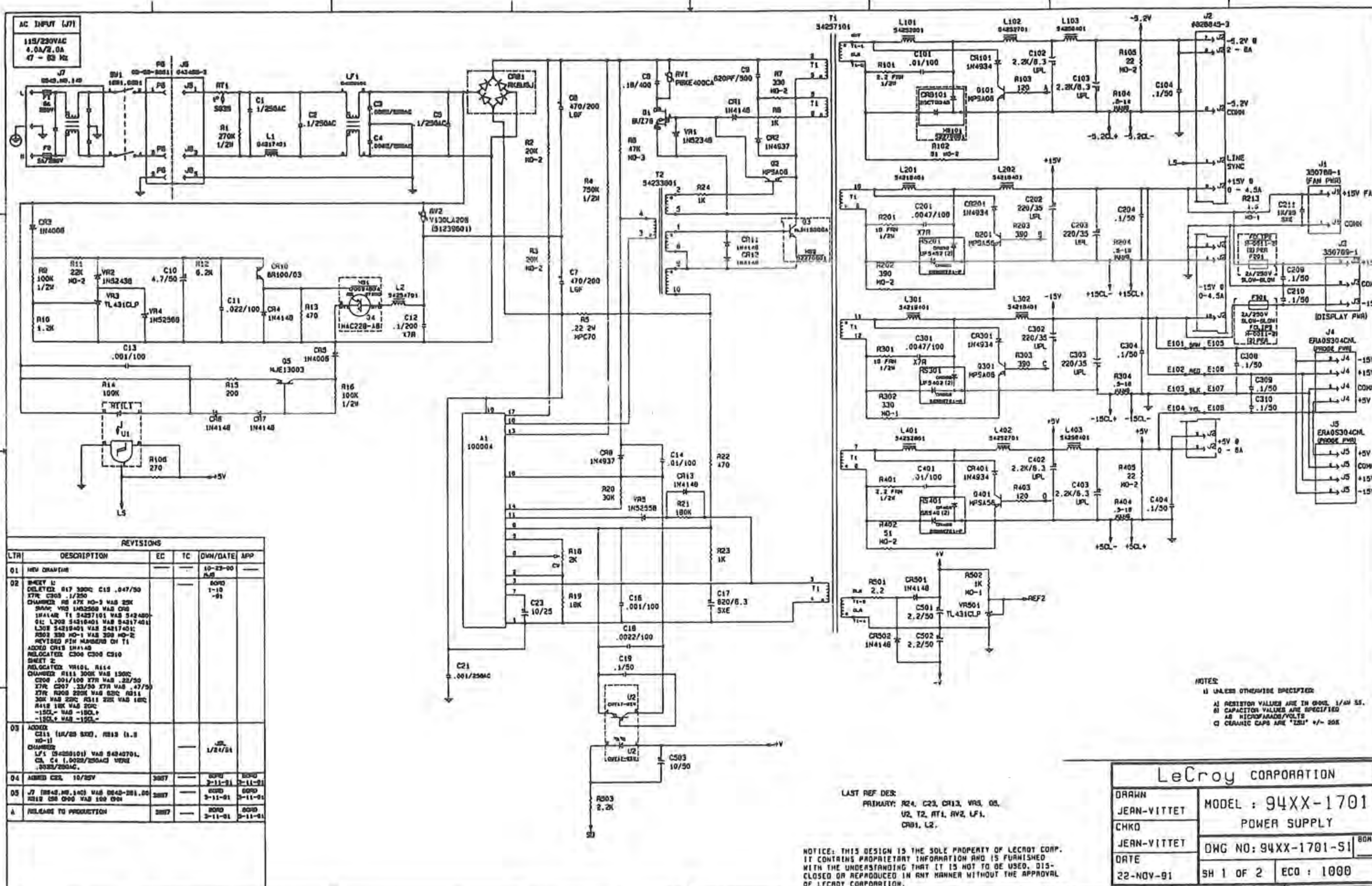
AC INPUT (J7)
115/230VAC
4.0A/2.0A
47 - 63 Hz
REVISIONS
NEW DRAWING
RELEASE TO PRODUCTION
NOTES:
1) UNLESS OTHERWISE SPECIFIED:
A) RESISTOR VALUES ARE IN OHMS, 1/4W 5%.
B) CAPACITOR VALUES ARE SPECIFIED AS MICROFARADS/VOLTS
C) CERAMIC CAPS ARE "Z5U" +/- 20%
LAST REF DES:
PRIMARY: R24, C23, CR13, VR5, Q5, U2, T2, RT1, RV2, LF1, CR81, L2.
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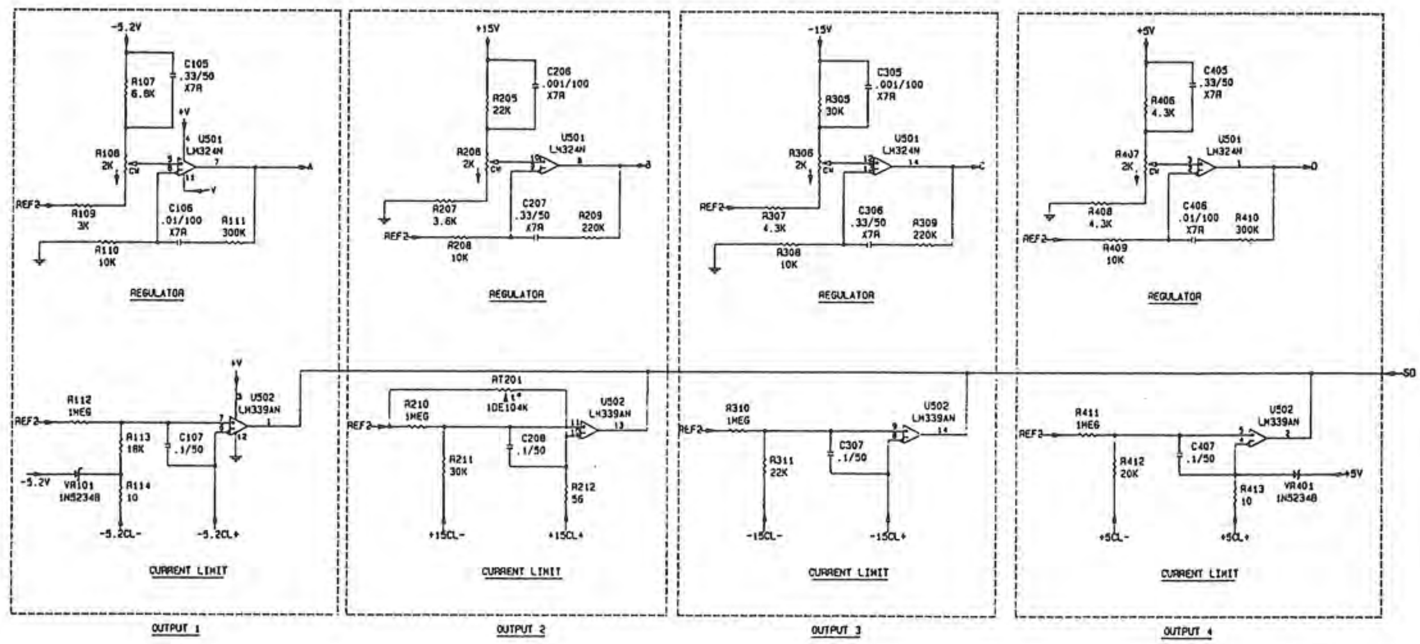
LeCroy CORPORATION
DRAWN
JEAN-VITTET
CHKD
JEAN-VITTET
DATE
22-NOV-91
MODEL : 94XX-1701
POWER SUPPLY
DWG NO: 94XX-1701-S1
SH 1 OF 2
ECO : 1000

REVISIONS					
LTR	DESCRIPTION	EC	TC	DWN	APP
—	SEE SHEET 1 FOR REVISIONS	—	—	—	—



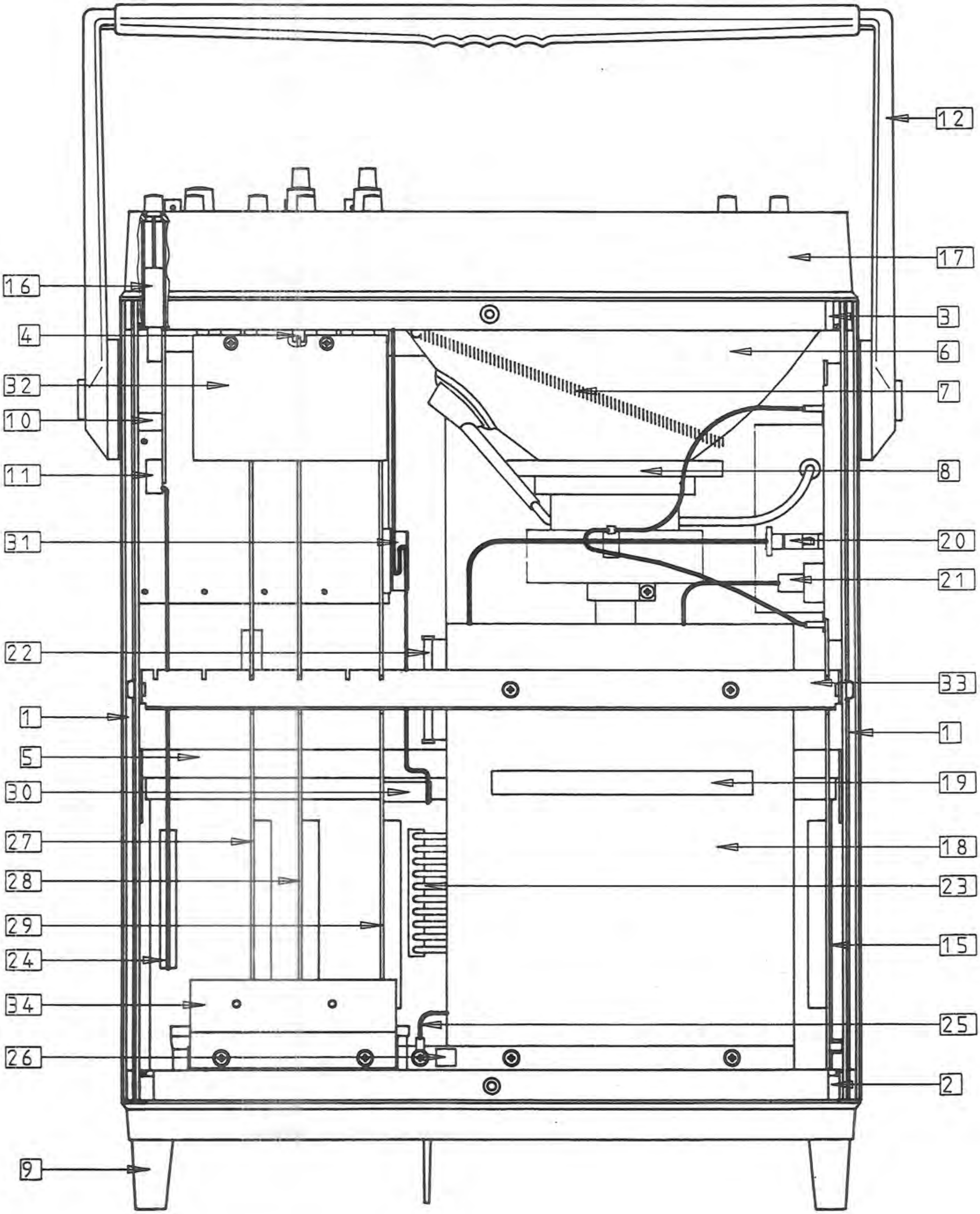
SEE SHT 1 FOR NOTES

LeCroy CORPORATION		
DRAWN JEAN-VITTET	MODEL : 94XX-1701 POWER SUPPLY	
CHKD JEAN-VITTET	DWG NO: 94XX-1701-S1	BOM
DATE 22-NOV-91	SH 2 OF 2	ECO : 1000

Chapter 7

MECHANICAL PARTS

Table of contents: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9

Figure 7.1

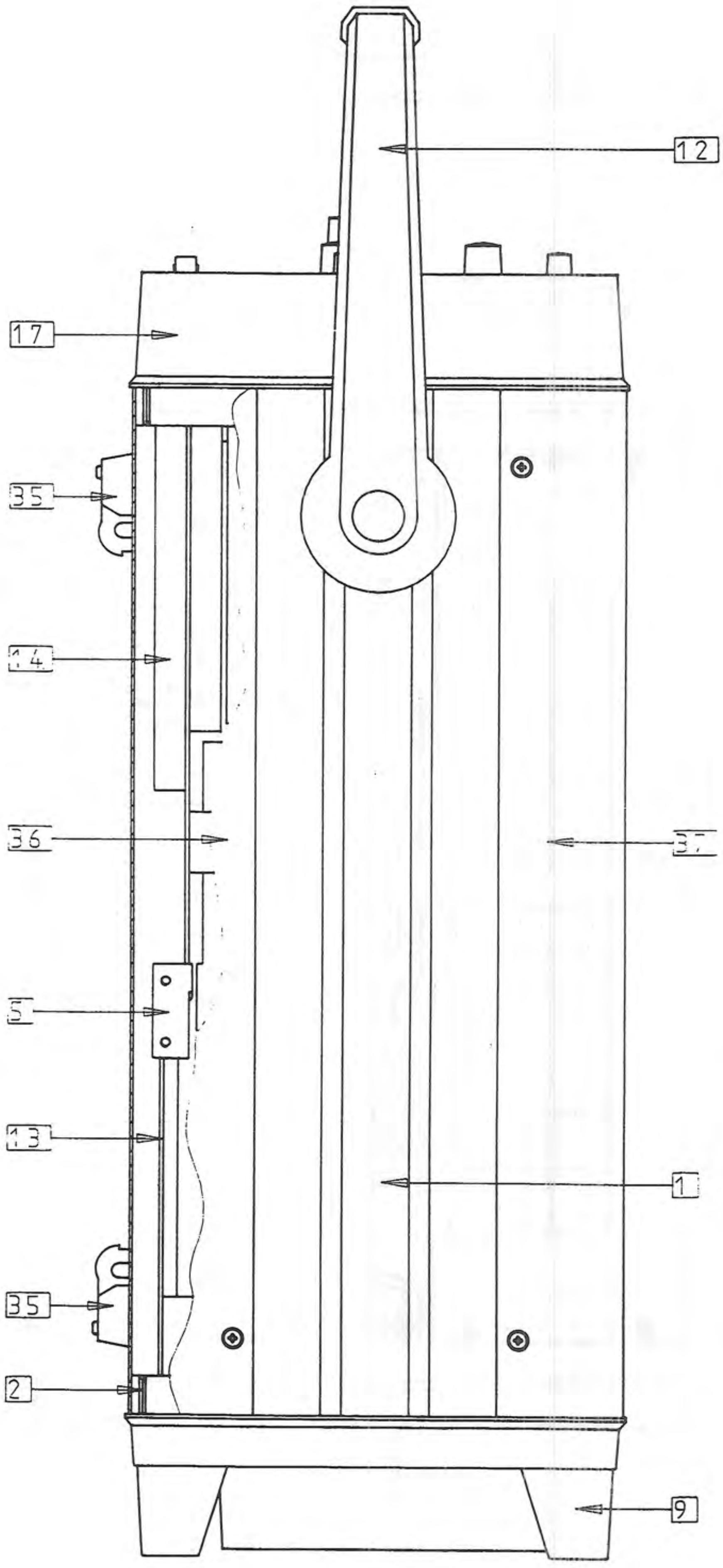
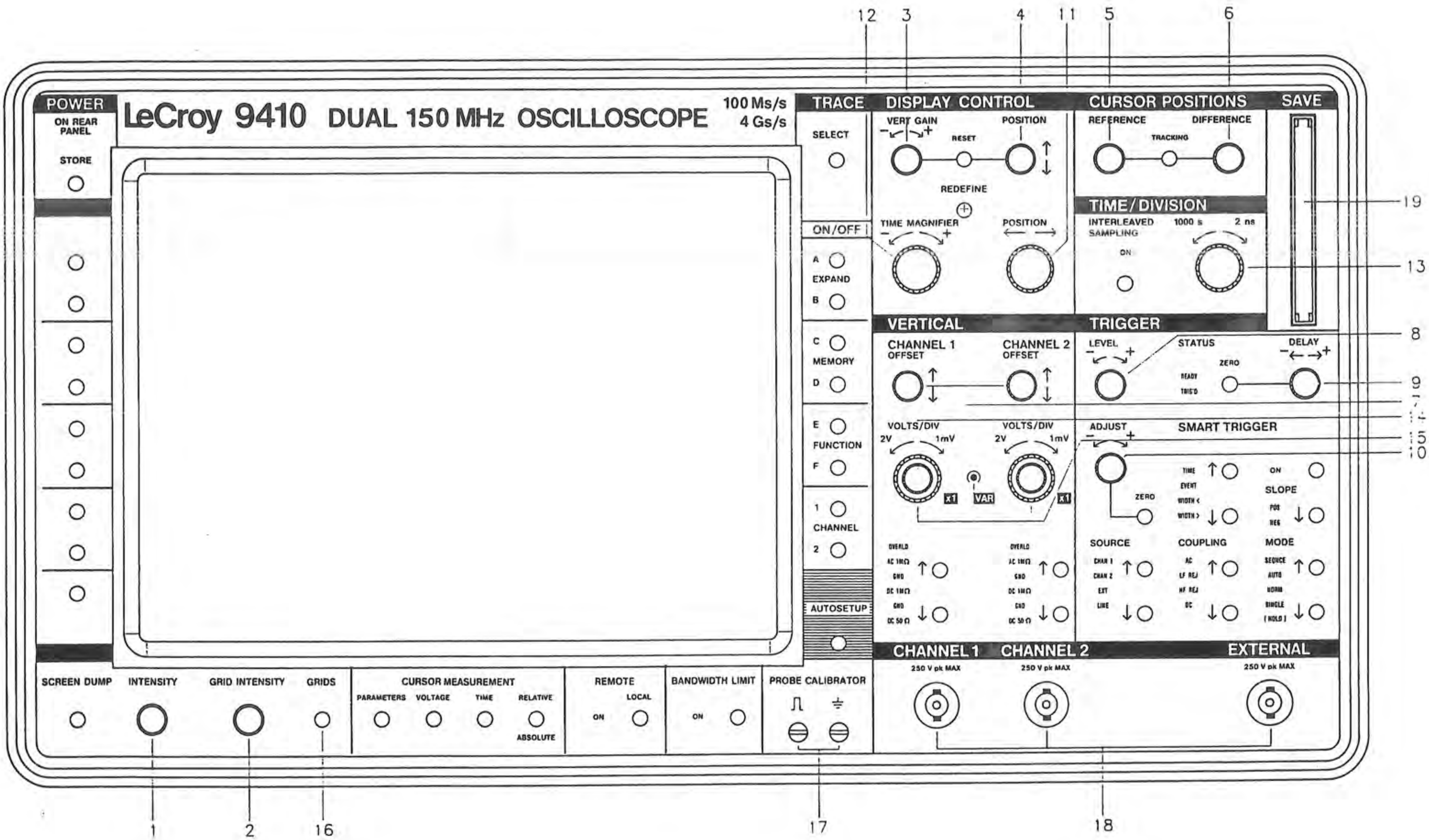


