Service Manual

Model 7015
DL1500C Series
Digital Oscilloscope

SM 701530-01E

YOKOGAWA
Yokogawa Electric Corporation

SM 701530-01E
1st Edition

IMPORTANT NOTICE TO THE USER

This manual contains information for servicing the YOKOGAWA Digital Oscilloscope DL1500C series. Confirm by serial number that this Service Manual covers the instrument to be serviced. **Do not use the wrong manual**.

Before any maintenance and servicing, **read all safety precautions carefully**.

Only properly trained personnel may carry out maintenance and servicing in accordance with and to the extent permitted by this Service Manual.

Do not disassemble the instrument or its parts, unless otherwise clearly permitted by this Service Manual.

Do not replace any part or assembly, unless otherwise clearly permitted by this Service Manual.

YOKOGAWA ELECTRIC CORPORATION (YOKOGAWA) does not in principle supply parts other than those listed in the Customer Maintenance Parts List in this Service Manual (mainly modules and assemblies). Therefore if an assembly fails, the user should replace the whole assembly and NOT components within the assembly (see NOTE). If the user attempts to repair the instrument by replacing individual components within the assembly, YOKOGAWA assumes no responsibility for any consequences, such as defects in instrument accuracy, functionality, or reliability, or user safety hazards.

YOKOGAWA does not offer more detailed maintenance and service information than that contained in this Service Manual.

All reasonable efforts have been made to assure the accuracy of the content of this Service Manual. However, there may still be errors such as clerical errors or omissions. YOKOGAWA assumes no responsibility of any kind concerning the accuracy or contents of this Service Manual, nor for the consequences of any errors.

NOTE YOKOGAWA instruments have been designed in a way that the replacement of electronic parts can be done on an assembly (module) basis by the user. YOKOGAWA instruments have also been designed in a way that troubleshooting and replacement of any faulty assembly can be done easily and quickly. Therefore, YOKOGAWA strongly recommends replacing the entire assembly over replacing parts or components within the assembly. The reasons are as follows:

- The instruments use high-performance microprocessors, large scale CMOS gate arrays and surface-mount components to provide state-of-art performance and functions.
- Repair of components can only be performed by specially trained and qualified maintenance personnel with special tools. In addition, repair of components requires various special parts and components, including costly ones. It also requires facilities where highly-accurate and expensive maintenance equipment and special tools are provided.
- When taking the service life and cost of the instruments into consideration, the replacement of assemblies offers the user the possibility to use YOKOGAWA instruments more effectively and economically with a minimum in downtime.

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INTRODUCTION

This manual contains information for servicing the YOKOGAWA Digital Oscilloscope DL1500C series.

NOTES This manual is the first edition, May 2000.

WARNING This Service Manual is to be used by properly trained personnel only. To avoid personal injury, do not perform any servicing unless you are qualified to do so. Refer to the Safety Precautions prior to performing any service.
Even in case of servicing according to this Service Manual and carried out by qualified personnel, YOKOGAWA assumes no responsibility for any result occurring from this servicing.

SAFETY PRECAUTIONS

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific WARNINGS given elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. YOKOGAWA ELECTRIC CORPORATION assumes no liability for the customer's failure to comply with these requirements.

General definitions of safety symbols used on equipment and in manuals

Explanation: To avoid injury, death of personnel or damage to the instrument, the operator must refer to an explanation in the instruction manual.

It represents a Function Grounding Terminal. Such terminals shold not be used as a "Protective Grounding Terminal".

WARNING

A **WARNING** sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in injury or death of personnel.

CAUTION

A **CAUTION** sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part of the product.

WARNING

Power Supply
Ensure the source voltage matches the voltage of the power supply before turning on the power.

Power Cord and Plug
To prevent an electric shock or fire, be sure to use the power supply cord supplied by YOKOGAWA. The main power plug must be plugged in an outlet with protective grounding terminal. Do not invalidate protection by using an extension cord without protective grounding.

Protective Grounding
The protective grounding terminal must be connected to ground to prevent an electric shock before turning ON the power.

Necessity of Protective Grounding
Never cut off the internal or external protective grounding wire or disconnect the wiring of protective grounding terminal. Doing so poses a potential shock hazard.

Defect of Protective Grounding and Fuse
Do not operate the instrument when protective grounding or fuse might be defective.

Fuse
To prevent a fire, make sure to use fuses with specified standard (current, voltage, type). Before replacing the fuses, turn off the power and disconnect the power source. Do not use a different fuse or short-circuit the fuse holder.

Do not Operate in an Explosive Atmosphere
Do not operate the instrument in the presence of flammable liquids or vapors. Operation of any electrical instrument in such an environment constitutes a safety hazard.

Do not Remove any Covers
There are some areas with high voltage. Do not remove any cover if the power supply is connected. The cover should be removed by qualified personnel only.

External Connection
To ground securely, connect the protective grounding before connecting to measurement or control unit.

HOW TO USE THIS MANUAL

This manual is meant to be used by qualified personel only. Make sure to have read the safety precautions at the beginning of this manual and the warnings/cautions contained in the referred chapter prior to carrying out any servicing.

This manual contains the following chapters:

1 GENERAL INFORMATION
Describes the introduction and safety considerations.

2 PERFORMANCE TEST
Describes the performance tests for checking performance of the instrument.

3 ADJUSTMENTS (for DL1540C/DL1540CL)
Describes the adjustments which can be adjusted by users.

4 PRINCIPLE OF OPERATION (for DL1540C/DL1540CL)
Describes the function block diagrams and principle of operation.

5 TROUBLESHOOTING (for DL1540C/DL1540CL)
Describes procedures for troubleshooting and how to handle in case parts need to be replaced.

6 SCHEMATIC DIAGRAM (for DL1540C/DL1540CL)
Describes the system configuration diagram.

7 CUSTOMER MAINTENANCE PARTS LIST
Contains exploded views and a list of replaceable parts.

Specifications are not included in this manual; for specifications, refer to IM 701530-01E.

CONTENTS

Chapter 1 GENERAL INFORMATION

This chapter describes the general information.

1.1 Introduction

This manual describes servicing information on YOKOGAWA Digital Oscilloscope DL1500C series.
This chapter contains information required for using this manual and information that must be known before starting servicing of the DL1500C series.

1.2 Safety Consideration

Thoroughly read the safety precautions at the beginning of this manual without fail. Also fully read warnings and cautions contained in each chapter.

Chapter 2 PERFORMANCE TEST

This chapter describes the following tests.

2.1 Introduction

The aim of the test is to check basic performance of the instrument. The order of the test is just for convenience and it does not have any significant meaning. Please use recommended equipment or their equivalents.

2.2 Test Environment

1) Please operate the instrument in the following environment.
- Ambient Temperature : 23±2˚C
- Humidity : 55±10% RH
- Voltage of power supply : Specified Voltage ±1%
- Frequency of power supply : Specified Frequency ±1%

2) Warm up time
- More than 30 minutes after energizing the instrument.
- Confirm that self calibration is correctly executed after 30 minutes warm up. (Please pay attention to warm up time of the each equipment which will be used in the test.)

2.3 Equipment Required

Table 2.1 Equipment Required

Equipment	Critical Specification	Recommended
DC Volt Standard	Accuracy : <0.05% Output Voltage : –20 V to 20 V Output Resolution : 1 mV	YOKOGAWA 7651
Signal Generator	Frequency : 0.1 to 150 MHz	Hewlett Packard 8657A
Power Meter	Frequency : 100 kHz to 150 MHz	Hewlett Packard 437B
Power Sensor	Frequency : 100 kHz to 150 MHz	Hewlett Packard 8482A
Function Generator	Triangular wave Frequency : 100 kHz Output Level : 800 mV	YOKOGAWA 7060
50 ohm Terminator		Hewlett Packard 1251-2277
Banana to BNC Conversion Adapter	Banana plug to BNC	YOKOGAWA 3669 22
N(P) to BNC(J) Conversion Adapter	N plug to BNC jack	Hewlett Packard 1250-0780
BNC(J) to N(J) Conversion Adapter	N jack to BNC jack	Hewlett Packard 1250-1474
BNC-BNC Cable	BNC to BNC	YOKOGAWA 3669 24

2.4 Vertical Axis DC Voltage Accuracy Test

Specifications

1 mV/div	:±(5% of 8 div + 1LSB)
100 mV/div	:±(1.5% of 8 div + 1LSB)
Other ranges	:±(2.5% of 8 div + 1LSB)

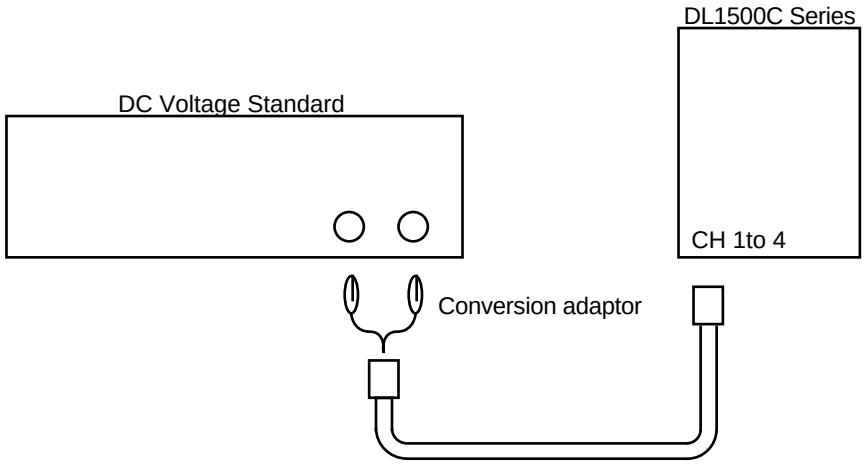
Permissible range

Range	Tolerance
1 mV/div (Available with DL1540C/DL1540CL)	±0.48 mV
2 mV/div	±0.48 mV
5 mV/div	±1.2 mV
10 mV/div	±2.4 mV
20 mV/div	±4.8 mV
50 mV/div	±12 mV
100 mV/div	±16 mV
200 mV/div	±48 mV
500 mV/div	±120 mV
1 V/div	±240 mV
2 V/div	±480 mV
5 V/div	±1.2 V

Equipment required

Equipment	Critical Specification	Recommended
DC Volt Standard	Accuracy : <0.05% Output Voltage : –20 V to 20 V Output Resolution : 1 mV	YOKOGAWA 7651
Banana to BNC Conversion Adapter	Banana plug to BNC	YOKOGAWA 3669 22
BNC-BNC Cable	BNC to BNC	YOKOGAWA 3669 24

Connection



Procedure

1) Set the DL1500C series as shown below.

VERTICAL (for all channels)		
	V/DIV	According to the inspection item below
	POSITION	0 DIV
	COUPLING	DC
	PROBE	1:1
HORIZONTAL		
	TIME/DIV	10 μs/div
TRIGGER		
	SOURCE	LINE
	MODE	AUTO
	DELAY	0 ms
ACQ		
	MODE	NORMAL: 5 V/div to 50 mV/div AVERAGE 256 times: 20 mV/div to 1 mV/div
MEASURE		
	MODE	ON
	TRACE	(Set to channel to be measured)
	ITEM	Select Avg.

2) Input the following voltages from the voltage generator to the DL1500C series to be tested, read the indication on the DL1500C series (value of Avg), and compare the reading with the tolerance.

Measurement Range	Test Input Voltage	Tolerance
1 mV/div	–4 mV, 0 mV, +4 mV	±0.48 mV
2 mV/div	–8 mV, 0 mV, +8 mV	±0.48 mV
5 mV/div	–20 mV, 0 mV, +20 mV	±1.2 mV
10 mV/div	–40 mV, 0 mV, +40 mV	±2.4 mV
20 mV/div	–80 mV, 0 mV, +80 mV	±4.8 mV
50 mV/div	–200 mV, 0 mV, +200 mV	±12 mV
100 mV/div	–400 mV, 0 mV, +400 mV	±16 mV
200 mV/div	–800 mV, 0 mV, +800 mV	±48 mV
500 mV/div	–2 V, 0 V, +2 V	±120 mV
1 V/div	–4 V, 0 V, +4 V	±240 mV
2 V/div	–8 V, 0 V, +8 V	±480 mV
5 V/div	–20 V, 0 V, +20 V	±1.2 V

3) Test all channels in the same manner.