Figure 7.2

ASSEMBLAGE SEQUENCE OF PARTS				SCREWS		WASHERS		NUTS	
POS	DESCRIPTION	PART NUMBER	QTY	PART NUMBER	QTY	PART NUMBER	QTY	PART NUMBER	QTY
1	SIDE PANEL	709 424 021	2						
2	REAR SUPPORT	709 424 041	1	550 440 108	4	551 440 300	4		
3	DISPLAY SUPPORT	709 424 031	1	550 440 108	4	551 440 300	4		
4	CARD GUIDE	530 410 001	5	550 430 104	10	551 430 300	10		
5	MOTHER CARD SUPPORT	709 424 051	1	550 440 108	4	551 440 300	4		
6	CRT ORANGE	321 220 009	1	550 440 416	4	554 440 202 709 450 071	4 4	552 440 100	4
7	SPRING EXT TYPE 190mm	554 310 001	1						
8	DEFLECTION YOKE	300 090 001	1						
9	REAR PANEL FOR 9410	F9410-9	1	550 440 406	6				
10	SPACER INSERT GUIDE	709 424 098	1	550 440 120	1	551 440 300	1	709 424 011	1
11	SUPPORT FOR MC	F9424-2	1						
12	HANDLE	530 301 005	1	550 440 120	2			709 424 011	2
13	94XX-1 WITH MC LOGIC	F9424-1	1	550 430 106	4	551 430 300	4		
14	DUAL CHANNEL FRONTEND	F9430-7	1	550 430 106 550 430 108	2 3	551 430 300	5		
15	DISPLAY CARD FOR 94XX	F9450-2	1	550 430 106	4	551 430 300	4		
16	INSERTION GUIDE MC	709 424 098	1						
17	DUAL CHANNEL FP CARD	F9410-5	1	550 440 406	6				
18	POWER SUPPLY 9451-1	315 040 015	1	550 440 105 550 440 506	4 2	551 440 300	4		
18	POWER SUPPLY 94XX-1701	94XX-1701	1						
19	LABEL 'DANGER---ONLY	377 051 005	1						
20	DISPLAY POWER CABLE	780 210 030	1						
21	CRT CABLE	780 299 025	1						
22	FRONTEND BASE CABLE	780 231 120	1						
23	BASE CARD POWER CABLE	780 220 015	1						
24	MEMORY CARD CABLE	780 231 131	1						
25	GROUND CABLE	780 544 512	1						
26	LABEL GROUND SYMBOL	377 131 001	1						
27	TIMEBASE CARD	F9420-4	1						
28	DUAL CHANNEL	F9410-3	1						
29	PROCESSOR CARD	F9410-6	1						
30	FRONT PANEL CABLE	780 411 236	1						
31	CABLE CLIP AD BACK	594 230 002	1						
32	CLOCK-BUS	F9420-8	1	550 430 106	2	551 430 300	2		
33	POWER SUPPLY SUPPORT	709 424 061	1	550 430 106	2	551 430 300	2		
34	CARD RETAINER	709 424 095	1	550 440 108	2	551 440 300	2		
35	FOOT	530 010 024	4	550 440 110	4	551 440 300	4	552 440 100	4
36	LOWER COVER	709 424 081	1	550 440 708	4	551 440 501	4		
37	UPPER COVER	709 424 071	1	550 440 708	4	551 440 501	4		

Figure 7.3



POWER
ON REAR PANEL
STORE
LeCroy 9410 DUAL 150 MHz OSCILLOSCOPE
100 Ms/s
4 Gs/s
TRACE
SELECT
ON/OFF
EXPAND
MEMORY
FUNCTION
CHANNEL
AUTOSETUP
DISPLAY CONTROL
VERT GAIN
RESET
POSITION
REDEFINE
TIME MAGNIFIER
CURSOR POSITIONS
REFERENCE
TRACKING
DIFFERENCE
SAVE
TIME/DIVISION
INTERLEAVED SAMPLING
1000 s
2 ns
ON
VERTICAL
CHANNEL 1 OFFSET
CHANNEL 2 OFFSET
VOLTS/DIV
2V
1mV
VAR
TRIGGER
LEVEL
STATUS
ZERO
DELAY
ADJUST
SMART TRIGGER
SLOPE
SOURCE
COUPLING
MODE
CHANNEL 1
CHANNEL 2
EXTERNAL
250 V pk MAX
SCREEN DUMP
INTENSITY
GRID INTENSITY
GRIDS
CURSOR MEASUREMENT
PARAMETERS
VOLTAGE
TIME
RELATIVE
ABSOLUTE
REMOTE
LOCAL
BANDWIDTH LIMIT
PROBE CALIBRATOR
1
2
3
4
5
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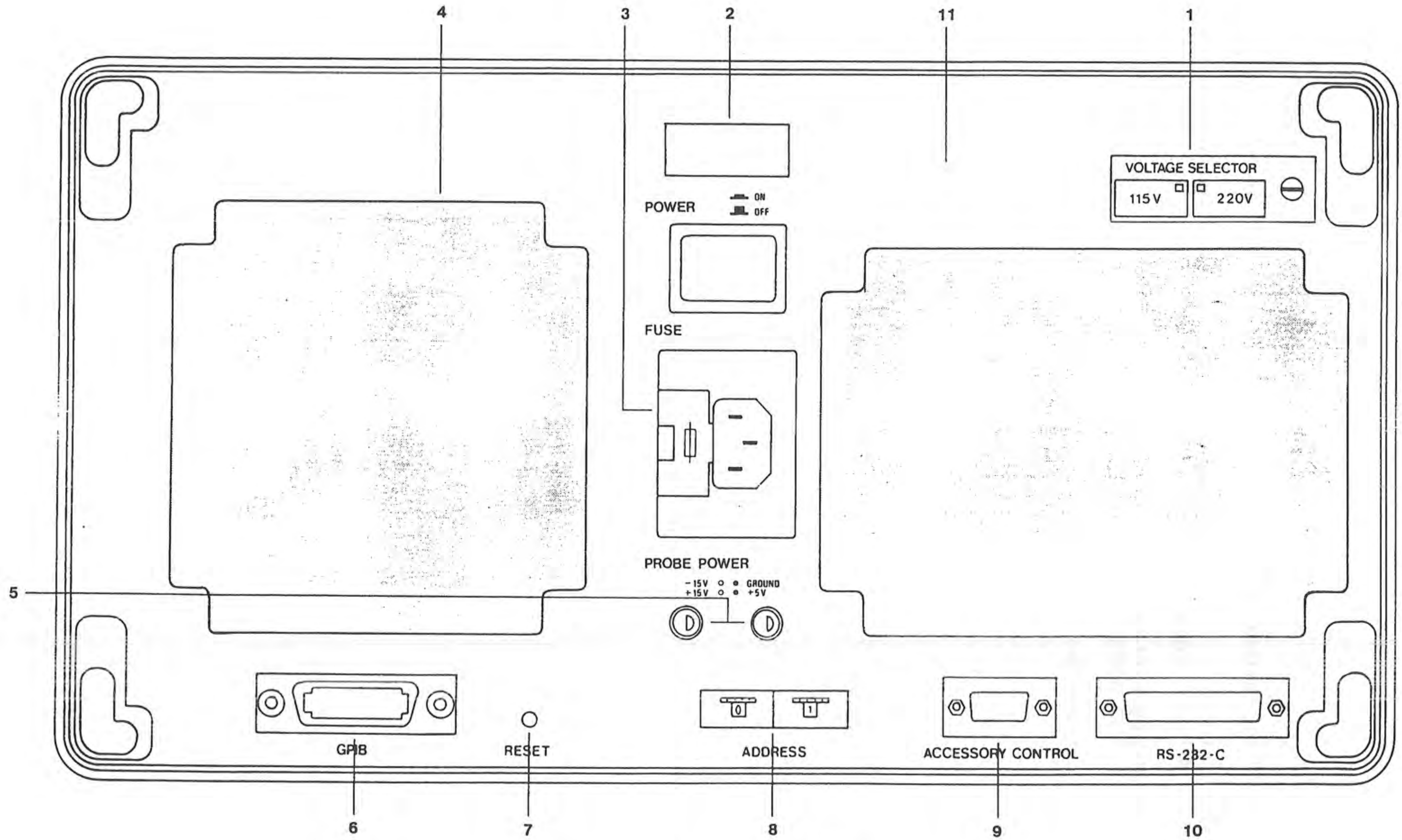
19

Figure 7.4

7.5 Front Panel description and part number

	Function:	Description:	Part number:
1)	Intensity	RES VAR cond plastic 5K knob for 1/8" shaft CAP for 021-1110 or 2215	184 437 502 536 168 003 536 068 006
2)	Grid intensity	Idem	
3)	Vert gain	RES VAR cond plastic 5K knob for 1/8" shaft CAP for knob 020-2215	184 417 502 536 168 001 536 068 003
4)	Position	Idem	
5)	Reference	Idem	
6)	Difference	Idem	
7)	CH1 and CH2 offset	Idem	
8)	Level	Idem	
9)	Delay	Idem	
10)	Adjust	Idem	
11)	Position	RES VAR cond plastic 5K knob for 1/8" shaft CAP for 020-3215 or 3415	184 417 502 536 168 002 536 068 005
12)	Time magnifier	Switch ROT M/stop 12 pins knob for 1/8" shaft CAP for knob 020-3215 or 3415	412 001 012 536 068 001 536 068 005
13)	Time/division	Idem	
14)	CH1 and CH2 volts/div variable gain	RES VARI cond plastic 5K knob 1/8" shaft CAP for knob 020-2215	184 427 502 536 068 002 536 068 003
15)	CH1 and CH2 volts/div	Switch Rot M/stop 12 pins	412 001 012
16)	Grids idem for all the other push button	Switch push button SPST Push switch extender	416 161 002 709 450 523

17)	Probe calibration		HPC 411 AIH
18)	Ch1/Ch2/ External input	COMM CO.AX PC MTG BNC	402 110 302
19)	Memory card option:		
	- 94XX-MC02:	128K Memory card	334 049 070
		Lithium battery	312 682 325
	- 94XX-MC04	512K Memory card	334 049 090



9410 Rear Panel

Figure 7.6

7.7 Rear panel description and part number (9410)

	Description	Part number
1)	Voltage selector cover	709 424 911
	Screw selector cover	709 424 941
2)	Serial number plate	709 410 903
	Tapping screws w/u tread	554 500 001
3)	Fuse slow blow 250V/2A	433 162 200
	Fuse slow blow 250V/4A	433 162 400
4)	Fan axial 12V	530 409 312
	Screws cyl int Hex M4x12	550 440 412
	Flat washers M4	551 440 100
	Washers shakeproof M4	551 440 400
5)	Power supply F9451-1	315 040 015
	or power supply 94XX-1701	94XX-1701
6)	Rtangle PCB CONN-FEM 24	453 520 024
7)	Switch pushbut (MON) SPDT	416 132 008
8)	Switch rotary BCD-1248	412 132 022
9)	HDR SOLD TAIL/MALE 9	454 110 009
10)	HDR SOLD TAIL/MALE 25	454 110 025
11)	REAR PANEL 94XX-9	709 424 901

Chapter 8

Parts List

CLASS CODE: 1
FINISHED GOODS-MANUFACTURED
PART: 9410
DESC: 150 MHz DUAL CH. 100 Ms/s DSO UOM: EA SC: M REV: A

COMPONENT PART	DESCRIPTION	RV	ITEM NUMBR	SC	ST UM	QTY PER ASSEMBLY
F9424-1	94xx-1 WITH MEMORY CARD LOGIC	C	1	R	EA	1.00
F9450-2	DISPLAY CARD FOR 94xx	J	2	R	EA	1.00
F9410-3	DUAL CHANNEL 100 Ms/s ADC	A	3	R	EA	1.00
F9420-4	TIMEBASE CARD	B	4	R	EA	1.00
F9410-5	DUAL CHANNEL FRONT PANEL CARD	A	5	R	EA	1.00
F9410-6	PROCESSOR CARD	C	6	R	EA	1.00
F9430-7	DUAL CHANNEL 150 MHz FRONTEND	D	7	R	EA	1.00
F9420-8	CLOCK-BUS	B	8	R	EA	1.00
F9410-9	REAR PANEL FOR 9410	C	9	R	EA	1.00
M9424	MECHANICAL FOR 9424	C	10	R	EA	1.00
ACCESSORIES-9410	ACCESSORIES FOR 9410	3	11	R	EA	1.00
F9424-2	SUPPORT FOR MEMORY CARD	A	12	R	EA	1.00

CLASS CODE: 2
SUBASSEMBLIES
PART: F9424-1
DESC: 94xx-1 WITH MEMORY CARD LOGIC UOM: EA SC: R REV: C

COMPONENT PART	DESCRIPTION	RV	ITEM NUMBR	SC	ST UM	QTY PER ASSEMBLY
102484471	CAP CERA DISC 100V 470 PF		1	P	EA	1.00
103307103	CAP CERA MONO 50V .01 UF		2	P	EA	35.00
103427104	CAP CERA MONO 100V .1 UF		3	P	EA	2.00
142214156	CAP TANT DIP CASE 15 UF		4	P	EA	2.00
142714685	CAP TANT DIP CASE 6.8UF		5	P	EA	2.00
146634106	CAP MINI ALUM 20% 10 UF		6	P	EA	2.00
147436033	CAP ALUM METAL CAN 33 UF		7	P	EA	4.00
161225101	RES COMP 1/8W 5% 100 OHMS		8	P	EA	1.00
161225103	RES COMP 1/8W 5% 10 K		9	P	EA	3.00
161225274	RES CARBON FILM 270 K		10	P	EA	1.00
161225302	RES COMP 1/8W 5% 3 K		11	P	EA	2.00
161225395	RES CARBON FILM 3.9 MEG		12	P	EA	1.00
161225471	RES COMP 1/8W 5% 470 OHMS		13	P	EA	1.00
161225683	RES COMP 1/8W 5% 68 K		62	P	EA	3.00
181447104	RES VARI CERMET 100 K		14	P	EA	2.00
190042103	RESISTOR NETWORK 10 K		15	P	EA	2.00
190042104	RESISTOR NETWORK 100K		16	P	EA	2.00
190832102	RES NETWORK 1 K		17	P	EA	1.00
190832103	RESISTOR NETWORK 10K		18	P	EA	1.00
190832471	RESISTOR NETWORK 470 OHMS		19	P	EA	2.00
200331074	IC DUAL FLOP 74HCT74		20	P	EA	1.00
200340173	IC D-TYP FLOP HCT173		21	P	EA	2.00
200373374	IC D-TYP FLOP 74HCT374		22	P	EA	2.00
200440040	IC12-ST BIN COUNT HCT4040		23	P	EA	1.00
200440102	IC COWN COUNT. 74HCT40102		24	P	EA	1.00
205277202	FIFO 1024X9 BITS		25	P	EA	1.00
205750000	IC AND-OR GATE ARRAY 16V8		300	P	EA	7.00
207171541	IC BUFFER/LINE DRI.HCT541		29	P	EA	9.00
207197210	IC BUS INTERF CONTR 7210		30	P	EA	1.00
207280703	IC 16-BIT DAC 703		31	P	EA	1.00
207440232	IC XMTR/RCVR MAX 232		32	P	EA	1.00
207470160	IC OCTAL BUS XCVR 75160A		33	P	EA	1.00
207470161	IC OCTL BUS XCEIR 75161A		34	P	EA	1.00
207472245	IC BUS TRANSCVR HCT245		35	P	EA	4.00
207552661	IC INTERFACE 2661A		36	P	EA	1.00
230020062	DIODE SWITCHING BAW62		37	P	EA	16.00
253010835	DIODE HOT CARRIER HP2835		38	P	EA	3.00
309040005	CRYSTAL OSCIL. 4.9152MHZ		39	P	EA	1.00
400331020	SOCKET IC ST DIP-20		40	P	EA	1.00
400412068	IC SOCKET GRID TYP 68-PIN		41	P	EA	1.00
403950002	POLARIZING KEY		42	P	EA	4.00
412022022	SWITCH ROTARY BCD-1248		43	P	EA	2.00
416132008	SWITCH PUSHBUT (MOM) SPDT		44	P	EA	1.00
453521024	CONN RT ANGLE IEEE FEM 24		45	P	EA	1.00
454110010	HDR SOLD TAIL/MALE PIN 10		46	P	EA	1.00
454211040	HDR SOLD TAIL TO MALE 40		47	P	EA	2.00
454320096	HDR DIP SOLD TO FEM 96		48	P	EA	6.00
454611009	HDR SOLD TAIL/MALE 9		49	P	EA	1.00
454611025	HDR SOLD TAIL/MALE 25		50	P	EA	1.00
455980001	MOUNT. HDW FOR CONN SHELL		51	P	EA	2.00
530040006	BUZZER 85DB 4 TO 7V		52	P	EA	1.00
550130108	SCREW CYL HD M3X8		53	P	EA	6.00
551430400	WASHER SHAKEPROOF M3		61	P	EA	4.00
554630100	THREADED INSERT M3X1.5		60	P	EA	4.00
585252236	RIVET HOLLOW 2.5X6MM		57	P	EA	12.00
719424103	PC BD PREASS'Y 9424-1	B	58	B	EA	1.00

CLASS CODE: 2
SUBASSEMBLIES
PART: F9424-1
DESC: 94xx-1 WITH MEMORY CARD LOGIC UOM: EA SC: R REV: C

COMPONENT PART	DESCRIPTION	RV	ITEM NUMBR	SC	ST UM	QTY PER ASSEMBLY	YIELD FACTR
MCL404	IC MEM GATE ARRAY MCL404		59	P	EA	1.00	1.000

CLASS CODE: 2
SUBASSEMBLIES
PART: F9424-2
DESC: SUPPORT FOR MEMORY CARD   UOM: EA SC: R REV: A

COMPONENT PART	DESCRIPTION	RV	ITEM NUMBR	SC	ST UM	QTY PER ASSEMBLY
103427104	CAP CERA MONO 100V .1 UF		1	P	EA	1.00
190642103	RESISTOR NETWORK 10 K		6	P	EA	1.00
200331027	IC 3-IN POS-NOR 74HC27		7	P	EA	1.00
403950002	POLARIZING KEY		5	P	EA	2.00
404500068	CONN BD TO BD 68 POS		4	P	EA	1.00
454611040	HDR DIP SOLD TO MALE 40		2	P	EA	1.00
550130108	SCREW CYL HD M3X8		8	P	EA	2.00
552130101	NUT HEX M3		9	P	EA	2.00
585252354	RIVET HOLLOW 2,5X9MM		10	P	EA	2.00
719424203	PC BD PREASS'Y 9424-2	E	3	B	EA	1.00

CLASS CODE: 2
SUBASSEMBLIES
PART: F9450-2
DESC: DISPLAY CARD FOR 94xx UOM: EA SC: R REV: J

COMPONENT PART	DESCRIPTION	RV	ITEM NUMBR	SC	ST UM	QTY PER ASSEMBLY
102412100	CAP CERA DISC 100V 10 PF		168	P	EA	1.00
102412101	CAP CERA DISC 100V 100PF		164	P	EA	2.00
102412120	CAP CERA DISC 100V 12 PF		165	P	EA	10.00
102412220	CAP CERA DISC 100V 22 PF		4	P	EA	1.00
102412470	CAP CERA DISC 100V 47 PF		5	P	EA	5.00
102412560	CAP CERA DISC 100V 56 PF		6	P	EA	1.00
102484821	CAP CERA DISC 100V 820 PF		7	P	EA	1.00
102940502	CAP CERA DISC 1KV .005 UF		8	P	EA	4.00
103307103	CAP CERA MONO 50V .01 UF		9	P	EA	57.00
103327102	CAP CERA MONO 50V .001 UF		10	P	EA	2.00
103327224	CAP CERA MONO 50V .22UF		11	P	EA	2.00
103427104	CAP CERA MONO 100V .1 UF		12	P	EA	4.00
103437334	CAP CERA MONO 100V .33 UF		13	P	EA	8.00
124171623	CAP POLYSTYR 1% .062 UF		14	P	EA	2.00
142714685	CAP TANT DIP CASE 6.8UF		15	P	EA	1.00
146544471	CAP MINI ALUM 20% 470UF		16	P	EA	4.00
146634106	CAP MINI ALUM 20% 10 UF		17	P	EA	18.00
146754470	CAP MINI ALUM 20% 47 UF		18	P	EA	1.00
147634102	CAP MINI ALUM 20% 1000 UF		19	P	EA	1.00
161335100	RES COMP 1/4W 5% 10 OHMS		20	P	EA	1.00
161335101	RES COMP 1/4W 5% 100 OHMS		21	P	EA	5.00
161335102	RES COMP 1/4W 5% 1 K		22	P	EA	16.00
161335103	RES COMP 1/4W 5% 10 K		23	P	EA	12.00
161335104	RES COMP 1/4W 5% 100 K		24	P	EA	8.00
161335105	RES COMP 1/4W 5% 1 MEG		25	P	EA	2.00
161335122	RES COMP 1/4W 5% 1.2 K		26	P	EA	5.00
161335132	RES COMP 1/4W 5% 1.3 K		27	P	EA	1.00
161335161	RES COMP 1/4W 5% 160 OHMS		28	P	EA	1.00
161335202	RES COMP 1/4W 5% 2 K		29	P	EA	6.00
161335203	RES COMP 1/4W 5% 20 K		30	P	EA	2.00
161335204	RES COMP 1/4W 5% 200 K		31	P	EA	1.00
161335221	RES COMP 1/4W 5% 220 OHMS		32	P	EA	8.00
161335223	RES COMP 1/4W 5% 22 K		33	P	EA	1.00
161335241	RES COMP 1/4W 5% 240 OHMS		34	P	EA	8.00
161335242	RES COMP 1/4W 5% 2.4 K		35	P	EA	4.00
161335271	RES COMP 1/4W 5% 270 OHMS		36	P	EA	2.00
161335272	RES COMP 1/4W 5% 2.7 K		37	P	EA	2.00
161335273	RES COMP 1/4W 5% 27 K		38	P	EA	1.00
161335302	RES COMP 1/4W 5% 3 K		39	P	EA	7.00
161335331	RES COMP 1/4W 5% 330 OHMS		40	P	EA	1.00
161335332	RES COMP 1/4W 5% 3.3 K		160	P	EA	6.00
161335333	RES COMP 1/4W 5% 33 K		42	P	EA	2.00
161335362	RES COMP 1/4W 5% 3.6 K		43	P	EA	3.00
161335394	RES COMP 1/4W 5% 390 K		44	P	EA	4.00
161335471	RES COMP 1/4W 5% 470 OHMS		45	P	EA	14.00
161335472	RES COMP 1/4W 5% 4.7 K		46	P	EA	2.00
161335473	RES COMP 1/4W 5% 47 K		47	P	EA	1.00
161335510	RES COMP 1/4W 5% 51 OHMS		48	P	EA	4.00
161335511	RES COMP 1/4W 5% 510 OHMS		49	P	EA	1.00
161335512	RES COMP 1/4W 5% 5.1 K		161	P	EA	7.00
161335560	RES COMP 1/4W 5% 56 OHMS		163	P	EA	4.00

CLASS CODE: 2
SUBASSEMBLIES
PART: F9450-2
DESC: DISPLAY CARD FOR 94xx UOM: EA SC: R REV: J

COMPONENT PART	DESCRIPTION	RV	ITEM NUMBR	SC	ST UM	QTY PER ASSEMBLY
161335565	RES COMP 1/4W 5% 5.6 MEG		51	P	EA	2.00
161335621	RES COMP 1/4W 5% 620 OHMS		52	P	EA	2.00
161335622	RES COMP 1/4W 5% 6.2 K		53	P	EA	2.00
161335623	RES COMP 1/4W 5% 62 K		54	P	EA	1.00
161335681	RES COMP 1/4W 5% 680 OHMS		55	P	EA	1.00
161335682	RES COMP 1/4W 5% 6.8 K		56	P	EA	2.00
161335752	RES COMP 1/4W 5% 7.5 K		57	P	EA	7.00
161335753	RES COMP 1/4W 5% 75 K		58	P	EA	3.00
161335821	RES COMP 1/4W 5% 820 OHMS		59	P	EA	2.00
161335912	RES COMP 1/4W 5% 9.1 K		60	P	EA	1.00
161445102	RES COMP 1/2W 5% 1K		61	P	EA	1.00
161445560	RES CARBON FILM 56 OHMS		62	P	EA	1.00
165375824	RES METAL FILM HV 820 K		63	P	EA	1.00
168031022	RES METAL FILM 2.2 OHMS		64	P	EA	26.00
168035125	RES METAL FILM HV 1.2 MEG		65	P	EA	1.00
168045336	RES HV 33M		66	P	EA	1.00
168531365	RES PREC RN55D 511 OHMS		67	P	EA	4.00
168531385	RES PREC RN55D 825 OHMS		68	P	EA	2.00
168531401	RES PREC RN55D 1.21 K		69	P	EA	7.00
168531445	RES PREC RN55D 3.48K		70	P	EA	1.00
168531447	RES PREC RN55D 3.65 K		71	P	EA	1.00
168531453	RES PREC RN55D 4.22 K		72	P	EA	1.00
168531471	RES PREC RN55D 6.49 K		169	P	EA	2.00
168531495	RES PREC RN55D 11.5K		74	P	EA	3.00
168531541	RES PREC RN55D 34.8 K		75	P	EA	1.00
172137022	RES WIREWOUND .22 OHMS		76	P	EA	1.00
180487103	RES VARI CERMET 10K		77	P	EA	2.00
180487202	RES VARI CERMET 2K		78	P	EA	1.00
180487205	RES VARI CERMET 2 MEG		79	P	EA	2.00
180487501	RES VARI CERMET 500 OHMS		80	P	EA	2.00
180487502	RES VARI CERMET 5K		81	P	EA	5.00
190042222	RESISTOR NETWORK 2.2 K		82	P	EA	5.00
190842222	RESISTOR NETWORK 2.2 K		83	P	EA	1.00
200440040	IC12-ST BIN COUNT HCT4040		84	P	EA	1.00
205271256	IC 32K X 8 RAM 62256-12		85	P	EA	2.00
205370256	IC UV E-PROM 27256G-25		86	P	EA	2.00
205750000	IC AND-OR GATE ARRAY 16V8		300	P	EA	4.00
207174244	IC OCTAL BUFFER HCT244		89	P	EA	2.00
207270312	IC 12-BIT C/A CONV DAC312		90	P	EA	2.00
207472245	IC BUS TRANSCVR HCT245		91	P	EA	2.00
208011005	IC VOLT FOLLOWER LM310N		92	P	EA	2.00
208031010	IC QUAD DIFF COMP LM339N		93	P	EA	1.00
208041001	IC 8-BIT DAC MONODAC-08EQ		94	P	EA	3.00
208041524	IC PULSE WIDTH MODUL 3524		95	P	EA	1.00
208110353	IC DUAL OP AMP LF353N		96	P	EA	2.00
208116365	IC OP AMP LM6365		97	P	EA	2.00
208130347	IC QUAD JFET OP AMP LF347		98	P	EA	1.00
208590336	IC VOLT REFERENCE LM336		99	P	EA	2.00
230110005	DIODE SWITCHING 1N4448		100	P	EA	14.00
230150045	DIODE PICOAMPERE BAV 45		101	P	EA	2.00

CLASS CODE: 2
SUBASSEMBLIES
PART: F9450-2
DESC: DISPLAY CARD FOR 94xx UOM: EA SC: R REV: J

COMPONENT PART	DESCRIPTION	RV	ITEM NUMBR	SC	ST UM	QTY PER ASSEMBLY
232990641	DIODE ARRAY (HV CASCADE)		102	P	EA	1.00
235040060	DIODE RECTIFIER LM60		103	P	EA	1.00
235820030	DIODE RECTIFIER EGP30D		104	P	EA	1.00
235930816	DIODE RECTIFIER 1A MR816		105	P	EA	1.00
240225720	DIODE ZENER 18V 1N720A		106	P	EA	2.00
240413755	DIODE ZENER 7.5V 1N755A		108	P	EA	2.00
240415754	DIODE ZENER 6.8V 1N754A		107	P	EA	2.00
240425751	DIODE ZENER 5.1V 1N751A		109	P	EA	1.00
240425752	DIODE ZENER 5.6V 1N752A		110	P	EA	1.00
240425758	DIODE ZENER 10V 1N758A		111	P	EA	1.00
240513977	DIODE ZENER 47V 1N977B		112	P	EA	1.00
253010835	DIODE HOT CARRIER HP2835		113	P	EA	15.00
270110003	TRANSISTOR NPN PN2222A		162	P	EA	3.00
270170001	TRANSISTOR NPN 2N5770		115	P	EA	17.00
270170002	TRANSISTOR NPN 2N5962		116	P	EA	21.00
275110001	TRANSISTOR PNP 2N2907A		117	P	EA	4.00
275170001	TRANSISTOR PNP 2N5087		118	P	EA	5.00
275170002	TRANSISTOR PNP 2N5771		119	P	EA	16.00
280180001	TRANSISTOR FET "N" U1897		120	P	EA	3.00
280190513	TRANSISTOR FET "N" IRF513		121	P	EA	2.00
280190642	TRANSISTOR FET "N" IRF642		122	P	EA	1.00
280190830	TRANSISTOR FET "N" IRF830		123	P	EA	1.00
281170001	TRANSISTOR FET "P" 2N5462		124	P	EA	4.00
281190523	TRANSISTOR FET "P" 9523		125	P	EA	2.00
301016103	INDUCTOR MOLDED 10 UH		126	P	EA	4.00
302380480	FILTER CHOKE 2 AMP 48 UH		127	P	EA	1.00
377051004	LABEL "DANGER HI VOLTAGE"		128	P	EA	1.00
400360028	SOCKET IC ST DIP-28		129	P	EA	2.00
400410121	IC SOCKET GRID TYP 121PIN		130	P	EA	1.00
429220001	SWITCH THERMAL 1A N.O.		131	P	EA	1.00
440290001	TRANSFORMER HV SWITCHING		132	B	EA	1.00
454110003	HDR SOLD TAIL/MALE PIN 3		133	P	EA	2.00
454111008	HDR SOLD TAIL/MALE PIN 8		134	P	EA	1.00
454121003	BLOC FOR SOCKETS 3-PIN		135	P	EA	1.00
454311003	HDR DIP SOLDER TO MALE 3		136	P	EA	2.00
454610096	HDR DIP SOLD TO MALE 96		137	P	EA	1.00
454711026	HDR DBL ROW RT ANGL 26		138	P	EA	1.00
454902001	KEYING PLUG (SNAP IN) BLK		139	P	EA	3.00
485011001	GROMMET 10MM OD 5MM ID		140	P	EA	1.00
500110001	TRANSIPAD "SMALL"		148	P	EA	2.00
500460005	MOUNTING KIT FOR TO-220		141	P	EA	6.00
550430105	SCREW CYL HD PHIL M3X5		142	P	EA	6.00
550430106	SCREW CYL HD PHIL M3X6		166	P	EA	4.00
550440106	SCREW CYL HD PHIL M4X6		144	P	EA	2.00
550440108	SCREW CYL HD PHIL M4X8		145	P	EA	2.00
551430300	WASHER SHAKEPROOF M3		146	P	EA	10.00
551440300	WASHER SHAKEPROOF M4		147	P	EA	4.00
554435401	RIVET "RIVSCREW" M 3.5		167	P	EA	2.00
560440004	SCREW PHILIPS 4-40X1/4		150	P	EA	6.00
585252354	RIVET HOLLOW 2,5X9MM		151	P	EA	2.00
709400231	HV MULTIPLIER SUPPORT	A	152	B	EA	1.00

CLASS CODE: 2
SUBASSEMBLIES
PART: F9450-2
DESC: DISPLAY CARD FOR 94xx UOM: EA SC: R REV: J

COMPONENT PART	DESCRIPTION	RV	ITEM NUMBR	SC	ST UM	QTY PER ASSEMBLY
709450201	HV UPPER COVER		154	B	EA	1.00
709450211	HV LOWER COVER		155	B	EA	1.00
709450221	FET SUPPORT		156	B	EA	1.00
709450231	SPACER HEX M3X6MM		157	B	EA	2.00
719450203	PC BD PREASS'Y 9450-2	J	158	B	EA	1.00
MDS403	DISPLAY PROCESSOR MDS403		159	B	EA	1.00