2.5 Frequency Response Test

Specifications

In repetitive sampling mode :DC to 150 MHz (–3 dB point)

Permissible range

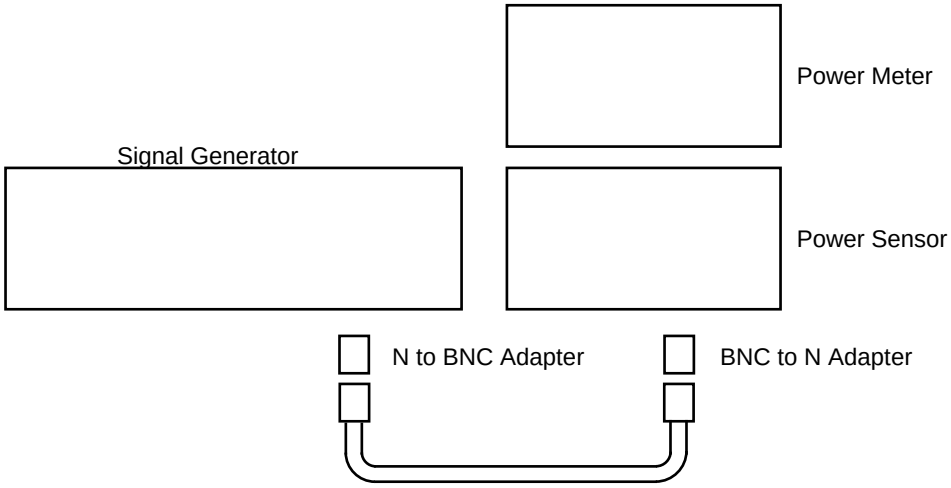
Input Frequency	Permissible Range
0.1 MHz	±1 dB
20.02 MHz	±1 dB
150 MHz	+1, –3 dB

Equipment required

Equipment	Critical Specification	Recommended
Signal Generator	Frequency : 0.1 to 150 MHz	Hewlett Packard 8657A
Power Meter	Frequency : 100 kHz to 150 MHz	Hewlett Packard 437B
Power Sensor	Frequency : 100 kHz to 150 MHz	Hewlett Packard 8482A
50 ohm Terminator		Hewlett Packard 1251-2277
N(P) to BNC(J) Conversion Adapter	N plug to BNC jack	Hewlett Packard 1250-0780
BNC(J) to N(J) Conversion Adapter	N jack to BNC jack	Hewlett Packard 1250-1474
BNC-BNC Cable	BNC to BNC	YOKOGAWA 3669 24

Calibration of standard signal generator

Connection



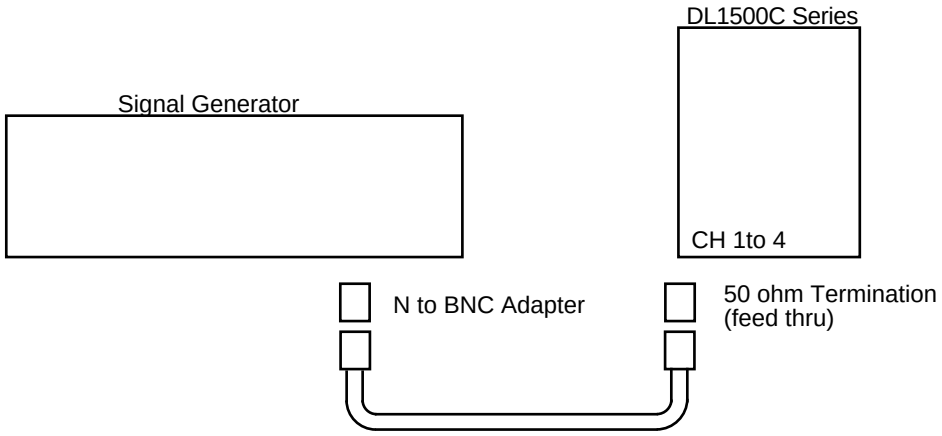
Procedure

Output the signals at the following frequencies and output levels from the standard signal generator and measure the output level with the power meter.

Output Frequency	Output Level
0.1 MHz	+16 dBm, +10 dBm, 0 dBm, –14 dBm
20.02 MHz	+16 dBm, +10 dBm, 0 dBm, –14 dBm
150 MHz	+16 dBm, +10 dBm, 0 dBm, –14 dBm

Frequency response test

Connection



Procedure

1) Set the DL1500C series as shown below.

VERTICAL (for all channels)		
	V/DIV	Set this according to the following measurement conditions
	POSITION	0 DIV
	COUPLING	DC
	PROBE	1:1
HORIZONTAL		
	TIME/DIV	Set this according to the following measurement conditions
TRIGGER		
	TYPE	EDGE
	MODE	NORMAL
	SOURCE	(Channel to be tested)
ACQ		
	MODE	NORMAL
MEASURE		
	MODE	ON
	TRACE	(Set to channel to be tested)
	ITEM	Select P-P

2) Input the following voltages to the DL1500C series, read the indications on the DL1500C series (P-P values), and compare the difference between these and the values measured by the power meter to the specified tolerances.

(i) Input sensitivity setting	1 V/div	Input level	+16 dBm (4 Vp-p)
(ii) Input sensitivity setting	500 mV/div	Input level	+10 dBm (2 Vp-p)
(iii) Input sensitivity setting	100 mV/div	Input level	0 dBm (632.5 mVp-p)
(iv) Input sensitivity setting	20 mV/div	Input level	–14 dBm (126.3 mVp-p)

Input Frequency	Permissible Range	T/div
0.1 MHz	±1 dB	5 µs/div
20.02 MHz	±1 dB	20 ns/div
150 MHz	+1, –3 dB	5 ns/div

3) Test all channels in the same manner.

2.6 Time-Base Axis Accuracy Test

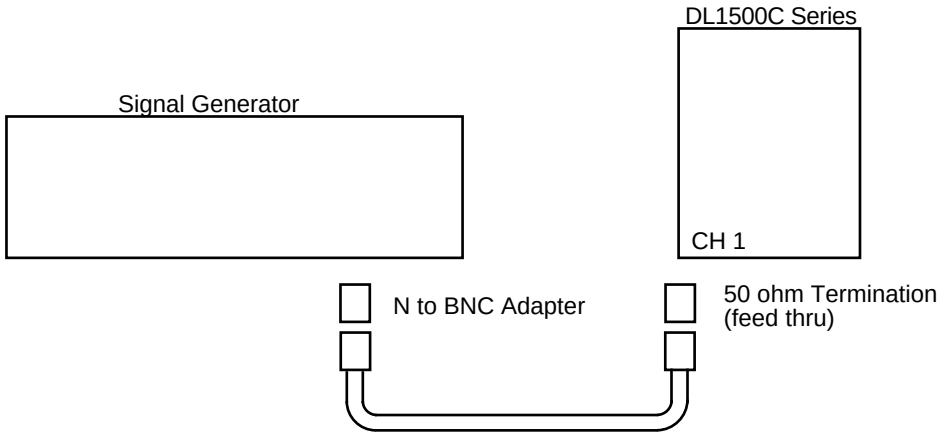
Specifications
±(0.01% + 500 ps)

Permissible range
50 kHz ± 10 kHz

Equipment required

Equipment	Critical Specification	Recommended
Signal Generator	Frequency : 0.1 to 150 MHz	Hewlett Packard 8657A
50 ohm Terminator		Hewlett Packard 1251-2277
N(P) to BNC(J) Conversion Adapter	N plug to BNC jack	Hewlett Packard 1250-0780
BNC-BNC Cable	BNC to BNC	YOKOGAWA 3669 24

Connection



Procedure

1) Set the standard signal generator as shown below.
   100.05 MHz 800 mVp-p

2) Set the DL1500C series as shown below.

VERTICAL (CH1)

V/DIV	200 mV/div
POSITION	0div
COUPLING	DC
PROBE	1:1

HORIZONTAL

TIME/DIV	10 µs/div (100 Msps)

TRIGGER

TYPE	EDGE
LEVEL	0 V
MODE	NORMAL
SOURCE	CH1
COUPLING	DC
EDGE	RISE

ACQ

MODE	NORMAL

MEASURE

MODE	ON
TRACE	CH1
ITEM	Select FREQ

The measured frequency using MEASURE must be 50 kHz ± 10 kHz.

2.7 Trigger Sensitivity Test

Specifications

DC to 150 MHz :1 divp-p

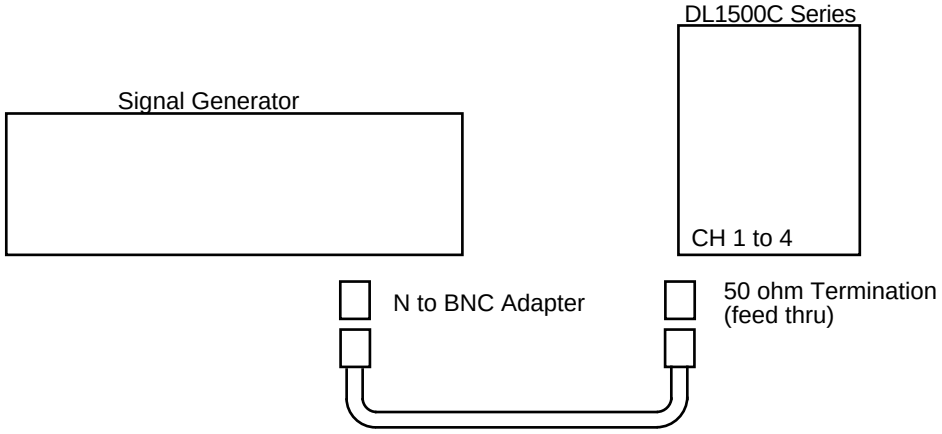
Permissible range

50 mV/div 150 MHz :–22 dBm (1 divp-p)

Equipment required

Equipment	Critical Specification	Recommended
Signal Generator	Frequency : 0.1 to 150 MHz	Hewlett Packard 8657A
50 ohm Terminator		Hewlett Packard 1251-2277
N(P) to BNC(J) Conversion Adapter	N plug to BNC jack	Hewlett Packard 1250-0780
BNC-BNC Cable	BNC to BNC	YOKOGAWA 3669 24

Connection



Procedure

1) Set the DL1500C series as shown below.

VERTICAL (CH1)

V/DIV	50 mV
OFFSET	0.0 V
COUPLING	DC
PROBE	1:1

HORIZONTAL

TIME/DIV	10 ns
REPETITIVE	Off

TRIGGER

TYPE	EDGE
LEVEL	0.0 V
MODE	NORMAL
SOURCE	CH1
COUPLING	DC
SLOPE	↑

2) Apply a signal of 150 MHz, –22 dBm (50 mVp-p/17.6 mVrms) to the CH1 input and check that the waveform stabilizes.

NOTES If the trigger is not actuated, vary the trigger level in the range of ± 0.5 div and check that the trigger is actuated.

3) Test all channels in the same manner.

2.8 Trigger Accuracy Test

Specifications

± (1 div + 10% of the trigger level)

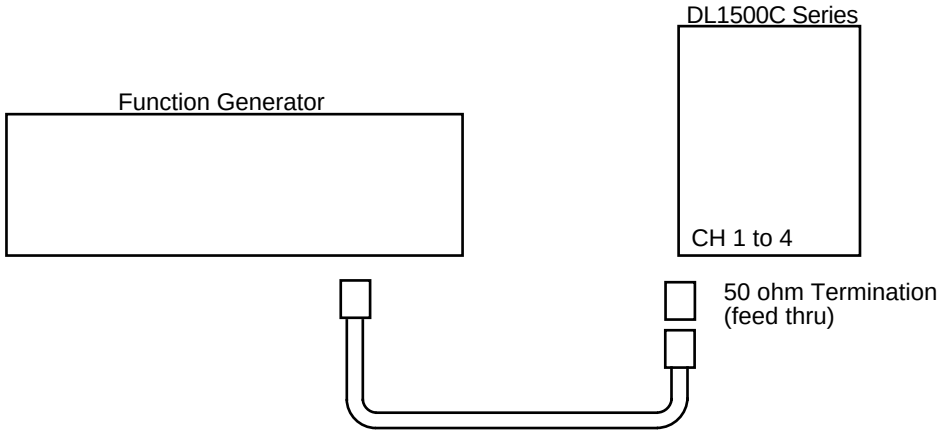
Permissible range

Trigger Level	Permissible Range
300 mV	170 mV to 430 mV
0 mV	–100 mV to 100 mV
–300 mV	–430 mV to –170 mV

Equipment required

Equipment	Critical Specification	Recommended
Function Generator	Triangular wave Frequency : 100 kHz Output Level : 800 mV	YOKOGAWA 7060
50 ohm Terminator		Hewlett Packard 1251-2277
BNC-BNC Cable	BNC to BNC	YOKOGAWA 3669 24

Connection



Procedure

1) Set the DL1500C series as shown below.

VERTICAL (CH1)		
	COUPLING	DC
	PROBE	1:1
	V/DIV	100 mV
	OFFSET	0.0 V
HORIZONTAL		
	TIME/DIV	5 μs
TRIGGER		
	TYPE	EDGE
	LEVEL	300 mV, 0 V, –300 mV
	MODE	NORMAL
	SOURCE	CH1
	COUPLING	DC
	SLOPE	↑, ↓
CURSOR		
	TYPE	V–T
	CURSOR TRACE	CH1
	CURSOR T1	0.0 s

2) Connect the function generator output to the CH1 input.
Acquire data with the slope in RISE and the trigger level at 300 mV, read the trigger point data V1, and check the value is within the following range: 170 mV to 430 mV
Similarly, each value of the trigger point data should be within the following corresponding range:

Slope	Trigger Level	Permissible Range
↑	300 mV	170 mV to 430 mV
↓	300 mV	170 mV to 430 mV
↑	0 mV	–100 mV to 100 mV
↓	0 mV	–100 mV to 100 mV
↑	–300 mV	–430 mV to –170 mV
↓	–300 mV	–430 mV to –170 mV

3) Test all channels in the same manner.

Chapter 3 ADJUSTMENTS (for DL1540C/ DL1540CL)

This chapter describes the following tests.

3.1 Introduction

When adjusting DL1540C/DL1540CL, remove the main unit cover, front panel, and bottom plate. For this, care must be taken for the following items.

WARNING Circuit patterns of the printed circuit board are exposed. Be careful when handling so that hands or fingers are not injured by the pin protrusions.

CAUTION Circuit patterns of the printed circuit board are exposed. If these patterns touch other metallic materials, electrical shorting will occur, causing the circuit to be damaged or burnt.

It is sometimes necessary to turn the DL1540C/DL1540CL upside down for adjustment. Be careful to prevent the instrument from toppling.

3.2 Test Environment

1) Please operate the instrument in the following environment.
- Ambient Temperature : 23±2˚C
- Humidity : 55±10% RH
- Voltage of power supply : Specified Voltage ±1%
- Frequency of power supply : Specified Frequency ±1%

2) Warm up time
- More than 30 minutes after energizing the instrument.
- Confirm that self calibration is correctly executed after 30 minutes warm up. (Please pay attention to warm up time of the each equipment which will be used in the test.)

3.3 Equipment Required

Table 3.1 Equipment Required

Equipment	Critical Specification	Recommended
DC Volt Standard	Output Level : >10 V Accuracy : <0.02%	YOKOGAWA 7651
Digital Volt Meter	Accuracy : <0.01%	YOKOGAWA 7551
Function Generator	Frequency : 1 kHz Output Level : >300 mVp-p with DC offset function	Hewlett Packard 8166A
Calibration Generator	Output Level : >30 Vp-p at open and flatness :<1% Output Level : >300 mVp-p at 50 ohm and rise time :<1 ns	Tektronix PG506A + TM501
BNC-BNC Cable		YOKOGAWA 3669 24
Clip-BNC Cable		YOKOGAWA 3669 26
50 ohm Terminators	Feed Thru Type	YOKOGAWA 7009 76

NOTE The values shown in the specification column are those set in this service manual. These values do not indicate the performances of the recommended equipment and tools. Therefore, non-designated equipment and tools, which satisfy the specifications, may be permitted for use.

The Function Generator setting values described in this service manual are those output when 50 ohm load resistance is applied.

The Function Generator setting values included in this service manual are described in the following two ways.

(1) Output level: 1 Vp-p
(2) Output level: 1.5 V to 2.5 V

(1) shows where the DC offset function is not used.
(2) shows where a DC offset of 2 V is added to the 1 Vp-p.

3.4 DC Gain Adjustment on the Attenuator Assembly

NOTE Before performing this DC gain adjustment, the reference voltage adjustment of the Analog Board Assembly must have been completed.

Procedure

1) Remove the unit cover, front panel, and bottom cover.
2) Allow the unit to warm up for 15 minutes or more.

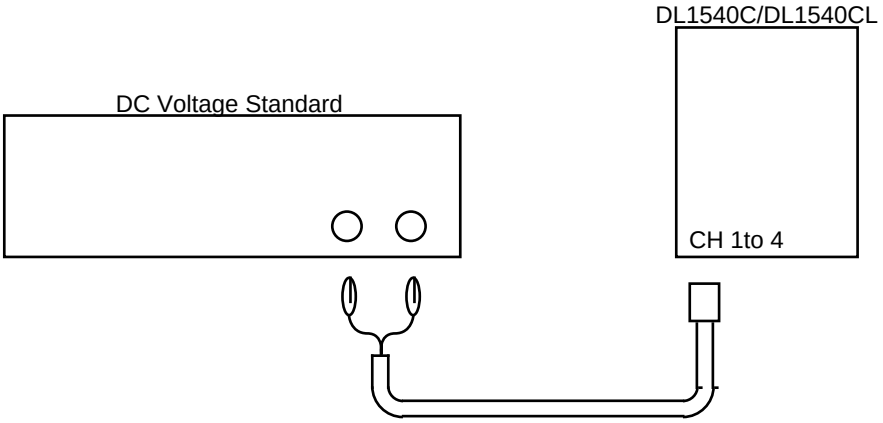


Figure 3.1 Connection Method

3) Connect each instrument as shown in Figure 3.1 Connection method.
4) Press the [INITIALIZE] key and select the {INITIAL EXEC} option to execute initialization.
5) Press the [CAL] and {CAL EXEC} option to perform calibration. After that, set AutoCal item {OFF} so as not to perform an automatic calibration.
6) Set up the DL1540C/DL1540CL series and DC Voltage Standard as follows.

DL1540C/DL1540CL series	ch1 to 4	Probe	:1:1
		Volt/div	:100 mV/div
		Position	:0 div
		Offset	:+10.000 V
	Bandwidth		:20 MHz
	Acquisition		:AVERAGE Count :8
	Measure Trace 1 to 4		:AVG
DC Voltage Standard	Output Level		:+10.000 V

7) Adjust the variable resistor (refer to Table 3.2 Adjustment Point) corresponding to each channel so that the DC wave form falls within 0±20 mV as shown in Figure 3.2 Observed waveform.
8) Perform the adjustment of 7) for all channels.

Table 3.2 Adjustment Point

Channel	Adjustment Point
ch1	RV1
ch2	RV2
ch3	RV3
ch4	RV4

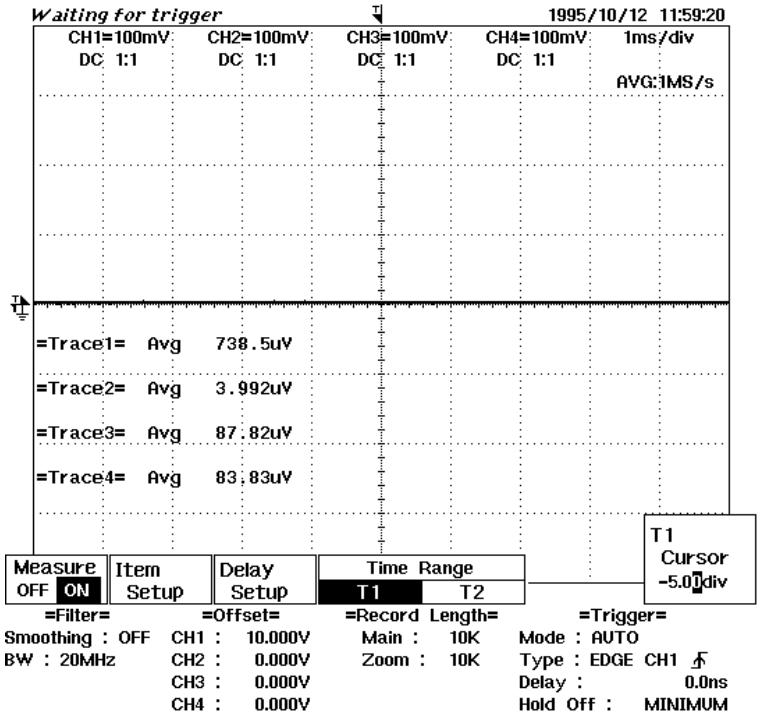
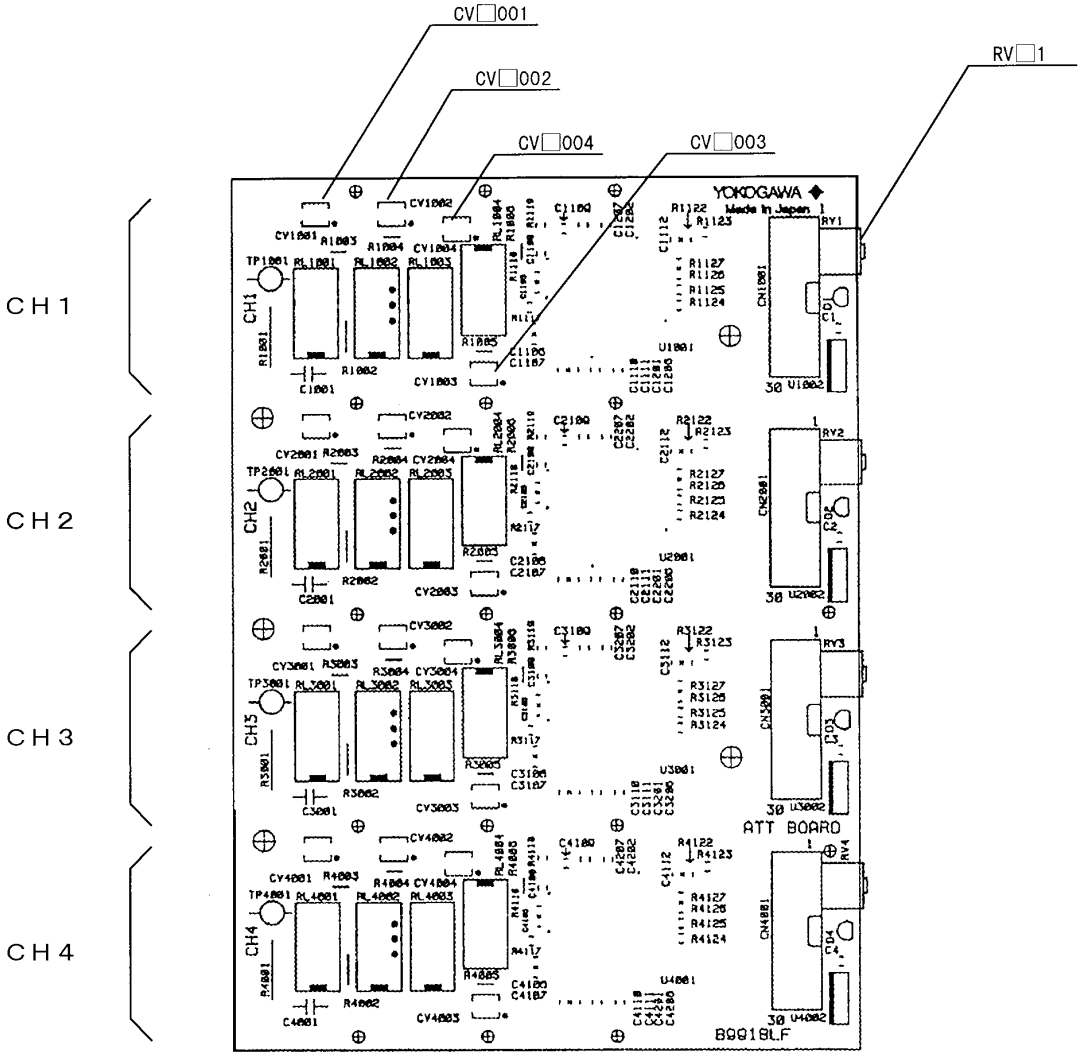


Figure 3.2 Observed Waveform



Write the channel number in the boxes.

Figure 3.3 ATT Assembly Adjustment Point Location Diagram

3.5 Reference Voltage Adjustment on the Analog Board Assembly

Procedure

1) Remove the unit cover, front panel, and bottom plate.
2) Turn power on and allow the unit to warm up for 15 minutes or more.
3) Adjust the variable resistor (RV1) so that the voltage between TP1 and TP2 (GND) falls within the following values.

5.075 to 5.085 V (5.08±0.005 V)

NOTE After completing this reference voltage adjustment, perform the ATT Assembly DC gain adjustment again.

Tester probe access is difficult when measuring the terminals TP1 and TP2. Be careful not to cause a circuit short.

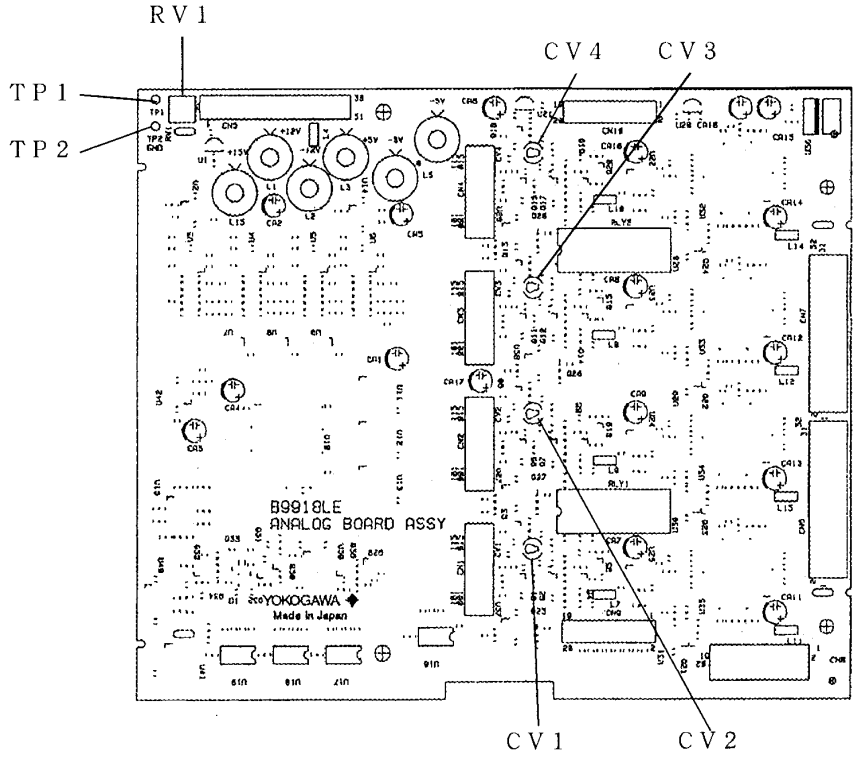


Figure 3.4 Adjustment Point Location Diagram

3.6 Threshold Level Adjustment on the Rear Assembly

Procedure

1) Remove the unit cover, front panel, and bottom plate.
2) Connect each instrument as shown in Figure 3.5 Connection method.
   Where a connection to TP9 cannot be made, remove the bracket on which the rear panel fan is mounted.

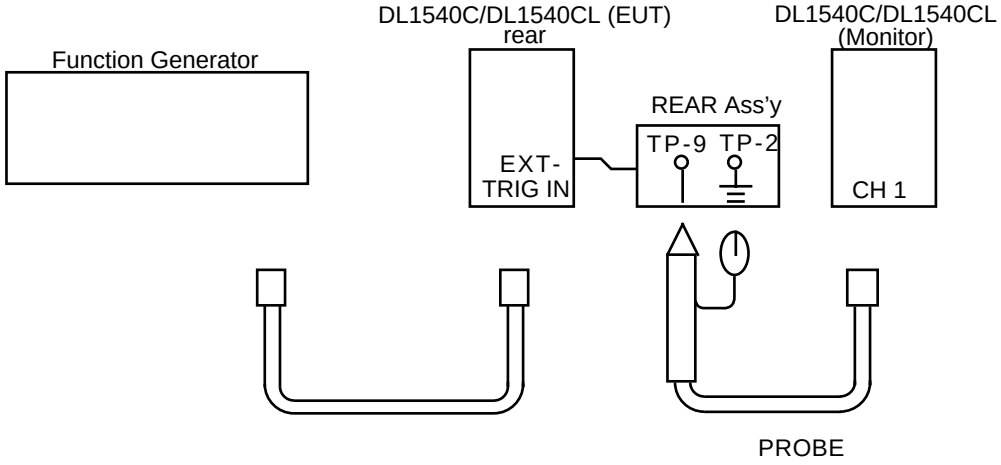


Figure 3.5 Connection Method

3) Press the [INITIALIZE] key and select the {INITIAL EXEC} option to execute initialization.
4) Set up the DL1540C/DL1540CL and Function Generator as follows.