CLASS CODE: 2
SUBASSEMBLIES
PART: F9410-3
DESC: DUAL CHANNEL 100 Ms/s ADC UOM: EA SC: R REV: A

COMPONENT PART	DESCRIPTION	RV	ITEM NUMBR	SC	ST UM	QTY PER ASSEMBLY
190642221	RESISTOR NETWORK 220 OHMS		4	P	EA	2.00
190642471	RESISTOR NETWORK 470 OHMS		5	P	EA	4.00
205750000	IC AND-OR GATE ARRAY 16V8		300	P	EA	1.00
207200200	IC 8-BIT FLASH ADC 77200		14	P	EA	2.00
208122002	IC VOLT REG POS UA7805		20	P	EA	1.00
208590336	IC VOLT REFERENCE LM336		22	P	EA	1.00
208591320	IC NEG VOLT REG LM320		23	P	EA	1.00
208591340	IC POS VOLT REG LM340		24	P	EA	1.00
290120005	DELAY LINE 5NS		34	P	EA	1.00
400410046	IC SOCKET GRID TYP 46		76	P	EA	2.00
402610002	CONN CO-AX PC MTG SMB		38	P	EA	2.00
403181008	HEADER STRT BREAKAW 8-PIN		39	P	EA	2.00
405764108	SOCKET SINGLE WIRE 8-POS		37	P	EA	2.00
454610096	HDR DIP SOLD TO MALE 96		41	P	EA	1.00
554435401	RIVET "RIVSCREW" M 3.5		44	P	EA	3.00
585252354	RIVET HOLLOW 2,5X9MM		45	P	EA	2.00
709450321	HEAT SINK FOR FADC	A	77	B	EA	2.00
719410303	PC BD PREASS'Y 9410-3	B	69	B	EA	1.00
CH599011061	ADHESIVE (THERMAL COND) 709		78	P	ML	0.04
HSH410	HYB SAMPLE & HOLD HSH410	C	70	B	EA	2.00
MDX407	IC DEMULTIPLEXER MDX407		18	P	EA	2.00
SM185457102	RES VARI CERMET 1 K		74	P	EA	6.00
SM185457103	RES VARI CERMET 10 K		1	P	EA	2.00
SM200167105	IC 2-3-2 OR/NOR 10H105		6	P	EA	1.00
SM200172000	IC 2-INPUT NAND 74F00		7	P	EA	1.00
SM205220168	IC 16K SRAM 6168SO-25		9	P	EA	16.00
SM207162965	IC MEMORY DRIVER 2965		12	P	EA	2.00
SM207360125	IC TRANSLATO MC10125		15	P	EA	5.00
SM207460116	IC LINE RECEIVER 10H116		16	P	EA	2.00
SM207878245	IC BUS TRANSCVR HCT 245		17	P	EA	2.00
SM207972157	IC DATA SEL/MUX 74F157A		19	P	EA	4.00
SM208470358	IC DUAL OP AMP 358D		21	P	EA	3.00
SM270330848	TRANSISTOR NPN BC848C		30	P	EA	2.00
SM275330858	TRANSISTOR PNP BC858C		32	P	EA	2.00
SM300446220	INDUCTOR .022 UH		79	P	EA	2.00
SM301502001	BEAD (FERRITE CHIP)		25	P	EA	6.00
SM652101103	RES CHIP (E24) 1% 10 K		48	P	EA	8.00
SM652101122	RES CHIP (E24) 1% 1.2 K		49	P	EA	4.00
SM652101151	RES CHIP (E24) 1% 150 OHM		50	P	EA	1.00
SM652101201	RES CHIP (E24) 1% 200 OHM		51	P	EA	2.00
SM652101222	RES CHIP (E24) 1% 2.2 K		52	P	EA	4.00
SM652101240	RES CHIP (E24) 1% 24 OHMS		53	P	EA	9.00
SM652101241	RES CHIP (E24) 1% 240 OHM		54	P	EA	7.00
SM652101273	RES CHIP (E24) 1% 27 K		75	P	EA	4.00
SM652101332	RES CHIP (E24) 1% 3.3 K		56	P	EA	6.00
SM652101390	RES CHIP (E24) 1% 39 OHMS		57	P	EA	2.00
SM652101392	RES CHIP (E24) 1% 3.9 K		58	P	EA	4.00
SM652101471	RES CHIP (E24) 1% 470 OHM		59	P	EA	7.00
SM652101510	RES CHIP (E24) 1% 51 OHMS		60	P	EA	14.00
SM652101681	RES CHIP (E24) 1% 680 OHM		61	P	EA	2.00
SM652101820	RES CHIP (E24) 1% 82 OHMS		62	P	EA	6.00

CLASS CODE: 2
SUBASSEMBLIES
PART: F9410-3
DESC: DUAL CHANNEL 100 Ms/s ADC UOM: EA SC: R REV: A

COMPONENT PART	DESCRIPTION	RV	ITEM NUMBR	SC	ST UM	QTY PER ASSEMBLY
SM661207103	CAP CERA CHIP 20% .01UF		64	P	EA	88.00
SM661250047	CAP CERA CHIP 4.7 PF		55	P	EA	2.00
SM661255220	CAP CERA CHIP 5% 22 PF		65	P	EA	2.00
SM666247106	CAP MOLD TANT CHIP 10 UF		67	P	EA	11.00

CLASS CODE: 2
SUBASSEMBLIES
PART: F9420-4
DESC: TIMEBASE CARD UOM: EA SC: R REV: B

COMPONENT PART	DESCRIPTION	RV	ITEM NUMBR	SC	ST UM	QTY PER ASSEMBLY
103336474	CAP CERA MONO 50V .47UF		1	P	EA	1.00
190042563	RESISTOR NETWORK 56K		6	P	EA	1.00
190642221	RESISTOR NETWORK 220 OHMS		7	P	EA	1.00
190642332	RESISTOR NETWORK 3.3 K		8	P	EA	1.00
190642562	RESISTOR NETWORK 5.6 K		9	P	EA	4.00
205750000	IC AND-OR GATE ARRAY 16V8		300	P	EA	2.00
207281703	IC MONO DAC 16 BIT 703JP		31	P	EA	1.00
208123002	IC +12 VOLT REG LM340T-12		36	P	EA	1.00
208124003	IC VOLT REG NEG LM320T-12		35	P	EA	1.00
290120005	DELAY LINE 5NS		53	P	EA	1.00
310060012	CRYSTAL 10PPM 12.4031MHZ		58	P	EA	1.00
310062100	CRYSTAL 10PPM 100MHZ		59	P	EA	1.00
402610002	CONN CO-AX PC MTG SMB		60	P	EA	4.00
403181008	HEADER STRT BREAKAW 8-PIN		61	P	EA	1.00
454340002	HDR MALE PIN TO WW 02		62	P	EA	2.00
454610096	HDR DIP SOLD TO MALE 96		63	P	EA	1.00
554435401	RIVET "RIVSCREW" M 3.5		64	P	EA	2.00
585252354	RIVET HOLLOW 2,5X9MM		68	P	EA	2.00
690000000	PINS/CLIP ON		125	P	EA	3.00
690681001	PIN EDGE CLIP STRAIGHT		127	P	EA	36.00
719420403	PC BD PREASS'Y 9420-4	B	129	B	EA	1.00
719450413	PC BD PREASS'Y 9450-41	B	130	B	EA	1.00
719450423	PC BD PREASS'Y 9450-42	C	131	B	EA	2.00
719450433	PC BD PREASS'Y 9450-43	C	132	B	EA	4.00
HTD405	HYBID TIME DIGIT. HTD405	A	133	B	EA	1.00
SM158043006	CAP VARIABLE 2 - 6 PF		2	P	EA	1.00
SM158043020	CAP VARIABLE 4.5-20 PF		3	P	EA	1.00
SM158044010	CAP VARIABLE 3-10PF		5	P	EA	3.00
SM200160101	IC OR/NOR GATE 10H101		10	P	EA	2.00
SM200160402	IC 16-BIT SCALER MCT402		11	P	EA	6.00
SM200167102	IC NOR GATE 10H102		12	P	EA	5.00
SM200167104	IC 2-IN AND GATE 10H104		13	P	EA	2.00
SM200167105	IC 2-3-2 OR/NOR 10H105		14	P	EA	3.00
SM200167107	IC 2-IN EXCL OR/NOR10H107		15	P	EA	3.00
SM200167109	IC 4-5 IN OR/NOR 10H109		16	P	EA	1.00
SM200167121	IC OR-AND/O-A-INV 10H121		17	P	EA	4.00
SM200167131	IC M-S TYP D FLOP 10H131		18	P	EA	16.00
SM200172000	IC 2-INPUT NAND 74F00		19	P	EA	1.00
SM200172011	IC 3-INPUT AND 74F11		20	P	EA	1.00
SM200172074	IC D-TYP FLOP 74F74		21	P	EA	3.00
SM200172113	IC J-K TYP FLOP 74F113		22	P	EA	1.00
SM200172374	IN D-TYP FLOP 74F374		23	P	EA	2.00
SM200178000	IC 2-INPUT NAND HCT00		24	P	EA	2.00
SM200178574	IC D-TYP FLOP HCT 574		25	P	EA	8.00
SM200267016	IC BINARY COUNTER 10H016		26	P	EA	3.00
SM200278040	IC COUNTER HCT4040		27	P	EA	3.00
SM200478573	IC D-TYP LATCH 74HCT573		28	P	EA	6.00
SM207160192	IC BUS DRIV MC10192		30	P	EA	1.00
SM207360125	IC TRANSLATO MC10125		32	P	EA	4.00
SM207460116	IC LINE RECEIVER 10H116		33	P	EA	9.00
SM207878245	IC BUS TRANSCVR HCT 245		34	P	EA	2.00

CLASS CODE: 2
SUBASSEMBLIES
PART: F9420-4
DESC: TIMEBASE CARD UOM: EA SC: R REV: B

COMPONENT PART	DESCRIPTION	RV	ITEM NUMBR	SC	ST UM	QTY PER ASSEMBLY
SM232120070	DIODE ARRAY BAV70		37	P	EA	2.00
SM236030099	DIODE SO-PKG BAV99		38	P	EA	8.00
SM270030019	TRANSISTOR NPN BFS19		39	P	EA	3.00
SM270030020	TRANSISTOR NPN BFS20		40	P	EA	1.00
SM270030092	TRANSISTOR NPN BFR92		41	P	EA	7.00
SM270040092	TRANSISTOR NPN BFR92R		42	P	EA	3.00
SM270130092	TRANSISTOR NPN BFR92A		43	P	EA	1.00
SM270140092	TRANSISTOR NPN BFR92AR		44	P	EA	2.00
SM270330848	TRANSISTOR NPN BC848C		45	P	EA	1.00
SM270340848	TRANSISTOR NPN 848CR		46	P	EA	1.00
SM275030550	TRANSISTOR PNP BF550		47	P	EA	4.00
SM275040550	TRANSISTOR PNP BF550R		48	P	EA	3.00
SM275330858	TRANSISTOR PNP BC858C		49	P	EA	5.00
SM275340858	TRANSISTOR PNP 858CR		50	P	EA	3.00
SM289240061	TRANSISTOR NPN BCV61		51	P	EA	1.00
SM289240062	TRANSISTOR ARRAY BCV62		52	P	EA	2.00
SM300446150	INDUCTOR .015UH		54	P	EA	2.00
SM300446330	INDUCTOR .033 UH		55	P	EA	1.00
SM300546151	INDUCTOR .15 UH		56	P	EA	1.00
SM652101101	RES CHIP (E24) 1% 100 OHM		69	P	EA	10.00
SM652101102	RES CHIP (E24) 1% 1 K		70	P	EA	15.00
SM652101103	RES CHIP (E24) 1% 10 K		71	P	EA	11.00
SM652101121	RES CHIP (E24) 1% 120 OHM		72	P	EA	4.00
SM652101122	RES CHIP (E24) 1% 1.2 K		73	P	EA	1.00
SM652101151	RES CHIP (E24) 1% 150 OHM		74	P	EA	15.00
SM652101152	RES CHIP (E24) 1% 1.5 K		134	P	EA	1.00
SM652101161	RES CHIP (E24) 1% 160 OHM		75	P	EA	5.00
SM652101162	RES CHIP (E24) 1% 1.6 K		76	P	EA	1.00
SM652101180	RES CHIP (E24) 1% 18 OHMS		77	P	EA	8.00
SM652101181	RES CHIP (E24) 1% 180 OHM		78	P	EA	4.00
SM652101182	RES CHIP (E24) 1% 1.8 K		79	P	EA	1.00
SM652101201	RES CHIP (E24) 1% 200 OHM		80	P	EA	6.00
SM652101202	RES CHIP (E24) 1% 2 K		81	P	EA	9.00
SM652101221	RES CHIP (E24) 1% 220 OHM		82	P	EA	8.00
SM652101222	RES CHIP (E24) 1% 2.2 K		83	P	EA	4.00
SM652101223	RES CHIP (E24) 1% 22 K		84	P	EA	1.00
SM652101242	RES CHIP (E24) 1% 2.4 K		85	P	EA	2.00
SM652101271	RES CHIP (E24) 1% 270 OHM		86	P	EA	20.00
SM652101272	RES CHIP (E24) 1% 2.7 K		87	P	EA	4.00
SM652101301	RES CHIP (E24) 1% 300 OHM		88	P	EA	3.00
SM652101302	RES CHIP (E24) 1% 3 K		89	P	EA	3.00
SM652101330	RES CHIP (E24) 1% 33 OHMS		90	P	EA	3.00
SM652101331	RES CHIP (E24) 1% 330 OHM		91	P	EA	17.00
SM652101332	RES CHIP (E24) 1% 3.3 K		92	P	EA	5.00
SM652101362	RES CHIP (E24) 1% 3.6 K		93	P	EA	5.00
SM652101391	RES CHIP (E24) 1% 390 OHM		136	P	EA	1.00
SM652101470	RES CHIP (E24) 47 OHMS		94	P	EA	32.00
SM652101471	RES CHIP (E24) 1% 470 OHM		95	P	EA	54.00
SM652101510	RES CHIP (E24) 1% 51 OHMS		96	P	EA	13.00
SM652101512	RES CHIP (E24) 1% 5.1 K		97	P	EA	10.00
SM652101560	RES CHIP (E24) 1% 56 OHM		98	P	EA	1.00

CLASS CODE: 2
SUBASSEMBLIES
PART: F9420-4
DESC: TIMEBASE CARD UOM: EA SC: R REV: B

COMPONENT PART	DESCRIPTION	RV	ITEM NUMBR	SC	ST UM	QTY PER ASSEMBLY
SM652101561	RES CHIP (E24) 1% 560 OHM		99	P	EA	2.00
SM652101562	RES CHIP (E24) 1% 5.6 K		100	P	EA	14.00
SM652101622	RES CHIP (E24) 1% 6.2 K		101	P	EA	24.00
SM652101680	RES CHIP (E24) 1% 68 OHMS		102	P	EA	3.00
SM652101681	RES CHIP (E24) 1% 680 OHM		103	P	EA	35.00
SM652101820	RES CHIP (E24) 1% 82 OHMS		105	P	EA	45.00
SM652101821	RES CHIP (E24) 1% 820 OHM		106	P	EA	36.00
SM652101822	RES CHIP (E24) 1% 8.2 K		107	P	EA	2.00
SM653125033	RES THICK FILM 5% 3.3 OHM		108	P	EA	2.00
SM661127104	CAP CERA CHIP 20% .1 UF		109	P	EA	2.00
SM661186180	CAP CERA CHIP 10% 18 PF		110	P	EA	2.00
SM661205332	CAP CERA CHIP 5% 3300 PF		122	P	EA	1.00
SM661207102	CAP CERA CHIP 10% .001UF		111	P	EA	6.00
SM661207103	CAP CERA CHIP 20% .01UF		112	P	EA	109.00
SM661250047	CAP CERA CHIP 4.7 PF		113	P	EA	2.00
SM661250082	CAP CERA CHIP .1% 8.2 PF		114	P	EA	4.00
SM661255100	CAP CERA CHIP 10PF		115	P	EA	1.00
SM661255101	CAP CERA CHIP 5% 100 PF		116	P	EA	2.00
SM661255181	CAP CERA CHIP 5% 180 PF		118	P	EA	1.00
SM661255221	CAP CERA CHIP 5% 220 PF		119	P	EA	1.00
SM661255270	CAP CERA CHIP 27PF		120	P	EA	5.00
SM661255330	CAP CERA CHIP 5% 33 PF		121	P	EA	2.00
SM661255560	CAP CERA CHIP 56PF		123	P	EA	9.00
SM666247106	CAP MOLD TANT CHIP 10 UF		124	P	EA	6.00

CLASS CODE: 2
SUBASSEMBLIES
PART: F9410-5
DESC: DUAL CHANNEL FRONT PANEL CARD UOM: EA SC: R REV: A

COMPONENT PART	DESCRIPTION	RV	ITEM NUMBR	SC	ST UM	QTY PER ASSEMBLY
103327103	CAP CERA MONO 50V .01 UF		1	P	EA	4.00
103427104	CAP CERA MONO 100V .1 UF		2	P	EA	8.00
161225103	RES COMP 1/8W 5% 10 K		3	P	EA	2.00
161225121	RES COMP 1/8W 5% 120 OHMS		4	P	EA	16.00
168531365	RES PREC RN55D 511 OHMS		5	P	EA	2.00
168531381	RES PREC RN55D 750 OHMS		6	P	EA	1.00
168531521	RES PREC RN55D 21.5 K		7	P	EA	1.00
169416473	RESISTOR DISC NTC 47 K		8	P	EA	1.00
184417502	RES VARI COND PLASTIC 5 K		9	P	EA	10.00
184427502	RES VARI COND PLASTIC 5 K		10	P	EA	2.00
184437502	RES VARI COND PLASTIC 5 K		11	P	EA	2.00
190001001	RES NETWORK SPECIAL		12	P	EA	1.00
200344138	IC DECODER 3TO8 74HCT138		13	P	EA	1.00
205644094	IC 8-BIT SHIFT REGHCT4094		14	P	EA	5.00
205750000	IC AND-OR GATE ARRAY 16V8		300	P	EA	1.00
207345051	IC MUX/DEMUX HCT4051		16	P	EA	4.00
208590385	IC VOLT REF LM385		17	P	EA	1.00
230020062	DIODE SWITCHING BAW62		18	P	EA	54.00
256243300	DIODE LED RED HLMP-0300		19	P	EA	2.00
256443421	DIODE LED YEL HLMP-0421		20	P	EA	35.00
403950002	POLARIZING KEY		21	P	EA	2.00
412001012	SWITCH ROT N/STOP 12-PINS		22	P	EA	4.00
416161003	SWITCH PUSHBUTTON SPST		23	P	EA	48.00
454211020	HDR SOLD TAIL TO MALE 20		24	P	EA	1.00
536068001	KNOB FOR 6MM SHAFT		1002	P	EA	4.00
536068002	KNOB FOR 3MM SHAFT		1003	P	EA	2.00
536068003	CAP (FOR KNOB 020-2215)		1004	P	EA	11.00
536068005	CAP FOR 020-3215 OR -3415		1005	P	EA	3.00
536068006	CAP FOR 021-1110 OR -2215		1006	P	EA	2.00
536168001	KNOB FOR 1/8" SHAFT		1007	P	EA	9.00
536168002	KNOB FOR 1/8" SHAFT		1008	P	EA	1.00
536168003	KNOB FOR 1/8" SHAFT		1009	P	EA	2.00
550430106	SCREW CYL HD PHIL M3X6		25	P	EA	8.00
551430300	WASHER SHAKEPROOF M3		26	P	EA	8.00
553230108	SPACER HEX M3X8MM		27	P	EA	4.00
554422004	SCREW SELF TAPPING PHIL HD		1010	P	EA	13.00
709400511	LED COVER 9400-5	A	28	B	EA	37.00
709450511	CALIBR.TERMIN. 9450-5		29	B	EA	2.00
709450523	PUSH SWITCH EXTENDER	D	30	B	EA	48.00
719430503	PC BD PREASS'Y 9430-51	A	31	B	EA	1.00
719430513	PC BD PREASS'Y 9430-52	A	32	B	EA	1.00
729424521	SPRING CONTACT		33	P	EA	1.00
FP9410-5	COMPLETED FRONT PANEL 9410-5	B	1000	R	EA	1.00
HPC411AIH	PROBE CALIBRATOR	A	34	R	EA	1.00