DL1540C/DL1540CL (EUT) (EUT : Equipment Under Test)	Trigger Source		:EXT (rising-up)
	EXT trig range		:0.15 V
DL1540C/DL1540CL (Monitor)	ch1	Coupling	:AC
		Volt/div	:200 mV/div
		Position	:0 div
	Time/div		:500 µs/div
	Bandwidth		:20 MHz
	Acquisition		:AVERAGE Count :8
	Measure Trace 1		:+WIDTH , -WIDTH
Function Generator	Wave Form		:Triangle wave
	Frequency		:1 kHz
	Output Level		:0 to +300 mV

5) Connect the probes attached to ch1 of DL1540C/DL1540CL to TP9 and TP2 terminals on Rear Assembly. Adjust the variable resistor (VR1) so that the duty of the observed waveform falls with 50±3%, as shown in Figure 3.6 Adjustment waveform.

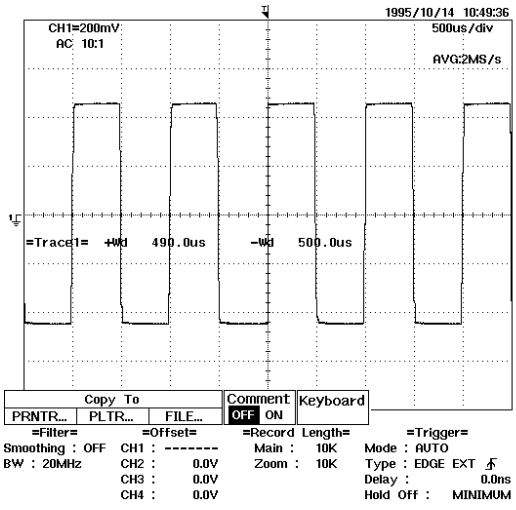


Figure 3.6 Adjustment Waveform

Chapter 4 PRINCIPLE OF THE OPERATION (for DL1540C/ DL1540CL)

This chapter describes the following tests.

4.1 Introduction

Figure 4.1 shows the block diagram of the analog section in the DL1540C/DL1540CL and Figure 4.2 shows that of the digital section in the same instrument.
The entire hardware consists of the analog section which includes the attenuator, preamplifier, multiplexer, A/D converter, and trigger circuit, and the digital section which includes the acquisition memory, data processing circuit, display control unit, CPU, keyboard, printer, etc...

4.2 Analog Section

This section consists of the ATT Assembly, Analog Board Assembly, and Trigger Board Assembly.

(1) ATT Assembly.

The ATT Assembly incorporates the switching circuits of the AC/DC input signal, GND/MEASURE and the 1/1, 1/10, and 1/100 switching circuit of the attenuator and the one chip amplifier.
The one chip amplifier is an IC intergrating approx. 800 elements including the FET buffer used to generate the high impedance input required for the oscilloscope. In addition, the amplifier also provides the functions of gain transfer, band limitation, DC offset clearance.
The 4 channels together provide a 150 MHz band with sensitivity up to a maximum of 1mV/div.
The division ratio and amplifying rate of the attenuator corresponding to the setting range are as shown in “Table 5.1 Setting range and Amplifying Level”.
The control of these factors is performed by the Analog Front-end controller on the Analog Board Assembly.

Table 4.1 Setting Range and Amplifying Level

Setting Range	Attenuator Division Ratio	Amplifying Rate	Remark
1 mV/div	1/1	x 20	1 mV/div is created by digital zoom (2 mV/div x 2)
2 mV/div	1/1	x 20	
5 mV/div	1/1	x 10	
10 mV/div	1/1	x 5	
20 mV/div	1/1	x 2.5	
50 mV/div	1/1	x 1	Setting ranges here depends on probe setting 1:1.
100 mV/div	1/10	x 5	
200 mV/div	1/10	x 2.5	
500 mV/div	1/10	x 1	
1 V/div	1/100	x 5	
2 V/div	1/100	x 2.5	
5 V/div	1/100	x 1	

(2) Analog Board Assembly

The Analog Board Assembly consists of the amplifier, A/D converter, analog frontend controller, trigger comparator, TV trigger circuit, etc.
The A/D converter incorporates a total of 4 units (one per channel) comprising 8 bits and 100 MS/s.
Where 2 channels are used, the analog signals are distributed to the switching circuits using the Multiplexer circuit and sampled at high speed (200 MS/s) based on the interleaving method.
The Analog Frontend Controller supplies the internal switching signal to the ATT Assembly. In addition it generates the PWM signal to produce the DC voltage necessary for DC-ADD, positioning function, and trigger threshold level.
A trigger output signal is sent from the one chip amplifier in the ATT Assembly to the Trigger comparator.
The signal is converted into a logic signal and transmitted to the trigger logic circuit on the ACQ Board Assembly. The TV trigger also corresponds to the HDTV.

(3) Trigger Board Assembly (option)

Mounting the Trigger Board Assembly with optional spec. on the ACQ Board Assembly will enable use of the OR trigger function and pulse width trigger function if any of the 4 channels satisfy the trigger conditions.

4.3 Digital Section

The digital section consists of the ACQ Board Assembly which performs the data processing and the CPU Board Assembly which performs the waveform processing, keyboard operation and printing of the printer.

(1) ACQ Board Assembly

The ACQ Board Assembly includes the acquisition memory, the vertical display processor, the horizontal display processor, the time-base controller and the time measurement component.
The max. length of the acquisition memory is 120 kW (in DL1540C) or 2 MW (in DL1540CL).
The vertical display processor perforos data entry into the acquisition memory, data processing, and data transmission into the display control circuit. The hardware of the processor is based on a type of pipeline processor, and the main functions are as follows.

- Perform a rate reduction to 25 MHz so as to write in the data to the acquisition memory.
- Perform a data thinning data compression so that a rate reduction in accordance with the time axis setting is made.
- Detect a data peak for the Envelope mode.
- Perform data averaging, data smoothing, and inversion processing.
- Perform calculation between the channels. (x, -, +).

The Horizontal Display Processor controls the data processing and the display circuit depending on the time axis setting or trigger signal. The hardware is a type of pipeline processor and the main functions are as follows.

- By dividing the sampling clock, send a timing necessary to incorporate data to the data processing circuit.
- Create an address for the acquisition memory, and control the operation of data incorporation or displayed data transmission.
- Calculate the trigger address and send the rearrangement data at the time of equivalence sampling, etc. to the data processing circuit.
- Monitor the trigger occurrence frequency to control an auto-trigger, etc.

The time-base controller performs a distribution of sampling clock time and a selection of trigger signal.
The time measurement section magnifies the time difference between the sampling clock time and trigger signal in the equivalence sampling mode to perform the time measurement precisely.

(2) CPU PCB Assembly

The CPU Board Assembly includes the display interface which is equipped with the integrated-display processor as the main components, in addition to the CPU, memory unit, the peripheral interface circuits for optional printer, floppy disk, keyboard, etc. The integrated-display processor receives the waveform data processed on the ACQ Board Assembly and generates the waveform data and the printer recording data via the data buffer. The functions of the integrated display processor are as follows.

- Generate the waveform data for the Graphic Control Processor.
- Generate the X-Y waveform data.
- Generate and control the recording data for printer

The CPU controls the peripheral circuits for memory, key input, floppy disk, clock, communication, etc. via the decoder & memory controller, in addition to controlling the entire system.

(3) LCD unit

The LCD unit uses a 6.4-inch (640×480) color TFT display with backlight.

(4) Printer Assembly (option)

The printer is a thermal sensitivity type with 6 dots per mm and 640 dots per line which prints out a hardcopy of CRT display in approx. 12 seconds.

(5) FDD Assembly

The FDD Assembly supports the formats of 640 kB, 720 kB, 1.2 MB, and 1.44 MB on 3.5-inch disk.

(6) Rear Assembly

The Rear Assembly is equipped with each connector for external trigger, external clock signal interface, GP-IB interface, and option box.

(7) GCP PCB Assembly

Combine the graphic display (Cursor, grid, character, etc.) and the waveform data from the integrated-display processor.

- Generate the display signal for the LCD unit and the VGA output.
- Adjust the LCD backlight brightness.
- Generate +3.3 V power

4.4 Functions of Each Gate Array

The following items describe the Gate Array functions used in each assembly.

(1) Vertical Display Processor (VDP)

Performs conversion to 25 MS/s 32 bit data from 100 MS/s 8bit data.
Performs thinning or compression of display data.
Performs averaging, Smoothing, Inverting, and calculations for the each channels.

(2) Horizontal Display Processor (HDP)

Controls the VDP according to the time/div setting and trigger signal.
Performs generation of the address to ACQ memory and management of the transmission of the display data.
Performs transmission of the rearrangement data information to the VDP.

(3) Time Base Controller (TBC)

Supplies the sampling clock for the A/D converter selection of the trigger signal source.
Controls the TEX.

(4) Time Extension (TEX)

Extends the time between the sampling clock edge and trigger signal to measure at equivalent sampling mode.

(5) First Trigger Logic (FTL)

Performs “OR” trigger, “Parallel Pattern” trigger, “Pulse Width” trigger.

(6) Analog Frontend Controller (AFC)

Selection of the “ATT”, “Amp Gain”, “Input Coupling”, etc.
Performs generation of the offset voltage, and trigger level voltage by internal D/A converter (PWM).

(7) Integrated Display Processor (IDP)

Performs generation of the waveform data and output signal for hardcopy printer.
Performs data handling for the waveform data (peak to peak compression, correction of the display position etc.).

(8) Trace RAM

Keeps the wave data for the display (compressed display data).

(9) Work RAM

Keeps the wave data for the hardcopy printer.

(10) CPU I/O Interface (CIO)

Acts as interface between the CPU and each peripheral device.
Performs generation of the drive signal for the hardcopy printer motor.
Acts as key control interface.

(11) Graphic Control Processor (GCP)

Performs generation of the display signal for the LCD unit.
Performs combination of the wave data, grid data, and cursor data for image handling.

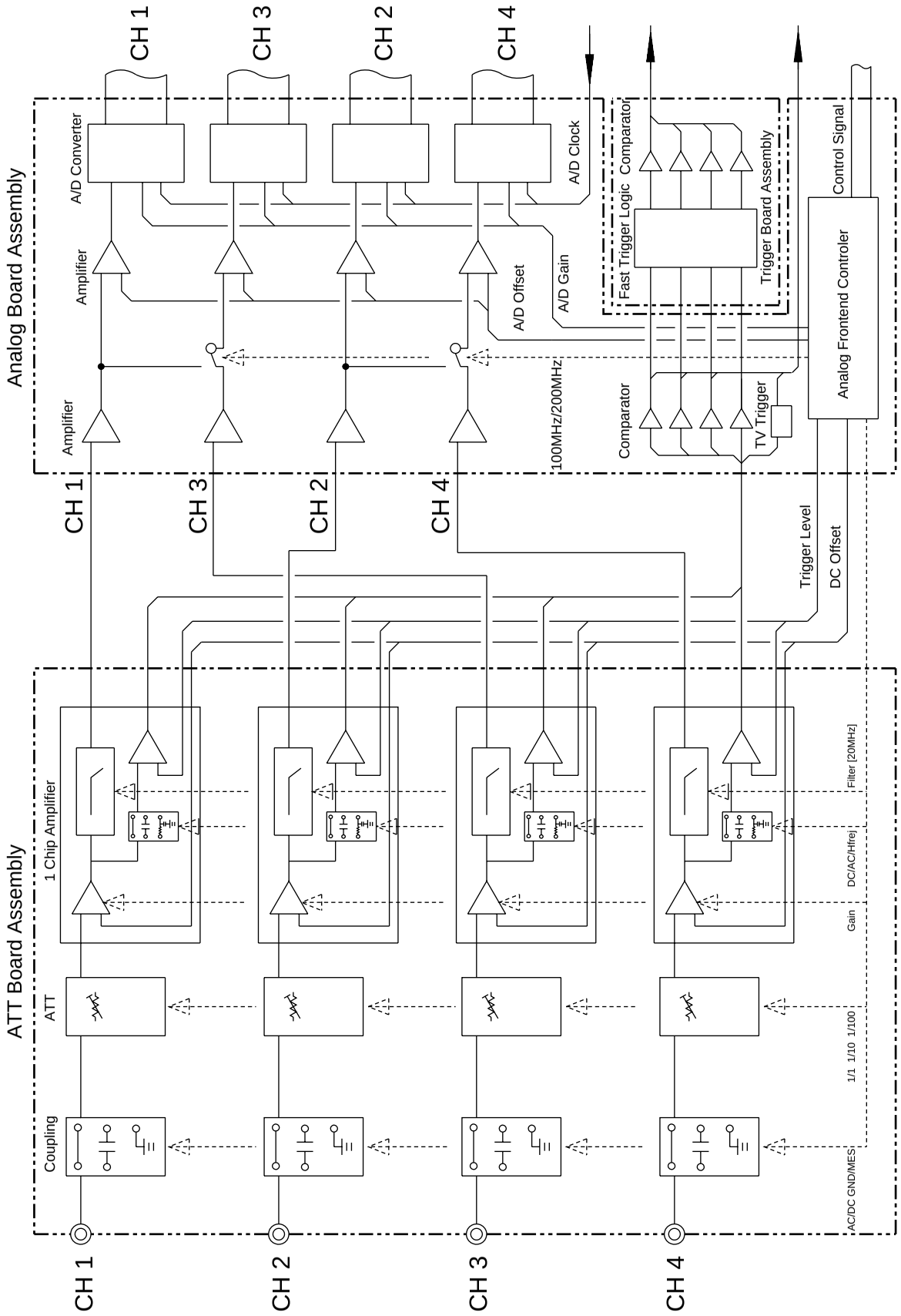


Figure 4.1 Block Diagram (Analog Section)