CLASS CODE: 2
SUBASSEMBLIES
PART: F9410-6
DESC: PROCESSOR CARD UOM: EA SC: R REV: C

COMPONENT PART	DESCRIPTION	RV	ITEM NUMBR	SC	ST UM	QTY PER ASSEMBLY
102412100	CAP CERA DISC 100V 10 PF		4	P	EA	1.00
102412220	CAP CERA DISC 100V 22 PF		6	P	EA	1.00
103307103	CAP CERA MONO 50V .01 UF		1	P	EA	35.00
103427104	CAP CERA MONO 100V .1 UF		2	P	EA	35.00
103506331	CAP CERA MONO 100V 330 PF		7	P	EA	1.00
103625151	CAP CERA MONO 100V 150 PF		5	P	EA	2.00
142214156	CAP TANT DIP CASE 15 UF		8	P	EA	1.00
146354107	CAP MINI ALUM 20% 100 UF		9	P	EA	3.00
147436033	CAP ALUM METAL CAN 33 UF		10	P	EA	1.00
161225027	RES COMP 1/8W 5% 2.7 OHMS		3	P	EA	2.00
161225102	RES COMP 1/8W 5% 1 K		11	P	EA	6.00
161225103	RES COMP 1/8W 5% 10 K		12	P	EA	4.00
161225206	RES CARBON FILM 20 MEG		13	P	EA	2.00
161225391	RES COMP 1/8W 5% 390 OHMS		14	P	EA	3.00
161225472	RES COMP 1/8W 5% 4.7 K		15	P	EA	1.00
168531229	RES PREC RN55D 19.6 OHMS		16	P	EA	1.00
168531389	RES PREC RN55D 909 OHMS		17	P	EA	1.00
168531401	RES PREC RN55D 1.21 K		18	P	EA	1.00
168531449	RES PREC RN55D 3.83 K		19	P	EA	1.00
168531585	RES PREC RN55D 100 K		20	P	EA	3.00
168531601	RES PREC RN55D 147 K		21	P	EA	1.00
168531633	RES PREC RN55D 316 K		22	P	EA	1.00
190042103	RESISTOR NETWORK 10 K		23	P	EA	4.00
190832220	RESISTOR NETWORK 22 OHMS		24	P	EA	1.00
190842102	RES NETWORK 1 K		25	P	EA	1.00
200344174	IC HEX D-FLOP 74HCT174		26	P	EA	1.00
200430393	IC BIN COUNTER HCT393		27	P	EA	2.00
200440390	IC DEC COUNTER 74HCT390		28	P	EA	2.00
200480167	IC REAL TIME CLOCK 58167		29	P	EA	1.00
205254256	IC 256 X 4 RAM 424256C		65	P	EA	4.00
205271256	IC 32K X 8 RAM 62256-12		30	P	EA	2.00
205272064	IC8192X8 RAM 6264LP-10		31	P	EA	2.00
205301000	UV E-PROM CMOS 1MBIT		32	P	EA	6.00
205640165	IC SHIFT REG HCT165		33	P	EA	1.00
205750000	IC AND-OR GATE ARRAY 16V8		300	P	EA	12.00
207172965	IC MEMORY DRIVER 2965		66	P	EA	1.00
207367576	IC 8-BIT ADC AD7576		36	P	EA	1.00
207472245	IC BUS TRANSCVR HCT245		37	P	EA	9.00
208011007	IC DUAL OP AMP LM358N		38	P	EA	1.00
208517705	IC VOLTAGE REG 7705		39	P	EA	1.00
208618212	IC VOLT DETECTOR 8212		40	P	EA	1.00
227792968	IC RAM CONTROLLER 2968A		64	P	EA	1.00
230020062	DIODE SWITCHING BAW62		45	P	EA	2.00
253010811	DIODE SCHOTTKY BAR HP2811		43	P	EA	2.00
256233209	DIODE LED (RED) TIL209A		44	P	EA	1.00
275110001	TRANSISTOR PNP 2N2907A		46	P	EA	1.00
280170104	TRANSISTOR FET N VN0104N3		47	P	EA	4.00
309041016	CRYSTAL OSCILLATOR 16MHZ		48	P	EA	1.00
310111032	CRYSTAL RESONATOR 32KH		49	P	EA	1.00
312660030	BATTERY PC MTG LITH 3V		50	P	EA	1.00
400331020	SOCKET IC ST DIP-20		51	P	EA	1.00

CLASS CODE: 2
SUBASSEMBLIES
PART: F9410-6
DESC: PROCESSOR CARD UOM: EA SC: R REV: C

COMPONENT PART	DESCRIPTION	RV	ITEM NUMBR	SC	ST UM	QTY PER ASSEMBLY
400360028	SOCKET IC ST DIP-28		52	P	EA	1.00
400360032	SOCKET IC ST DIP-32		53	P	EA	6.00
403950002	POLARIZING KEY		57	P	EA	2.00
411430002	SWITCH ROCKER PC MTG (4)		58	P	EA	1.00
454211020	HDR SOLD TAIL TO MALE 20		59	P	EA	1.00
454610096	HDR DIP SOLD TO MALE 96		60	P	EA	1.00
585252354	RIVET HOLLOW 2,5X9MM		61	P	EA	2.00
7194XX603	PC BD PREASS'Y 94xx-6	A	62	B	EA	1.00
MNX401	ICMIN MAX GATEARR. MNX401		63	B	EA	1.00
SM207668020	IC 32-BIT U-PROC 68020		41	P	EA	1.00
SM207668881	IC CO-PROCESSOR 68881		42	P	EA	1.00

CLASS CODE: 2
SUBASSEMBLIES
PART: F9430-7
DESC: DUAL CHANNEL 150 MHz FRONTEND UOM: EA SC: R REV: D

COMPONENT PART	DESCRIPTION	RV	ITEM NUMBR	SC	ST UM	QTY PER ASSEMBLY
158849009	CAP VARIABLE .5 - 2.5 PF		1	P	EA	2.00
158849012	CAP VARIABLE 5.0-15 PF		2	P	EA	2.00
158849013	CAP VARIABLE 6-25 PF		3	P	EA	2.00
208144001	IC ADJ POS VOLT REG UA78G		4	P	EA	1.00
208144002	IC ADJ NEG VOLT REG UA79G		15	P	EA	1.00
208591320	IC NEG VOLT REG LM320		5	P	EA	1.00
208591340	IC POS VOLT REG LM340		6	P	EA	1.00
280151440	MATCHED PAIR JFET U440		81	P	EA	2.00
402110302	CONN CO-AX PC MTG BNC		8	P	EA	3.00
403950002	POLARIZING KEY		59	P	EA	2.00
430490003	RELAY 2 FORM C DPDT		63	P	EA	7.00
454150010	HDR SOLD TAIL/PC EDG10		10	P	EA	1.00
454211040	HDR SOLD TAIL TO MALE 40		11	P	EA	1.00
454311008	HDR MALE PIN TO WW (2X4)8		12	P	EA	2.00
454340012	HDR MALE PIN TO WW 12		14	P	EA	1.00
550425106	SCREW CYL HD PHIL M2.5X6		1003	P	EA	5.00
550425520	SCREW FLAT HD PHIL 2,5X20		1004	P	EA	15.00
554435401	RIVET "RIVSCREW" M 3.5		58	P	EA	4.00
709424711	UPPER RF SHIELD	A	1000	B	EA	1.00
709424731	FRONT RF SHIELD	A	1002	B	EA	1.00
709430701	LOWER RF SHIELD	A	1001	B	EA	1.00
719430703	PC BD PREASS'Y 9430-7	G	61	B	EA	1.00
780261129	SMB-SMC CABLE 29		9	B	EA	2.00
MFE409	MONOL. DSO FRONT END (500MHZ)		13	B	EA	2.00
MTR408	TRIGGER COUPLING & COMPARATOR		16	B	EA	3.00
SM168651297	RES METAL FILM 1% 100 OHMS		64	P	EA	4.00
SM168659004	RES METAL FILM .1% 900 OHMS		65	P	EA	1.00
SM168659005	RES METAL FILM .1% 300.0 K		66	P	EA	9.00
SM168659006	RES METAL FILM .1% 111.1 K		67	P	EA	3.00
SM168659297	RES METAL FILM .1% 100 OHMS		68	P	EA	1.00
SM185457103	RES VARI CERMET 10 K		18	P	EA	2.00
SM185457201	RES VARI CERMET 200 OHMS		17	P	EA	1.00
SM185457203	RES VARI CERMET 20 K		19	P	EA	7.00
SM185457503	RES VARI CERMET 50 K		20	P	EA	1.00
SM200178004	IC HEX INVERTER HCT04		23	P	EA	1.00
SM200178138	IC 3-8 LINE DECOD HCT 138		24	P	EA	3.00
SM205616094	IC 8-ST.SHIFT REG HCT4094		25	P	EA	6.00
SM207178366	IC HEX LINE DRIVER 74HCT366		21	P	EA	2.00
SM207770201	IC ANALOG SWITCH DG201		26	P	EA	5.00
SM207978153	IC 4-INPUT MUX HCT153		27	P	EA	1.00
SM208470007	IC OP AMP OP-07		22	P	EA	1.00
SM208470347	IC J-FET OP AMP 347		141	P	EA	2.00
SM208470351	IC J-FET OP AMP 351		29	P	EA	1.00
SM208470353	IC DUAL OP AMP 353		30	P	EA	7.00
SM208870339	IC VOLT COMPARATOR 339		31	P	EA	1.00
SM208971881	IC VIDEO SYNC SEPARATOR LM1881		142	P	EA	1.00
SM236030099	DIODE SO-PKG BAV99		34	P	EA	6.00
SM240050033	DIODE ZENER TZM-C-3V3		69	P	EA	3.00
SM240050039	DIODE ZENER TZM-C-3V9		32	P	EA	3.00
SM240050051	DIODE ZENER TZM-C-5V1		33	P	EA	2.00
SM252023018	DIODE PIN BAT 18		82	P	EA	8.00

CLASS CODE: 2
SUBASSEMBLIES
PART: F9430-7
DESC: DUAL CHANNEL 150 MHz FRONTEND UOM: EA SC: R REV: D

COMPONENT PART	DESCRIPTION	RV	ITEM NUMBR	SC	ST UM	QTY PER ASSEMBLY
SM270130092	TRANSISTOR NPN BFR92A		36	P	EA	6.00
SM270130093	TRANSISTOR NPN BFR93A		72	P	EA	2.00
SM270140092	TRANSISTOR NPN BFR92AR		73	P	EA	4.00
SM270330848	TRANSISTOR NPN BC848C		37	P	EA	1.00
SM275030093	TRANSISTOR PNP BFT93		39	P	EA	2.00
SM275040093	TRANSISTOR PNP BFT93R		35	P	EA	2.00
SM275330858	TRANSISTOR PNP BC858C		40	P	EA	2.00
SM280120056	TRANSISTOR JFET N-CH BSR56		75	P	EA	4.00
SM280124416	TRANSISTOR JFET N-CH SST4416		76	P	EA	4.00
SM289240062	TRANSISTOR ARRAY BCV62		41	P	EA	4.00
SM289772003	TRANSISTOR ARRAY 2003		42	P	EA	1.00
SM300367680	INDUCTOR MULTILAYER .068 UH		79	P	EA	2.00
SM300446220	INDUCTOR .022 UH		143	P	EA	2.00
SM300486104	INDUCTOR WOUND 100uH		144	P	EA	2.00
SM301502001	BEAD (FERRITE CHIP)		44	P	EA	24.00
SM652101100	RES CHIP (E24) 1% 10 OHMS		86	P	EA	12.00
SM652101101	RES CHIP (E24) 1% 100 OHM		87	P	EA	19.00
SM652101102	RES CHIP (E24) 1% 1 K		88	P	EA	1.00
SM652101103	RES CHIP (E24) 1% 10 K		89	P	EA	8.00
SM652101104	RES CHIP (E24) 1% 100 K		90	P	EA	4.00
SM652101105	RES CHIP (E24) 1% 1 M		91	P	EA	4.00
SM652101106	RES CHIP (E24) 1% 10 MEG		92	P	EA	4.00
SM652101116	RES CHIP (E24) 1% 11 M		94	P	EA	2.00
SM652101121	RES CHIP (E24) 1% 120 OHM		95	P	EA	2.00
SM652101122	RES CHIP (E24) 1% 1.2 K		96	P	EA	5.00
SM652101123	RES CHIP (E24) 1% 12 K		97	P	EA	3.00
SM652101151	RES CHIP (E24) 1% 150 OHM		98	P	EA	4.00
SM652101152	RES CHIP (E24) 1% 1.5 K		99	P	EA	2.00
SM652101162	RES CHIP (E24) 1% 1.6 K		140	P	EA	4.00
SM652101163	RES CHIP (E24) 1% 16 K		100	P	EA	2.00
SM652101164	RES CHIP (E24) 1% 160 K		145	P	EA	2.00
SM652101183	RES CHIP (E24) 1% 18 K		101	P	EA	2.00
SM652101200	RES CHIP (E24) 1% 20 OHMS		102	P	EA	5.00
SM652101202	RES CHIP (E24) 1% 2 K		103	P	EA	4.00
SM652101203	RES CHIP (E24) 1% 20 K		104	P	EA	4.00
SM652101220	RES CHIP (E24) 1% 22 OHMS		105	P	EA	2.00
SM652101221	RES CHIP (E24) 1% 220 OHM		146	P	EA	2.00
SM652101223	RES CHIP (E24) 1% 22 K		147	P	EA	2.00
SM652101240	RES CHIP (E24) 1% 24 OHMS		107	P	EA	12.00
SM652101241	RES CHIP (E24) 1% 240 OHM		108	P	EA	2.00
SM652101242	RES CHIP (E24) 1% 2.4 K		109	P	EA	4.00
SM652101243	RES CHIP (E24) 1% 24 K		110	P	EA	7.00
SM652101301	RES CHIP (E24) 1% 300 OHM		113	P	EA	1.00
SM652101302	RES CHIP (E24) 1% 3 K		114	P	EA	9.00
SM652101332	RES CHIP (E24) 1% 3.3 K		116	P	EA	5.00
SM652101390	RES CHIP (E24) 1% 39 OHMS		148	P	EA	4.00
SM652101391	RES CHIP (E24) 1% 390 OHM		117	P	EA	1.00
SM652101392	RES CHIP (E24) 1% 3.9 K		118	P	EA	2.00
SM652101471	RES CHIP (E24) 1% 470 OHM		119	P	EA	14.00
SM652101472	RES CHIP (E24) 1% 4.7 K		120	P	EA	2.00
SM652101474	RES CHIP (E24) 1% 470 K		121	P	EA	1.00

CLASS CODE: 2
SUBASSEMBLIES
PART: F9430-7
DESC: DUAL CHANNEL 150 MHz FRONTEND UOM: EA SC: R REV: D

COMPONENT PART	DESCRIPTION	RV	ITEM NUMBR	SC	ST UM	QTY PER ASSEMBLY
SM652101510	RES CHIP (E24) 1% 51 OHMS		122	P	EA	16.00
SM652101512	RES CHIP (E24) 1% 5.1 K		123	P	EA	9.00
SM652101560	RES CHIP (E24) 1% 56 OHM		124	P	EA	1.00
SM652101561	RES CHIP (E24) 1% 560 OHM		125	P	EA	3.00
SM652101683	RES CHIP (E24) 1% 68 K		128	P	EA	2.00
SM652101684	RES CHIP (E24) 1% 680 K		129	P	EA	1.00
SM652101750	RES CHIP (E24) 1% 75 OHMS		130	P	EA	8.00
SM652101752	RES CHIP (E24) 1% 7.5 K		131	P	EA	2.00
SM652101821	RES CHIP (E24) 1% 820 OHM		132	P	EA	3.00
SM652101824	RES CHIP (E24) 1% 820 K		134	P	EA	1.00
SM652101910	RES CHIP (E24) 1% 91 OHMS		135	P	EA	3.00
SM652101913	RES CHIP (E24) 1% 91 K		136	P	EA	2.00
SM652101914	RES CHIP (E24) 1% 910 K		137	P	EA	1.00
SM652180115	RES CHIP (E24) .5% 1.1 MEG		149	P	EA	2.00
SM653185224	RES THICK FILM 220 K		47	P	EA	2.00
SM661127104	CAP CERA CHIP 20% .1 UF		48	P	EA	6.00
SM661205822	CAP CERA CHIP 8200PF		83	P	EA	3.00
SM661207103	CAP CERA CHIP 20% .01UF		50	P	EA	105.00
SM661255047	CAP CERA CHIP 4.7 PF		138	P	EA	1.00
SM661255068	CAP CERA CHIP 6.8 PF		53	P	EA	2.00
SM661255101	CAP CERA CHIP 5% 100 PF		74	P	EA	4.00
SM661255102	CAP CERA CHIP 5% 1000 PF		80	P	EA	11.00
SM661255150	CAP CERA CHIP 5% 15 PF		139	P	EA	4.00
SM661255221	CAP CERA CHIP 5% 220 PF		150	P	EA	4.00
SM661255330	CAP CERA CHIP 5% 33 PF		151	P	EA	1.00
SM661255331	CAP CERA CHIP 5% 330 PF		54	P	EA	3.00
SM661255470	CAP CERA CHIP 47PF		152	P	EA	5.00
SM661255821	CAP CERA CHIP 5% 820 PF		55	P	EA	1.00
SM661256120	CAP CERA CHIP 10% 12 PF		153	P	EA	2.00
SM661495561	CAP CERA CHIP 5% 560 PF		56	P	EA	3.00
SM661666223	CAP CERA CHIP 10% .022 UF		84	P	EA	2.00
SM661726103	CAP CERA CHIP 10% .01 UF		43	P	EA	10.00
SM666327225	CAP MOLD TANT CHIP 2.2 UF		57	P	EA	23.00
SM666427105	CAP MOLD TANT CHIP 1 UF		45	P	EA	3.00

CLASS CODE: 2
SUBASSEMBLIES
PART: F9420-8
DESC: CLOCK-BUS UOM: EA SC: R REV: B

COMPONENT PART	DESCRIPTION	RV	ITEM NUMBR	SC	ST UM	QTY PER ASSEMBLY
454150021	HDR SOLD TAIL/PC EDG21		1	P	EA	2.00
719420803	PC BD PREASS'Y 9420-8	B	2	B	EA	1.00
9420-8-SUB	SUBCONTRACTOR BOM FOR F9420-8		3	R	EA	0.00

CLASS CODE: 2
SUBASSEMBLIES
PART: F9410-9
DESC: REAR PANEL FOR 9410 UOM: EA SC: R REV: C

COMPONENT PART	DESCRIPTION	RV	ITEM NUMBR	SC	ST UM	QTY PER ASSEMBLY
205750000	IC AND-OR GATE ARRAY 16V8		300	P	EA	2.00
455021018	CONNECTOR PIN (FEMALE)		1003	P	EA	2.00
455210002	BLOCK FOR CRIMP MALE PIN2		1004	P	EA	1.00
530409312	FAN AXIAL 12V		1005	P	EA	1.00
550440412	SCREW CYL INT HEX		1016	P	EA	4.00
551440100	FLAT WASHER M4		1012	P	EA	4.00
551440400	WASHER SHAKEPROOF M4		1013	P	EA	4.00
554500001	TAPPING SCREW W/U-THREAD		1018	P	EA	2.00
709410903	SERIAL NUMBER PLATE	A	1002	B	EA	1.00
709424911	VOLTAGE SELECTOR COVER	A	1001	B	EA	1.00
709424941	SCREW FOR SELECTOR COVER	A	1014	B	EA	1.00
RP94XX-9	REAR PANEL 94XX-9	A	1000	R	EA	1.00

CLASS CODE: 2
SUBASSEMBLIES
PART: M9424
DESC: MECHANICAL FOR 9424 UOM: EA SC: R REV: C

COMPONENT PART	DESCRIPTION	RV	ITEM NUMBR	SC	ST UM	QTY PER ASSEMBLY
300090001	DEFLECTION YOKE		1	P	EA	1.00
315040015	POWER SUPPLY 9451-1		1043	B	EA	1.00
321220009	CRT ORANGE 90 DEG DEFL 9"		1019	P	EA	1.00
377051005	LABEL "DANGER———ONLY"	A	1020	B	EA	1.00
377131001	LABEL (GROUND SYMBOL)		1041	P	EA	1.00
389000000	ADHESIVE APENFIX		1049	P	ME	0.10
433162200	FUSE SLO-BLO 250V 2AMP		7	P	EA	2.00
433162400	FUSE SLO-BLO 250V 4 AMP		6	P	EA	2.00
455020001	CONNECTOR PIN (FEMALE)		2	P	EA	4.00
455121003	CONNECTOR HOUSING 3		3	P	EA	2.00
455950002	CLAMP WITH STRAIN RELIEF		4	P	EA	2.00
485023008	BUMPER (FOOT) BLACK RUBBER		1046	P	EA	4.00
530010024	FOOT FOR COMPAC ENCLOSURE		1032	P	EA	4.00
530301005	HANDLE (U-SHAPE)		1021	B	EA	1.00
530410001	CARD GUIDE NON METALLIC		1022	P	EA	5.00
544310001	SPRING EXT TYPE 190 MM		1023	B	EA	1.00
550425505	SCREW FLAT HD PHIL M2.5X5		1044	P	EA	1.00
550430104	SCREW CYL HD PHIL M3X4		1013	P	EA	10.00
550430106	SCREW CYL HD PHIL M3X6		1011	P	EA	14.00
550430108	SCREW CYL HD PHIL M3X8		1012	P	EA	3.00
550440105	SCREW CYL HD PHIL M4X5		1038	P	EA	4.00
550440108	SCREW CYL HD PHIL M4X8		1037	P	EA	15.00
550440110	SCREW CYL HD PHIL M4X10		1033	P	EA	5.00
550440120	SCREW CYL HD PHIL		1035	P	EA	3.00
550440120	SCREW CYL HD PHIL		1053	P	EA	1.00
550440406	SCREW CYL INT HEX M4X6		1007	P	EA	12.00
550440416	CYL INT HEX M4X16		1024	P	EA	4.00
550440506	SCREW FLAT HD PHIL M4X6		1045	P	EA	2.00
550440708	SCREW LARGE HEAD M4X8		1010	P	EA	8.00
551430300	WASHER SHAKEPROOF M3		1016	P	EA	27.00
551440300	WASHER SHAKEPROOF M4		1039	P	EA	24.00
551440300	WASHER SHAKEPROOF M4		1054	P	EA	1.00
551440400	WASHER SHAKEPROOF M4		1040	P	EA	2.00
551440501	WASHER FLAT (SPRING) M4		1025	P	EA	8.00
552440100	NUT HEX M4		1015	P	EA	10.00
554440202	FLAT WASHER M4		1018	P	EA	4.00
594120003	TIEWRAP		5	P	EA	2.00
594120003	TIEWRAP		1026	P	EA	3.00
594230002	CABLE CLIP ADHESIVE BACK		1047	P	EA	1.00
709424011	NUT FOR HANDLE	A	1034	B	EA	3.00
709424021	SIDE PANEL	C	1000	B	EA	2.00
709424031	DIPLAY SUPPORT	B	1001	B	EA	1.00
709424041	REAR SUPPORT	B	1002	B	EA	1.00
709424051	MOTHER CARD SUPPORT	B	1003	B	EA	1.00
709424061	POWER SUPPLY SUPPORT	A	1004	B	EA	1.00
709424071	UPPER COVER	B	1005	B	EA	1.00
709424081	LOWER COVER	B	1006	B	EA	1.00
709424095	CARD RETAINER	C	1048	B	EA	1.00
709424096	INSERTION GUIDE FOR MC	E	1050	B	EA	1.00
709424098	SPACER FOR INSERTION GUIDE	A	1051	B	EA	1.00
709450071	NEOPRENE WASHER	A	1014	B	EA	4.00

CLASS CODE: 2
SUBASSEMBLIES
PART: M9424
DESC: MECHANICAL FOR 9424 UOM: EA SC: R REV: C

COMPONENT PART	DESCRIPTION	RV	ITEM NUMBR	SC	ST UM	QTY PER ASSEMBLY
780210030	DISPLAY POWER CABLE	A	1028	B	EA	1.00
780220015	BASE CARD POWER CABLE	A	1029	B	EA	1.00
780231120	FRONT END BASE CABLE	B	1030	B	EA	1.00
780231131	MEMORY CARD CABLE	A	1052	B	EA	1.00
780299025	CRT CABLE	B	1031	B	EA	1.00
780411236	FRONT PANEL CABLE	A	1027	B	EA	1.00
780544512	GROUND CABLE	A	1042	B	EA	1.00

CLASS CODE: 2
SUBASSEMBLIES
PART: ACCESSORIES-9410
DESC: ACCESSORIES FOR 9410 UOM: EA SC: R REV: 3

COMPONENT PART	DESCRIPTION	RV	ITEM NUMBR	SC	ST UM	QTY PER ASSEMBLY
407099008	PLUG FOR AC LINE -ENGLAND		10	P	EA	0.05
433162200	FUSE SLO-BLO 250V 2AMP		11	P	EA	2.00
433162400	FUSE SLO-BLO 250V 4 AMP		13	P	EA	2.00
589202100	AC CORD/PLUG FOR FRANCE		8	P	EA	0.05
589202200	AC CORD/PLUG FOR GERMANY		9	P	EA	0.25
589203100	AC CORD/"SEV-ASE" PLUG		7	P	EA	0.10
589203218	AC CORD/US-CANADA PLUG		6	P	EA	0.55
597940011	SHIPPING CARTON 9400		15	B	EA	1.00
597940014	PLASTIC BAG FOR 9400		4	P	EA	2.00
597940015	MANUAL/ACCESSORY CTN 9400		5	B	EA	2.00
597942403	SHIPPING INSERT (REAR) 9424		12	B	EA	2.00
709424091	DSO COVER 9424	D	14	B	EA	1.00
9410-OM-E	9410 OPERATOR'S MANUAL - ENG		16	B	EA	0.90
9410-OM-F	9410 OPERATOR'S MANUAL - ENG		18	B	EA	0.10
94XX-P01	:10 PASS PROBE 150MHZ (TESTED)		1	R	EA	2.00
94XX-RCM-E	94XX SERIES REMOTE CONTROL MAN		17	B	EA	1.00

Chapter 9

Connecting the 9410 to a plotter or a printer.

Table of contents

9. Introduction

LeCroy oscilloscopes are supplied with a list of plotters and printers known to work with them. This list is not final, so any suggestions are welcome.

While the 9400 oscilloscope can only be connected to plotters, the 9410 and all other instruments of the same generation can be with some printers. Possible differences will be described.

HP plotter responses to some RS-232 configuration commands have been modified. Consequently, the 9410 generation DSO support HP plotters of two types. They may however, despite these changes, work with HPGL compatible plotters from other manufacturers.

Before connecting a plotter to a DSO, do not forget to select the appropriate settings in the plotter menu and the RS-232 menu pages.

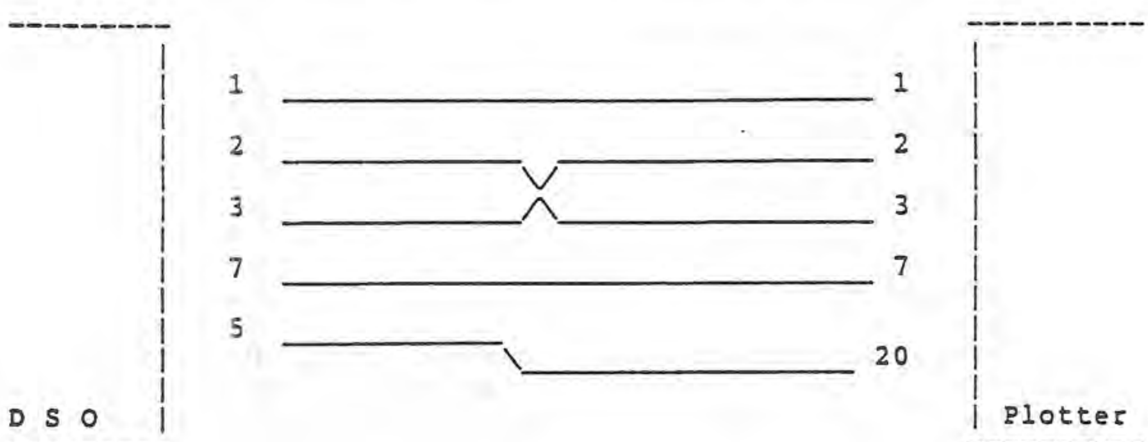
RS-232 connection:

The following settings are assumed for the scope:

Baud rate:	9600
Character:	8 bits
Parity:	none
Stop bits:	1

Any exceptions will be mentioned.

A cable with the following pinout can be used in almost every cases:



The cable has D25 connectors with male pins on both sides.

GPIB connection:

To have a plot done through GPIB initiated with the front-panel SCREEN DUMP push-button, you must set the DSO in TALK ONLY mode (by positioning the back-panel switches at an address above 31) and the plotter in LISTEN ONLY mode (see below) before powering on both machines. No controller is needed in this mode.

If a computer controls the GPIB bus, both the scope and the plotter must be set in ADDRESSED mode. The address switches must be under 31 on the scope. In the following list, plotter address 7 is given as an example. Remember that manual plotting is impossible in this mode, only the controller can initiate a plot.

Remark: the listen only mode does not work on some old HP plotters such as HP7585B or HP7475. The plotter must be set to listener before being able to receive any commands, which is a violation of the GPIB standard.

9.1 Plotters

9.1.1 HP 7470A Plotter

Switch setting:

- RS-232 Connection:
  S1 and S2: 0 0
  Y/D: D
  A4/US: user selectable
  B4 to B1: 1 0 1 0

- GPIB LISTEN ONLY:
  A4/US: user selectable
  16 to 1: 1 1 1 1 1

- GPIB Addressed:
  A4/US: user selectable
  16 to 1: 0 0 1 1 1

9.1.2 HP 7550A Plotter

Responses to some ESC characters commands are not the same in this plotter as in older HP models like the 7470A. In fact, ESC sequences of commands which give excellent results in the 7470A can prevent any handshake in RS-232.

Problems of this kind have been reported in the case of ESC.R and ESC.@ commands. When combined with ESC.I and ESC.N, ESC.@ breaks up all handshakes.

- RS-232 configuration:
  - Enter into display 5 (HP-IB MONITOR...)
  - Select STANDARD OF STANDARD/ENHANCED
  - Enter into SERIAL sub-menu (display 6)
  - For DATA_FLOW, select REMOTE. Either STANDALONE or EAVESDROP may be chosen.
  - Enter into display 7 (DUPLEX, PARITY, BAUD).
  - Select FULL duplex.
  - Configuration PARITY and BAUD rate to the same values as on the DSO.

A standard cable may be used, provided it has a female connector on the plotter side.

Do not start a plot while a sheet of paper is being loaded!

- GPIB configuration:
  If the scope is in TALK ONLY, the plotter must be in LISTEN ONLY. Selection will be done at Display 5.

- Note:
  It seems that the plotter must be powered off, then on again, to take any configuration change into account.

9.1.3 Hitachi 672 Graph Plotter (or NSA 672)

As this plotter is compatible with the 7470A, select this mode on the plotter menu page.

Switch settings:

- RS-232 Connection:

Sw. A, 1 and 2:	1 1 (ISO A3)	or (ISO A4)
Sw. A, 3 to 8:	1 0 1 1 0 1	
Sw. B:	1 1 1 1	

- Note:
  When switches are set to ISO A4, the pen must be manually repositioned at the top of the page (or the plotter reset by powering it off and on) before loading a new sheet of paper.

9.1.4 Graphtec FP5301

Switch setting:

- RS-232 Connection:

Switch S1:	1	2	3	4	5	6	7	8
	0	0	0	0/1	0	0	0	0
Switch S2:	1	2	3	4	5	6	7	8
	1/0 (1)	0	0	0	1	0	0	0

Switch S3:	1	2	3	4	5	6	7	8
	1	1	1	1	1	0	1	1

- GPIB Connection:

Switch S1:	1	2	3	4	5	6	7	8
	0	0	0	0	0	1	0	1

Switch S2:	1-2	3-4	5-6	7-8	9-10
	0	0	1	1	1

Switch S3: LISTEN ONLY or ADDRESSABLE

Notes:
- (1) select a baud rate factor of 1/16.
- FP5301-UM-151 has an internal switch that select step size. Select .1 mm per step.

9.1.5 Philips PM 8151

- RS-232 Connection:
  The cable must be connected to the MODEM (ON LINE) port.

  The baud rate will be 2400 baud.

  Switches:

  S1: OFF (No time sharing)

  S2: 2400 bauds

S3:	1	2	3	4	5	6
	V24	free	8 bits	1 stop	no par.	not used

S4:	1	2			5	6
	OFF	free			Auto buff. mess. (no kaut)	free enable

  3 and 4 are not used

- GPIB Connection:
  Switches:

  A6: Select LISTEN ONLY (LON) or ADDRESSED MODE (no LON).

A5	A4	A3	A2	A1
0	0	1	1	1

  PP2 and P1 to P3: user selectable.