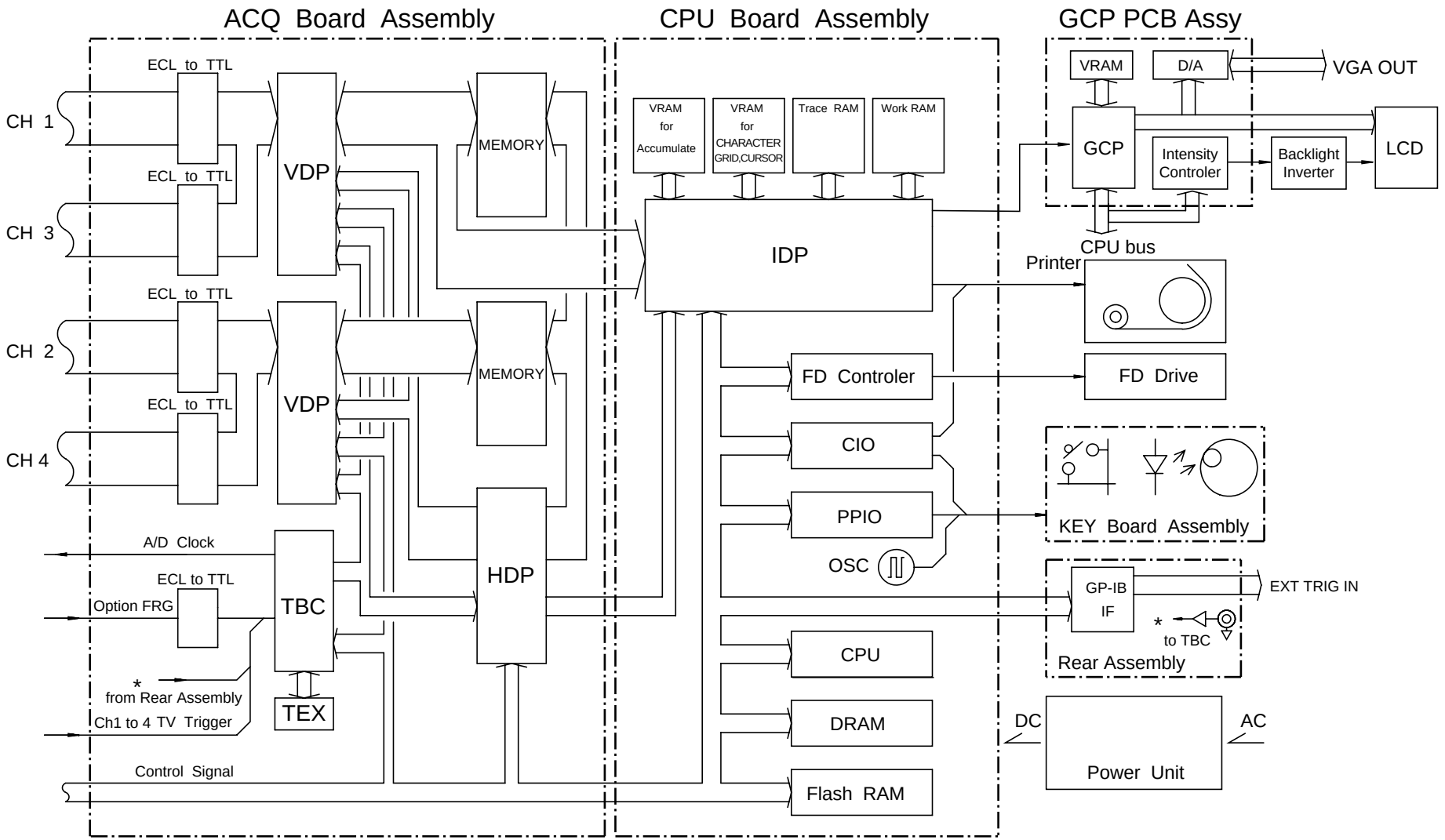


Figure 4.2 Block Diagram (Digital Section)

Chapter 5 TROUBLESHOOTING (for DL1540C/DL1540CL)

This chapter describes the following tests.

5.1 Introduction

This chapter describes possible solutions for rectifying errors.
In such cases, assembly removal may be required.
Please keep the following precautions in mind.

WARNING Replacing assembly is to be performed only by qualified service technicians who are aware of the hazard involved (such as fire and electrical shock).

NOTES If an error message is displayed, the error may have been caused by incorrectly operating the unit.
Check the User's Manual, and perform the correct operation.

5.2 Flowchart

"Figure 5.1 Troubleshooting flowchart" shows an analytical method for handling trouble occurrence.

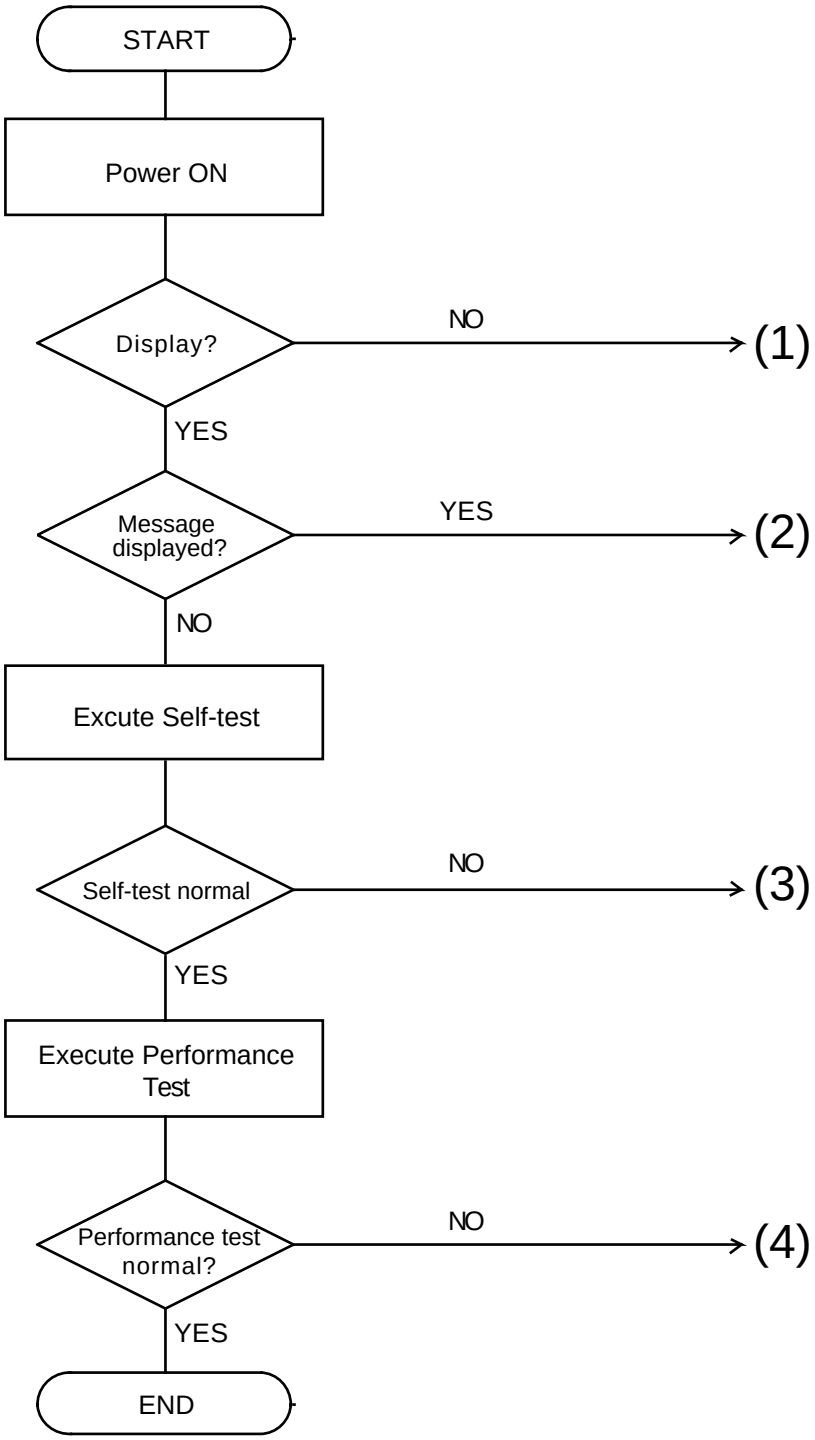


Figure 5.1 Troubleshooting Flowchart

(1)

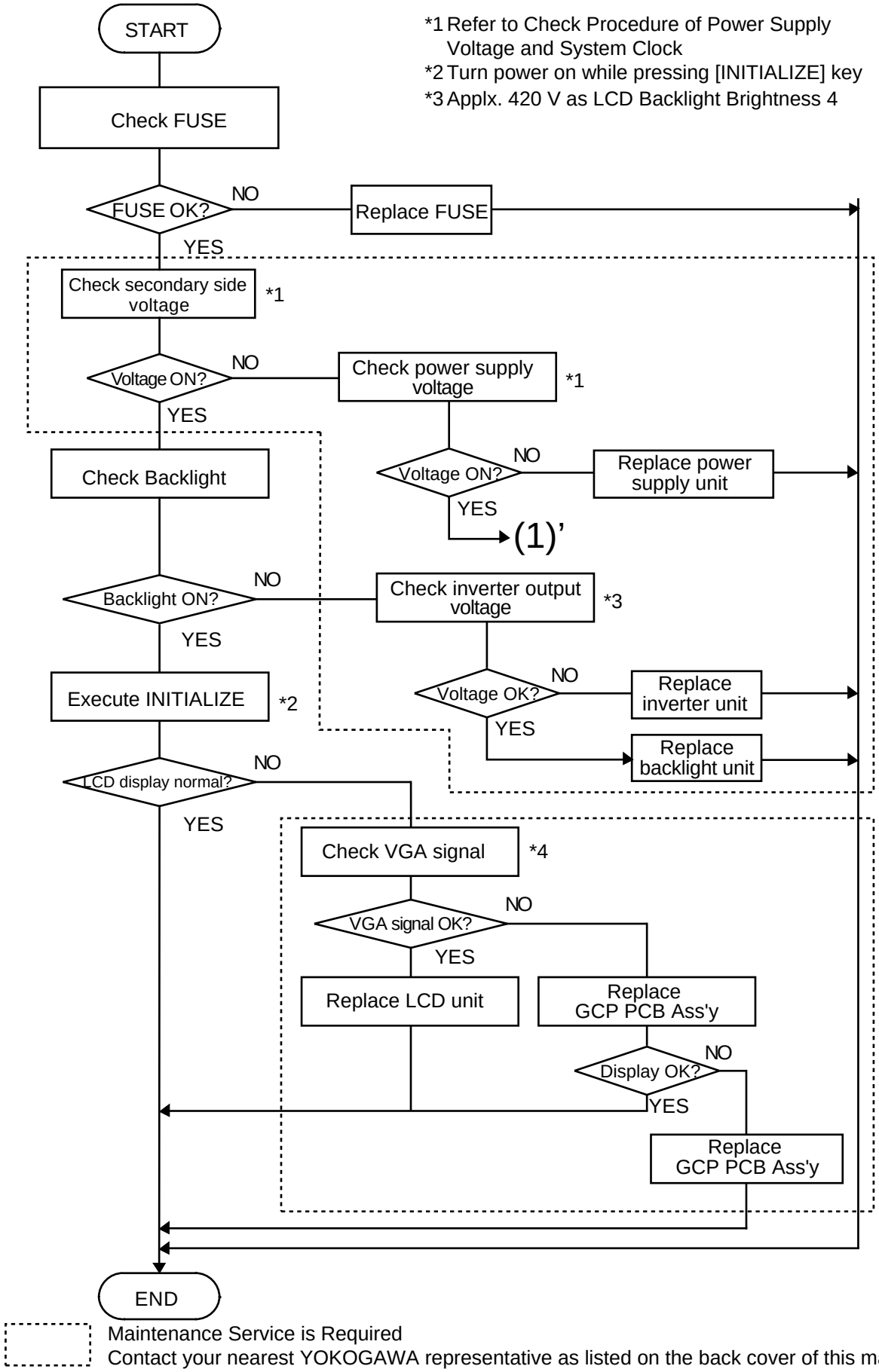


Figure 5.2 Troubleshooting Flowchart for Display Unit

(1)'

A short may occur in an assembly other than the power supply unit.
To check in which voltage line a short has occurred, use a circuit tester and investigate each assembly to which voltage is supplied.
Table 5.1 shows "Correspondence of Assembly to Voltage" the relationship between assemblies and the voltages supplied to them.

Table 5.1 Correspondence of Assembly to Voltage

Voltage Series	Assembly
+5 V	ACQ BOARD Assembly
	ATT Assembly
	ANALOG BOARD Assembly
	KEY BOARD Assembly
	CPU PCB Assembly
	GCP PCB Assembly
	PRINTER Assembly
	REAR Assembly
	TRIG Assembly
	PLOAD Assembly
–5 V	ACQ BOARD Assembly
	ATT Assembly
	ANALOG BOARD Assembly
	CPU PCB Assembly
	TRIG Assembly
+12 V	ANALOG BOARD Assembly
	CPU PCB Assembly
	GCP PCB Assembly
	REAR Assembly
	FUN
–12 V	ANALOG BOARD Assembly
	ATT Assembly
	CPU PCB Assembly
	GCP PCB Assembly
	REAR Assembly
+12 Vur	ANALOG BOARD Assembly
	ATT Assembly
	CPU PCB Assembly
+24 V	CPU PCB Assembly
	PRINTER Assembly

(2)

When trouble occurrs, refer to the instruction manual, to determine whether the trouble is caused by erroneous operation or by a defect in the hardware. Table 5.2 shows "Correspondence of Messages to Defective Assemblies" where trouble may be due to a hardware failure.

Table 5.2 Correspondence of Messages to Defective Assemblies

	Message	Assembly
602	No floppy disk inserted.	
604	Storage media is defective.	
605	File not found.	FDD Assembly
615	Formatting error.	
646-654	Storage media is defective.	
707	The roll chart is not secured.	
708	No roll chart.	PRINTER Assembly
709	Printer is overheating. Turn OFF the power immediately.....	
712	No printer installed.	
719	Calibration Error!	ANALOG BOARD Assembly
		ATT Assembly
723	Low temperature error has been detected in printer.	PRINTER Assembly
900	The back-up lithium battery has run out. The back-up	CPU PCB Assembly
901	Cooling fan has stopped .Turn OFF the power immediately.	Fan
902	Flash Memory Erase Error.	CPU PCB Assembly
903	Flash Memory Write Error.	

(3)

When trouble occurrs, check the test item displaying FAIL and select the relevant defective item from Table 5.3 shows “Correspondence of Test Items to Defective Assemblies”. If necessary, replace the defective assembly.

Table 5.3 Correspondence of Test Items to Defective Assemblies

Test Item	Assembly
CAL	ATT Assembly ANALOG BOARD Assembly ACQ BOARD Assembly
BOARD	CPU PCB Assembly GCP PCB Assembly ANALOG BOARD Assembly ACQ BOARD Assembly REAR PANEL BOARD Assembly
LCD	LCD UNIT CPU PCB Assembly GCP PCB Assembly
FDD	FDD Assembly CPU PCB Assembly
PRINTER	PRINTER Assembly CPU PCB Assembly

(4)

When trouble occurrs, check the nonconforming test item and select the relevant defective assembly from Table 5.4 shows “Correspondence of Test Items to Defective Assemblies”. If necessary, replace the defective assembly.

Table 5.4 Correspondence of Test Items to Defective Assemblies

Test Item	Assembly
2.4 Vertical Axis DC Voltage Accuracy Test	ATT Assembly ANALOG BOARD Assembly ACQ BOARD Assembly
2.5 Frequency Response Test	ATT Assembly ANALOG BOARD Assembly
2.6 Time-base Accuracy Test	ACQ BOARD Assembly
2.7 Trigger Sensitivity Test	ATT Assembly ANALOG BOARD Assembly
2.8 Trigger Accuracy Test	ATT Assembly ANALOG BOARD Assembly

5.3 Self Test

After turning the power on, press the [MISC] key and select the {To NextMenu} & {SelfTest...} options to call up the display of “Figure 5.3 Self test item”.

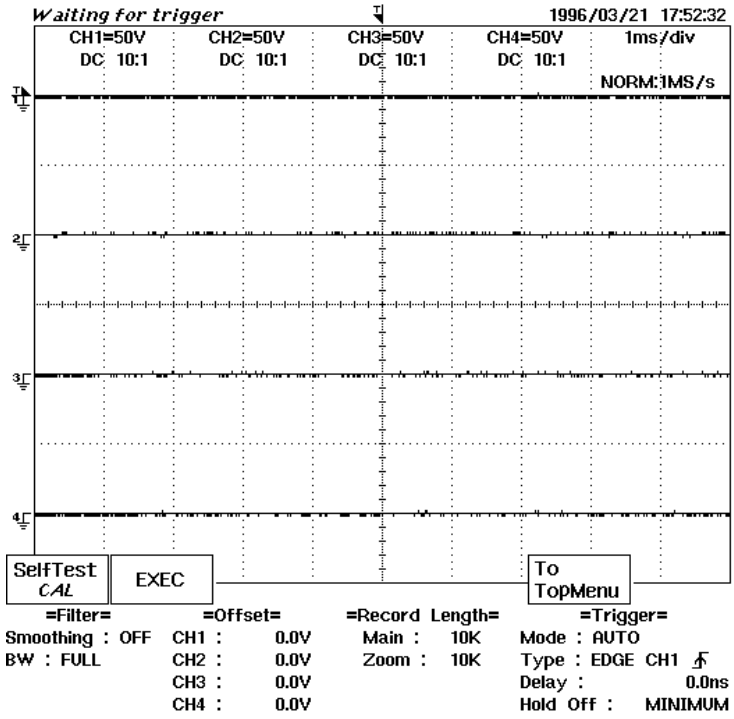


Figure 5.3 Self Test Item

In addition, each of the execution items is popped up by selecting the {SelfTest} item (refer to Figure 5.4 “Self Test Item”). After selecting the execution item, the selected item can be tested by pressing the {EXEC}.

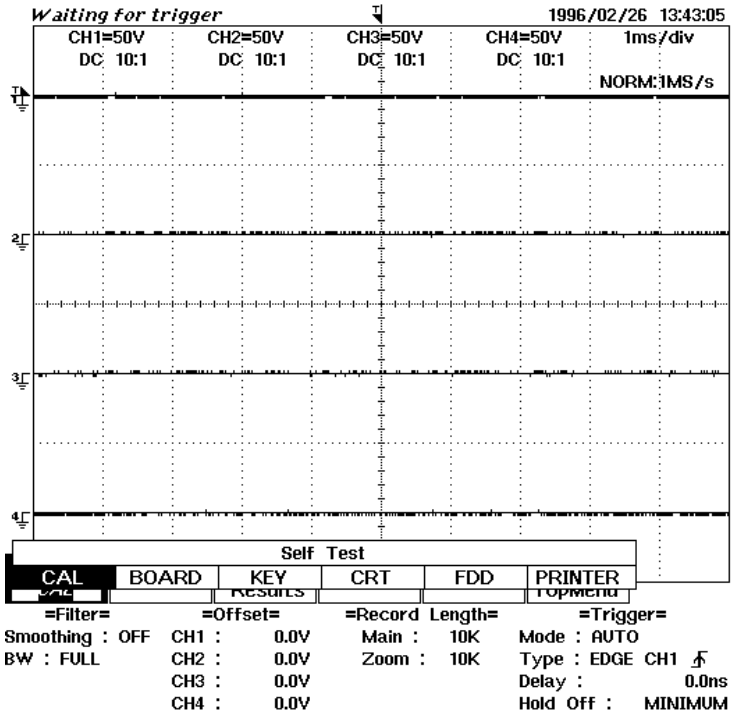


Figure 5.4 Self Test Item

5.3.1 Self Test (CAL)

The calibration is performed and its result is displayed.

Figure 5.5 Execution Results of Calibration (Under Normal Conditions)

Figure 5.6 shows examples where calibration results are abnormal.

Figure 5.6 Execution Results of Calibration (When Abnormality is Present)

5.3.2 Self Test (BOARD)

The gate arrays, peripheral ICs, and RAM chips on each printed board assembly are tested and the results are displayed (refer to Figure 5.7).

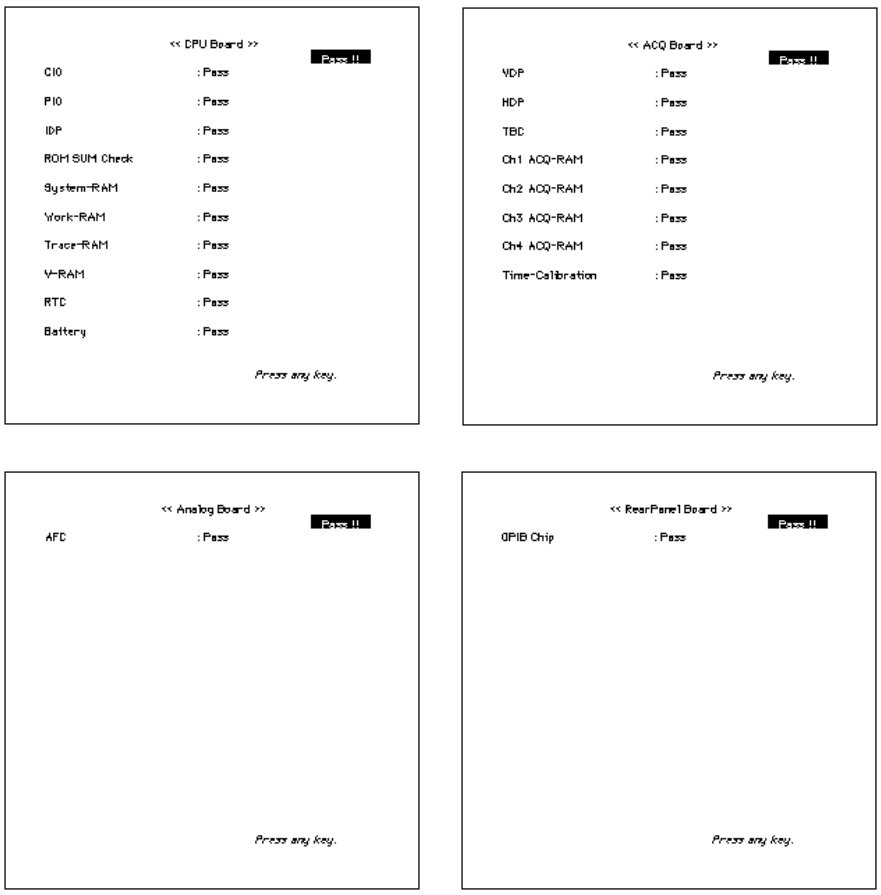


Figure 5.7 Execution Results of Self Test (BOARD)

5.3.3 Self Test (KEY)

Check the operations of the LEDs, key-switches, and rotary knobs on the front panel.

1) “LED Testing” is displayed on the LCD and the LEDs on the front panel (8 LEDs excluding Trig’d) automatically light up in sequence.
2) Illustration of the front panel is then displayed on the LCD. By operating the keys and the rotary knob, the corresponding displays on the LCD are highlighted.

5.3.4 Self Test (CRT)

The following contents are displayed. These displays are switched by pressing the option keys.

1) The frames for display areas on LCD is displayed.
   A frame is displayed on the LCD.
2) The panel patterns with are different brightness and color displayed.
   Screen patterns of different intensity are displayed.
   The entire screen is displayed in white.
3) The characters used on the DL1540C/DL1540CL series are displayed.

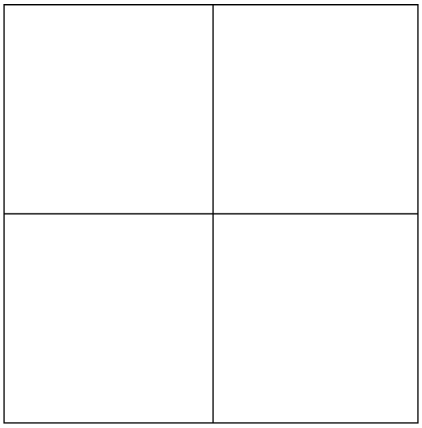


Figure 5.8 Display Area Frames

5.3.5 Self Test (FDD)

The Read/Write test is performed for each of the 1.44 MB/1.2 MB/720 KB formatted disks.

1) Insert each formatted disk into the FDD and select the {exec} option. “FDD Read” is displayed and the read test is performed. When the test has been completed normally, “Pass” is displayed on the LCD.
2) Subsequently, “FDD Write” is displayed and the write test is performed.
   When the test has been completed normally, “Pass” is displayed on the LCD.
   The inserted disk type is also displayed at the same time.

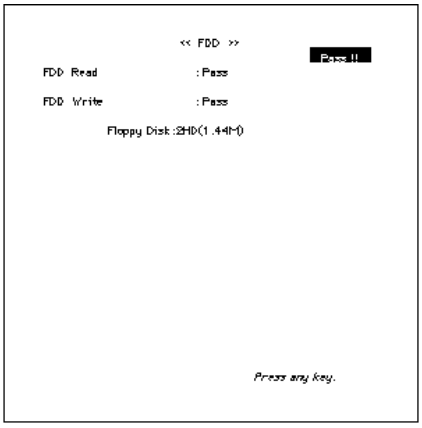


Figure 5.9 Self Test (FDD) Window

5.3.6 Self Test (PRINTER)

Where the DL1540C/DL1540CL series is equipped with the optional printer (/B5), print out the patterns shown in “Figure 5.10 Printer print patterns” on the printing paper.

1) Checkered pattern every other 2 dots.
2) Vertically printed lines on alternate dots.
3) Checkered pattern every other 10 dots.

For the software version before 1.32.