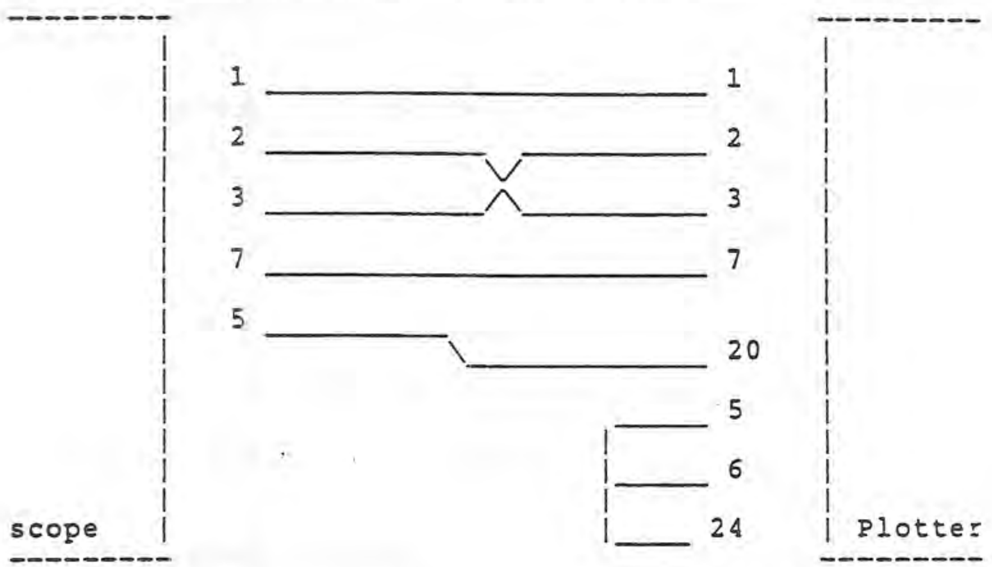
9.1.6 Philips PM 8153

PM 8153 B/1 (GPIB) and PM 8153 S/1 are PM 8151 compatible while PM 8153 B/6 and PM m8153 S/6 are HP 7470A compatible. Select the appropriate mode on the plotter menu page.

9.1.7 Gould computagraph

As the Gould plotter is compatible with the HP 7470A, select this mode on the plotter menu page.

For an RS-232 connection, a special cable is necessary:



(male connector) (female connector)

This cable must be plugged into the plotter's MODEM port.

9.2 Printers

Only the 9410 generation of DSO will support printers. Exception: the 9400 with the Raster Printer option (option OP03) denoted by a 'P' in its identification string does support the HP ThinkJet.
Interfacting is possible through RS-232, GPIB directly and via adapter through CENTRONICS.

9.2.1 CENTRONICS Printers

Most printers use a Centronics Parallel connection which makes direct interconnection impossible. To further confude the issue most PC computers use a 25-pin D connector for both the serial and parallel connections. The only difference being that one connector is equipped with male pins and the other with female pins.

The standard cable supplied between IBM computers and parallel printers has one 25-pin D connector on one end and a Centronics connector on the other end. Because the computer end of the cable is the same as the connector on the 9410, you and your customers might assume they are ready to connect and print .... NOT TRUE .... they can connect, but may not be able to print.

Here are some Hints and Things to look for:

1. If the printer has a 25-pin D connector on it then you can be 99% sure it's a serial printer and ready for a direct straight through cable to the 9410.

2. If the printer has a Centronics connector on it then you can be 99% sure it's a parallel printer and will require a Serial to Parallel converter.

The SP-100 Serial to Parallel converter is distributed by:

MICRO MEDIA CORP.
3241 Amber Street
Philadelphia, PA 19134
Telex: (215) 739-0888
Fax: (215) 739- 6466
Cost: $45.00 (Retail Single Quantity)

and by DISTRELEC in Switzerland.

It has been tested and found to be perfectly suited to converting your customer's parallel printer to work with the 9410.

The converter plugs directly into the Centronics connector on the printer. The other end of this small box (approx. 1" x 3" x 3") has the 25-pin RS-232 connector to allow the connection of a straight through RS-232 cable (male to female) to the 9410. The SP-100 is supplied with a 9-volt power supply that plugs into the Ac power line and converter power input connector. The 8-position Dip-Switch on the side of the converter should be set as follows:

SP-100 Switch 2, 3, 6, 8 ON (Down Position-Toward numbers) others OFF.

The following hard-copy parameters are required on the 9410:

Select Main Menu, Auxiliary Setups, Hardcopy.
Hard Copy:
Select device type: EPSON FX80 OR COMPATIBLE printer.
Hardcopy port: RS-232 (must use 8 bits with printers).
Graphics Density and Plot size are menu selectable.

Select RS-232
RS-232 Remote Control Port Settings:
Baud rate:9600
Characters length (bits): 8
Parity: none
Number of stop bits: 1

The following printers and printer switch positions have been tested:

		Switch 1	Switch 2
1.	Epson LQ-1000	1, 2, 3, 4 ON	2, 6, 7 ON
2.	Diconix 150P	1 ON	2, 6, 7 On
3.	HP-ThinkJet 2225C	2, 4, 5 ON	

Note: All Epson and Epson Compatible printers are likely to work if the switches are set properly. (Some experimentation may be required).

The customer must purchase his own accessories since we do not supply them.

Some other available Serial to Parallel converters need power through the RS-232 lines. Do not use them, as we do not guaranty that the serial port is able to furnish enough power.

9.3 RS-232 Printers

9.3.1 Epson FX80

It is possible to use the standard RS-232 cable. Such a printer has the optional RS-232 interface "# 8143" installed. The configuration that follows is valid for the default scope setting. The standard cable is usable.

In the particular case of an FX850:

- the main switches SW1 SW2 remain at the factory configuration:

SW1	1	2	3	4	5	6	7	8
	OFF	OFF	ON	OFF	OFF	ON	ON	ON

SW2	1	2	3	4
	ON	OFF	OFF	OFF

- the 8143 switches are set to:

1	2	3	4	5	6	7	8
ON	OFF	OFF	OFF	n/a	OFF	OFF	ON

- the 8143 jumpers remain at the factory settings:

J1	J2	J3	J4	J5	JC	JNOR	JRVE	JF	JX
OFF	OFF	OFF	OFF	ON	OFF	ON	OFF	ON	OFF

Note: Epson printers only support XON/XOFF support handshake if they have a print buffer. Such printers are:
FX, FX+, JX-80, LQ-800/1000, EX-800 and LQ-25000.
Otherwise, use DTR/RTS handshake.

9.3.2 HP QUIETjet

9.3.3 CITIZEN 120D

To use this printer with the default RS-232 settings and the default Plotter setting of the 9410, select the following switch configuration:

Dip switch bank 1: ALL OFF except 3 and 8.
Dip switch bank 2: ALL OFF.

9.3.4 HP LaserJet (will be supported as of release 2,6)

Make sure that Page Feed is ON in the Plotter menu to use the LaserJet.

It is advisable to start out in single density with a size of A5. Then, depending upon the internal buffer size on the LaserJet, the image size and/or density can be increased. At one point, the internal buffer size of the DSO is also reached. The image is simply truncated, indicating that either density or size have to be reduced.

9.3.5 HP ThinkJet (HP 2225D)

To use printer with the default RS-232 settings and with the default cable select the following switch configuration:

- mode switch:

1	2	3	4	5	6	7	8
0	0	0	0: 11" page length 1: 12" page length	0	0	0	0

- RS-232 switch:

1	2	3	4	5
1	0	0	0	0
(use DTR Handshake)	(8 bits, parity none)		(9600 bauds)	

Note: it may be possible that old ThinkJet recognize only the Epson protocol. If it is the case use the EPSON.

9.3.6 Brother printers

The Brother M-1509 and M-1709 have been tested with a serial connection. On the oscilloscope select "EPSON FX-80 or compatible printer".

Use a cable with 2 male plugs like the following one:

```
---------                                                   ---------
        |                                                   |
        |   1 ____________________________________ 1        |
        |                                                   |
        |   2 ________________    ________________ 2        |
        |                     \/                            |
        |   3 ________________/\________________ 3          |
        |                                                   |
        |   4 ________________    ________________ 4        |         }
        |                     \/                            |         }  optional
        |   5 ________________/\________________ 5          |         }
        |                                                   |
        |   7 ____________________________________ 7        |
        |                                                   |
        |   6 ______________                                |
        |                   \                      20       |
        |                    \____________________          |
 scope  |                                                   | printer
---------                                                   ---------
```

The switch settings are identical for both the printers:

- SW1:

1	2	3	4	5	6	7	8
ON	ON	ON	OFF	ON	n/a	n/a	ON

- SW1:

1	2	3	4	5	6	7	8
< ----------- ALL OFF ------------ >							

- SW1:

1	2	3	4	5	6	7	8
OFF	OFF	OFF	OFF	11": OFF 12": ON	OFF	ON	OFF

9.4 GPIB Printers

9.4.1 HP QUIETJet

Make sure the dip switches on the backplane of the printer are set to

- SRQ Enable: 0

- GPIB LISTEN ONLY:
  LISTEN ALWAYS: 1
  A5 to A1: 0 0 1 1 1

- GPIB Addressed:
  LISTEN ALWAYS: 0
  A5 to A1: 0 0 1 1 1

9.4.2 HP THINKJet (HP 2225A)

Make sure the dip switches on the backplane of the printer are set to

- SRQ Enable: 0
- GPIB LISTEN ONLY:
  LISTEN ALWAYS: 1
  A5 to A1: 0 0 1 1 1
- GPIB Addressed:
  LISTEN ALWAYS: 0
  A5 to A1: 0 0 1 1 1

9.4.3 HP PaintJet (black/white only)

Make sure the dip switches near the GPIB connector are set to:

- GPIB LISTEN ONLY:
  NORM/SCS : NORM
  A3 to A1 : 1 1 1
  PC8/ROM8 : N/A
  ENG/MET : has to match paper size ENG = 11" MET = 12"
- GPIB addressed:
  NORM/SCS : NORM
  A3 to A1 : any combination except 1 1 1
  (correspond to add. 0-6)
  PC8/ROM8 : N/A
  ENG/MET : has to match paper size ENG = 11" MET = 12"

9.5 Information on GPIB

9.5.1 Introduction

This section is a simple description of the GPIB interface as an aid to understanding the interface in the 9410 DSO: it is not intended as a complete specification of the system.

The GPIB system is designed for the interaction of a number of interacting devices, which may transmit or receive information as required. The system includes data lines over which the actual data are sent, bus management lines for control, and handshake lines to ensure correct acceptance of data at the right destination. The main features of the bus are summarized below:

Maximum number of devices	15
Maximum bus length	20 meters or 2 meters per device, whichever is less
Connection	star or chain

Note that more than half of any connected devices must be powered up, even if they will not be used.

Data lines		8 DIO 1 to 8
Handshake lines	DAV	Data available
	NRFD	Not ready for data
	NDAC	not data accepted
Bus management lines	EOI	End or identity
	IFC	Interface clear
	SRQ	Service request
	ATN	Attention
	REN	Remote enable

Active level	+0,4 V
Inactive level	+3,3 V

Note that all signal lines are active low, and that they are wire ORed to allow participation by all devices.

In addition, there are 8 ground lines, making a total of 24 lines.

9.5.2 Functions in the GPIB

In order to allow satisfactory interconnection of several devices the following functions must be provided

- Enabling any device to transmit data
- Preventing any device from transmitting data
- Enabling any device to receive data
- Preventing any device to receive data
- Transmitting data to a specific device
- Ensuring that only one device is transmitting
- Ensuring that transmitting takes place only when reception is possible
- Enabling any device to request servicing
- Identify type of data to be sent

Any device can be activated into the "talk" or "listen" state, and can be de-activated by the commands "untalk" and "unlisten". Also a device can be a "controller".

Maximum number of current talkers	1
Maximum number of current listeners	14
maximum number of current controllers	1

Function of bus lines:

- DAV Data available; talker says the data on the line are valid.

- NRFD Not ready for data; listener says it is not ready for more data. All listeners must release the NRFD line, i.e., let it go high, before talker can send.

- NDAC Not data accepted; listener says it has not yet accepted the data. Talker must hold all data lines steady until all listeners have released this line, i.e., it goes high.

Clearly, the NRFD and NDAC are easy to implement by a wired OR system, so that any one device asserting the signal prevents progress to the next step. Progress is made at the speed of the slowest listener. A simple timing diagram is given in figure 9.1, and another way of presenting the system is given in figure 9.2.

The bus management lines functions as follows:

- EOI End Or Identify; talker sends this with last byte of a block transfer to indicate last byte. Also used with ATN to parallel poll devices for their status bit.

- IFC InterFace Clear; places the GPIB system into a quiescent state.

- SRQ Service ReQuest; any device can send it to the controller to indicate need for attention, and to request interruption of current operations.

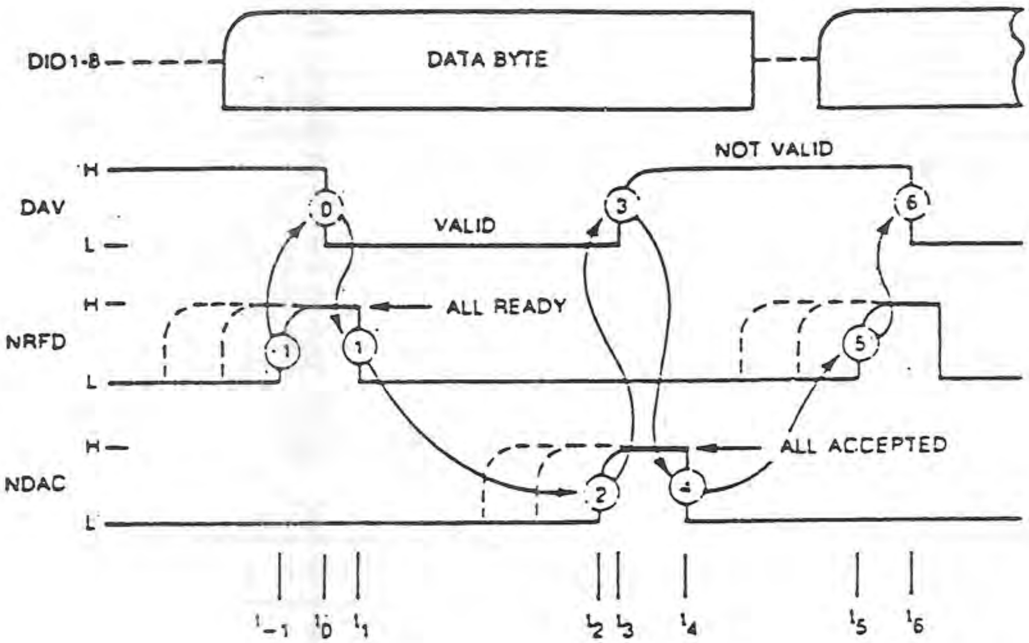
- ATN Attention; controller sends this to specify whether DIO lines are to be used for interface messages, e.g., addressing, or for data.

- REN Remote ENable; selects a device as being under local or remote control.

Addressing of the devices on the GPIB bus consult a specialized GPIB-IEEE488 document.

The principles of GPIB are quite simple - the system must wait for all users, and lines are wire ORed so that all can pull the lines down.

The handshake sequence is illustrated in two ways. In figure 9.1 the signal waveforms are sketched, while figure 9.2 is a flowchart.

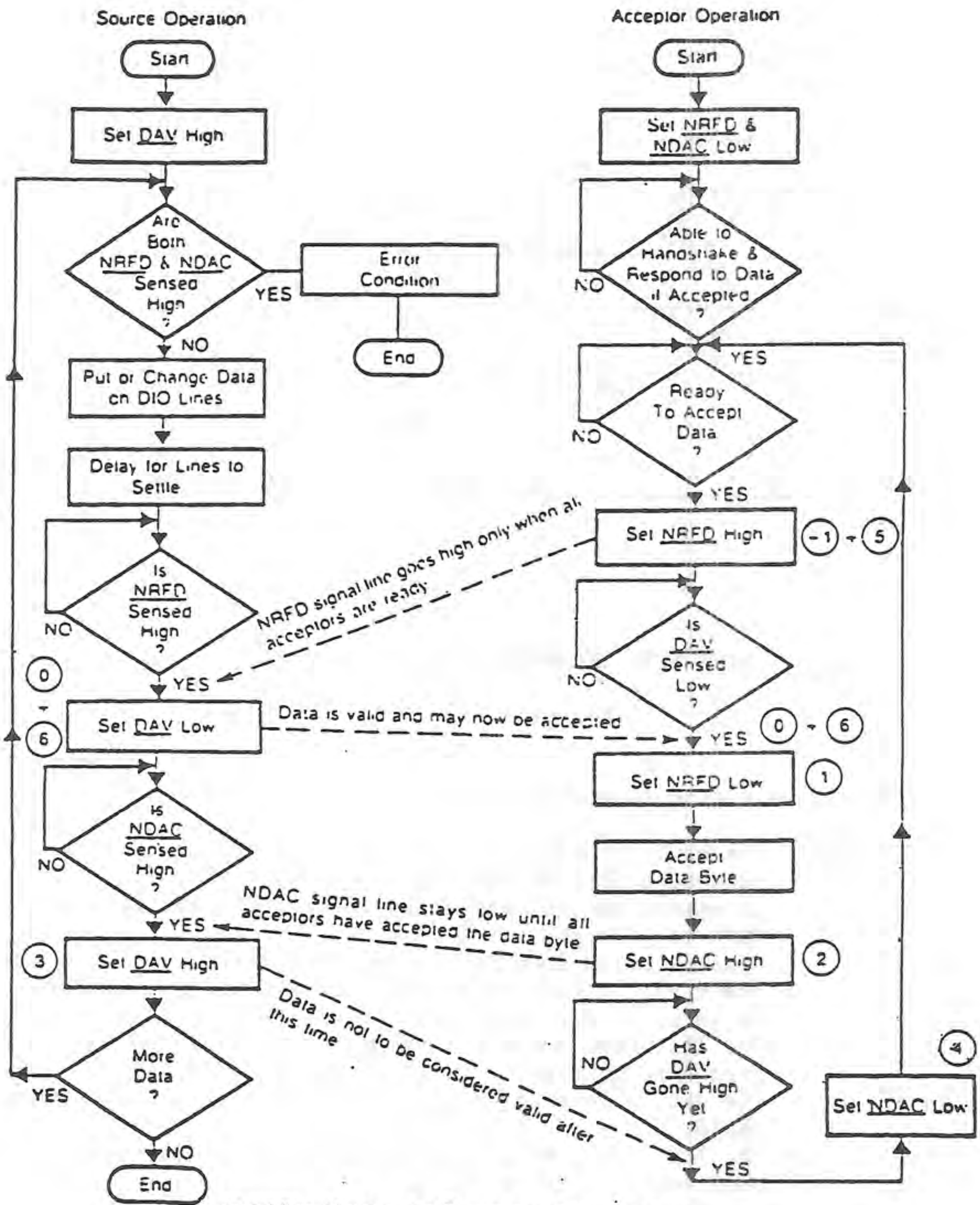


DATA BYTE TRANSFER IN GPIB IEEE-488

Figure 9.1

The handshake timing sequence proceeds as follows:

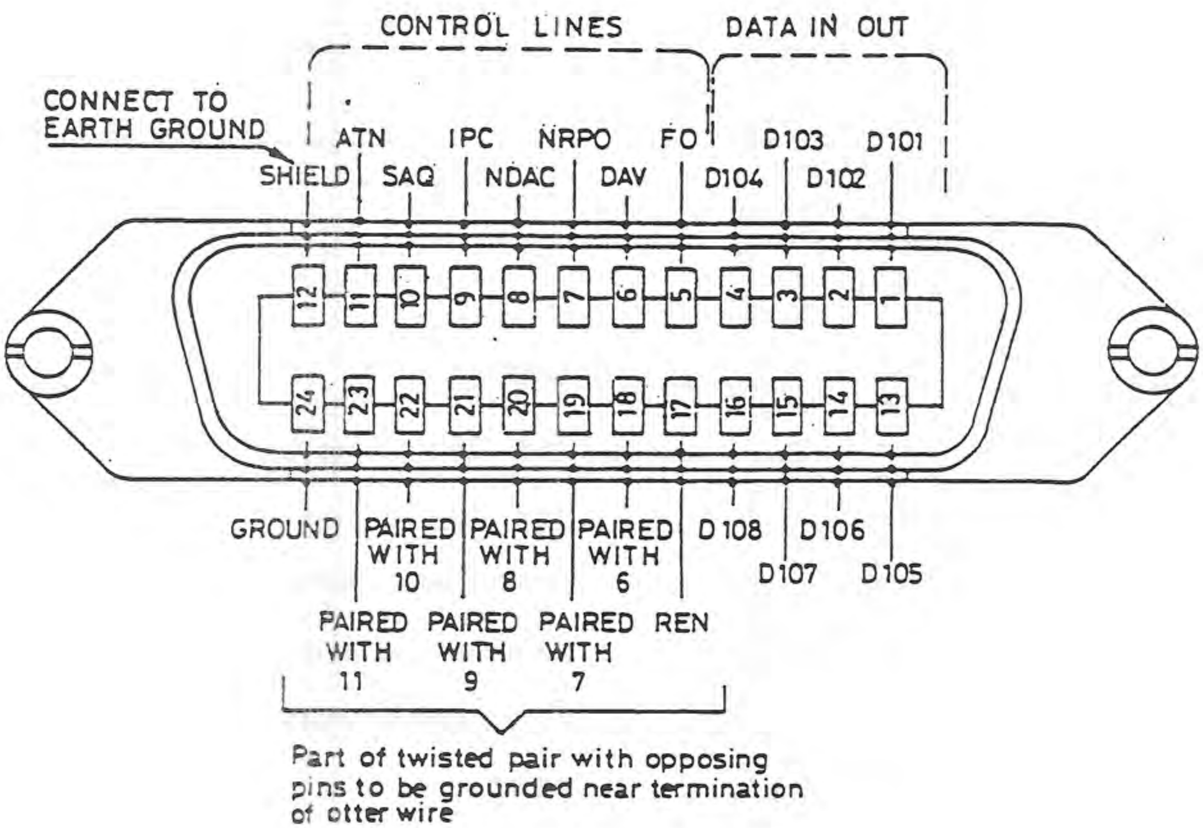
Preliminary	The source checks for presence of listeners and places the next data byte on the data lines DI01-8.
t-1	Acceptors one by one become ready for byte. Last one allows NRFD to go high.
t0	Sources pulls down DAV to validate data.
t1	The first litener to accept the data pulls down NRFD to show it is no longer ready for a new byte.
t2	The listeners one by one accept the data, and the last one lets NDAC go high.
t3	The source sets DAV high to show this byte is no longer valid.
t4	The listeners one by one accept this, the first one pulling NDAC low for the next cycle.
t5	As for t-1.



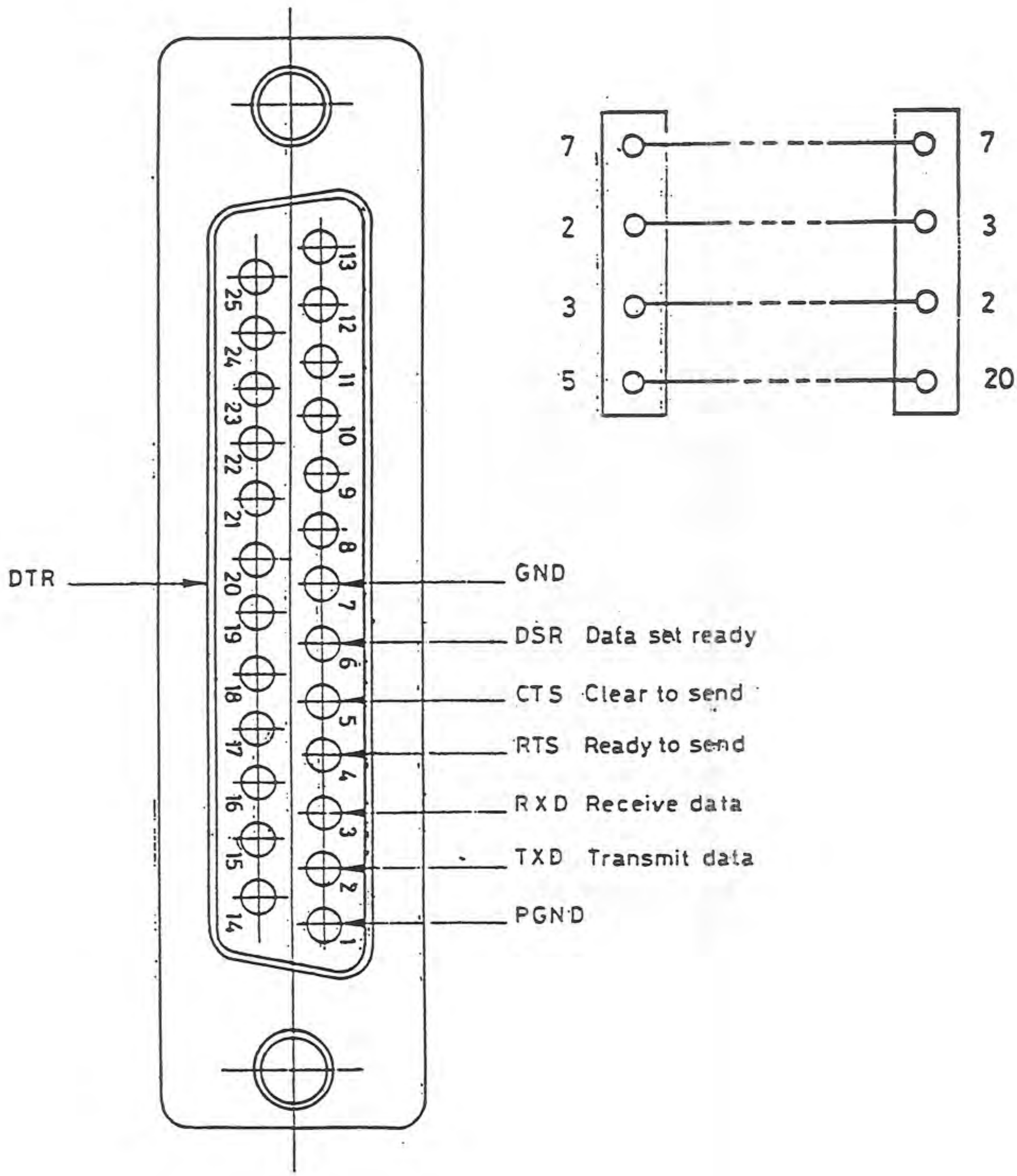
Logical flow of events for Source and Acceptor when transferring data using the handshake process

HANDSHAKE TIMING SEQUENCE IN GPIB IEEE-488

Figure 9.2



GPIB / IEEE-488 INTERFACE



RS232-C INTERFACE

APPENDIX A

Dec	Hex	ASCI char	IBM-PC char	IEEE-488 Multiline Interface Message (Sent with Attention true)
0	00	NUL		
1	01	SOH	^A	GTL - Go To Local
2	02	STX	^B	
3	03	ETX	^C	
4	04	EOT	^D	SDC - Selected Device Clear
5	05	ENQ	^E	PPC - Parallel Poll Configure
6	06	ACK	^F	
7	07	BEL		
8	08	BS		GET - Group Execute Trigger
9	09	HT		TCT - Take Control
10	0A	LF		
11	0B	VT		
12	0C	FF		
13	0D	CR		
14	0E	SO	^N	
15	0F	SI	^O	
16	10	DLE	^P	
17	11	DC1	^Q	LLO - Local Lock Out
18	12	DC2	^R	
19	13	DC3	^S	
20	14	DC4	^T	DCL - Device Clear
21	15	NAK	^U	PPU - Parallel Poll Unconfigure
22	16	SYN	^V	
23	17	ETB	^W	
24	18	CAN	^X	SPE - Serial Poll Enable
25	19	EM	^Y	SPD - Serial Poll Disable
26	1A	SUB		
27	1B	ESC	^[	
28	1C	FS	^\	
29	1D	GS	^]	
30	1E	RS	^^	
31	1F	US	^_	
32	20	SP		MLA - My Listen Address (listen 0)
33	21	!	!	MLA - My Listen Address (listen 1)
34	22	"	"	MLA - My Listen Address (listen 2)
35	23	#	#	MLA - My Listen Address (listen 3)
36	24	$	$	MLA - My Listen Address (listen 4)
37	25	%	%	MLA - My Listen Address (listen 5)
38	26	&	&	MLA - My Listen Address (listen 6)
39	27	'	'	MLA - My Listen Address (listen 7)
40	28	(	(	MLA - My Listen Address (listen 8)
41	29	)	)	MLA - My Listen Address (listen 9)
42	2A	*	*	MLA - My Listen Address (listen 10)
43	2B	+	+	MLA - My Listen Address (listen 11)
44	2C	,	,	MLA - My Listen Address (listen 12)
45	2D	-	-	MLA - My Listen Address (listen 13)

Dec	Hex	ASCII char	IBM-PC char	IEEE-488 Multiline Interface Message (Sent with Attention true)
46	2E	.	.	MLA - My Listen Address (listen 14)
47	2F	/	/	MLA - My Listen Address (listen 15)
48	30	0	0	MLA - My Listen Address (listen 16)
49	31	1	1	MLA - My Listen Address (listen 17)
50	32	2	2	MLA - My Listen Address (listen 18)
51	33	3	3	MLA - My Listen Address (listen 19)
52	34	4	4	MLA - My Listen Address (listen 20)
53	35	5	5	MLA - My Listen Address (listen 21)
54	36	6	6	MLA - My Listen Address (listen 22)
55	37	7	7	MLA - My Listen Address (listen 23)
56	38	8	8	MLA - My Listen Address (listen 24)
57	39	9	9	MLA - My Listen Address (listen 25)
58	3A	:	:	MLA - My Listen Address (listen 26)
59	3B	;	;	MLA - My Listen Address (listen 27)
60	3C	<	<	MLA - My Listen Address (listen 28)
61	3D	=	=	MLA - My Listen Address (listen 29)
62	3E	>	>	MLA - My Listen Address (listen 30)
63	3F	?	?	UNL - Unlisten
64	40	@	@	MTA - My Talk Address (talk 0)
65	41	A	A	MTA - My Talk Address (talk 1)
66	42	B	B	MTA - My Talk Address (talk 2)
67	43	C	C	MTA - My Talk Address (talk 3)
68	44	D	D	MTA - My Talk Address (talk 4)
69	45	E	E	MTA - My Talk Address (talk 5)
70	46	F	F	MTA - My Talk Address (talk 6)
71	47	G	G	MTA - My Talk Address (talk 7)
72	48	H	H	MTA - My Talk Address (talk 8)
73	49	I	I	MTA - My Talk Address (talk 9)
74	4A	J	J	MTA - My Talk Address (talk 10)
75	4B	K	K	MTA - My Talk Address (talk 11)
76	4C	L	L	MTA - My Talk Address (talk 12)
77	4D	M	M	MTA - My Talk Address (talk 13)
78	4E	N	N	MTA - My Talk Address (talk 14)
79	4F	O	O	MTA - My Talk Address (talk 15)
80	50	P	P	MTA - My Talk Address (talk 16)
81	51	Q	Q	MTA - My Talk Address (talk 17)
82	52	R	R	MTA - My Talk Address (talk 18)
83	53	S	S	MTA - My Talk Address (talk 19)
84	54	T	T	MTA - My Talk Address (talk 20)
85	55	U	U	MTA - My Talk Address (talk 21)
86	56	V	V	MTA - My Talk Address (talk 22)
87	57	W	W	MTA - My Talk Address (talk 23)
88	58	X	X	MTA - My Talk Address (talk 24)
89	59	Y	Y	MTA - My Talk Address (talk 25)
90	5A	Z	Z	MTA - My Talk Address (talk 26)
91	5B	[	[	MTA - My Talk Address (talk 27)
92	5C	\	\	MTA - My Talk Address (talk 28)

Dec	Hex	ASCII char	IBM-PC char	IEEE-488 Multiline Interface Message (Sent with Attention true)
93	5D	]	]	MTA - My Talk Address (talk 29)
94	5E	^	^	MTA - My Talk Address (talk 30)
95	5F	_	_	UNT - Untalk
96	60	`	`	
97	61	a	a	
98	62	b	b	
99	63	c	c	
100	64	d	d	
101	65	e	e	
102	66	f	f	
103	67	g	g	
104	68	h	h	
105	69	i	i	
106	6A	j	j	
107	6B	k	k	
108	6C	l	l	
109	6D	m	m	
110	6E	n	n	
111	6F	o	o	
112	70	p	p	
113	71	q	q	
114	72	r	r	
115	73	s	s	
116	74	t	t	
117	75	u	u	
118	76	v	v	
119	77	w	w	
120	78	x	x	
121	79	y	y	
122	7A	z	z	
123	7B	{	{	
124	7C	|	|	
125	7D	}	}	
126	7E	~	~	
127	7F	NUL		
128	80		Ç	
129	81		ü	
130	82		é	
131	83		â	
132	84		ä	
133	85		à	
134	86		å	
135	87		ç	
136	88		ê	
137	89		ë	
138	8A		è	
139	8B		ï	

Dec	Hex	ASCII char	IBM-PC char	IEEE-488 Multiline Interface Message (Sent with Attention true)
140	8C		î	
141	8D		ì	
142	8E		Ä	
143	8F		Å	
144	90		É	
145	91		æ	
146	92		Æ	
147	93		ô	
148	94		ö	
149	95		ò	
150	96		û	
151	97		ù	
152	98			
153	99		Ö	
154	9A		Ü	
155	9B		¢	
156	9C		£	
157	9D		¥	
158	9E		₧	
159	9F		ƒ	
160	A0		á	
161	A1		í	
162	A2		ó	
163	A3		ú	
164	A4		ñ	
165	A5		Ñ	
166	A6		ª	
167	A7		º	
168	A8		¿	
169	A9		⌐	
170	AA		¬	
171	AB		½	
172	AC		¼	
173	AD		¡	
174	AE		«	
175	AF		»	
176	B0			
177	B1		▒	
178	B2		▓	
179	B3		│	
180	B4		┤	
181	B5		╡	
182	B6		╢	
183	B7		╖	
184	B8		╕	
185	B9		╣	
186	BA		║	
187	BB		╗	

Dec	Hex	ASCII char	IBM-PC char	IEEE-488 Multiline Interface Message (Sent with Attention true)
188	BC		╝	
189	BD		╜	
190	BE		╛	
191	BF		┐	
192	C0		└	
193	C1		┴	
194	C2		┬	
195	C3		├	
196	C4		─	
197	C5		┼	
198	C6		╞	
199	C7		╟	
200	C8		╚	
201	C9		╔	
202	CA		╩	
203	CB		╦	
204	CC		╠	
205	CD		═	
206	CE		╬	
207	CF		╧	
208	D0		╨	
209	D1		╤	
210	D2		╥	
211	D3		╙	
212	D4		╘	
213	D5		╒	
214	D6		╓	
215	D7		╫	
216	D8		╪	
217	D9		┘	
218	DA		┌	
219	DB		█	
220	DC		▄	
221	DD		▌	
222	DE		▐	
223	DF		▀	
224	E0		α	
225	E1		β	
226	E2		Γ	
227	E3		π	
228	E4		Σ	
229	E5		σ	
230	E6		μ	
231	E7		τ	
232	E8		Φ	
233	E9			
234	EA		Ω	

Dec	Hex	ASCII char	IBM-PC char	IEEE-488 Multiline Interface Message (Sent with Attention true)
235	EB		δ	
236	EC		∞	
237	ED		φ	
238	EE		ϵ	
239	EF		∩	
240	F0		≡	
241	F1		±	
242	F2		≥	
243	F3		≤	
244	F4		⌠	
245	F5		⌡	
246	F6		÷	
247	F7		≈	
248	F8		°	
249	F9		•	
250	FA		·	
251	FB		√	
252	FC		η	
253	FD		²	
254	FE		▪	
255	FF			