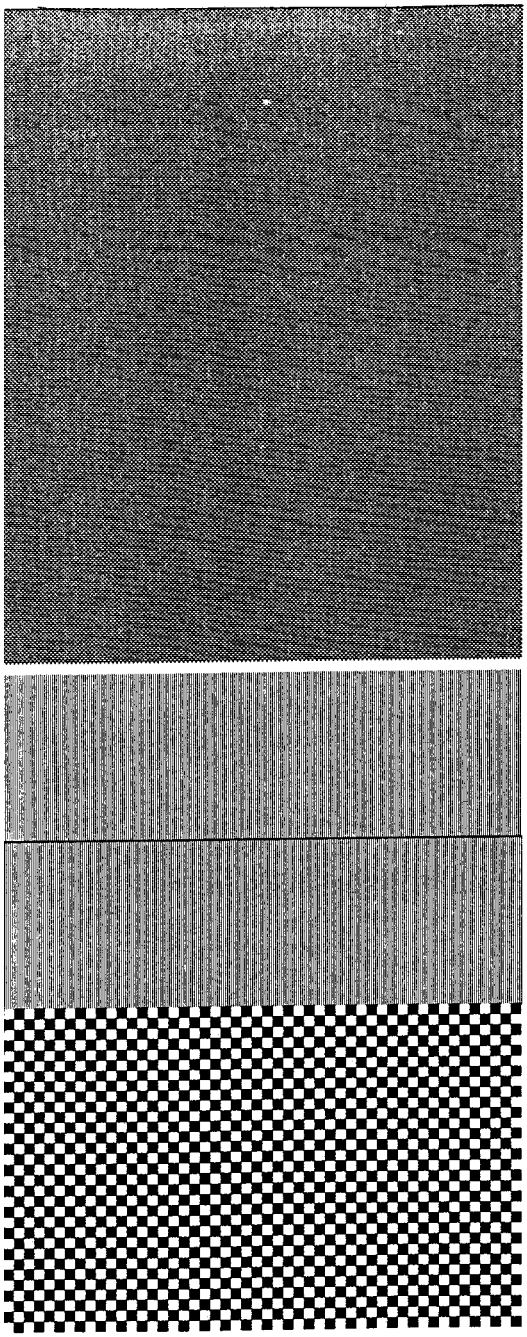
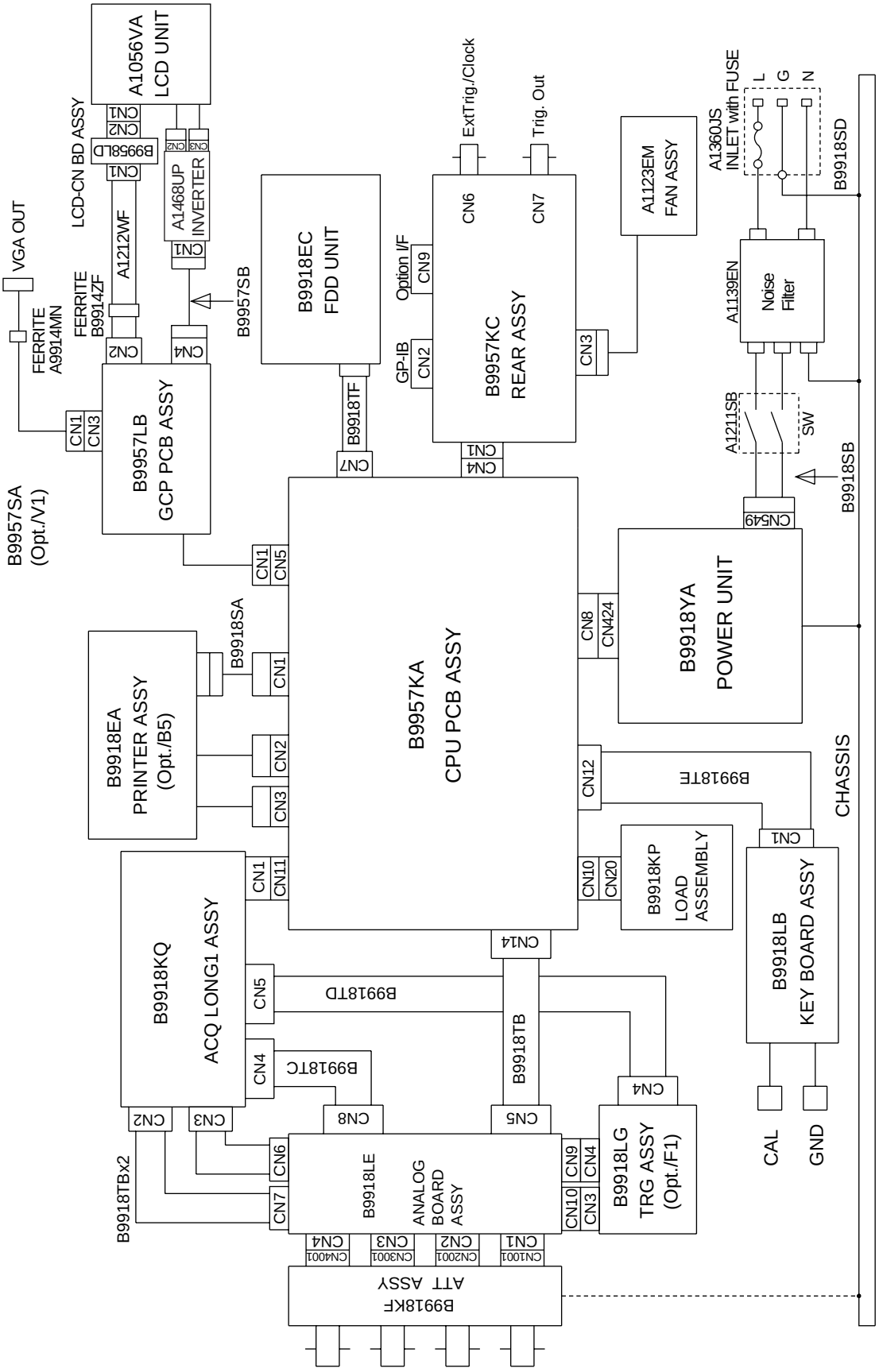
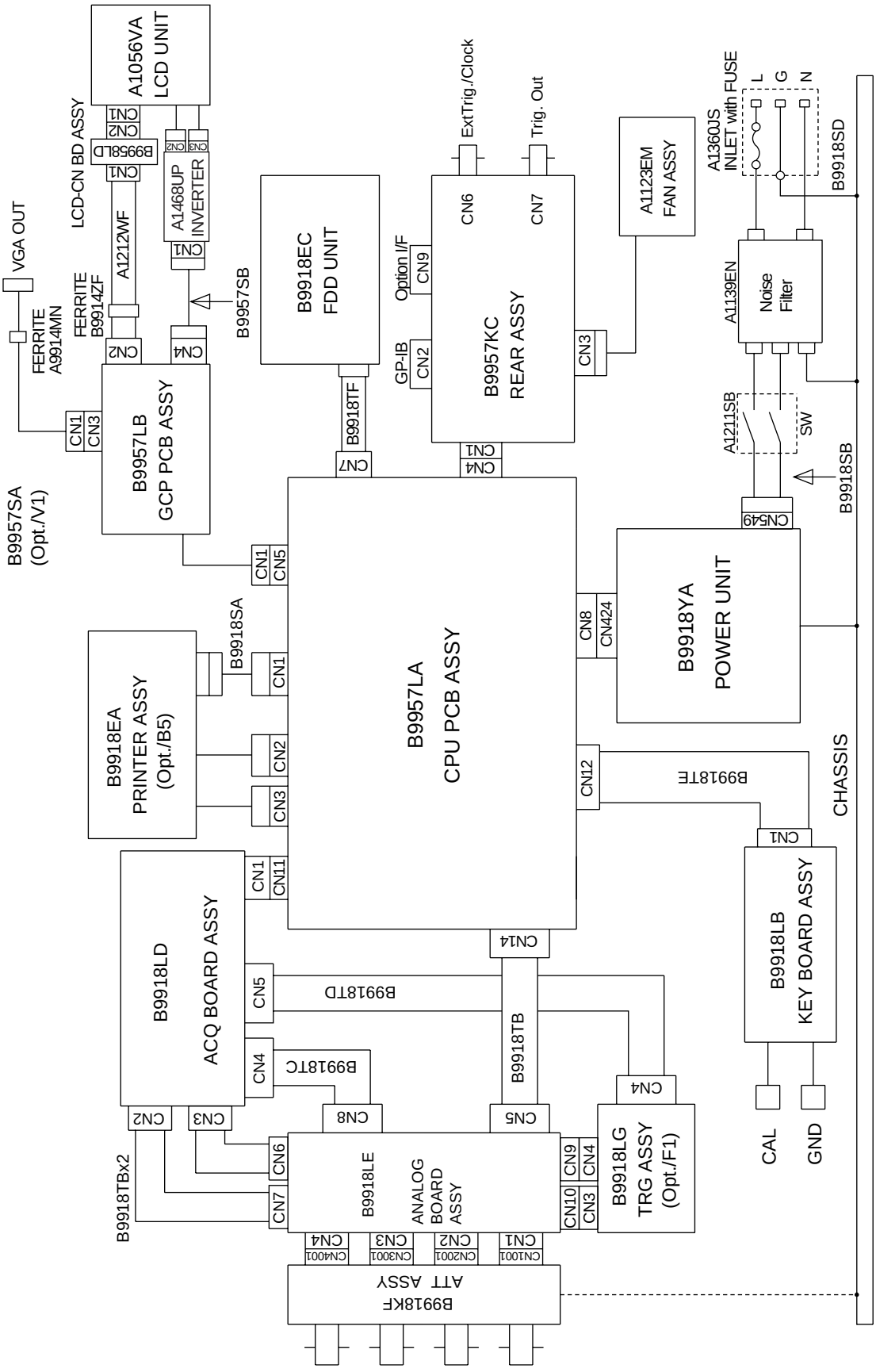


Figure 5.10 Printer Print Patterns

Chapter 6 SCHEMATIC DIAGRAM (for DL1540C/DL1540CL)

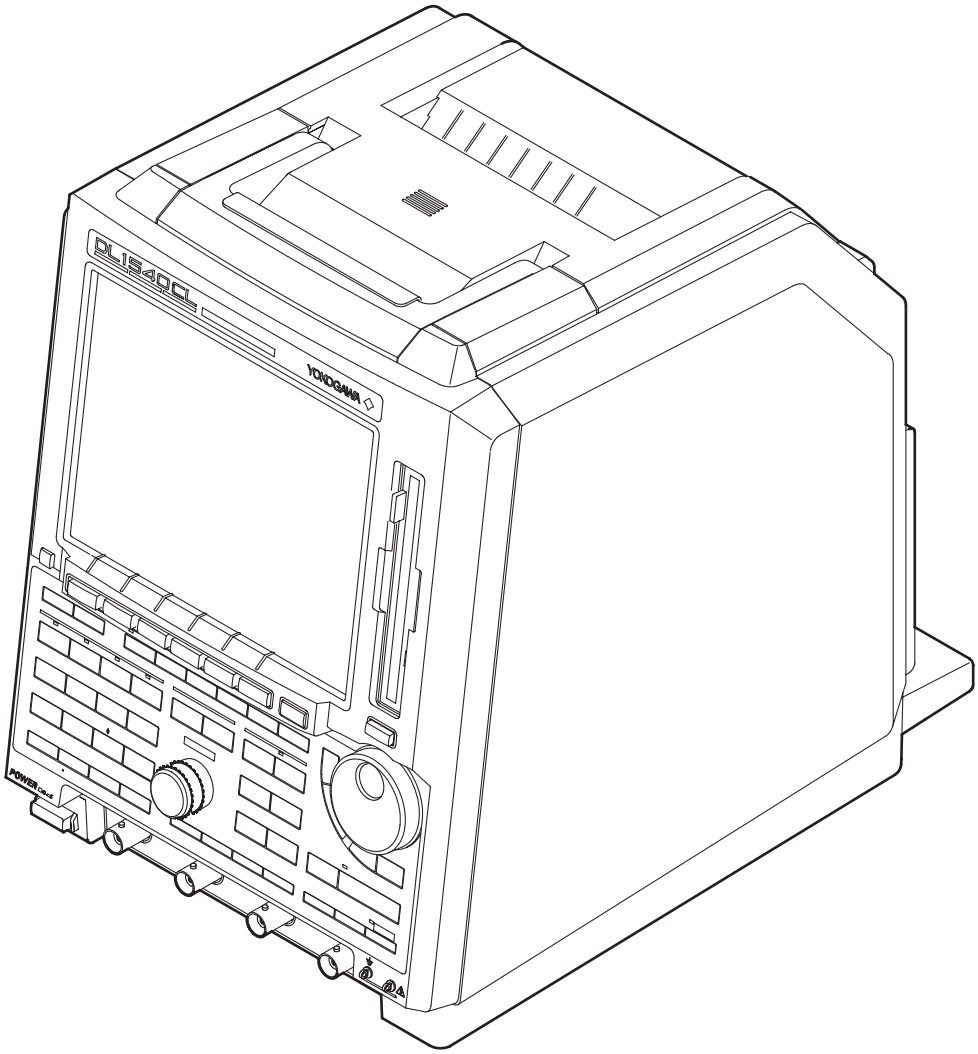


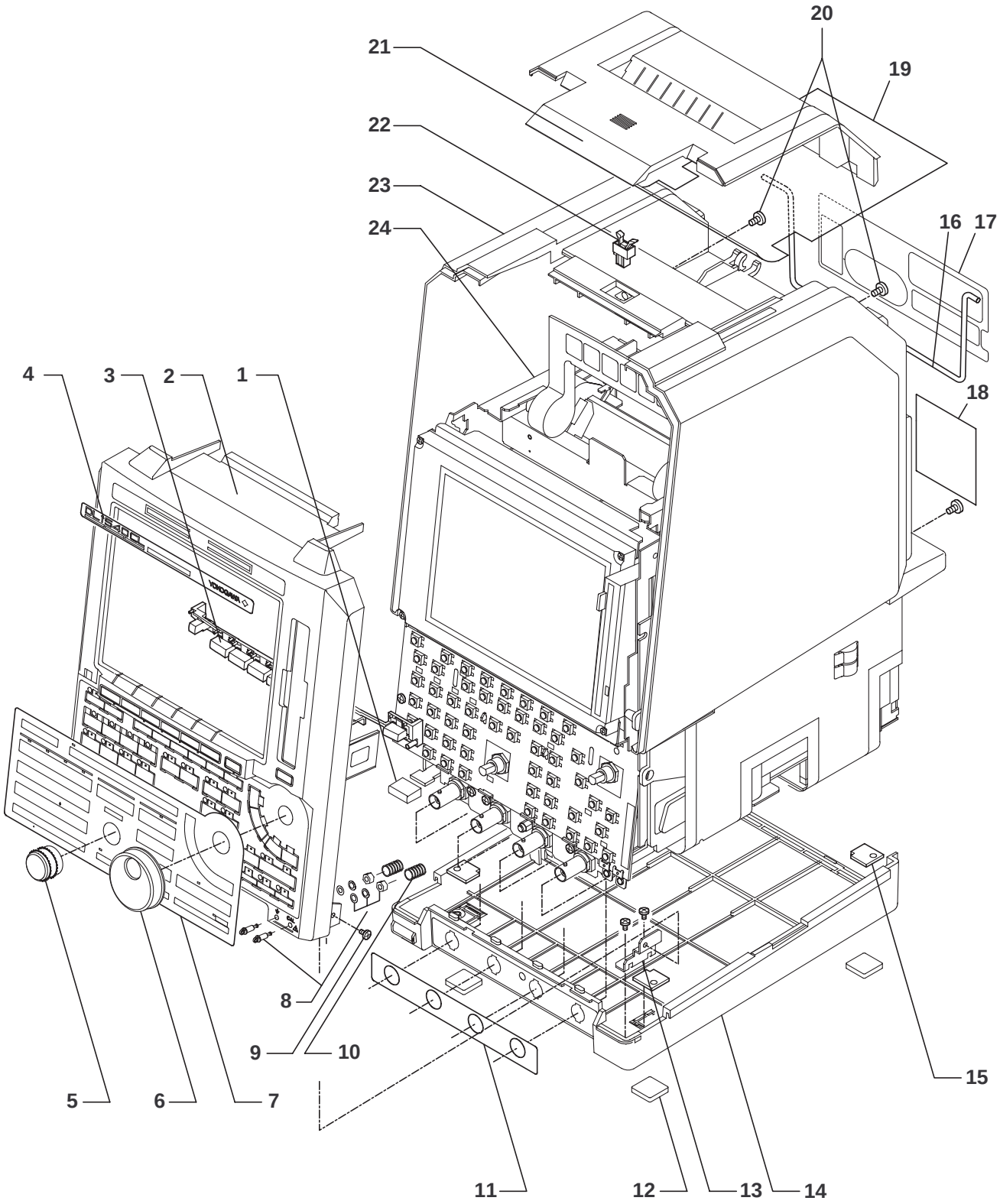

A1056VA
LCD UNIT
LCD-CN BD ASSY
B9958LD
A1212WF
A1468UP
INVERTER
VGA OUT
FERRITE
B9914ZF
FERRITE
A9914MN
B9957SA
(Opt./V1)
B9957LB
GCP PCB ASSY
B9957SB
B9918EC
FDD UNIT
B9918TF
Option I/F
GP-IB
B9957KC
REAR ASSY
ExtTrig./Clock
Trig. Out
A1123EM
FAN ASSY
A1360JS
INLET with FUSE
L
G
N
B9918SD
A1139EN
Noise
Filter
A1211SB
SW
B9918SB
CN549
B9957LA
CPU PCB ASSY
B9918YA
POWER UNIT
B9918SA
B9918EA
PRINTER ASSY
(Opt./B5)
B9918TE
B9918LB
KEY BOARD ASSY
CHASSIS
B9918LD
ACQ BOARD ASSY
B9918TD
B9918TC
B9918TB
B9918LE
ANALOG
BOARD
ASSY
B9918LG
TRG ASSY
(Opt./F1)
B9918TBx2
CAL
GND
B9918KF
ATT ASSY

Chapter 7 CUSTOMER MAINTENANCE PARTS LIST

This chapter contains the Customer Maintenance Parts Lists for ordering parts and location of the parts in the instrument.

7.1 Standard Accessories (for DL1500C Series)




20
21
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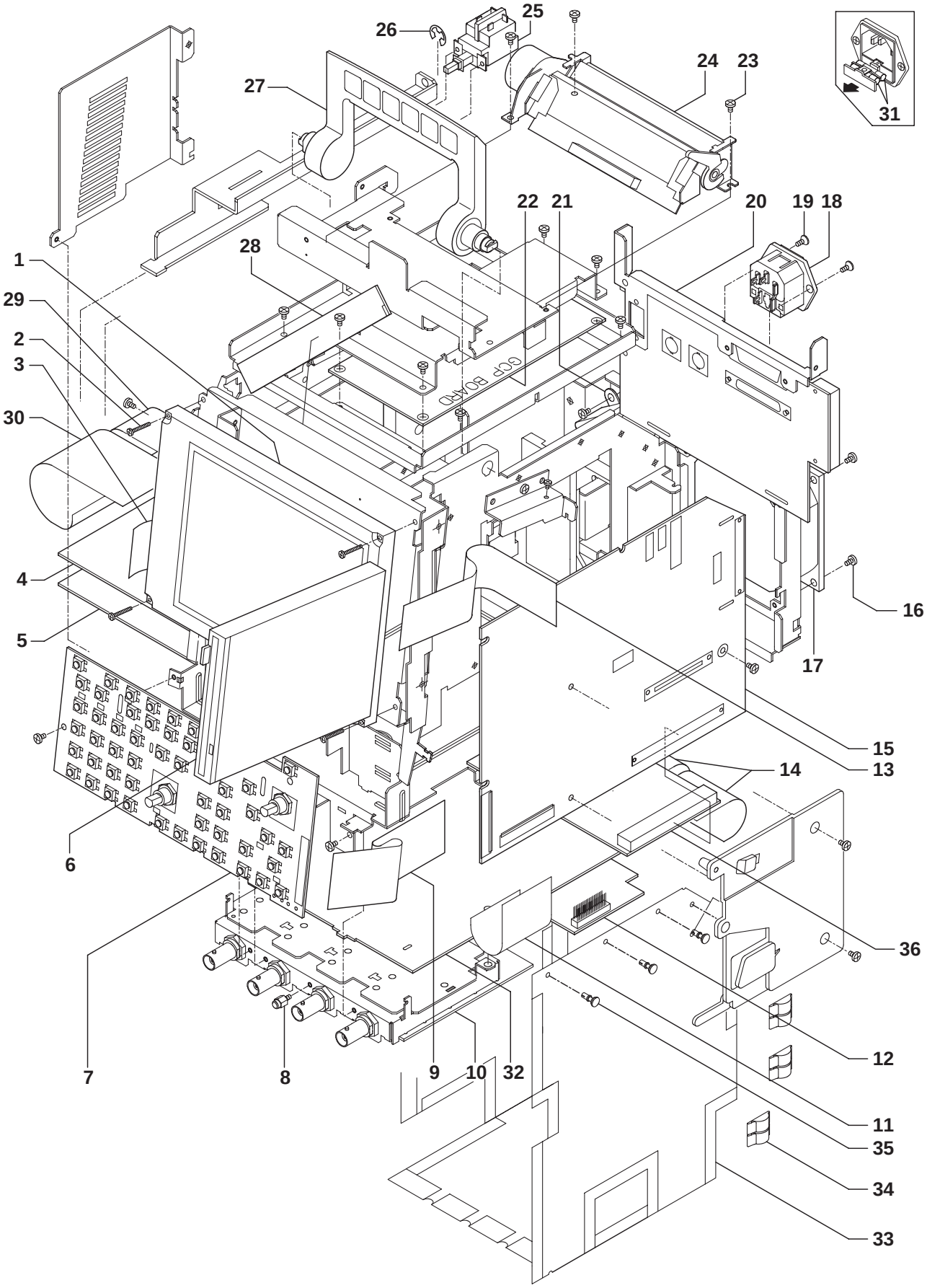
14

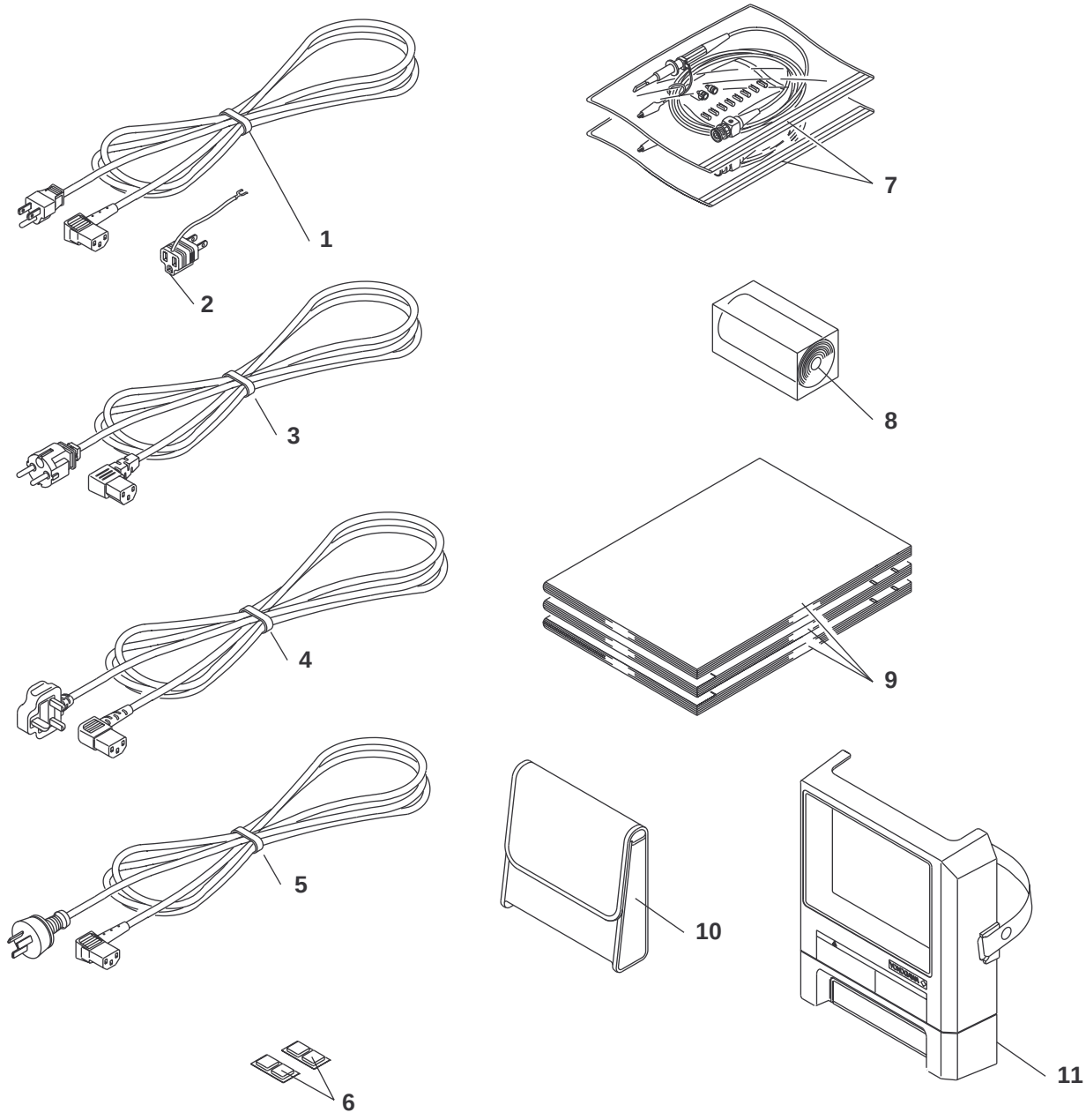
Item	Part No.	Qty	Description
1	A9102ZG	1	Knob
2	B9957DE	1	Front Bezel
3	B9918DL	1	F-Key Assembly
4	B9957CG	1	Sheet (701530) } (select)
	B9957CM	1	Sheet (701540) }
5	A9080ZG	1	Knob
6	A9115ZG	1	Knob
7	B9918CH	1	Sheet
8	A1490JT	2	Terminal
9	Y9306LB	2	B.H.Screw,M3x6
10	B9918CC	2	Spring
11	B9918EP	1	Sheet
12	A9088ZM	2	Stopper (Standard Accessories)(see page 6)
13	B9918BW	1	Bottom Frame
14	B9918EN	1	Bottom Cover
15	B9918BX	4	Bottom Plate
16	B9918CF	1	Support
17	B9957CL	1	Sheet } (select)
	B9957CP	1	Sheet (/V1) }
18	B9918ES	1	Sheet
19	B9918CY	1	Sheet (/B5)
20	Y9408LB	4	B.H.Screw,M4x8
21	B9918DW	1	Printer Cover
22	B9858GB	1	Clamp
23	B9957EM	1	Top Cover
24	-	1	DL1500 Sub Assembly (see page 4)

DL1500C Sub Assembly



Item	Part No.	Qty	Description	
1	A1056VA	1	LCD	
2	Y9204LB	4	Screw	
3	A1212WF	1	Multiconductor	
4	B9918YA	1	Power Unit	
5	B9918LD	1	ACQ Board Assembly (701530)	(select)
	B9918KQ	1	ACQ LONG1 Assembly (701540)	
6	A1092UN	1	Memory System	
7	B9918LB	1	Key Board Assembly	
8	B9918BT	1	Rod	
9	B9918TE	1	Cable	
10	B9918KF	1	ATT Assembly	
11	B9918TB	1	Cable	
12	B9918KG	1	TRG Assembly (/F1)	
13	B9918TF	1	Cable	
14	B9918TB	2	Cable	
15	B9957LA	1	CPU PCB Assembly (701530)	(select)
	B9957KA	1	CPU PCB Assembly (701540)	
16	Y9306LB	4	B.H.Screw,M3x6	
17	A1123EM	1	Fan Assembly	
18	A1360JS	1	Socket and Holder	
19	Y9305EB	2	Screw	
20	B9957KC	1	Rear Assembly	
21	B9918SK	1	Noise Filter Assembly	
22	B9957LB	1	GCP Board Assembly	
23	Y9306LB	3	B.H.Screw,M3x6	
24	A1194UD	1	Printer Assembly (/B5)	(select)
	B9918BQ	1	Blind Plate (not /B5)	
25	A1211SB	1	Push Switch	
26	Y9250ET	1	Retainer E	
27	B9918DS	1	Handle	
28	A1468UP	1	Power Supply	
29	B9918TC	1	Cable	
30	B9918TD	1	Cable (/F1)	
31	A1351EF	2	Fuse	
32	B9918LE	1	Analog Board Assembly	
33	B9918EQ	1	Sheet	
34	B9918EU	6	Spring	
35	B9918ET	12	Rivet	
36	B9918KP	1	Load Assembly (701540)	

Standard Accessories



Item	Part No.	Qty	Description
1	A1006WD	1	Power Supply Code (UL.CSA standard) *1.*2
2	A1253JZ	1	3P-2P Adapter *1
3	A1009WD	1	Power Supply Code (VDE standard) *3
4	A1054WD	1	Power Supply Code (BS standard) *4
5	A1024WD	1	Power Supply Code (SAA standard) *5
6	A9088ZM	2	Stopper
7	700996	2	Probe
	700996	2	Probe (/E1)
8	B9850NX	1	Roll Chart (/B5)
9	-	1	Instruction Manual
10	B9918EZ	1	Soft Case
11	B9957DG	1	Front Cover

Note:
*1 7015□0 - □-M
*2 7015□0 - □-D
*3 7015□0 - □-F
*4 7015□0 - □-Q
*5 7015□0 - □-R